

Science Action Club

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Youth in Science Action Club (SAC) use citizen science to investigate nature, document their discoveries, share data with the scientific community, and design strategies to protect the planet. Through collaborations with regional and national partners, SAC expands access to environmental science curriculum and training resources.

Mark, a student at a Northern California middle school located amongst towering redwoods, was not doing well in his classes. Teachers struggled to capture his interest, and he wasn't connecting socially, either. As a last attempt to reach him, Mark's science teacher suggested he join a new afterschool science club: Science Action Club (SAC). Although at first reluctant to participate in anything outside of school, Mark enjoyed the hands-on exploration of bugs. Afterschool staff noticed Mark's growing interest and his difficulty with social interactions and started giving Mark leadership roles in the club. Soon, he became a mentor for younger club members and began researching insects on his own time. This research led to conversations with his science teacher, who then helped support Mark in making up many of his missed

assignments. After months of catch-up, Mark was successfully able to graduate from middle school with a special honor for his leadership role in SAC. Both the afterschool staff and the school day science teacher attributed Mark's success to opportunities he had to explore a new interest in insects through the SAC program. Programs such as SAC, which give young people the chance to explore science and the environment beyond the classroom, can help cultivate an enthusiasm in students that supports in-school learning as well. In fact, 74% of youth in SAC say that these activities increased their excitement for in-school science. Reading about camouflage and looking at textbook diagrams, after all, is not the same as being able to engineer your own arthropod that blends in with its surroundings.



SAC youth at Presidio Middle School in San Francisco draw a scale model of a bald eagle in the school yard and include messaging to raise awareness about environmental threats to birds. Photo by California Academy of Sciences.

[Science Action Club](#) is a [citizen science](#)-focused out-of-school-time program that [leverages the power of partnerships](#) to deliver environmental learning experiences to youth. From urban centers like Chicago and Compton to fish camps in Alaska, SAC works with schools, museums, and community organizations to get over 18,000 youth per year into their local environment to study the bugs, birds, and clouds around them (Ballard et al. 2016). As youth make authentic discoveries in their neighborhoods and contribute to large-scale research projects, they develop an intrinsic motivation to protect the spaces they come to value (Ballard, Dixon, and Harris 2017; Barton and Tan 2008; NSTA 2003).

Designed for youth in grades 5–8, SAC uses citizen science as an education and engagement strategy—a way to address science, technology, engineering, and math (STEM) learning goals,

teach discrete STEM skills, and build STEM identities among the next generation of critical thinkers and environmental stewards (Afterschool Alliance 2016). *Citizen science* is a global movement in which scientists and the general public collaborate to answer some of the most pressing questions about our planet. Many big scientific questions require more data than a single scientist, or even a team of scientists, could collect. In SAC, youth share their observations of the natural world with scientists around the globe who use those data to better understand environmental changes over time. Through this experience, youth learn the process of science investigation and discovery, and make valuable contributions to the field.

Founded in 2011 as a partnership between the [California Academy of Sciences](#), the San Francisco Beacon Initiative, and two middle schools in San Francisco Unified School District, the program now has [800 clubs in 21 states](#) across the country, but has retained its original character as an entry-level science and nature learning experience. The program is designed to hook middle school youth at a pivotal time in their academic careers, when their experience with science learning is most apt to either solidify or shrink students' natural curiosity (Afterschool Alliance 2011; NSTA 2016). SAC aims to get pre- and early adolescents permanently excited about science and nature by enabling them to actively contribute to authentic research, connect with the global scientific community and each other, and reflect on their progress over time.

Spark curiosity, inspire wonder, and foster environmental agency

The program features three environmental science [units](#): *Bird Scouts*, *Bug Safari*, and *Cloud Quest*. Each unit is anchored by an established citizen science project and includes 12 multifaceted hands-on experiences that take youth outside to investigate local nature, document discoveries, share data, and design strategies to protect the natural world.



SAC youth use specimen collection tools at the Science Day Camp, sponsored by the City of Kerman Recreation Department, in Kerman, California.

Photo by City of Kerman Recreation Department.

Bird Scouts explores feathers, flight, and the features that make birds unique. Using binoculars,

field guides, and digital technology, youth conduct a series of hands-on projects, games, and experiments to learn basic birding skills, as well as investigate environmental changes that impact bird behavior. Youth then conduct local bird counts and submit their observation checklists to [eBird](#), a citizen science project from the Cornell Lab of Ornithology and National Audubon Society that helps scientists track changes in bird distribution and abundance across the globe.

Bug Safari explores small creatures with big environmental impacts. On local field expeditions at or around their club meeting sites, youth search for bugs, collect specimens, and post photographs to [iNaturalist](#), a citizen science project and online social network for biodiversity research sponsored by the California Academy of Sciences. Collaborating with the scientific community and other student contributors to iNaturalist, youth identify arthropod species and document habitat conditions that influence our planet's health.



SAC youth at Footsteps Child Care in Belmont, CA place their cloud models on an altitude chart.

Photo by Footsteps Child Care.

Cloud Quest explores the impact of clouds on Earth's weather and climate systems. Using the [GLOBE Observer](#) citizen science platform, youth identify sky conditions and report their discoveries to NASA. Researchers then map these observations to satellite image data in order to study how clouds influence the flow of energy through Earth's atmosphere.

All three units prioritize helping youth develop discrete scientific process skills that can be applied in multiple ways and have notable relevance. For example, in addition to learning how to identify a juvenile red-tailed hawk or estimate percent cloud cover in the sky, SAC activities challenge youth to tackle real problems and design creative solutions, like how to clean oil from soiled feathers or design buildings with limited carbon footprints. This strengthens creativity, cooperation, initiative, and other skills that are essential for surviving and thriving in the 21st century (P21 2007). Furthermore, SAC activity challenges are all connected to sophisticated environmental issues such as habitat destruction, pollution, and climate change, but are presented from a solutions-based perspective and explained using clear, developmentally

appropriate language. Links to age-appropriate videos and articles provide extra context, and every activity includes a call to action that invites youth to apply their new knowledge to the world outside of their afterschool or summer program.

SAC's activity designs were informed by the needs, constraints, and opportunities afforded by the OST (Out-of-School Time) environment. The California Academy of Sciences collected feedback from teachers, principals, and afterschool staff through listening sessions, focus groups, and surveys, in collaboration with Oakland-based evaluation firm [Public Profit](#). Each SAC meeting session is highly active and participatory, and includes multiple points of entry for youth with varying levels of STEM interest and experience. Factors like seasonality, weather, and daylight influenced the sequence of activities in the guidebook, ensuring that youth are able to conduct outdoor investigations year-round. The guidebook activities build on one another for enhanced learning over time but can also be enjoyed as stand-alone experiences for a drop-in community, especially when new youth are supported by more experienced peer leaders. All three units align with the *Next Generation Science Standards* grades 3–5 and middle school bands, including several science and engineering practices, disciplinary core ideas, and crosscutting concepts.

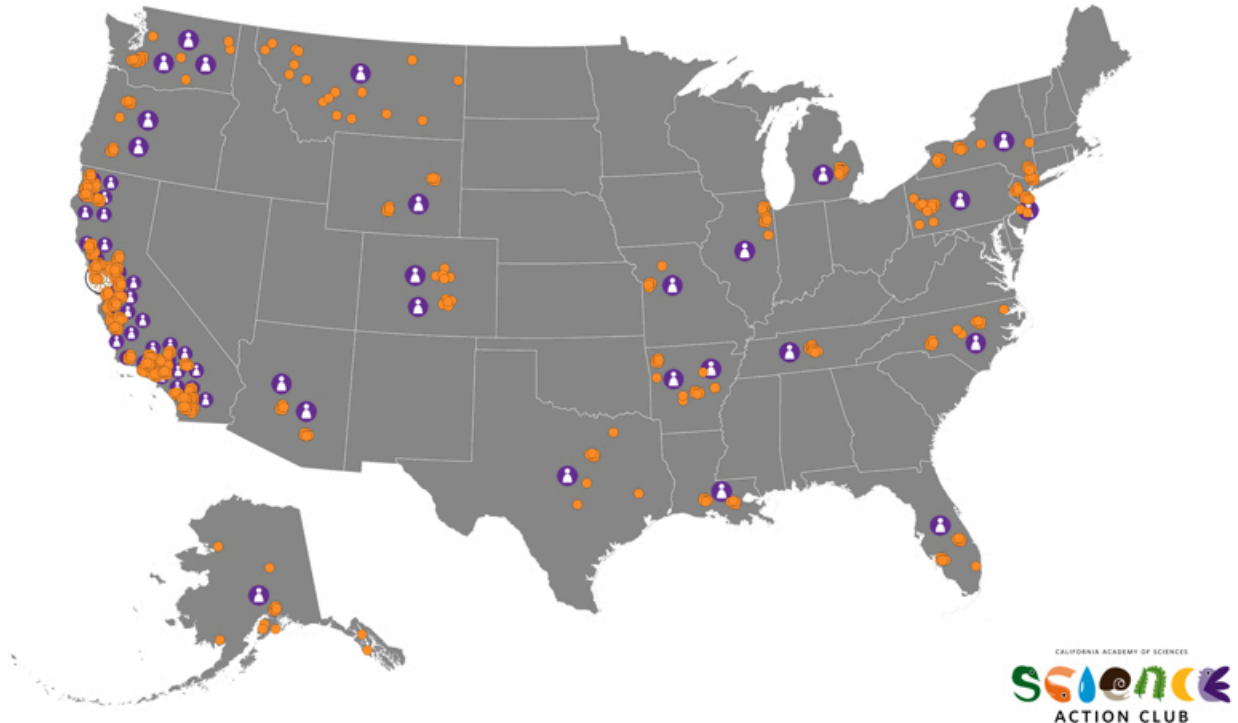
The power of partnerships



Youth in Science Action Club at Irving Elementary School in Bozeman, Montana, work with student volunteers from Montana State University to practice using binoculars.

Designed to transform environmental education at scale, SAC's reach and impact is a direct result of its [successful partnerships](#). Collaborating with national and statewide trainer networks, global citizen science programs, afterschool and summer learning agencies, universities, schools, and families, Science Action Club identifies and leverages each partner's expertise to create an interconnected web of environmental education champions, all committed to engaging learners in authentic and meaningful STEM experiences. Beyond the training experiences that build SAC trainer and activity leader networks, the Academy has launched a [Facebook page](#) for SAC educators, staff, and partners. Here, SAC members can share their programmatic

challenges and successes with the broader nationwide SAC educator community. Past posts have shared requests for additional resources, add-on activities individual clubs have found useful, and many reports of unique bugs, birds, and clouds found by youth.



The Academy brings together Trainers (purple points) from across the country to develop supporting relationships through an in-person professional development workshop. Trainers then develop local support networks with individual activity leaders (orange dots).

The focus on high-impact partnerships has allowed the California Academy of Sciences to extend its environmental content expertise well beyond the museum in San Francisco. Through partnerships with trainer networks supported by the [California School-age Consortium](#) (CaSAC), [OregonASK](#), and the [National Girls Collaborative](#), SAC trains professional development specialists to become certified SAC trainers. In turn, SAC trainers customize the Academy's curriculum resources to train program staff in their own communities, bringing SAC to youth in more than 220 cities and towns across the United States. This strategy provides the flexibility and support needed to meet every learner and educator right where they are, regardless of their location or their science and education background.

While implementation varies widely among participating afterschool programs, summer camps, libraries, and community centers, a typical school-year program completes the SAC curriculum through a dozen weekly sessions with 15–20 youth who meet for 60–90 minutes. Most programs implement two units per school year. The sessions are led by the participating program's own instructors, referred to as SAC activity leaders, who come from a variety of demographic, educational, and professional backgrounds (see below).

Gender

Male	18%
Female	82%

Highest level of education completed

High school diploma or GED	27%
Associate's degree	16%
Bachelor's degree	33%
Master's degree	23%

Years of experience with youth

Fewer than 3 years	19%
3-5 years	26%
6-10 years	20%
More than 10 years	33%

Age

Under 21	7%
21-24	28%
25-29	11%
30-34	13%
35-44	14%
45-54	14%
55+	13%

Current professional status *

One job	62%
Two jobs	29%
Three or more jobs	9%
Student	30%

* Totals more than 100%

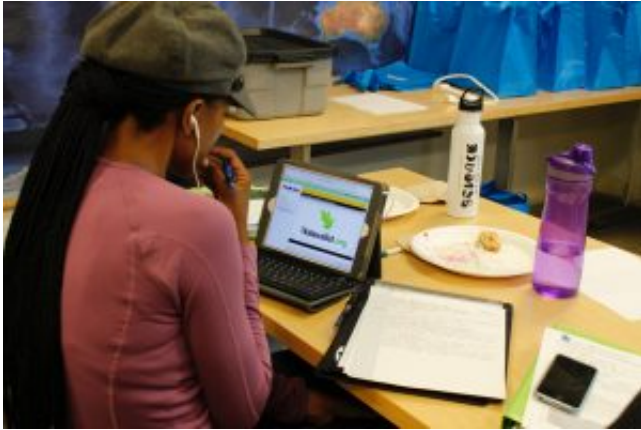
Science background

No science since high school	16%
At least one science class after high school	54%
Degree in science or a related field	17%



Teachers from across Montana gather on Centennial Mall at Montana State University to practice cloud and sky observations on Thursday, October 19, 2017, during the MSU Science Action Club training. Teachers will take the training to be citizen scientists and teach their students as part of the science curriculum in middle schools and out-of-school programs. MSU Photo by Adrian Sanchez-Gonzalez.

Given the diversity of SAC educators' experience with science education and youth development, high-quality professional development training has been a cornerstone of the SAC program since its inception. Originally, SAC trained activity leaders directly through face-to-face workshops in San Francisco. In 2014, recognizing the scaling limitations of that model, SAC transitioned to a train-the-trainer approach, leveraging a partnership with [CalSAC](#), a statewide afterschool network, to identify and train a cohort of OST professional development experts ("trainers") who in turn could train SAC activity leaders in their own communities. In 2016 SAC replicated that model for national expansion in partnership with the [National Girls Collaborative](#) and launched a blended learning training consisting of a two-hour online course for both trainers and activity leaders, a two-day, in-person Training of Trainers (ToT) hosted by the California Academy of Sciences, and a five-hour in-person training for activity leaders led by regional trainers.



The SAC Educator Portal provides online professional development training and access to digital supports and resources. Photo by California Academy of Sciences.

To address issues of fidelity of implementation, the program created a list of readiness factors to help an OST provider determine if SAC would be successful at their site. This list includes a range of factors like designating a staff person to complete the training and facilitate the program and identifying a teacher or administrator to forge or maintain connections to the school day science curriculum.

In the blended learning version, the online training is completed prior to the in-person workshop, with the goal of presenting a clear and compelling overview of the full SAC experience and the resources available. Because the designated activity leader is frequently someone who was assigned that role by a supervisor and is unfamiliar with SAC, the online training provides a comprehensive overview that introduces the program, identifies its purpose and value, and clarifies expectations. Through text, video, and animation, the online training also provides detailed guidance for all 12 activities in each environmental science unit, as well as background information and recommended teaching strategies for supporting learners to develop strong STEM identities. Educators may complete the training at their own pace and return to it as a resource as needed. The transition to a blended learning format has been key to addressing the issue of how the program could scale nationally while still retaining high-quality program implementation.

Trainers working with afterschool activity leaders at SAC sites shared their feedback:

- 99% were excited about leading a SAC training.
- 94% thought the train-the-trainer model was useful and necessary.
- 99% reported that science was fun.
- 99% of both trainers and afterschool leaders were inspired to learn more about science and nature.

Afterschool activity leaders at SAC sites also indicated the following:

- 100% felt they were able to help youth connect with the natural world.
- 97% reported that they learned useful teaching strategies.
- 100% noted that it is important to include STEM in afterschool programming.
- 97% learned new science skills and concepts during trainings.

The in-person workshop creates an environment in which new and returning participants can share knowledge, ask questions, and get hands-on practice with SAC activities in a supportive and nurturing environment. In both the ToT and Activity Leader Training (ALT), educators learn which STEM concepts to emphasize with youth, which science practices to highlight, and how to address common challenges that activity leaders may present, such as lack of confidence with science or fear of nature. They trade examples of successes achieved and lessons learned, practice giving constructive feedback, and role-play common scenarios from the youth and activity leader perspectives. In addition, activity leaders practice facilitating and conducting SAC activities and citizen science experiences, such as submitting bird count checklists to [eBird](#), or submitting arthropod observations to [iNaturalist](#) for identification.



SAC Trainers use a quadrat to closely observe biodiversity.
Photo by California Academy of Sciences.

SAC trainers follow up with activity leaders shortly after the ALT and continue to monitor progress and provide ongoing support throughout the programming period. This includes reviewing attendance data and informal feedback submitted by activity leaders and scheduling check-in phone calls or site visits. For trainers already employed in a position that requires them to supervise, support, or train staff, these responsibilities are inherently built in. Other trainers must build relationships with the activity leaders and their OST organizations, which frequently paves the way for further collaborations.

Beginning in spring 2018 Science Action Club will offer a do-it-yourself, fully online training

option to enable wider independent access to SAC curriculum and training resources. The addition of this program component will provide another training option for program staff to complete a SAC training.

Case study: Science Action Club in Montana

The [Montana Girls STEM Collaborative](#), based within Montana State University's Academic Technology and Outreach Division, has been an exemplary partner in this work and [demonstrates how collaborations can support youth engagement across many learning environments](#).



Educators from across Montana traveled to Montana State University in Bozeman for a full-day Science Action Club *Bug Safari* training. Educators practiced using SAC protocols and mobile apps to contribute to citizen science.

MSU Photo by Adrian Sanchez-Gonzalez.

In the 2016–2017 school year, the Montana Girls STEM Collaborative launched Science Action Club at 40 elementary and middle schools, afterschool clubhouses, libraries, and park facilities throughout the state. SAC trainers in Montana intentionally focused the club recruitment process on communities with 2,500 or fewer residents to reach rural audiences that have historically lacked access to high-quality STEM learning experiences. This included publicizing access to SAC's grant-funded kits, curricula, and training resources via social media, e-newsletters, and a university press release. The collaboration was also publicized by the

Montana Afterschool Alliance, the Montana Environmental Education Association, the Montana Office of Public Instruction, and the Montana Small Schools Alliance, among other educator-serving organizations.

A diverse array of programs were selected to participate in SAC, including school-based and community-based afterschool programs supported by Boys & Girls Clubs, YMCAs, 4-H Council, United Way, and local library branches. Several educators, particularly those from the smallest communities, worked in both in-school and out-of-school settings.

Montana trainers incorporated roundtable discussions of locally relevant topics into their workshops, including how to find and collect bugs during the long winter season and how to connect with local experts, such as tribal elders, U.S. Forest Service personnel, beekeepers, farmers, and ranchers. The SAC educators' Facebook group also was popular with Montana educators, who are often located at great geographic distances from each other.



Montana K–12 teachers practice finding bugs as part of the Science Action Club event hosted by Montana State University on Thursday, October 20, 2016, in Bozeman, Montana. MSU Photo by Adrian Sanchez-Gonzalez.

Linking in-school and out-of-school experiences

In Fortine, Montana (population 169), resource teacher Dawn Black and seventh- and eighth-grade teacher Laurel Thomson recruited students to SAC via posters at school, fliers sent home

to parents, and by word of mouth. Thomson said that students enjoyed the outdoor observations and the hands-on activities and games, including building birdhouses and feeders, learning to use binoculars, and creating to scale chalk drawings of birds like California condors with a nine foot wingspan. She also said that when severe winter weather hampered outdoor bug collection activities, SAC members took to their 100-year-old school's dusty basement and their bus barn to seek arthropods and collect and test samples of sawdust from under a pellet stove, dirt from under floorboards, and spiderweb debris.

As a classroom teacher as well as a SAC afterschool leader, Thomson said she was able to incorporate many SAC activities and concepts into her classroom, including ecosystems, biodiversity, and geoscience information that corresponds with the standard curriculum. Thomson, a 10-year teaching veteran, said she learned new information about bugs and birds and was impressed with the SAC lesson plans, which she said helped her not only with new ideas for those particular STEM subjects but with general ways to improve her own teaching.

In Libby, Montana, a town in the Kootenai National Forest between the Cabinet Mountains to the south and the Purcell Mountains to the north, Afterschool Site Coordinator Mandy Bell said she prioritizes sharing the SAC curriculum with her partner in-school educators, who encourage youth to share their SAC experiences with the rest of the class.

Building STEM identities



Youth in Science Action Club's Bird Scouts program conduct a bird count in their school yard. Youth use the mobile app Merlin Bird ID to identify birds before uploading their observations to the citizen science platform eBird.

In Livingston, Montana, located just north of Yellowstone National Park, SAC was hosted by Links for Learning, an afterschool and summer enrichment program supported by the 21st Century Community Learning Centers grant. SAC activity leader Margy Dorr said she was drawn to SAC because it offered STEM enrichment via hands-on activities while connecting youth with their beautiful surrounding environment and wildlife.

“The fact that we get to take kids outside and do bird observation walks, get out in the sunshine, listen to the birds...I thought was a great experience for our kids,” she said. “I would always start each club by asking them to put on their citizen scientist hat, and from the get-go they were in the mind frame of speaking and thinking and listening like a scientist would.” Dorr added that she presented each SAC activity as that day’s “mission,” and that the students particularly enjoyed the owl pellet dissection, playing the role of ornithologists and inventing a backstory about the owl as they discovered each item inside its pellet.

Dorr said she appreciated that SAC helped students learn to use different tools and scientific skills, including how to ask questions and find answers. “They found they were capable of carrying out investigations, and they learned that their voice does matter and that no one is too young to be a scientist.”

Other Montana clubs included a 4-H mentoring program that reached youth facing challenges such as poverty, drug abuse, or minimal access to social programs; a Boys & Girls Club on the Northern Cheyenne Reservation; and a partnership with an afterschool GIS Club.

Leveraging partnerships to impact environmental learning

These [testimonials](#) are supported by evaluation data that is collected annually using pre- and post-tests, focus groups, and parent surveys. Longitudinal data is currently being collected to understand where students go after graduating from high school. Program data collected by Public Profit evaluation firm show that more than 75% SAC youth have experienced increased confidence in their science skills and developed stronger STEM identities since participating in the program, and 82% of SAC youth agreed that being in Science Action Club made them want to learn more about science. In our increasingly complex and changing world, we need our future leaders to have the knowledge, skills, and self-confidence to tackle tough problems and design creative, effective solutions, and we need an informed populace to serve as the next generation of global citizens and environmental stewards.

Science Action Club’s impact on youth and informal STEM educators is a testament to the power of partnerships in transforming environmental education. By leveraging meaningful and intentional cross-sector collaborations and keeping youth at the center of the program design focus, partners can pool their expertise, share resources, and expand youth access to high-quality STEM learning opportunities.