CITIZEN SCIENCE:
THEORY AND PRACTICE

Embedding Citizen Science in Libraries: A SciStarter and Arizona State University Case Study of Adoption, Scaling, and Sustaining Participation

COLLECTION:
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TARA COX
DARLENE CAVALIER
DERON ASH
EMMA GILES
CAROLINE NICKERSON

*Author affiliations can be found in the back matter of this article

ABSTRACT

Public access to citizen science remains uneven, with many communities underrepresented in participatory research opportunities. Public libraries, as trusted community institutions, hold the potential to bridge these gaps by serving as hubs for lifelong learning and civic engagement. This case study examines the strategies, theoretical grounding, and outcomes that supported the adoption, scaling, and sustainability of Libraries as Community Hubs for Citizen Science, a multi-phase initiative led by Arizona State University and SciStarter. Designed to embed citizen science innovations within public library systems, the initiative progressed through three phases—an Arizona pilot (2017–2019), a scale-up pilot (2020–2021), and an ongoing national expansion (2021–2024+)—that collectively tested, refined, and demonstrated a replicable model for institutionalizing participatory science in libraries.

Drawing on mixed-method evaluation data and informed by a theory of change based in educational scaling (Coburn 2003), adult learning (Knowles et al. 2015), and the role of libraries as facilitator organizations and conduits for lifelong learning (Falk and Dierking 2010; Lankes 2016), the analysis identifies key mechanisms that supported adoption and sustained engagement of citizen science in libraries. These included staff capacity-building, collaboration with local communities, and national outreach through professional learning communities and library networks.

Findings demonstrate that libraries can serve as durable civic infrastructures for public participation in science—expanding equitable access, fostering ongoing engagement in citizen science, and connecting communities to research. We conclude by distilling essential elements and transferable lessons for other GLAM (Galleries, Libraries, Archives, and Museums) institutions, both in the United States (US) and globally, offering a conceptual framework for embedding participatory science into GLAM organizational practices to advance long-term public engagement with research.

CORRESPONDING AUTHOR:
Tara Cox
SciStarter, US
taralalovic@gmail.com

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INTRODUCTION

Public participation in science has evolved rapidly over the past two decades, driven by growing recognition that complex societal challenges such as biodiversity loss, climate change, and public health cannot be addressed by scientific expertise alone, but require collaboration between scientists and the broader public (Bonney et al. 2009; Shirk et al. 2012; Pandya 2012). Increasingly, these challenges are understood as "wicked problems": issues characterized by uncertainty, interdependence, and the need for coordinated action across domains, sectors, and communities (Hodgkinson et al. 2022). Addressing such problems requires not only new scientific knowledge, but also social innovations—new models and practices that meet social needs while strengthening society's capacity to act collectively (Murray et al. 2010; Mulgan et al. 2007).

Citizen science provides mechanisms for engaging the public in confronting such problems by enabling individuals to contribute to data collection, analysis, and problem-solving, in partnership with researchers (Haklay 2013; Hecker et al. 2018). Beyond expanding research capacity, citizen science can foster collective learning, civic engagement, and new relationships between scientific institutions and communities (Cavalier and Kennedy 2016). However, realizing this potential depends on the presence of institutional structures that can translate participatory ideals into sustained, locally meaningful practice.

Despite the proliferation of projects and platforms, inequities in access and participation persist. Engagement opportunities often remain concentrated among highly educated, urban, and digitally connected populations (Pandya 2012; Soleri et al. 2016; Dawson 2018). These gaps mirror broader inequities in informal science learning and digital access more broadly (National Academies of Sciences, Engineering, and Medicine [NASEM] 2015). As a result, the data reflect these patterns of participation, which can in turn introduce systematic bias (Carlen et al. 2024). Addressing these disparities requires trusted, community-based institutions capable of bridging scientific and civic spheres (Carballo-Cárdenas and Tobi 2016; Ballard et al. 2017) and possessing the capacity to develop and sustain new participation models, partnerships, and practices that respond to locally defined needs.

The Institute of Museum and Library Services (IMLS) identifies more than 9,000 unique public library administrative systems in the U.S., which operate a combined total of over 17,000 individual locations (IMLS, 2023). As free, trusted civic spaces deeply embedded in daily life, libraries have long supported informal and lifelong learning (Oldenburg 1999; Falk and Dierking 2010; Hildreth 2012). Increasingly, libraries are recognized not only as repositories of information but as *facilitator organizations*—intermediary institutions that connect people, ideas, and resources in pursuit of community-defined goals and civic participation (Kranich 2019; Lankes 2016; Widdersheim and Koizumi 2016). In this role, libraries are positioned to support social innovation and citizen science. Scholarship shows that by hosting participatory research initiatives, libraries transform patrons into co-creators of knowledge while strengthening community capacity and democratic engagement (Cigarini et al. 2021; Mumelaš and Martek 2024). Framed within social innovation theory, these efforts reposition libraries as local innovation intermediaries that generate public value by connecting community priorities with scientific inquiry (Desmarchelier 2024; Rabe 2024).

Building on this premise, Arizona State University (ASU) and SciStarter launched the Libraries as Community Hubs for Citizen Science initiative in 2017 to explore libraries' potential as facilitators of citizen science engagement. Over successive phases, the project scaled from a local pilot in Arizona to a national network of hundreds of libraries. Its theory of change positions libraries as hubs for citizen science–focused social innovation, highlighting how institutional capacity-building, professional development, and partnership cultivation work together to support increased and sustained public participation in science.

The initiative sought to address known barriers to participation—limited awareness of opportunities (Lewandowski et al. 2017), restricted access to tools and technologies (Hobbs and White 2012), the isolating nature of participation (Eveleigh et al. 2014; Rotman et al. 2014), and lack of local relevance or institutional support (Pandya 2012; Soleri et al. 2016). It also responded to the intersecting needs of three key audiences: libraries seeking meaningful, customizable STEM programming aligned with their capacity; community members looking for accessible, short-term citizen science experiences and low-cost tools; and scientists requiring mechanisms to recruit, train, and retain volunteers. SciStarter, a global online hub for citizen science, served as the connective platform, enabling libraries to convene groups and anchor citizen science within community life.

Herein, we examine how the initiative's design, theoretical grounding, and implementation strategies supported the adoption, scaling, and sustainability of libraries as community hubs for citizen science. Drawing on mixed-method evaluation data, the analysis integrates frameworks from educational scaling (Coburn 2003), adult learning and communities of practice (Wenger 1998; Knowles et al. 2015), and systems change (Kania and Kramer 2011) to interpret the initiative's evolution. The discussion considers implications for other GLAM

institutions (Galleries, Libraries, Archives, and Museums) seeking to embed participatory science within their infrastructures.

While this case study focuses on public libraries in the United States (US), libraries worldwide are increasingly recognized as promising institutional sites for citizen science. According to the International Federation of Library Associations and Institutions, there are more than two million libraries worldwide, including public, academic, school, and other types of libraries. Moreover, there is a growing body of evidence documenting libraries' roles in convening communities, mediating access to scientific tools and data, and supporting participatory inquiry across diverse cultural contexts (Cigarini et al. 2022; Kloetzer et al. 2021). Recent syntheses further suggest that libraries globally face similar opportunities and constraints—including staff capacity, institutional positioning, and sustainability—when embedding citizen science into practice (Mumelaš et al. 2025). By situating the US-based initiative within this broader international landscape, this study contributes insights relevant to libraries and GLAM institutions globally.

CASE DESCRIPTION: OVERVIEW OF THE LIBRARIES AS COMMUNITY HUBS FOR CITIZEN SCIENCE INITIATIVE

The Libraries as Community Hubs for Citizen Science initiative unfolded over three iterative phases between 2017 and 2024, each designed to test, refine, and scale a model for positioning libraries as trusted intermediaries for citizen science engagement. Guided by a theory of change linking institutional capacity-building, professional development, and partnership cultivation to increase public participation in science, the project evolved from a localized pilot in Arizona to a nationwide network of more than 900 libraries.

Each phase built intentionally upon the lessons of the previous one. Phase I explored feasibility through a small-scale pilot in six Arizona libraries, focusing on co-design, community alignment, and proof of concept. Phase II expanded statewide through a mini-grant model that supported broader adoption, local adaptation, and translation of materials. Phase III extended the model nationally, integrating frameworks of educational and equitable scaling (Coburn 2003; Cox et al. 2024) and adult learning (Knowles et al. 2015) to guide professional development and network sustainability.

The following section outlines the activities and implementation strategies across each phase, illustrating how the initiative's design principles were applied and adapted in diverse contexts. Evaluation findings and key lessons learned are presented in subsequent sections.

PHASE I: ARIZONA PILOT

The initial phase of the Libraries as Community Hubs for Citizen Science initiative (2017–2019) focused on testing the feasibility of positioning public libraries as intermediaries between scientists and communities. The pilot explored whether libraries could effectively introduce citizen science to their patrons, facilitate participation, and build local capacity for sustained engagement. To do so, the project team partnered with six libraries across the greater Phoenix area, intentionally selecting a mix of urban and rural locations that served diverse populations—including youth, families, and older adults—with varying levels of experience in STEM programming. Participating libraries were chosen based on both their community reach and their expressed interest in experimenting with citizen science programming:

1. Maricopa County Library District, Southeast Regional
2. Maricopa County Library District, White Tan
3. Mesa Public Library, Main Library
4. Pinal County Library District, Apache Junction
5. Scottsdale Public Library, Appaloosa
6. Scottsdale Public Library, Civic Center

The pilot was grounded in a participatory design process that brought together library staff, community members, and scientists to co-create approaches for integrating citizen science into library services. This collaborative process revealed that libraries were not only capable of supporting citizen science learning but uniquely positioned to circulate citizen science kits containing specialized tools that enabled patrons to participate directly in real-world research projects. Co-design workshops identified three critical conditions for success: (1) kits must be simple to use and easy to circulate through standard library lending systems; (2) projects must balance scientific rigor with accessibility for non-specialist audiences; and (3) resources should connect local interests to broader national research efforts.

To guide program refinement, evaluators from Arizona State University's Office of Evaluation and Educational Effectiveness conducted a successes, weaknesses, opportunities, and threats (SWOT) analysis with library staff and expert advisors to map existing capacities, anticipated barriers, and needed supports. Concurrently, community dialogues at each library site surfaced local priorities and assets, revealing strong public interest in projects related to public health (air and water quality), environmental stewardship (biodiversity and gardening), and astronomy.

KIT NAME	CITIZEN SCIENCE PROJECT	TOOLS
Measuring Light in the Night	Measure light pollution using simple sky observations and light meters.	Light meter
Zombee Hunting	Track the spread of parasitic "zombie flies" affecting honeybees.	Fly trap
Explore Biodiversity	Document biodiversity through photography and digital submissions on iNaturalist.	Clip on lenses
Stream Mapping	Monitor stream location and temperature to assess water flow.	Thermometer
Monitor Air Quality	Measure particulate matter and document environmental observations.	AirBeam monitor

Table 1 Pilot citizen science kits.

Building on these insights, the project team developed five loanable citizen science kits (Table 1), each containing low-cost scientific instruments, step-by-step guides, and links to SciStarter.org for project registration and data submission. The selected projects reflected both community interests and national research priorities.

Deployment of these kits across six libraries tested the model's capacity to support community-based citizen science and provided data on patterns of kit use, participant learning, and program sustainability. Specifically, Phase I aimed to: (1) evaluate how libraries could facilitate access to tools and projects; (2) understand how patrons engaged with and learned from the kits; (3) identify the program's impacts on knowledge, confidence, and participation; and (4) determine which components—tools, projects, resources, or processes—were most effective in supporting engagement.

PHASE II: STATEWIDE EXPANSION

Following Phase I refinements, the Arizona State Library administered mini-grants (~$3,000–$4,000) to enable broader adoption across Arizona libraries. These mini-grants were designed to underwrite local kit acquisition, promotional campaigns, or staff time for programming and thus reduce the upfront financial barrier for smaller libraries. The supplemental narrative documents that grant cycles generated additional library involvement, including participation by Pima County libraries and the production of Spanish-language kit materials in response to local demand. The grants functioned as a lever for statewide diffusion by providing opportunities for libraries of all sizes and budgets to participate, and as a model for other jurisdictions seeking to subsidize local adoption.

PHASE III: NATIONAL SCALE-UP

The third phase – Scaling, Supporting, and Sustaining Libraries as Community Hubs for Citizen Science (SSSL) – focused on national scale-up of the program model through the intertwined lenses of educational scaling (Coburn 2003), equitable scaling in informal STEM programs (Cox et al. 2024), and adult learning and professional capacity-building (Knowles et al. 2015). These frameworks collectively informed both the design and implementation of activities, positioning library staff as adult learners, co-creators, and local agents of social innovation within a distributed system of practice.

Conceptual framing and implementation

Following Coburn's (2003) multidimensional model, scaling was understood not only as numerical expansion but as a deepening process characterized by spread, depth, sustainability, and shift in ownership. Cox et al. (2024) extended this framework by emphasizing *equitable scaling*: the need for adaptation to local contexts, distributed leadership, and responsiveness to community voice. Meanwhile, Knowles' principles of adult learning guided the capacity-building approach—recognizing library staff as self-directed, experience-based learners who value relevance, immediate applicability, and collaboration. Together, these perspectives framed scaling as both a pedagogical and an organizational process (Table 2).

Activities and outcomes

From September 2021 to April 2022, ten libraries were selected to receive $1,600 mini-grants to pilot citizen science kits co-designed with their communities. The application process, which attracted 61 submissions from 29 states, demonstrated national demand and readiness for engagement. Participants reported increased staff confidence, improved integration of citizen science into programming, and stronger community partnerships—outcomes consistent with Knowles' emphasis on empowerment and relevance as drivers of adult learning.

The ten expansion libraries were:

1. Arkansas River Valley Regional Library System (AR)
2. Augusta-Richmond County Library (GA),
3. Bartholomew County Public Library (IN)
4. Everett Public Library (WA)
5. Framingham Public Library (MA)
6. ImagineIF Libraries (MT)
7. LaSalle Public Library (IL)
8. Lee County Library (NC)
9. Margaret R. Grundy Memorial Library (PA)
10. Show Low Public Library (AZ)

FRAMING	IMPLEMENTATION
Spread and access (Coburn 2003)	The initiative expanded from six Arizona libraries (2017–2019) to more than 900 libraries across 49 states (2021–2024). This expansion was facilitated by open-access digital resources, replicable program models, and national partnerships with the American Library Association (ALA), Association for Rural and Small Libraries (ARSL), STAR Net, Night Sky Network, Girl Scouts, and others. However, aligning with Cox et al.'s equity-centered scaling framework, dissemination was intentionally adaptive rather than prescriptive. Toolkits and templates were designed for contextual modification, enabling libraries to localize projects, integrate translated materials, and highlight regionally relevant issues such as pollinator health or water quality.
Depth of learning and practice (Knowles et al. 2015)	To cultivate depth, the initiative invested in professional learning experiences grounded in adult learning theory. Activities included self-paced online training modules ("Foundations of Citizen Science" and "Libraries as Community Hubs for Citizen Science"), monthly community-of-practice calls, and a professional development webinar series attended by more than 2,000 participants. These opportunities reflected Knowles' assumptions that adult learners are motivated by internal goals, learn best through problem-centered approaches, and build understanding through reflection and peer exchange. Webinars, for example, were structured around real challenges (e.g., integrating citizen science into summer reading or managing kit circulation systems) and featured librarian-led case examples to support situated learning. This approach deepened both conceptual understanding and the integration of citizen science into library operations.
Shift in ownership and local agency (Coburn 2003; Cox 2024)	A significant evolution from earlier phases reflected Coburn's shift in ownership. Whereas ASU and SciStarter had previously produced and distributed standardized kits, Phase III transitioned toward library-led kit creation and adaptation. Using SciStarter's open "kit-building guides," participating libraries independently sourced materials, selected regionally relevant projects, and collaborated with community partners such as 4-H clubs, Girl Scouts, and local astronomy groups to customize kits to member needs. This shift distributed leadership, cultivated local ownership, and reinforced Cox et al.'s call for shared power in equitable scaling. Libraries became co-designers and implementers rather than recipients—illustrating a maturation of practice from adoption to institutional embedding.
Sustainability and systems integration (Coburn 2003)	Sustainability was conceptualized as both institutional and networked. The project embedded citizen science within existing library infrastructures —circulation systems, programming calendars, and statewide networks —ensuring persistence beyond the grant period. Drawing on adult learning literature that links sustained engagement to ongoing reflection and community support, the initiative fostered continuity through the Citizen and Community Science Library Network, which grew to more than 1,200 members across 900 organizations. Peer mentoring, open educational resources, and cross-network partnerships provided the conditions for continuous learning and collective adaptation, key markers of long-term sustainability within Coburn's framework.

Table 2 Conceptual frameworks mapped onto implementation activities.

Beyond this expansion, the initiative's reach extended to libraries across the country. Libraries were not offered financial incentives as in previous phases, but were offered support to establish programming and kits through a national community of practice and professional development infrastructure that included several elements:

- Citizen and Community Science Library Network: As of October 2025, the network has over 1,200 members across 900 organizations in 49 states.
- Libraries as Community Hubs for Citizen Science training module: As of October 2025, completed by 439 participants.
- Professional Development Webinar Series: Between September 2021 and December 2024, the series yielded 2,000 registrants across 15 sessions.
- Citizen Science Kit Guides: As of October 2025, the guides were downloaded 5,472 times.
- Library pages on SciStarter: As of October 2025, webpages dedicated to library resources and professional development were viewed 324,153 times.

Together, these activities reflected a learning ecosystem that connected local action with national infrastructure—illustrating spread through networks, depth through professional learning, ownership through co-design, and sustainability through institutional embedding.

THEORY OF CHANGE

The Libraries as Community Hubs for Citizen Science initiative developed its theory of change during Phase III to articulate how the program's strategies contribute to adoption, scaling, and sustainability across the national library network, framing this work as a process of social innovation, in which new practices, relationships, and forms of participation are developed through collective action, local adaptation, and shared ownership (Murray et al. 2010; Mulgan et al. 2007).

This framework was grounded in three complementary bodies of literature: (1) Malcolm Knowles' principles for adult learning, which emphasize self-directed, experience-based, and relevant learning, as essential for professional capacity building; (2) Cynthia Coburn's (2003) dimensions of scaling educational innovations, which define scale not only as numerical growth but as encompassing depth of practice, spread of innovation, shift in ownership, and

institutionalization of change; and (3) Guidelines for Equitable Scaling Informal STEM Programs (Cox et al. 2024), which highlight the need to adapt models across diverse contexts while maintaining attention to inclusion, local relevance, and shared ownership.

These frameworks collectively informed the development of a theory of change (Figure 1) that guided Phase III design, implementation, and evaluation. The theory proposed that when library staff engage in meaningful professional learning (Knowles), participate in communities of practice that enable peer exchange and adaptation (Coburn), and are supported to customize programs to their local contexts (Cox et al.), libraries can become durable community hubs for citizen science. For the purposes of this theory of change, any library staff member who participates in initiative activities—whether completing self-guided trainings, attending webinars, contributing to a citizen science project, or engaging in other related efforts—is considered a member of the network.

As visualized in Figure 1, The Theory of Change for Libraries as Community Hubs for Citizen Science includes:

- Inputs combined digital infrastructure (SciStarter), research and evaluation expertise (ASU), national partnerships, and community assets such as library spaces and public trust.
- Core activities operationalized adult learning and scaling principles through professional development, co-design, and networked community building
- Outputs included trained staff, active citizen science programs, and increased visibility of libraries as science engagement intermediaries.
- Short-term outcomes (Year 1) focused on enhancing library staff confidence and competence to lead citizen science programs (Knowles' learning principles).
- Medium-term outcomes (Years 2–5) reflected diffusion of practice and shared ownership among libraries (Coburn's spread and ownership).
- Long-term outcomes (Years 5–10) envisioned systemic change: institutionalization of citizen science within library systems and broader public participation in research (Coburn's institutionalization; Cox et al.'s equity-centered sustainability).

This theory of change also served as an evaluation framework, specifying indicators for capacity, diffusion, equity, and institutionalization to be measured in the national expansion phase. Indicators for short-term and medium-term outcomes are described below.

EVALUATION

The evaluation approach evolved alongside the program itself. Phase I and II focused on testing feasibility and documenting emergent outcomes, while Phase III was explicitly guided by the conceptual frameworks and

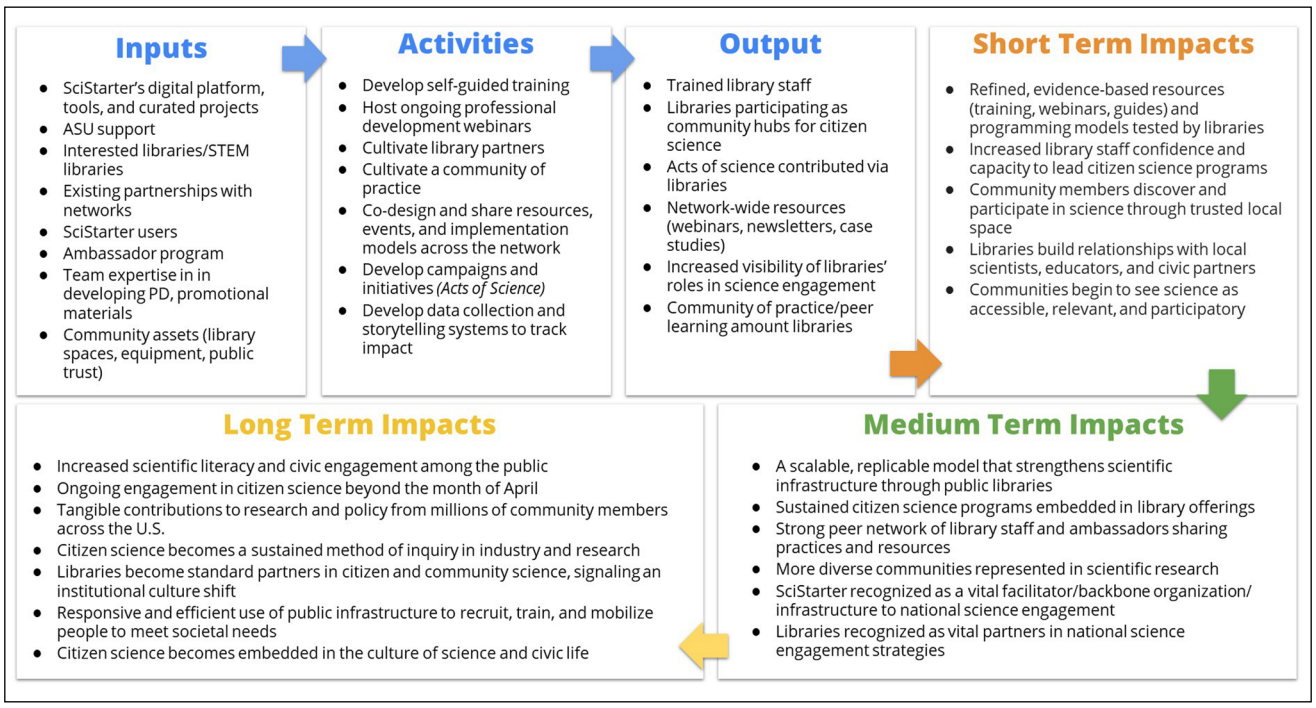


Figure 1 Theory of Change for Libraries as Community Hubs for Citizen Science.

theory of change developed during program maturation. The evaluation thus progressed from exploratory documentation to theory-informed inquiry, using the frameworks of Knowles, Coburn, and Cox et al. to define and measure constructs such as capacity building, diffusion, ownership, and equity in scaling.

PHASES I AND 2 EVALUATION

Methodology

Evaluators used a multi-method evaluation approach to study Phase I and Phase II activities. Data were collected from library staff, patrons, and project partners through surveys, interviews, observations, and community forums. Ethical approval for this study was obtained from the Institutional Review Board of Arizona State University under Study00007231 on 10/25/17. All participants provided written informed consent in accordance with the Declaration of Helsinki.

Objectives

The evaluation focused on: (1) library feedback via weekly check-ins and pre/post surveys; 2) patron engagement and satisfaction via surveys embedded in kits; and 3) program impact via circulation statistics and SciStarter analytics.

Findings

Phases I and II of the initiative surfaced several key findings, summarized in Table 3. Overall, the data indicate positive short-term impacts on both library staff and patrons, as well as strong engagement with program resources.

The pilot also surfaced operational constraints that directly informed iteration. Evaluators documented significant staff turnover during the pilot—five of six lead staff positions shifted—which created discontinuities in practice and pointed to the need for materials resilient to personnel changes. Library staff requested facilitator-focused guidance and promotional templates to offset limited marketing capacity; they also identified instrument maintenance and replacement as ongoing operational considerations. The project team used these data to prioritize the development of modular, self-paced facilitator tutorials, maintenance checklists, and a marketing toolkit to support adoption across varied library settings.

Constraints and limitations

It is important to highlight that the Covid-19 pandemic had significant effects on early expansion of the program. Many libraries remained partially open or closed to the public through 2022.

PHASE III EVALUATION

Methodology

To evaluate the effectiveness of the expansion of the initiative, a mixed-methods approach was employed. Quantitative and qualitative data were collected through a survey (2023) distributed to the Citizen and Community Science Library network, which at the time included 600 members. The survey, designed by ASU evaluators, included questions on program implementation, audience reach, perceived benefits, alignment with community needs, and

METRICS	DETAILS
Librarian satisfaction	Phases I and II: 24 librarians (67%) reported being "Satisfied" or "Very satisfied"
Total kit circulation	223 times (2017–2020) across pilot libraries
Top 5 most-used kits	1. iNaturalist—79 loans 2. Zombee Hunting—68 loans 3. Globe at Night—45 loans 4. Air Quality—20 loans 5. Stream Mapping—11 loans
Patron self-reported outcomes	Awareness: M = 4.42/5 Interest: M = 4.33/5 Knowledge: M = 4.17/5 Confidence in data collection: M = 3.67/5 Confidence in data interpretation: M = 3.58/5
Repeat borrowing	92% of patrons indicated they would borrow a kit again
Participation demographics	Strong participation among women, a historically underrepresented group in STEM
Patron feedback	"I think it's great. I was really surprised…I was thinking…you get the monitor, you're going to download the app on your own phone and all that. But it came with the phone, which I thought was a considerable investment…I was really impressed with the quality of the kit."
Librarian feedback	"It's obvious that professionals were involved in creating materials…I really appreciate the quality."

Table 3 Phases I and II findings.

ongoing challenges. Libraries were also invited to provide narratives, feedback, and programming metrics through optional open-ended questions and follow-up interviews. Survey responses (n = 51) were analyzed using descriptive statistics to identify participation trends and engagement outcomes, while thematic coding was applied to open-ended responses to extract common challenges and best practices. Ethical approval for this study was obtained from the Institutional Review Board of Arizona State University under Study00013271 on 1/28/21. All participants provided written informed consent in accordance with the Declaration of Helsinki.

Objectives

The evaluation sought to understand: 1) how libraries integrated citizen science into their offerings, 2) the alignment of citizen science programs with community needs, 3) the effectiveness of professional development supports, and 4) the broader impacts on public participation and engagement.

Findings

The findings from Phase III suggest that the initiative has moved beyond initial engagement and produced medium-term impacts in library-based citizen science. Unlike short-term outcomes, which primarily reflect immediate satisfaction, kit use, or knowledge gains, medium-term impacts are evident in changes to library practices, program offerings, and community relationships. Twenty-one librarians described a variety of ways (Table 4) their libraries engage the community in citizen/community science:

KEY INSIGHTS

Local relevance and community-driven priorities are critical for adoption and sustained engagement. Therefore, the initiative shifted from distributing pre-built citizen science kits to supporting libraries in creating their own kits. Although this approach introduced logistical challenges—such as backorders, multi-source purchasing, and administrative approvals—it allowed for greater local adaptation, customization to community needs, and long-term sustainability. Libraries could select projects and materials aligned with their patrons' interests while ensuring kits could be updated over time based on feedback. This distributed model strengthened ownership, adaptability, and scalability across the network.

The pandemic had lingering effects on library operations during the early national rollout (September 2021—May 2022). Reduced staffing, limited hours, and seasonal timing delayed some programming and kit use. Evaluators noted these disruptions influenced both participation and the pace of implementation, emphasizing the importance of resilient program design that can accommodate unexpected operational challenges.

Ongoing virtual professional development was an effective strategy for building library staff knowledge and capacity as demonstrated by the following findings based on post-webinar surveys administered by program evaluators (Table 5).

Additionally, recorded webinars, slide summaries, and asynchronous engagement enabled staff to participate

CATEGORY	DESCRIPTION/EXAMPLES
Kit-based and take-home resources	• Circulating science kits (new or locally provided, e.g., state environmental agencies) • STEM "Brain Buster" or "science-to-go" kits • Project-specific kits: birder backpacks, water-testing kits • Some kits paused during COVID-19, affecting circulation trends
In-person and programmatic engagement	• Hosting lectures, workshops, demonstrations by scientists/local experts on wildlife, plants, bats, pollinators, robotics • Hands-on activities: science-based crafts, intergenerational nature journaling, egg incubators, caterpillar-to-butterfly displays, STEM festivals • Partnerships with schools, colleges, parks, aviaries, and organizations (Audubon, Native Plant Society, 4H)
Community partnerships and events	• Collaborating on local monitoring or conservation projects (e.g., PurpleAir monitors) • Supporting major public science events (e.g., solar eclipses: viewing parties, glasses, educational programs) • Planning/relaunching BioBlitz and other citizen science projects using resources like SciStarter
Observations on engagement	• Kit circulation alone has limited reach • Participation increases when programs, outreach, or displays accompany kit • Many libraries are in early stages, planning quarterly programs or gradually introducing kits
Alignment with library purpose (29 librarians, 2023 Survey)	• Fulfills educational and recreational needs; promotes lifelong learning • Brings resources to patrons and engages them in communities • Enriches scientific literacy and provides family-oriented opportunities • Aligns with STEM/STEAM programming and environmental initiatives • Engages historically underrepresented populations in science

Table 4 Description of library activities by category.

METRIC	DETAILS
Webinar series	12 webinars (2021–2023)
Registrations	2,185 registrants
Overall ratings	99% were rated "good," "very good," or "excellent" (N = 199)
Participant familiarity	Beginner-level familiarity ranged from 15% to 63% (N = 199)
Confidence gains	80–100% (N = 199) felt confident discussing citizen science with patrons/community 86–100% (N = 199) could direct patrons to SciStarter resources
Skills development	54–75% (N = 199) increased confidence in building, cataloging, and promoting kits 60–96% (N = 199) reported enhanced skills in planning, hosting, and tailoring programs
Interest and engagement	74–100% (N = 199) reported increased interest in citizen science 68–89% (N = 199) gained knowledge of participation opportunities (e.g., Pollinator Palooza, Boost Your Eclipse Programming)

Table 5 Virtual professional development evaluation findings.

despite scheduling constraints. Library staff reported that sharing experiences and ideas during webinars enhanced learning and strengthened a sense of community. This approach highlights the value of sustained peer-to-peer networks as mechanisms for adoption, troubleshooting, and skill building, consistent with communities-of-practice theory (Wenger 1998).

Engagement data revealed that partnerships initiated directly between libraries and community-based organizations (CBOs) were more effective than those facilitated through centralized, national coordination. Feedback from early partners prompted a shift from developing CBO-specific tutorials to emphasizing strategic presentations at national convenings, which served to raise awareness and stimulate local collaboration. This decentralized approach strengthened community networks, enabling CBOs and libraries to co-develop programming and expand opportunities for meaningful participation in citizen science.

Phase III evaluation demonstrates that successful adoption, scaling, and sustainability of citizen science in libraries depends on programs that: 1) align with community needs, 2) enable local adaptation and ownership, 3) provide ongoing professional support, 4) leverage peer learning networks, and 5) foster local partnerships. These mechanisms collectively reinforced libraries as community hubs for science engagement while enabling long-term participation across diverse populations.

TRANSFERABLE INSIGHTS FOR GLAM INSTITUTIONS

The Libraries as Community Hubs for Citizen Science initiative demonstrates that sustained public participation in research within GLAM institutions depends on aligning professional learning, institutional infrastructure, and community relevance—practices tied closely to the development of social innovations (Murray et al. 2010; Mulgan et al. 2007). The lessons from this multi-phase effort can guide museums, libraries, and cultural organizations seeking to integrate participatory research programs into their operations, while also offering insights relevant to the wider field of Citizen Science, including the humanities and social sciences. Three overarching insights emerged: building institutional capacity, scaling through networks, and sustaining participation through alignment with local context and equity.

BUILDING INSTITUTIONAL CAPACITY FOR PARTICIPATION (ADOPTION)

Early engagement and capacity-building among staff are foundational for adoption. From a social innovation perspective, these efforts represent a shift in professional norms—positioning staff not only as program deliverers, but as facilitators of knowledge co-production with their communities. Libraries' success in citizen science programming was driven by investments in professional learning and access to turnkey tools that empowered staff to experiment and iterate within their own contexts.

For other GLAM institutions, this suggests that adoption depends less on technical expertise and more on fostering staff confidence, relevance, and ownership. Applying Knowles' adult learning principles, institutions can:

- offer modular, self-paced professional development that honors staff autonomy and existing expertise;
- embed reflection and peer exchange to link new practices to familiar program models; and
- position participatory science as complementary—not additional—to institutional missions (e.g., public engagement, education, or stewardship).

By framing participation as an extension of existing roles rather than a new initiative, GLAM institutions can lower barriers to entry and increase institutional buy-in.

SCALING THROUGH NETWORKS AND SHARED OWNERSHIP (SCALING)

Scaling participation requires moving beyond replication toward distributed leadership. During Phase III, the Libraries as Hubs model expanded through a national network that facilitated mutual learning and adaptation rather than top-down dissemination. This aligns with Coburn's (2003) dimensions of scale, emphasizing depth, spread, ownership, and institutionalization. GLAM institutions can similarly pursue networked scaling by:

- establishing peer-to-peer communities of practice that connect staff across sites and disciplines;
- encouraging local adaptation of shared resources (e.g., customizable kits, exhibits, or programs) to promote ownership; and
- developing shared language and metrics to document and communicate collective impact.

Rather than measuring success solely by the number of participating sites, institutions can assess the quality and depth of integration—how staff, volunteers, and visitors internalize and sustain participatory approaches.

SUSTAINING THROUGH LOCAL RELEVANCE AND EQUITY (SUSTAINABILITY)

Long-term sustainability hinges on maintaining alignment with community priorities and inclusive practices. The equitable scaling framework (Cox et al., 2024) underscores that durable participation depends on responsiveness to local contexts and the intentional inclusion of underrepresented groups.

In practice, libraries achieved this by co-designing programs around issues meaningful to their patrons—pollinators, air quality, or light pollution—thereby ensuring that citizen science was both scientifically valuable and socially relevant. For GLAM institutions, sustainability emerges when participation is mutually beneficial: advancing institutional missions while addressing community interests and capacities.

Institutions can strengthen sustainability by:

- embedding participatory science within long-standing community engagement strategies;
- leveraging trusted partnerships to reach diverse participants; and
- co-developing programs that reflect local concerns, cultural assets, and accessibility needs.

Equity-oriented sustainability transforms participation from a project-based effort into an institutional ethos.

SUMMARY

Across adoption, scaling, and sustainability, the Libraries as Hubs model illustrates that institutional transformation in public participation is iterative and relational. It requires balancing fidelity to core principles with flexibility for local adaptation. The interplay of professional learning, networked collaboration, and equitable engagement created conditions under which citizen science could become a normalized, resilient feature of library practice.

For other GLAM institutions, this synthesis highlights three transferable strategies:

1. invest in staff learning that values autonomy and relevance;
2. cultivate peer networks to share ownership and social innovation; and
3. embed programs within local ecosystems to ensure equitable and enduring participation.

Together, these strategies provide a roadmap for translating participatory science from isolated projects to institutional practice across the GLAM sector.

CONCLUSION

The Libraries as Community Hubs for Citizen Science initiative evolved from a feasibility pilot to a national network exemplifying how libraries—and by extension, other GLAM institutions—can serve as community intermediaries for public participation in research. Phase I demonstrated proof of concept: that libraries could engage patrons in meaningful citizen science experiences. Phase II refined the model and resources to support replication. Phase III, informed by theory, revealed the mechanisms by which learning, adoption, and equity interact to sustain participation at scale.

By grounding later phases in adult learning, scaling, and equity frameworks, the initiative advanced from a program that worked to one that could explain why and how it worked. For GLAM institutions navigating similar challenges—integrating participatory practices within complex systems—the case underscores a central insight: sustainable engagement arises not from a single innovation but from alignment among people, purpose, and place. These findings may also inform how GLAM institutions approach other forms of participatory research across disciplines that emphasize public contribution, shared authority, and community relevance. Beyond

citizen science, this case contributes to the literature on social innovation in GLAM institutions by demonstrating how participatory research can function as a catalyst for organizational learning, role redefinition, and more equitable public engagement When institutions empower staff as learners, build networks that share ownership, and design for equitable participation, they can transform public spaces into enduring platforms for scientific research, civic contribution, and shared solutions.

DATA ACCESSIBILITY STATEMENT

This case study draws on data as reported in evaluation reports and program documentation produced by the Arizona State University Office of Evaluation and Educational Effectiveness (ASU UOEEE). Access to underlying evaluation data is subject to ASU UOEEE policies and data retention timelines as defined in the relevant research protocol. Program documentation cited in the manuscript may be requested from the corresponding author where permissible.

ETHICS AND CONSENT

Ethical approval for the studies used in this article were obtained from the Institutional Review Board of Arizona State University under Study00007231 on 10/25/17 and Study00013271 on 1/28/21. All participants provided written informed consent in accordance with the Declaration of Helsinki.

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COMPETING INTERESTS

Darlene Cavalier, a coauthor on this paper, is on the editorial team for this *Citizen Science: Theory and Practice* special collection; Cavalier is also the Founder of SciStarter.

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. The first draft of the manuscript was written by Tara Cox. Darlene Cavalier contributed to manuscript development and authorship. Emma Giles, Caroline Nickerson, and Deron Ash provided critical review and feedback on previous versions of the manuscript. All authors read and approved the final manuscript.

AUTHOR AFFILIATIONS

Tara Cox orcid.org/0009-0002-5443-4923
SciStarter, US

Darlene Cavalier orcid.org/0000-0002-6886-3289
Arizona State University, US

Deron Ash
Arizona State University, US

Emma Giles orcid.org/0009-0004-7002-3600
Arizona State University, US

Caroline Nickerson orcid.org/0000-0002-0052-9620
SciStarter, US

REFERENCES

Ballard, H.L., Robinson, L.D., Young, A.N., Pauly, G.B., Higgins, L.M., Johnson, R.F. and **Tweddle, J.C.** (2017) Contributions to conservation outcomes by natural history museum-led citizen science: examining evidence and next steps, *Biological Conservation*, 208, pp. 87–97. DOI: https://doi.org/10.1016/j.biocon.2016.08.040

Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K.V. and **Shirk, J.** (2009) Citizen science: a developing tool for expanding science knowledge and scientific literacy, *BioScience*, 59(11), pp. 977–984. DOI: https://doi.org/10.1525/bio.2009.59.11.9

Carballo-Cárdenas, E.C. and **Tobi, H.** (2016) Citizen science regarding invasive lionfish in Dutch Caribbean MPAs: drivers

and barriers to participation, *Ocean & Coastal Management*, 133, pp. 114–127. DOI: https://doi.org/10.1016/j.ocecoaman.2016.09.014

Carlen, E.J., Estien, C.O., Caspi, T., Perkins, D., Goldstein, B.R., Kreling, S.E.S., Hentati, Y., Williams, T.D., Stanton, L.A., Des Roches, S., Johnson, R.F. and **Young, A.N.** (2024) Building equitable and inclusive urban field research through community partnerships, *Citizen Science: Theory and Practice*, 9(1), p. 9. DOI: https://doi.org/10.5334/cstp.755

Cavalier, D. and **Kennedy, E.B.** (eds.) (2016) *The Rightful Place of Science: Citizen Science*. Tempe, AZ: Consortium for Science, Policy & Outcomes.

Cigarini, A., Bonhoure, I., Vicens, J. and **Perelló, J.** (2021) Public libraries embrace citizen science: Strengths and challenges, *Library & Information Science Research*, 43(2), 101090. DOI: https://doi.org/10.1016/j.lisr.2021.101090

Cigarini, A., Bonhoure, I., Vicens, J. and **Perelló, J.** (2022) Citizen science at public libraries: data on librarians' and users' perceptions of participating in a citizen science project in Catalunya, Spain, *Data in Brief*, 40, 107713. DOI: https://doi.org/10.1016/j.dib.2021.107713

Coburn, C.E. (2003) Rethinking scale: moving beyond numbers to deep and lasting change, *Educational Researcher*, 32(6), pp. 3–12. DOI: https://doi.org/10.3102/0013189X032006003

Cox, T., Stafford, E., Early, E., Lerman, L., Thompson, T., Toro, S. and **Torres-Gerald, L.** (2024) *Guidelines for equitably scaling informal STEM programs*. Seattle, WA: National Girls Collaborative Project. Available at: https://ngcproject.org/ScalingInformalSTEMPrograms

Dawson, E. (2018) *Equity, Exclusion and Everyday Science Learning: The Experiences of Minoritised Groups*. London: Routledge. DOI: https://doi.org/10.4324/9781315266763

Desmarchelier, B., Djellal, F., and **Gallouj, F.** (2024) Public libraries as social innovators. *Public Library Quarterly*, 44(1), 1–20. DOI: https://doi.org/10.1080/01616846.2024.2357399

Eveleigh, A., Jennett, C., Blandford, A., Brohan, P. and **Cox, A.L.** (2014) Designing for dabblers and deterring drop-outs in citizen science, in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York: ACM, pp. 2985–2994. DOI: https://doi.org/10.1145/2556288.2557262

Falk, J.H. and **Dierking, L.D.** (2010) The 95 percent solution: school is not where most Americans learn most of their science, *American Scientist*, 98(6), pp. 486–493. DOI: https://doi.org/10.1511/2010.87.486

Haklay, M. (2013) Citizen science and volunteered geographic information: overview and typology of participation, in Sui, D., Elwood, S. and Goodchild, M. (eds.) *Crowdsourcing Geographic Knowledge: Volunteered Geographic Information (VGI) in Theory and Practice*. Dordrecht: Springer, pp. 105–122. DOI: https://doi.org/10.1007/978-94-007-4587-2_7

Hecker, S., Haklay, M., Bowser, A., Makuch, Z., Vogel, J. and **Bonn, A.** (eds.) (2018) *Citizen Science: Innovation in Open Science, Society and Policy*. London: UCL Press. DOI: https://doi.org/10.14324/111.9781787352339h

Hildreth, S. (2012) Inspiring libraries as community anchors, *National Civic Review*, 101(4), pp. 44–47. DOI: https://doi.org/10.1002/ncr.21093

Hobbs, S.J. and **White, P.C.L.** (2012) Motivations and barriers in relation to community participation in biodiversity recording, *Journal for Nature Conservation*, 20(6), pp. 364–373. DOI: https://doi.org/10.1016/j.jnc.2012.08.002

Hodgkinson, I.R., Mousavi, S. and **Hughes, P.** (2022) Citizen science—discovering (new) solutions to wicked problems, *Public Money & Management*, 42(2), pp. 133–136. DOI: https://doi.org/10.1080/09540962.2021.1967630

Institute of Museum and Library Services. (2023) *Public Library Survey Report*. [Data Report] Available at: https://www.imls.gov/research-evaluation/surveys/public-libraries-survey-pls

Kania, J. and **Kramer, M.** (2011) Collective impact, *Stanford Social Innovation Review*, 9(1), pp. 36–41.

Knowles, M.S., Holton, E.F. and **Swanson, R.A.** (2015) *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development*. 8th edn. New York: Routledge.

Kloetzer, L., Lorke, J., Roche, J., Golumbic, Y., Winter, S. and **Jõgeva, A.** (2021) 'Learning in citizen science', in Vohland, K., Land-Zastrau, R., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., Samson, R. and Wagenknecht, K. (eds.) *The science of citizen science*. Cham: Springer, pp. 283–308. DOI: https://doi.org/10.1007/978-3-030-58278-4_15

Kranich, N. (2019) *Libraries and Democracy: The Cornerstones of Liberty*. Chicago, IL: American Library Association.

Lankes, R.D. (2016) *The New Librarianship Field Guide*. Cambridge, MA: MIT Press. DOI: https://doi.org/10.7551/mitpress/10433.001.0001

Lewandowski, E., Caldwell, W., Elmquist, D. and **Oberhauser, K.** (2017) Public perceptions of citizen science, *Citizen Science: Theory and Practice*, 2(1), p. 3. DOI: https://doi.org/10.5334/cstp.77

Mulgan, G., Tucker, S., Ali, R. and **Sanders, B.** (2007) *Social innovation: what it is, why it matters and how it can be accelerated*. London: The Young Foundation.

Mumelaš, D. and **Martek, A.** (2024) Benefits of citizen science for libraries, *Publications*, 12(1), 8. DOI: https://doi.org/10.3390/publications12010008

Mumelaš, D., Matijević, I. and **Ivanjko, T.** (2025) 'Citizen science in libraries worldwide: A systematic review', *Journal of Librarianship and Information Science*. DOI: https://doi.org/10.1177/09610006251342825

Murray, R., Caulier-Grice, J. and **Mulgan, G.** (2010) *The Open Book of Social Innovation: Ways to Design, Develop and Grow Social Innovation*. London: The Young Foundation and NESTA.

National Academies of Sciences, Engineering, and Medicine (2025) *Equity in K-12 STEM Education: Framing Decisions for the Future*. Washington, DC: The National Academies Press. DOI: https://doi.org/10.17226/26859

Oldenburg, R. (1999) *The Great Good Place*. New York: Marlowe & Company.

Pandya, R.E. (2012) A framework for engaging diverse communities in citizen science in the US, *Frontiers in Ecology and the Environment*, 10(6), pp. 314–317. DOI: https://doi.org/10.1890/120007

Rabe, A.K. (2024). *Libraries as enablers of citizen science: Collaboration, value creation, and social impact*. MA thesis. Swedish School of Library and Information Science. Available at: http://www.diva-portal.org/smash/record.jsf?pid=diva2:1878806 (Accessed: 17 February 2026)

Rotman, D., Preece, J., Hammock, J., Procita, K., Hansen, D., Parr, C. and **Jacobs, D.** (2014) Dynamic changes in motivation in collaborative citizen-science projects, in *Proceedings of the ACM Conference on Computer Supported Cooperative Work*. New York: ACM, pp. 611–622. DOI: https://doi.org/10.1145/2531602.2531612

Shirk, J.L., Ballard, H.L., Wilderman, C.C., Phillips, T., Wiggins, A., Jordan, R. and **Bonney, R.** (2012) Public participation in scientific research: a framework for deliberate design, *Ecology and Society*, 17(2), p. 29. DOI: https://doi.org/10.5751/ES-04705-170229

Soleri, D., Long, J.W., Ramirez-Andreotta, M.D., Eitemiller, R. and **Pandya, R.** (2016) Finding pathways to more equitable and meaningful public–scientist partnerships, *Citizen Science: Theory and Practice*, 1(1), p. 9. DOI: https://doi.org/10.5334/cstp.46

Wenger, E. (1998) *Communities of Practice: Learning, Meaning, and Identity*. Cambridge: Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511803932

Widdersheim, M. and **Koizumi, M.** (2016) 'Conceptual modelling of the public sphere in public libraries', *Journal of Documentation*, 72(4), pp. 591–610. DOI: https://doi.org/10.1108/JD-06-2015-0079. [1]

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