Growing computer science education in afterschool:

Opportunities and challenges

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Afterschool Alliance

afterschoolalliance.org

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Acknowledgements

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Introduction

Computer science education is rapidly being recognized as essential for all students to develop into successful citizens of the 21st century. A diverse group of stakeholders, including educators, business and industry, policymakers, and parents all agree on the importance of computer science. Significant workforce needs in particular are driving the push for computer science education. In comparison to all other U.S. job categories, computing is projected to have the largest percent growth between 2014 and 2024.[1] And this projected growth may not even entirely capture the full number of American jobs that require computing and IT-related skills. According to a 2015 study from Change the Equation, 7.7 million Americans say their jobs require them to use computers in complex ways, which is more than twice the U.S. Bureau of Labor Statistics' estimate of workers in computing occupations.[2]

Beyond the need to fill important jobs, as a society we want kids to become the creators and innovators for the next generation—making technology work for them and designing solutions for their communities—not just passively consuming technology. Furthermore, computer science education, or more specifically computational thinking, instills critical thinking, problem-solving skills and logical reasoning. These are skills that are transferable to a broad range of domains. In order for young people to take advantage of these benefits, we must ensure they are exposed to engaging, relevant, and rigorous computer science education early in their education, and are provided opportunities to build their interest and skills throughout the grade span.

Too many young people currently lack access to computer science education. According to a 2016 Gallup study, 40 percent of school principals report having at least one computer science class available in which students can learn computer programming or coding.[3] While this number is up from 25 percent in 2015, it is not sufficient. Furthermore, there is a highly inequitable distribution of access, with black, Hispanic and lower-income students being less likely than other students to have computer science learning opportunities in their schools.[4] And in rural and small-town schools, computer science classes are far less prevalent than in cities and suburbs.[5]

Computer science education advocacy efforts have, to date, focused primarily on what happens during the school day, specifically in relation to growing the number of high school computer science courses offered and increasing the number of students taking the AP Computer Science exam. However, education stakeholders are increasingly adopting the model of a *learning ecosystem*—the idea that it is necessary to call on multiple educational institutions to effectively engage and teach all students.[6] This means intentionally harnessing the unique contributions of schools, afterschool and summer learning programs, museums and science centers, libraries, and other community organizations, while providing a pathway for student learning from preschool through high school graduation. In fact, the new K-12 Computer Science Framework, released in 2016, states that "informal education organizations are essential to the computer science education ecosystem and should be included as critical stakeholders in state and district implementation efforts" (pg. 167-168).[7]

[1] Computing jobs are projected to grow by 19 percent, whereas all other jobs will grow by just 11 percent. "Vital Signs," Change the Equation, http://vitalsigns.changetheequation.org/state/united-states/demand#fields-growing

[2] "Bridging the Computer Science Access Gap," Change the Equation, http://changetheequation.org/new-data-bridging-computer-science-access-gap

[3] Google Inc. & Gallup Inc. (2016). Trends in the State of Computer Science in U.S. K-12 Schools. http://goo.gl/j291E0

[4] Google. (2015). Searching for Computer Science: Access and Barriers in U.S. K-12 Education. https://services.google.com/fh/files/misc/searching-for-computer-science_report.pdf

[5] "Bridging the Computer Science Access Gap," Change the Equation, http://changetheequation.org/new-data-bridging-computer-science-access-gap

[6] For more about learning ecosystems for science, technology, engineering and math (STEM) education, visit http://stemecosystems.org/what-are-stem-ecosystems/

[7] The K-12 Computer Science Framework outlines the essential ideas in computer science for all students, and provides guidance for states, districts and organizations implementing computer science education. Informal education organizations are defined as providing "extracurricular, out-of-school, afterschool, camp, or other learning environments beyond the scope of the school day." Read more at https://k12cs.org/

Afterschool and the potential for computing education

Today, 10.2 million children participate in afterschool programs, which amounts to about 18 percent of all school-aged youth. African-American and Hispanic children, as well as youth from low-income households, participate in afterschool programs in higher numbers.[8] Afterschool programs offer a tremendous opportunity to reach more kids with computer science, and to reach them at an earlier age. As this report will illustrate, there is incredible interest in computer science within the afterschool field. If computer science education stakeholders can work together to meet the stated needs of afterschool practitioners, we can bring all hands on deck and advance toward the ultimate goal of computer science for all.

About this report

The Afterschool Alliance began with two goals—first, to better understand the afterschool field's familiarity with and interest in computer science or computing education. Second, we hoped to gauge the perceived challenges and potential solutions that could help the afterschool field expand its computing education offerings. To answer those questions, we surveyed afterschool program directors and managers and conducted focus groups with selected local and state-level afterschool leaders in 2015. It is our hope that our findings provide K-12 computer science education stakeholders with an understanding of how best to support the growth of quality, sustainable computing education within the afterschool field.

Defining computer science and computing

We opt to use "computing" rather than "computer science" as computing is a more inclusive term, reflecting a wide range of computer-related pursuits, including computer science, information technology (IT) and computational thinking. Within the context of K-12 education, the goal of such activities is that students learn how to create technology, instead of just learning how to use it.

Under this umbrella, kids might pursue a diverse set of activities such as programming and building a robot to compete in a robotics competition, writing code for an animation that tells a story, designing a mobile app or website, making their own video game, or even developing a computer algorithm that solves simple math problems.

[8] Afterschool Alliance. (2014). *America After 3PM*: Afterschool Programs in Demand. Washington, D.C. www.afterschoolalliance.org/AA3PM

[9] Definition borrowed from Ashcraft, C., Eger, E., and Friend, M. (2012). Girls in IT: The Facts. Boulder, CO: National Center for Women & Information Technology. www.ncwit.org/thefactsgirls

Survey findings

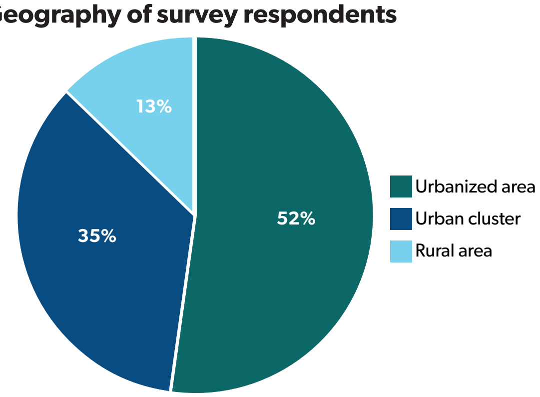
About the respondents

376 afterschool programs completed the survey. On average, these programs operate for 4 hours per day, 4.4 days per week, and primarily represent *comprehensive*[10] afterschool programs, as opposed to clubs or extracurricular activities that might only meet once per week.

Geography. While this survey is not nationally representative, we did see a broad geographic spread in the states and types of communities of the respondents. Survey responses came from 46 states, with only Delaware, Nevada, North Dakota, and Washington not represented. Responses were distributed between states fairly equally based on population, with the exception of Arizona, which accounted for 20 percent of respondents.

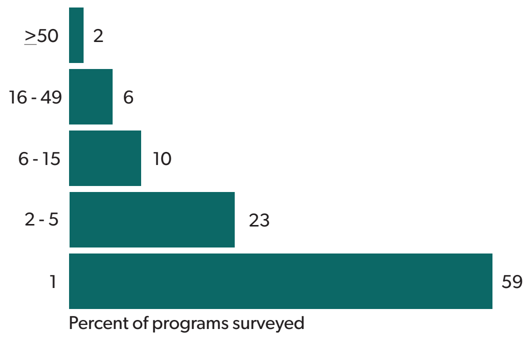
We classified respondents' communities into three groups as defined by the 2010 Census.[11] Roughly 52 percent of programs are located in urbanized areas, 35 percent in urban clusters, and 13 percent in rural areas. The community geography of our survey respondents mirrors the national distribution of children—across the United States, 84.5 percent of children live in urban areas, while 15.5 percent live in rural areas.[12]

Geography of survey respondents

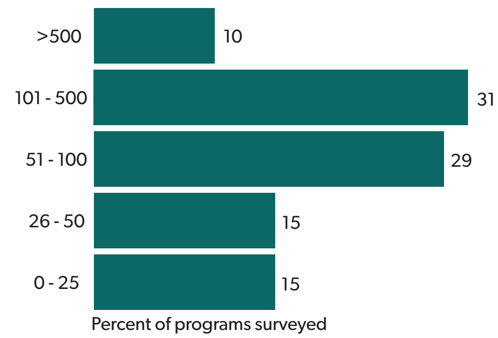


Program size. The sizes of programs represented in the survey vary significantly, from small programs serving one local community to those operating nationally. Almost 60 percent of programs operate only in one location, and over 80 percent of programs have five or fewer sites, suggesting that the majority of these programs operate on a local level. However, statewide and national organizations are also represented, with roughly 20 percent of programs having more than six sites and 10 percent having more than 16. Daily attendance of programs varied from three to 10,000 students, with a median of 90 students served per day. This reflects the varying proportions of local, regional, statewide and national programs represented by survey respondents.

Number of sites operated by afterschool programs



Daily attendance across sites



Demographics. A large proportion of survey responses (44 percent) came from afterschool programs serving high-poverty student populations, while 35 percent of the responses came from middle-poverty communities and 21 percent from respondents serving low-poverty populations.

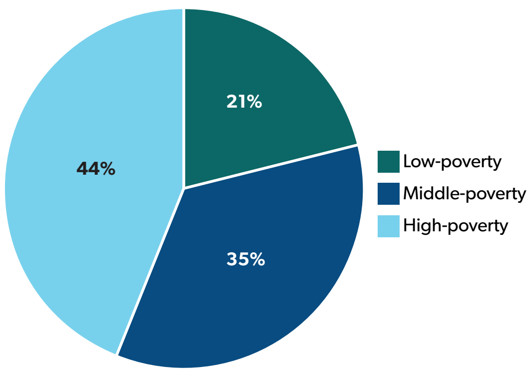
[10] We define comprehensive afterschool programs as sites that a child regularly attends and that provide a supervised environment that typically includes a healthy snack or meal and homework help along with enrichment activities. Comprehensive afterschool programs most often take place in schools or community-based organizations and are different from individual activities such as sports, special lessons, or hobby clubs, and different from childcare facilities that provide supervision but not enrichment.

[11] As defined by the 2010 U.S. Census, urbanized areas have a population greater than 50,000. Urban clusters, which are primarily moderate sized cities and suburbs, have populations between 2,500 and 50,000. Areas with populations less than 2,500 are considered rural. www.census.gov/geo/reference/ua/urban-rural-2010.html

[12] U.S. Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Bureau. (2014). Child Health USA 2014. Rockville, Maryland: U.S. Department of Health and Human Services. mchb.hrsa.gov/chusa14/population-characteristics/rural-urban-children.html

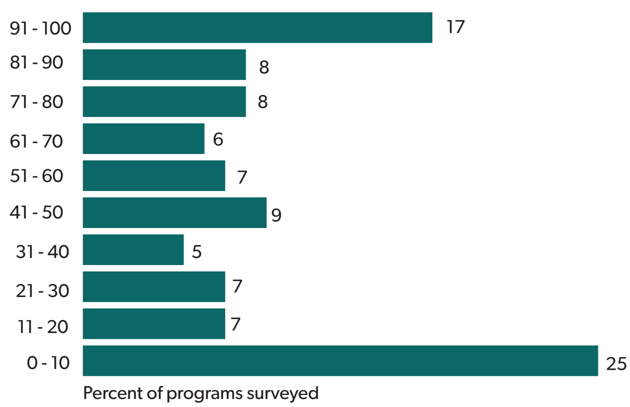
No relationship was seen linking the apparent wealth of the community and the likelihood of the afterschool program offering computer science. For example, 40.3 percent of programs serving low-poverty populations reported that they offered computing, compared to 46.3 percent of programs serving high-poverty populations—a difference that is not statistically significant due to the sample size.

Level of community wealth



About 25 percent of afterschool programs responding to the survey serve a majority-Caucasian student population, with less than 10 percent of students from African American, Hispanic, or Native American backgrounds. Seventeen percent of programs primarily served students underrespresented in computer science, with student populations that are 91 to 100 percent African American, Hispanic, or Native American. The demographics of the student population served—with regard to either poverty level or student demographics—had no relationship with the likelihood of an afterschool program's status or history of offering computer science.

Percent of minority students

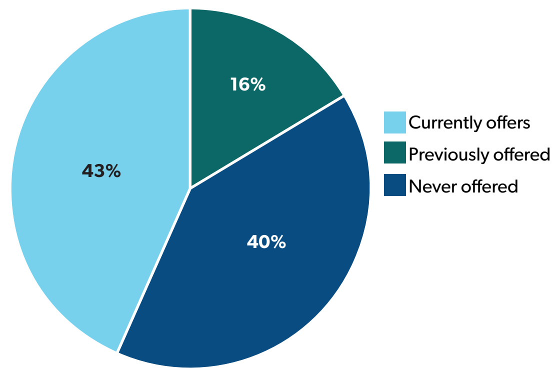


[13] Using the same designations as the National Center for Education Statistics in their report, The Condition of Education 2010, we defined student populations as "high-poverty" when 76 to 100 percent of students were eligible for the federal free and reduced-price lunch program (FRLP) and "low-poverty" when up to 25 percent of students qualified. nces.ed.gov/programs/coe/analysis/2010-index.asp

Afterschool programs' experience with and interest in offering computing

Afterschool programs have a mixed history with computing education. Overall, 59 percent of the afterschool programs surveyed were either offering computing to their students at the time of the survey (43 percent) or had previously offered computing (16 percent). The remaining 40 percent of respondents had never offered computing education to their students for a variety of reasons that will be examined later in this report.

Afterschool programs' experience with computing

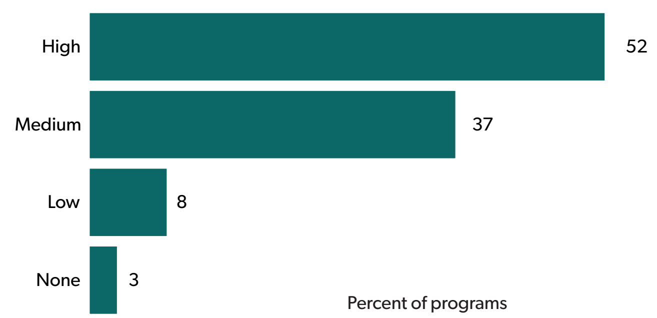


Interest in offering computing education is high. Almost all of the afterschool programs (97 percent) that had offered computing in the past said they are either extremely likely or likely to offer it again in the future. The three percent of respondents with no interest in computing represented highly specialized afterschool programs with very specific educational missions unrelated to science, technology, engineering or math (STEM).

Among the programs that had never offered computing education before (40 percent of respondents), 89 percent indicated a high or medium level of interest in offering computing in the future.

Additionally, respondents indicated a strong interest in developing professional skills in the computing education field. Among those with experience offering computing, 87 percent would participate in professional development opportunities should they become available.[14]

Interest in computing among afterschool programs that haven't offered it before



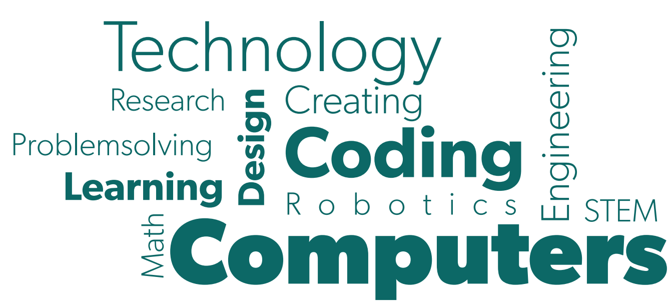
Afterschool professionals connect computing education to the future success of students. Many survey respondents recognized the importance of computing education specifically in relation to the future success of their students, citing opportunities related to college and career. However, it was clear that individuals with experience offering computing were more likely to make this connection than those who hadn't offered computing before (8.3 percent versus 3.2 percent).

Associations with computing. Though overall interest in offering computing was high, some respondents did have negative associations with computing and computer science. For example, one respondent called computer science "tedious," and another referred to it as "a socially isolating phenomenon." Though negative associations were limited to just six respondents, it is important to note that misconceptions about what computing and computer science are, as well as the debate over the role of technology in learning, present a very real obstacle for the expansion of K-12 computing education both in and out of school.[15] On the positive side, several respondents described computer science as a "fun," "exciting," and "engaging" way for students to learn and grow.

Associations with computer science and computing

To better understand how afterschool practitioners conceptualize computing education, we asked the open-ended question, *"What comes to mind when you hear computing or computer science?"* Responses reflected several recurring themes, which are represented by relative response frequency in the word cloud to the right. Survey respondents most often used words like computers, technology, learning, and coding. They also mentioned terms like designing, problem solving, engineering or robotics, though with less frequency.

Words and terms most frequently associated with computer science and engineering



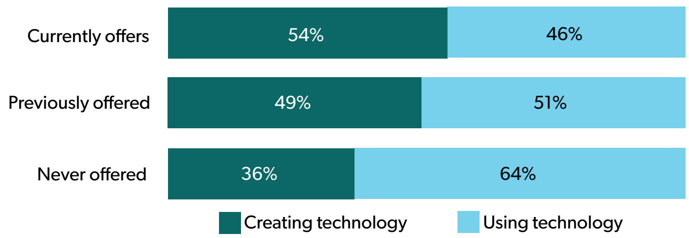
[14] Specifically, we asked survey takers about their interest in participating in in-person "train-the-trainer workshops" to support teaching computing in the afterschool environment.

[15] For communications research on how the American public talks and thinks about STEM education, see: Volmert, A., Baran, M., Kendall-Taylor, N., & O'Neil, M. (2013). "You have to have the basics down really well": Mapping the gaps between expert and public understandings of STEM learning. Washington, DC: FrameWorks Institute. frameworksinstitute.org/k12-stem-learning.html

Afterschool programs that currently offer computing were significantly more likely to associate "coding" or "programming" with computer science or computing (almost 40 percent) than those who had never offered (23 percent) or previously offered it (27 percent). Trends were similar for "robotics"—of those respondents who had never offered computing, less than 1 percent mentioned robotics, while it was mentioned by approximately 5 percent of those who currently or previously offered computing. The term "problem-solving" also saw a significant difference between groups—more than 7 percent of individuals who currently offer computing made the association with problem-solving, whereas it was mentioned by less than 2 percent of those who had never offered computing.

Digging deeper on understandings of computing education. To further analyze respondents' understanding of computing and computer science, we examined the context in which the words and phrases were used and placed them into two categories: those referring to the use of technology, which represents computer literacy, versus those referring to the creation of technology, which is how we've defined computing education. Words and phrases that pointed to the conflation of computing education with computer literacy, included for example "using computers for research, typing," "using email and the internet, proper use of social media," and "using the internet to research." Afterschool programs with experience offering computing were more likely to mention words and phrases related to the creation of technology than those who had never offered computing.

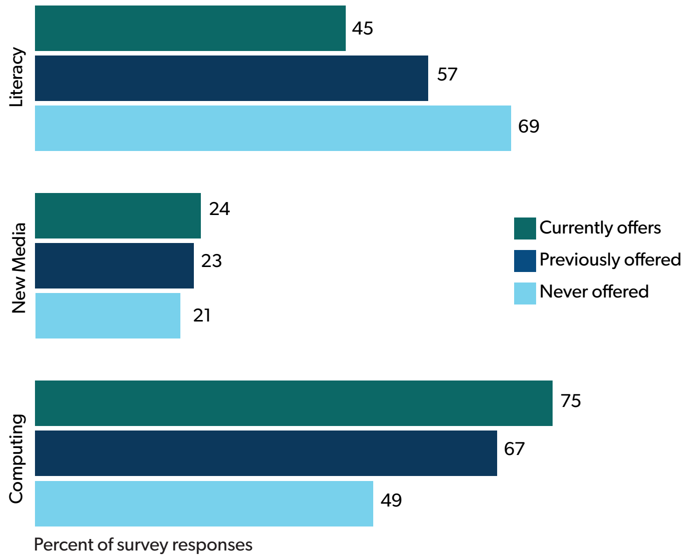
Creating vs. using technology: Afterschool programs' understanding of computing education



Top activities associated with computing. Respondents were asked to identify the top three activities they associate with computer science or computing. We coded the activities into three categories: *Computing* (such as coding, designing hardware or software, and IT), *new media* (such as video production, audio production, photo editing, and 3-D printing), and *computer literacy* (such as typing, use of Microsoft Office, internet use and safety, and information literacy).

Three-quarters of respondents with experience offering computing listed at least one traditionally-defined computing activity, compared to less than half of those with no experience offering computing. Similarly, respondents whose afterschool programs had never offered computing were more likely to list activities focused on computer literacy (69 percent) than those currently offering computing (45 percent). The mention of new media was relatively consistent across all three groups surveyed.

Activities associated with computing by type



Computing activities being offered by afterschool programs

Robotics is the most popular activity across all afterschool programs that have either previously offered or currently offer computing. Robotics activities are available to students at almost 75 percent of programs currently offering computing. The next most frequently offered activities were creation of animations and other media; video game design; and activities featuring hardware integration such as Makey Makey, Arduino, or Lilypad.

Survey respondents collectively reported having used more than fifty of the numerous products and platforms available for teaching computing. The most popular were Lego robotics (35 percent of programs having used this product), Scratch (15 percent), Minecraft (9 percent), Google's CS First (7 percent), and Makey Makey (7 percent).

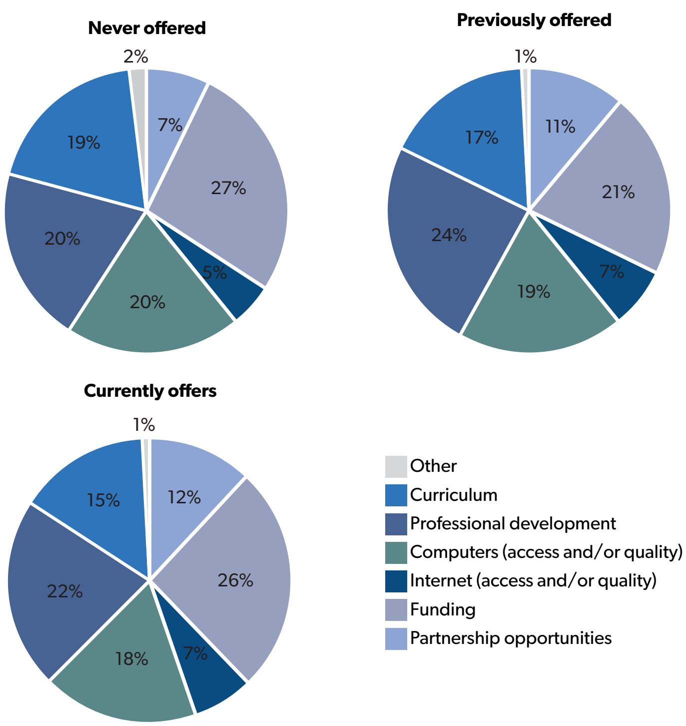
Required resources and biggest challenges

Survey participants were asked to identify the most helpful resources for starting or maintaining computing in their afterschool program. For all groups, the three most important resources were funding, professional development, and access to quality computers, though some variation existed in their order. Curriculum was a close fourth for all groups.

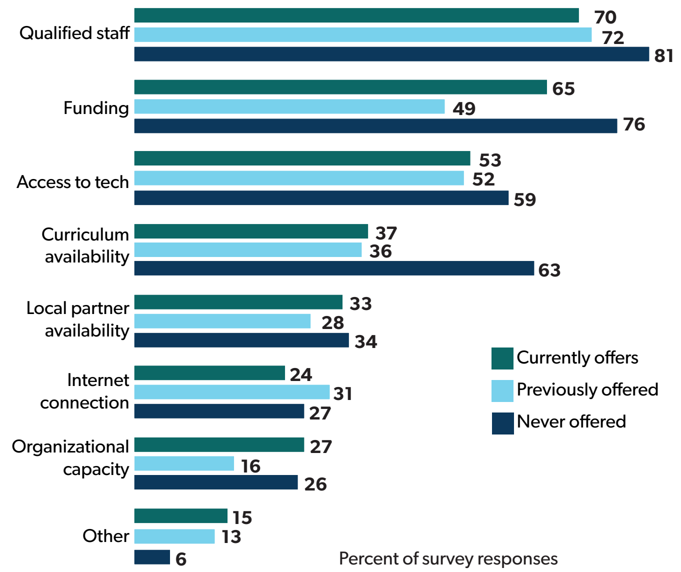
Between groups, there was a significant difference in the importance placed on partnerships—only 7 percent of those without experience offering computing identified partnerships as one of their three most important resources, compared to 11.2 percent and 12 percent of those with current or previous experience offering computing, respectively. Overall, respondents who have never offered computing placed slightly more importance on the resources necessary for getting programs started—such as funding, computers and curriculum—while individuals who currently offer or previously offered computer science were more likely to list resources necessary for program maintenance, such as partnerships, internet access and professional development.

Survey respondents indicated that the biggest challenges facing computing in the afterschool environment mirrored the four most important resources they identified. These included, in rank order, qualified staff, funding, access to reliable computers or technology, and curriculum availability.

Resources helpful to afterschool programs starting or maintaining computer intiatives



Challenges to offering computing in afterschool setting



The most significant variation between the three groups is seen in the relative importance of a curriculum. Almost two-thirds of individuals who had never offered computing listed curriculum as a challenge, compared to only one third of those with experience offering computing. Many individuals mentioned a desire for curricula designed specifically for afterschool settings.

Within the "other" category, respondents mostly mentioned resources such as a designated physical space for computing lessons, adequate time for training and implementation, and the challenge of demonstrating how computing fits into the goals of their current program (despite an individual interest). Interestingly, organizational capacity was not a commonly cited challenge to offering computing. This indicates that if afterschool programs could access the resources discussed above, they would have both the desire and ability to integrate computing into their program.

Focus groups

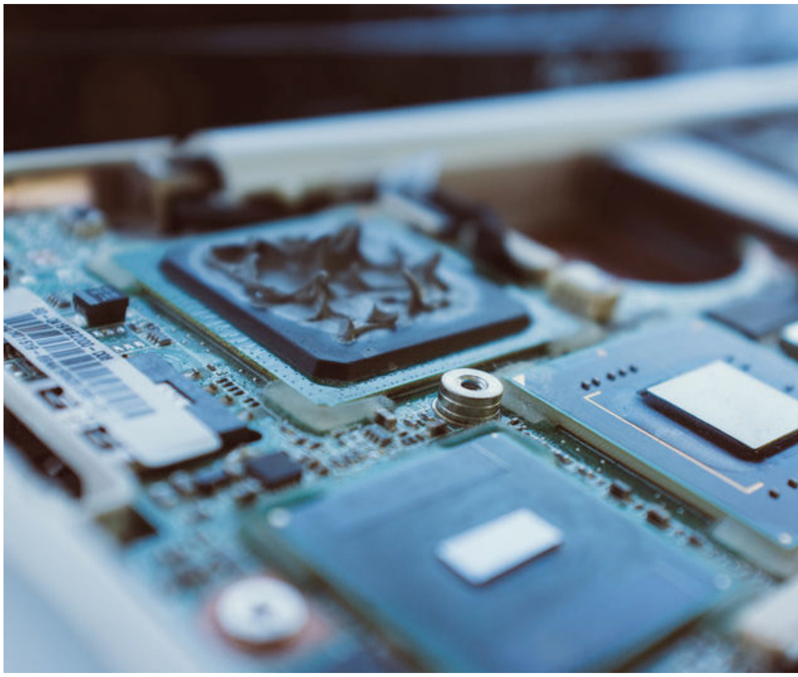
We conducted two focus groups with select populations—state-level organizations building systems to support afterschool and local afterschool leaders experienced in directing programs and citywide advocacy. These results are therefore not nationally representative, but provide an expert lens through which we can surface challenges and opportunities on a larger scale.

Statewide afterschool networks

There are currently 50 statewide afterschool networks[16] that work to expand quality afterschool and summer learning programs in their states. Approximately half are engaged in building systems to support the growth of afterschool STEM.[17] Representatives from six statewide afterschool networks—New Hampshire, New York, North Carolina, Oregon, South Carolina, and Texas—joined our focus group. At the time of the focus group, these networks were working to increase the capacity of afterschool programs to offer computing education, either statewide or in targeted regions.

Focus group participants felt that the statewide afterschool networks had an important role in expanding afterschool computing education in their states by building the capacity of afterschool educators: connecting programs to resources, facilitating professional development opportunities, and building relationships with industry partners. The focus group identified key challenges they actively face in their work, and discussed potential strategies for overcoming them:

- **Building connections with industry.** Focus group participants recognized the importance of working with business and industry partners in the computing and technology fields. These partnerships can provide vital resources for afterschool programs, including classroom volunteers, content experts, funding, and other in-kind support. However, participants expressed concerns about the field's ability to effectively connect to and communicate with industry.
    - The first challenge identified was the ability to "speak the same language," which points to the difficulty in bridging the organizational cultures between community-based organizations and for-profit industry. In addition, focus group participants indicated that afterschool practitioners, as well as staff from the statewide afterschool networks, often lack confidence in utilizing technical language related to current and emerging technologies.
    - All focus group participants noted their network's lack of sufficient capacity to dedicate the time and attention required to build and maintain industry partnerships, recognizing that this is often an even greater challenge for individual afterschool programs. Several networks expressed a strong interest in exploring the possibility of hosting AmeriCorps VISTAs focused on expanding computing science in afterschool, since the opportunity and need for such partnerships is so great.[18]



[16] Through over a decade of investment from the C.S. Mott Foundation, the statewide afterschool networks pursue state-level policy and partnerships to support afterschool programs, and provide technical assistance and professional development for afterschool practitioners. For more information, see www.statewideafterschoolnetworks.net

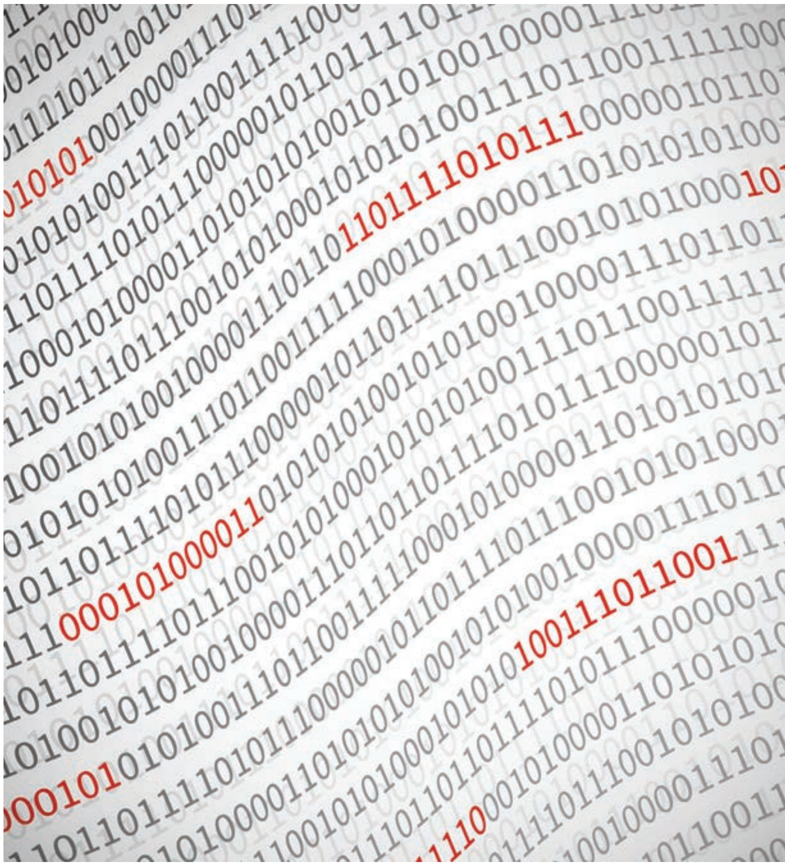
[17] To learn more about ongoing state system-building work for afterschool STEM see expandingstemlearning.org

[18] The Afterschool Alliance manages a cohort of AmeriCorps VISTAs, hosted by the statewide afterschool networks, focused on expanding STEM within the states. All of the state networks were familiar with this program, and two in the focus group have hosted Afterschool STEM VISTAs. AmeriCorps VISTA is a project of the Corporation for National & Community Service. www.nationalservice.gov/programs/americorps/americorps-vista

- **Developing strong educators.** Another significant challenge identified by the focus group is a dearth of educators who are competent in teaching computer science principles and who have also developed strong classroom facilitation skills and an understanding of youth development principles. In the focus group members' experience, educators must have all of these competencies to lead a successful and sustainable afterschool computing program. Frequently, expert volunteers from industry have little experience working with youth, particularly in a non-classroom or informal setting, and have rarely been exposed to models of creative and engaging teaching techniques. Conversely, most afterschool program staff lack coding skills and knowledge of computer science principles.

- **Curricula suited for the afterschool environment and its goals.** While focus group participants were aware of several computing curricula used by afterschool programs, they still felt the available selection isn't always adequate for the needs of the afterschool environment. They stated that some of the more popular curricula tend to reduce the opportunity for creativity and innovation, two qualities valued by many practitioners in the out-of-school time space. Focus group participants suggested that new computing curricula in development should focus on the creation of technology as an end goal, rather than focusing solely on learning a new coding language.

Promising practices. While no focus group participant had found the perfect solution for their state, particularly because their computing initiatives were so new, a few had identified promising practices. The networks strongly emphasized the importance of in-person, hands-on training for both afterschool educators and industry volunteers. Several suggested summer workshops as an effective venue and hypothesized that having afterschool practitioners and industry representatives work in partnership would further their relationships and maximize the training's success. Another idea the group discussed was the possibility of having high school students act as near-peer mentors for elementary and middle school programs, reinforcing older students' computing skills while helping to fill the immediate demand for skilled facilitators.



[19] To learn more about the Afterschool Ambassador program, see www.afterschoolalliance.org/ambassadors.cfm

Local afterschool leaders

The Afterschool Ambassadors[19] are a group of afterschool leaders selected by the Afterschool Alliance to receive advocacy training and support. Each year, a new class of Ambassadors is selected from effective afterschool programs across the country. Nine current and former Ambassadors participated in this focus group, representing afterschool programs with a range of expertise and experience with computing. Ambassadors represented Atlanta, Georgia; Birmingham, Alabama; Camdenton, Missouri; Walla Walla, Washington; Knoxville, Tennessee; Omaha, Nebraska; Orland Park, Illinois; Pittsburgh, Pennsylvania; and Tampa, Florida. All Ambassadors have significant on-the-ground experience leading and managing afterschool programs.

Overall, this focus group felt very strongly that the afterschool environment provides a unique and exceptional environment for learning computer science; however, they recognized that developing and maintaining a computing initiative can be very difficult, especially in rural and low-income communities. The following summarizes the main points of discussion:

- **Misunderstandings and preconceptions of computing are common.** It's necessary to establish a community-wide understanding of the differences between computing and technology literacy, as confusion between the two is common. The perception that computer science is "scary" persists among afterschool educators, volunteers, program managers and directors, administrators from partner schools, and other community partners. Finding ways for these groups to directly observe the potential for afterschool computing education and the impact of computing on youth can be highly effective.

- ***All students* aren't always targeted.** Focus group participants had observed that in their local areas, resources and funding for computing education was often allocated to magnet schools, high-achieving or Advanced Placement-track students, and college-bound students. Many students are thus left out, resulting in inequitable access to computing opportunities. Participants remarked that any computing program, whether in or out of school, should ensure relevance for students by helping them understand college and career opportunities in computer science, as well as its relevance in everyday life.

- **Partnerships can help achieve accessibility and success.**

  - Afterschool computing programs are often dependent on parent, community and industry volunteers, and programs are most successful with a diverse network of volunteer support both in role of engagement and commitment level (e.g. ongoing classroom support vs. one-time volunteering vs. behind-the-scenes support).

  - Frequently, nonprofit afterschool programs or community-based organizations rely heavily on schools and districts for access to computer labs and classroom spaces in the hours after school. Participants believed that many afterschool programs would benefit from guidance on navigating this issue.

- **The structure of funding streams can prove challenging for some afterschool programs.** The focus group discussed how both public and private funding is often intended for large-scale initiatives and is highly competitive. Ambassadors indicated that smaller, more flexible grants at the local level would be greatly useful for afterschool programs, particularly programs just getting started in computing and programs not located in a city center. Additionally, Ambassadors stressed that the application and reporting requirements for smaller grants should be less onerous, to relieve the burden on small afterschool programs that have limited development and evaluation capacity.

Recommendations

Our research into the state of computing in the afterschool field reveals widespread interest and support, as well as several serious challenges. Based on our survey findings and focus group discussions, we make the following recommendations for advancing computing education in afterschool. Although we have addressed these recommendations to specific groups we believe are most able to enact them, all are best achieved through partnerships among the many stakeholders in computer science education.

Computer science education experts:

1. **Conduct targeted outreach to the afterschool field to educate them on computing.** Survey responses indicated confusion as to what computing is and the types of skills and competencies students are expected to gain from computing education. Computing was most often misidentified as computer literacy and use of new media, even among those afterschool programs with experience offering computing education. As the Afterschool Ambassador focus group highlighted, community-wide misconceptions exist not only among afterschool practitioners, but also among parents, students, and school and community partners. Our findings echo recent research that documents high percentages of educators, parents and students incorrectly identifying computer science activities.[20] Targeted education efforts will help the afterschool field understand how computing education aligns with their current organizational goals and, in turn, educate others to create buy-in for these programs.

2. **Increase professional development opportunities for out-of-school time educators.** Almost 75 percent of survey respondents identified finding qualified staff as a top barrier to offering computing, and both focus groups echoed this concern. As such, growing the number of professional development opportunities for afterschool educators should be a primary focus for those interested in advancing computer science education.

   Organizations in a position to develop and administer professional development in computing should note a strong preference for in-person and hands-on training, though virtual opportunities may also meet some need. Afterschool providers want these opportunities: 87 percent of survey respondents with experience offering computing said they would be interested in participating.

3. **Develop engaging curricula designed for the afterschool environment.** Almost one-fifth of survey respondents and several focus group members indicated a desire for more curricula designed specifically for afterschool settings. Curriculum developers should develop curricula and resources that are mindful of the particular affordances of the out-of-school learning environment. Developers should actively seek front-end input and feedback from afterschool practitioners on the most useful structure and components of these curricula.

[20] Google. (2015). Images of Computer Science: Perceptions Among Students, Parents and Educators in the U.S. services.google.com/fh/files/misc/images-of-computer-science-report.pdf

Afterschool leaders and practitioners:

1. **Document promising practices.** Overall, computing education is still relatively new to the afterschool field, and programs currently engaged in computing are developing innovative solutions to challenges and adapting existing computing resources to the afterschool environment. Given the number of survey respondents who had experience with computing, there is certainly expertise that can be gleaned from the field. Afterschool leaders should create resources that capture this expertise, reflecting multiple program models to reflect diverse student demographics and community types.

2. **Share existing resources more broadly.** Among survey respondents representing afterschool programs that hadn't previously offered computing, many reported difficulties finding computing curriculum. Given that afterschool programs with experience offering computing found this significantly less challenging, facilitating resource sharing among programs and broadly disseminating available resources would be beneficial. If computer science education experts can work with afterschool leaders to develop an education campaign explaining what computing is, grow professional development opportunities, and develop computing curriculum for afterschool, leading national and state afterschool organizations can disseminate these broadly to the field.

3. **Support individual afterschool programs' capacity for partnerships.** Brokering and sustaining partnerships with business and industry requires a significant amount of staff time, posing a challenge for many afterschool programs. Both the statewide afterschool network representatives and the Afterschool Ambassadors felt that the networks could help to broker partnerships between afterschool and industry. However, as many statewide afterschool networks have limited capacity to focus on one issue, afterschool leaders should look for creative ways to increase the capacity of the afterschool field to build industry partnerships.

Industry partners and grantmakers:

1. **Engage and invest in meaningful partnerships with afterschool providers.** Both the statewide afterschool network and Afterschool Ambassador focus groups often cited the importance of industry partners, not only for providing funding, but for supplying volunteers and expertise, facilitating worksite visits, and offering internship opportunities to students. The business and industry communities should look closely at afterschool as a promising space for providing learning opportunities in computing to more students. When developing a partnership with an afterschool program, both parties should have an open dialogue, actively working to bridge organizational cultures, understand institutional missions, and learn each other's "lingo."

2. **Support training for employee volunteers.** Industry partners should ensure that employees who desire to work with students can access training on managing classrooms in an informal environment, presenting computing content in engaging ways, and working with youth. An afterschool provider with expertise in youth development principles would be an ideal partner in this endeavor.

3. **Provide and promote a diverse array of funding opportunities.** While funding is generally a top concern for afterschool programs, it is of particular importance when considering the cost of technology equipment required for teaching computing and the increased human resources costs necessary to support professional development. While only one focus group delved into an extended discussion of funding, survey participants named funding as the resource most needed to implement a computing initiative. Grantmakers in K-12 computer science education should ensure that afterschool programs are eligible recipients for funds, and that funding opportunities are widely disseminated to the afterschool field through local and statewide networks.

    - The focus group comprised of local afterschool leaders had two specific recommendations for funders: First, provide smaller, more flexible grants at the local level to ease entry barriers for afterschool programs new to computing. Second, appropriately scope the application and reporting requirements for smaller grants to reflect the limited development and evaluation capacity of lower-resource afterschool programs.