It Takes a Network

How to Scale Up an Afterschool STEM Program

Pendred Noyce, Laura Martin, Jacob Sagrans, & Jan Mokros

Quickly disseminating an innovative, timely afterschool program raises challenges, from recruitment and professional development to assessment, program fidelity, and quality. In this paper, we describe our experience as project developers, trainers, and researchers working with an afterschool network, Imagine Science, to disseminate a middle school club program about epidemic diseases and data. What we learned from working with this network may be useful to others who have created an afterschool science, technology, engineering, and mathematics (STEM) program they hope to spread widely.

At its simplest, scaling up simply means finding ways for a quality educational program to affect significantly more students—increasing both reach and impact (Education Northwest, 2020). Beyond mere counting, a successful scale-up demonstrates fidelity to the program's core principles and leads to improved outcomes for a broad range of students. In out-of-school STEM, scaling typically involves increasing use of a pedagogical approach or a particular curriculum.

Professional development for the frontline staff who work directly with children is crucial to any

PENDRED NOYCE, MD; **LAURA MARTIN**, PhD; **JACOB SAGRANS**, PhD; and **JAN MOKROS**, PhD, are researchers at Tumblehome, Inc., a nonprofit dedicated to inspiring young people in science through the power of story. Tumblehome works with partners to create, pilot, test, and disseminate out-of-school time curriculum materials that combine science, mathematics, and engineering with deliberate attention to developing social and work readiness skills.

scale-up effort. One common strategy is a train-the-trainers model, in which lead trainers prepare a cadre of teacher–leaders or professional developers to present an innovative approach to large numbers of practitioners. While this strategy is cost-effective, it may lead to dilution if fewer practitioners than expected implement the new approach. For example, one study notes that, after a train-the-trainer intervention, one-third of the trained Girl Scout troop leaders reported no changes in their practice (Lingwood & Sorenson, 2014). The authors did not discuss what support local supervisors gave to troop leaders.

Ongoing support may be crucial to realize changes in practice. One approach is to create supportive peer groups. The ACRES program (Afterschool Coaching for Reflective Educators in STEM) offered an intensive, in-place approach to changing pedagogical practice in which small groups gathered in person or online for instruction in strategies, along with discussion, mutual observation, and mentoring (Peterman et al., 2021). Each learning module included six hours of coaching as participants applied the module's principles to their own afterschool setting (Peterman et al., 2021). This cost-effective approach supported pedagogical change in instructors across distances too great to allow repeated in-person training.

A third approach can be found in the Planets project (Clark et al., 2021). This project designed professional development resources as tiered support, addressing afterschool educators' immediate needs, STEM content and practices, pedagogy, and activity extensions. Project leaders found that helping educators understand the basic science of the project facilitated fidelity of implementation of the activities (Clark et al., 2021).

Whatever the approach to professional development, a perennial challenge for scaling is that the impact of staff development may be lost when staff turns over. When new staff members need to learn a new program, the rate at which the program reaches additional young people slows down. Afterschool and summer sites tend to experience a high rate of turnover due to low pay and the fact that many positions are temporary (Education Northwest, 2020). The result is pressure for staff development to be quick and simple. Sites are rarely in a position to invest much money or time in professional development for staff who may be available to work for only one season. Click2Science addressed this problem by offering short, just-in-time online modules to teach specific skills in afterschool science education, such as setting up the room and asking open-ended questions (Fenton et al., 2019). Although there is evidence that use of Click2Science increased program quality, the modules address generic afterschool science skills, not specific curricula (Fenton et al., 2019).

A challenge (as well as an opportunity) in scaling up change is the fact that, in *adopting* a program, sites need to *adapt* the program's educational experiences to their particular environments, including their staffing, schedules, and facilities. A project called Philadelphia Playful Learning Landscapes (Perlman Robinson, 2019) sought to transform varied spaces into learning opportunities for children outside of school. The project identified "scaling building blocks" that contributed to the success of the project. These scaling strategies, which brought in community players from many levels, included cultivating leadership, forging alliances among institutions and nonprofits, sharing data, and encouraging flexibility at sites (Perlman Robinson, 2019).

In examining the role of afterschool programs in STEM education, the Afterschool Alliance (2015) offered a recommendation to "strengthen partnerships between the larger STEM education community and afterschool programs to advance practice and policy" (p. 18). Similarly, the Wallace Foundation (Kauh, 2011) found that strong networks across communities, led by a coordinating body, were key to success. In afterschool STEM, *networks* often refers to the state networks coordinated by TIES (Teaching Institute for Excellence in STEM). In this paper, however, we use *networks* more broadly to refer to any bodies or organizational structures that encourage communication, a sense of membership, commitment to similar goals, coordination, and common learning among service providers. Perlman Robinson (2019) uses the term "landscapes" and Kauh (2011) uses the term "systems" to refer to similar community-based support structures. Relationships between networks and researchers have also been found to support effective programming (Ferinde, 2022). Such approaches support the adoption of new practices in multiple settings with adaptations to existing strategies and plans.

In sum, components of innovative projects that successfully reach scale within the constraints of afterschool settings include a strategy for staff training that takes turnover into account with short, basic training modules; materials and activities that can be adapted to different settings through STEM content, practice, and pedagogy; the availability of support for individual program facilitators; and coordinated support networks across communities that are working toward the same outcomes. Data Detectives Clubs, the program we created and evaluated, addressed these components of successful scaling.

The Program: Data Detectives Clubs

During 2020, we created a program of engaged learning called COVID-Inspired Data Science Education through Epidemiology (CIDSEE) to help middle school youth understand data and learn from COVID-19 and other pandemics. Focusing on the epidemiology of infectious disease and centering on real data, the program included an adventure novel, technology tools, and hands-on activities brought together in a club format called Data Detectives. Because neither data science nor epidemiology is usually taught in schools, we elected to offer the 15-hour curriculum through afterschool programs.

The goals of the CIDSEE project (locally called the Data Detectives program) were to:

1. Increase participants' confidence, interest, knowledge, and skills in using datasets and data tools to address understand pandemics like COVID-19
2. Spark youth interest in the data-driven work of epidemiology and affiliated STEM occupations, including research, modeling, data analysis, and science communication
3. Serve at least 400 underserved youth over three years

Funded by a grant from the National Science Foundation, the Data Detectives Clubs intervention comprised:

- An 11-chapter adventure book that takes youth to different times in history and places in the world where outbreaks and pandemics have occurred
- A 15–20 hour curriculum including reading time, hands-on activities, and discussion
- An 80-page facilitator's guide to understanding the content and conducting the program
- Four to six hours of facilitator training
- Use of special free software including Concord Consortium's CODAP, which allows users to graph the relationships among variables, and NetLogo, which shows contagion patterns in populations with different vaccination rates, population density, and other inputs that users can manipulate
- Access to a Padlet (an app that collects in one place all the links needed for the program), slide decks, and two-minute animations on selected topics and activities
- Hands-on activities ranging from testing samples of liquid for contamination to playing kazoos to follow the up-and-down curves of time-series graphs

[a] Virtual visits by a person working with data in health or another field

[a] Participation by youth and facilitators in surveys and interviews

Scaling issues included how to manage limited staff time and knowledge, how to adapt activities for different sites, and how to encourage contact among peers and community organizations. We sought to address these issues by training facilitators to implement the program. Training sessions, conducted remotely, consisted of review of the facilitator's guide, which outlined lessons and activities; small-group practice with the project software; and discussion of the project's science concepts and of social-emotional topics as they applied to program participants. STEM content and practices, pedagogy, and activity extensions were all part of the training plan. Thanks to periodic check-ins and follow-up training when requested, the trainees, who came from different partner cities, formed a community of practice with the project staff.

The greatest adjustments we made in response to trainee feedback over the course of the project revolved around the use of the CODAP graphing tool. We added hands-on exercises for facilitators to complete before training, spent more time to emphasize CODAP during the training, and created short step-by-step videos highlighting specific CODAP features. Club facilitators could refer to these videos to refresh their knowledge at any point during the program.

As an incentive for afterschool programs to weave together all these elements and persist through data collection, we offered each club a stipend of $1,500, paid at the conclusion of the curriculum unit. Despite this incentive, we found that organizing calendars and communicating expectations and data collection needs club by club, with the goal of reaching at least

400 youth, was a daunting prospect. To make the scaling task manageable, we decided to work with Imagine Science.

The Network: Imagine Science

Launched in 2015 after 18 months of planning, Imagine Science is a collaborative initiative undertaken by four major youth-serving organizations: Boys & Girls Clubs, 4-H, YMCA-USA, and Girls, Inc. Its mission is to build excitement and confidence in young people from low-income communities in pursuing STEM careers. It brings innovative, hands-on STEM programming to the hardest-to-reach youth in cities where all four organizations have a presence. As the network launched, the four Imagine Science partners carefully selected cities or regions for their initial programming. In each candidate location, across six states, Imagine Science's small staff reached out with questions about the community and built ownership among the various youth clubs and afterschool programs. The process of becoming an Imagine Science community partner generally required a year of planning, after which the partner received three years of modest start-up funding. Selection criteria for all Imagine Science partner cities (currently 19) are:

- Each city must have clubs affiliated with at least one of the four major youth-serving organizations.
- The city and each member club need to have at least some STEM work in development.
- Local leaders need to be strong, committed to STEM, and committed to sharing funding and impact data.
- Each partner city must embrace the call for substantial professional development and continual assessment for improvement.
- Each city's sites serve a high proportion of youth challenged by poverty, minority status, or limited English proficiency.
- Programs offered are not drop-in programs; youth are expected to attend continuously over each season.

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Imagine Science did a remarkable job of holding partner communities to these principles. From inception through summer 2021, when it began to implement Data Detectives Clubs, partner cities met the target population criterion: Of the young people served, 58 percent were girls, 89 percent youth of color, and 83 percent youth from low-income households. At the end of each season, clubs surveyed their participating students and many of their instructors using the Common Instrument Suite (Noam et al., 2020). Results were shared at an annual "Harvest Session" attended by one individual from each club in each partner city. Attendees examined data from their own city and from Imagine Science as a whole; then, together, they discussed how to strengthen their offerings. In this way, Imagine Science became a network with shared goals, strategies, and commitments, such as the commitment to continuous program improvement.

For the Data Detectives Clubs, Imagine Science provided primarily logistical support, helping to recruit, screen, troubleshoot, and monitor the partner cities that implemented the program. Problems affecting Imagine Science community sites at baseline, before they implemented Data Detectives Clubs, were similar to those of all afterschool programs. Staffing was a challenge before, during, and after the pandemic. For many curricula and activities, club facilitators had little access to training. Despite close monitoring by Imagine Science staff, in some cities not all institutional partners displayed equal commitment. Plans for sustainability after three years of start-up funding from Imagine Science ran out were sometimes difficult to implement.

Nevertheless, being part of a network meant receiving support and advice from other community sites. The Imagine Science manager was so available to partner city leaders as to sometimes seem ubiquitous. Optional one-hour quarterly whole-network calls allowed partner cities to discuss common issues such as scheduling, staff changes, or attendance. Cross-organization and cross-state friendships originating from the annual Harvest Sessions offered another channel of friendly support; for example, leaders shared strategies for supporting youth in the reading expected in Data Detectives Club. Follow-up discussion groups with club facilitators showed that sharing information among clubs and cities was viewed as a valuable aspect of the project.

How Imagine Science Scaled Up Data Detectives

There is no mandatory curriculum for Imagine Science, but sharing curricula has been one of the most common ways Imagine Science partner cities collaborate. In 2021, partner cities expressed a desire for more training on specific high-quality curricula. The Data Detectives program offered a detailed curriculum accompanied by four to six hours of specific professional development for club facilitators. The project also offered recorded online tutorials on use of the technology tools.

Communication and Coordination

Communication between the partner cities and the Data Detectives program developers came about both through the Imagine Science coordinator and through the group evaluating our training and support for clubs, Strategic Learning Partners for Innovation. Feedback led us to increase professional development time for the technology tools and to create an audiobook version of the book for struggling readers. It also convinced us that partner city leaders did not have the time or clout to schedule their own career visitors, so the development team took on that role.

A strength of local clubs was their ability to adapt the program to children's needs; club facilitators often lived in the communities where they taught. Partner sites varied in their implementation of scheduling, hands-on activities, and discussion topics. For example, in communities that had lost members to the pandemic, facilitators spent extra time discussing the social and emotional effects of COVID. Facilitators also exercised caution—and asked for advice—when discussing and modeling the effect of vaccination on disease spread. Some parents expressed concerns over the vaccine chapter, but none removed their children from the clubs. The enthusiasm and dedication of the program facilitators more than made up for any gaps in their science preparation.

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Not every Imagine Science city took on Data Detectives. Based on her familiarity with the organizations and their leaders, the Imagine Science program coordinator helped identify cities that had the capacity to undertake a complex program. The coordinator publicized the program, selected cities, coordinated with us to schedule professional development, and monitored the cities' progress through frequent phone calls. These regular contacts served as a way of monitoring adherence to the curriculum. The curriculum, however, was flexible: Activities related to the book chapter topics could be offered in different order or skipped if clubs were facing limited time. Time with the computer modules and their extensions was also flexible. The coordinator gathered demographic and attendance data from the partner cities, helped to coordinate the career visits, and made certain that partner cities administered and turned in the end-of-program surveys. As a result of her diligence and the enthusiasm of the partner cities, Data Detectives reached approximately 1,000 youth, more than twice our goal, in the project's first three years.

As we reached out to new cities, those that decided not to participate cited a lack of background among staff, a younger youth population than was optimal, or lack of an administrator to oversee the program.

Training

Our training workshops connected us with facilitators over the life of the project and informed our ability to grow the number of partner cities involved. We consistently took comments and critiques into consideration as we revised the workshop for delivery to new partners.

Feedback on the training began with a survey of all participants and continued with focus groups and interviews with selected facilitators. In the survey on the first year's workshops, 12 of 17 respondents rated the training experience as "very effective." Similarly, most participants reported the workshop made them feel excited about running the Data Detectives Club. Areas that received lower effectiveness ratings were preparing youth to make career connections, additional technology skills needed for implementation, and preparing the program for implementation with youth. These considerations were incorporated into subsequent training sessions.

A year later, a focus group of four facilitators who were also school STEM teachers discussed the potential for using the curriculum in schools. The teachers liked the program very much and discussed how it might be integrated into formal middle school instruction. They noted that finding space in the school curriculum for new units is difficult. However, they agreed that, where teachers had flexibility to, for instance, implement interdisciplinary studies, project-based learning, integrated STEM classes, or structured units, Data Detectives would be an asset. They felt the club approach would be appropriate for beginning teachers working in interdisciplinary school programs, such as those that combine science, mathematics, and reading.

Finally, in 2023, we interviewed seven new facilitators. All said that they loved the training. They found the facilitator's guide particularly useful; one said that it was "awesomely organized." The interviewees reported that they felt supported by the materials and the training. Over time, the training became an important factor in extending the reach of the project because it responded to facilitators' needs, allowing more partner cities to successfully deliver the program.

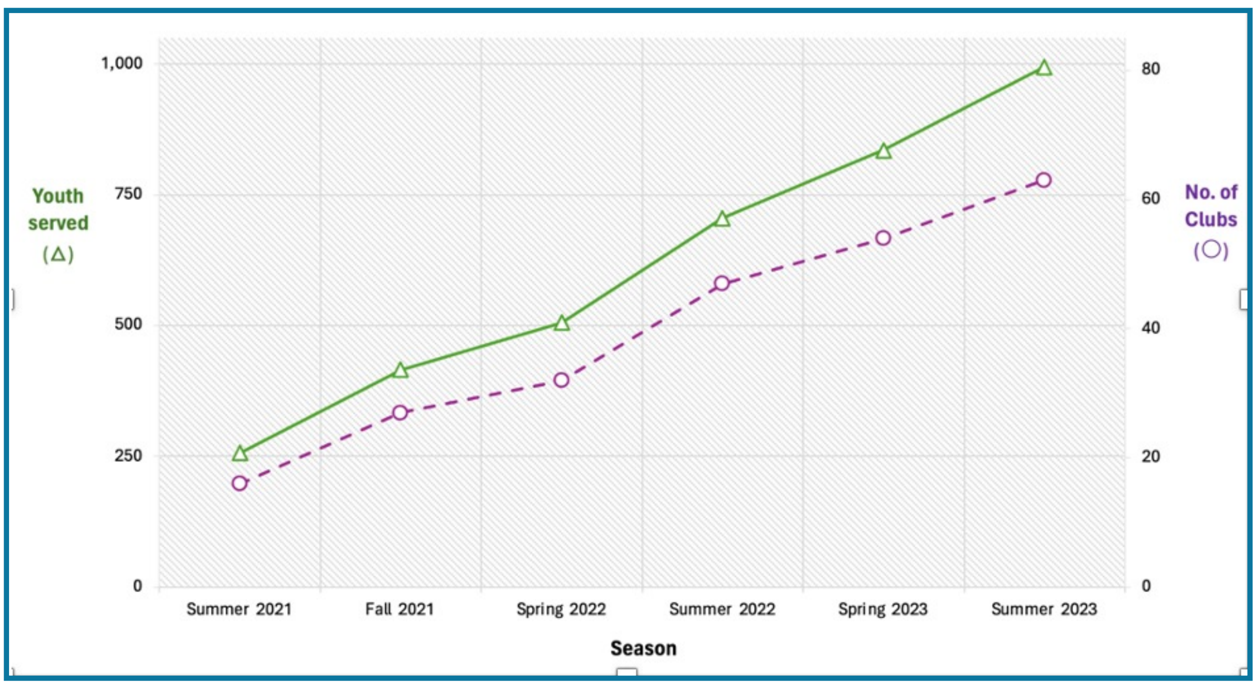
Figure 1 shows the growth of Data Detectives in terms both of young people served and of participating clubs. The number of Imagine Science partner cities implementing the program increased from six in summer 2021 to 19 in summer 2023.

Results of the Collaboration

The emphasis Imagine Science placed on evidence-based practice, data collection, and sharing through annual Harvest Sessions created a culture of openness and curiosity about data. More concretely, Imagine Science staff played an invaluable role in facilitating data collection, with repeated reminders to partner cities about scheduling surveys and reporting demographic and attendance data. This persistence allowed our assessment partner, Partnerships in Education and Resilience (PEAR), to derive robust findings from the intervention.

PEAR administered the Common Instrument Suite (Noam et al., 2020), a validated self-rating tool for youth in afterschool programs. The survey invites participants to rate how their attitudes have changed from the beginning of the program to the end with respect to STEM engagement, identity, and

Figure 1. Data Detective Scale-up: Clubs and Youth



career interest. To these validated scales, we added 14 customized questions to study engagement, identity, and career interest and general interest in data science and epidemiology topics, as well as attitudes toward reading and understanding of the community impact of data science. The surveys were administered to 647 youth participating in the program between summer 2021 and summer 2023.

Results showed that youth demonstrated statistically significant positive changes on all three scales of the PEAR-validated survey. PEAR compared the Data Detectives data to its national convenience sample of all 7,377 elementary and middle school youth who took the retrospective pre-post Common Instrument Suite (Little et al., 2020) through summer 2020. Data Detectives participants had higher growth rates than the comparison group on all three scales, as shown in Figure 2. There were no significant differences among participants of different ages, grades, genders, races, or ethnicities; length of participation also did not correlate with growth rates. Data Detectives participants also showed positive changes on the 14 custom survey items, including questions about data science identity, epidemiology career interest, perceptions of community impact of science, science story engagement, and the extent to which reading science stories prompted curiosity about science. We detailed research on students' learning specifically about time-series data in a separate recently submitted paper (Mokros et al., 2024).

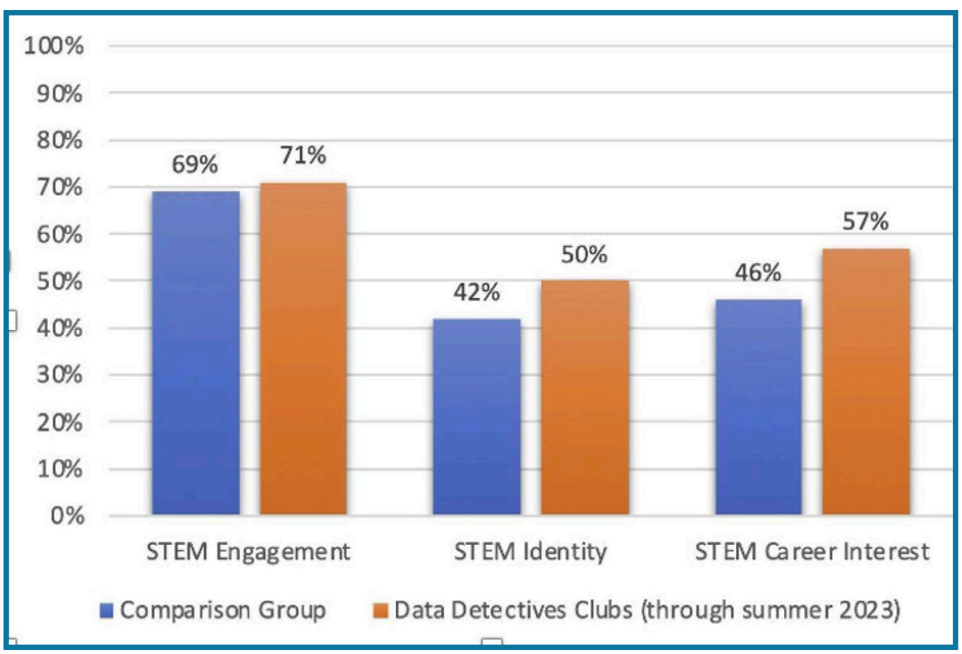
During the scale-up, we occasionally fielded expressions of interest from afterschool clubs and programs that were not part of the Imagine Science network. We tried to be responsive to requests, providing both materials and training. However, we found that unaffiliated sites, even when they had science specialists on staff, had trouble achieving consistent youth attendance, completing the program in the face of competing priorities, and providing data. Through spring 2024, 12 unaffiliated clubs completed the curriculum, and three were cancelled. In contrast, Imagine Science clubs had 56 completions with only one cancellation. Without the support of a network of peers and the Imagine Science program coordinator, program staff tended to revert to their usual afterschool programming.

For more information on Data Detectives Clubs, visit https://tumblehome.org/.

The Importance of Afterschool Networks to Curriculum Scale-up

In 2020 and 2021, with schools closed and out-of-school time programs scrambling to meet children's needs, we felt a special urgency to pilot, improve, and disseminate our Data Detectives curriculum. Our technological and scientific partners helped us continually update program content. However, it was our work with Imagine Science that allowed us to meet and exceed our scale-up goals. Perhaps the most important factor was that, even before implementing this new curriculum, members of the network had already committed to the idea of high-quality science programming and to common principles of professional

Figure 2. Participant Growth in STEM Engagement, Identity, and Career Interest



development, assessment, data gathering, and continuous improvement.

The process of applying to implement Data Detectives required partner cities to commit to a set of expectations for staff attendance at training, for completion of the program, and for data collection. The enthusiasm of administrators and their support for front-line facilitators helped overcome issues such as managing schedule conflicts, supporting students for whom reading was a challenge, or handling the diversity of students' skills. None of the progress outlined in this article could have happened without the organizational structure of the Imagine Science network and the close two-way communication between the network coordinator and individual partner cities. Working through a network that shared common goals and commitments allowed the program developers to focus on improving the offering while the network attended to encouraging partner cities to implement the curriculum with fidelity even as they made necessary adaptations.

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