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Inspiring Girls and their Female After school Educators to Pursue Computer Science and other STEM Careers

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ABSTRACT
The dearth of women, particularly women of color, in science, technology, engineering, and mathematics (STEM) fields is a well-known problem (National Academy of Sciences, 2010). After school and summer programs exist to encourage girls and young women to study and pursue careers in these fields (National Research Council, 2009). From evaluations of these programs, we can learn what program participants are gaining, and if longer-term studies are conducted, we might see that these girls are pursuing college majors in STEM or entering the workforce as computer scientists, software developers, or electrical engineers. But what of the educators who lead the programs? Does teaching girls about STEM change educators' views of STEM learning and careers? In this paper, we look at findings from one program, a computer science after school and summer program for middle school girls implemented in the United States and Canada, focusing on the program leaders to see if they experience changes in their views of STEM and their interest in pursuing STEM careers. These leaders are generally young adult women of color with little background in STEM who are considering next steps in their own careers. Our mixed-methods approach includes surveys, interviews, and observations as data sources.

KEYWORDS
computer science; IT; after school; girls; women; careers; STEM

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INTRODUCTION

In the United States, information technology (IT) jobs, which include high-technology computer science and engineering jobs as well as lower-technology computing careers, are predicted to grow faster than all other professional sector jobs, up to 22% over the next decade (U.S. Dept. of Labor, 2010). Currently, women in the U.S. miss out on these opportunities, holding less than a quarter of these positions. The numbers are worse for Latina and African American women: fewer than 7% of Latina or African American women have degrees or careers in these fields (National Academy of Sciences, 2010). We know from educational research that the fundamental obstacles to girls entering the STEM (science, technology, engineering, and mathematics) workforce today are the value they place on STEM careers, their interest in STEM topics, and their perceived success in STEM fields (Barman, 1996; Brickhouse et al., 2000; Chambers, 1983; Eccles, 1994, 2005, 2007) To increase girls' perception of the value of and their potential success in STEM careers, they need to see their interests reflected in STEM courses and informal learning opportunities so that science, technology, and mathematics become a central part of the "girls they are" (Brickhouse et al., 2000). Research in the U.S. on increasing girls' interest in computer science learning and careers specifically (Margolis & Fisher, 2002; Goode et al, 2006; NCWIT, 2007; and Denner, 2011) and in STEM in general (Eccles, 1994; Halpern et al., 2007) finds that to overcome these fundamental obstacles, girls should participate in tasks that are relevant to their lives and have a larger social impact, work collaboratively, connect with role models in STEM professions who are from the same gender and racial backgrounds, and receive feedback and encouragement from parents and educators. Systemic supports in programs and organizations are needed to encourage girls and women in computer science specifically and STEM in general (Cohoon, 2011; Watermeyer & Stevenson 2010).

In the U.S., after school settings led by youth development professionals are a promising locale for youth to engage with STEM and become interested in STEM careers (NRC, 2009). However, "computer science programs are often overlooked and underfunded, leading to insufficient curricula, a lack of teacher training in computer science, and decreased gender and ethnic diversity in computer science programs and careers" (The Coalition for Science After school, 2010, December 6). After school educators (youth development staff who work directly with the youth to facilitate the after school programs) vary widely in education and work experience; many are young (in their 20s and 30s) and come into the field with little experience. Furthermore, mobility is high, employment is often part-time, and training opportunities are infrequent (Yohalem & Pittman, 2006). Few programs have a staff person dedicated to science (Chi, Freeman, & Lee, 2008). However, after school educators can be important agents for encouraging youth in STEM learning (National Research Council, 2009). Some evidence suggests that their lack of STEM knowledge may be a benefit: these after school educators may be more likely than adults with formal STEM training to allow learners to explore and follow the scientific inquiry process (Coalition for Science After school, n.d.). They are likely to be trained in youth development, and these skills, too, may help them in teaching STEM (Coalition for Science After school, n.d.).

Build IT Program Overview

How, then, to develop staff capacity in after school programs to effectively deliver a computer science program? In this paper, we review data from six years of program evaluations of Build IT, an after school computer science program for girls. The data indicate that growth in staff capacity at both individual and organizational levels is possible and may lead to staff themselves developing an interest in computer science fields and careers. We propose that the processes used to develop and implement the computer science program—co-design, educative curriculum materials, and extensive professional development opportunities—may be at the root of these findings.

Build IT is a two-year after school and summer youth-based curriculum for middle school girls that can be run over four semesters and for 4 weeks during the summer or held during school breaks (e.g. summer, winter, spring). The Build IT program encourages girls to develop IT fluency, interest in mathematics, and knowledge of IT careers. The six units of Build IT focus on the design process, the mathematics in computer science, network computing, game design, and the development of Internet applications. While coding is a part of the program, the emphasis is on collaborative activities that are relevant to the girls' lives and engage girls with real users and IT professional role models who look like them.

Launched in 2005 with funding from the National Science Foundation (NSF), Build IT began with several years of piloting at Girls Incorporated of Alameda County in California, an affiliate in the Girls Incorporated (Girls Inc.) network of affiliate organizations. Girls Inc., a youth development organization based in the U.S., annually serves more than 900,000 girls aged between 5 and 18 in the United States and Canada, through its after school programs and website. Girls Inc. encourages girls, who are primarily African American or Latina and from low socioeconomic status (SES) backgrounds, to be "strong, smart, and bold". The organization provides programming after school and during holidays to these communities (low SES, African American, and Latino) in rural and urban settings. Incorporating a computer science program into their offering encourages girls to become technology fluent and to consider a challenging, well-paying job in a technology field.

From 2008 to 2012, with funding from The Noyce Foundation, SRI and Girls Inc. scaled Build IT to additional Girls Inc. affiliates. Build IT has achieved scale and sustainability at 33 girl-serving youth development sites and has reached more than 2,000 girls and 50 after school educators throughout the United States and Canada to date. Importantly, the program includes professional development and curricular strategies to support after school educators who frequently do not have strong STEM backgrounds when they first encounter the curriculum.

The development team—SRI International's Center for Technology in Learning, a learning sciences research organization and Girls Inc., a provider of youth development programs for girls—created Build IT's professional development and curriculum using a co-design approach to promote STEM learning in a youth development context. Co-design for technology-rich education innovations is a "highly-facilitated, team-based process in which educators, researchers, and developers work together in defined roles to design an educational innovation, implement the innovation with educators and students [youth] as a prototype, and evaluate each prototype's significance for addressing a concrete educational need" (Roschelle, Penuel, & Schectman, 2006). This co-design approach puts the people—in this case, educators and youth—at the center of the technology-infused curriculum innovation.

The curriculum materials are intended to teach computer science to after school educators as much as they are designed to reach youth. The program recognizes that middle school girls are at a critical juncture for engaging with technology and computer science; it uses research-based approaches for engaging middle school girls, especially girls from African American and Latina backgrounds, in technology and computer science. Additionally, the materials are educative for staff, embedding within the curriculum information and resources that help these after school educators to learn and reflect on concepts in order to teach them well. The after school educators who facilitate these activities are frequently women of color in their 20s and 30s who are still determining their career paths. They, along with the girls, are at a critical juncture in their future career decisions.

The professional development offered to these educators includes both initial extensive training and ongoing training that is integrated with the curriculum and designed to fit in with the youth development organization's professional development training and support structures. Like the curriculum itself, the program's professional development was co-designed by both learning scientists and youth development experts blending best practices for professional development from the learning sciences and youth development.

Overview of Build IT Outcomes

Data from the pilot scale-up that involved 7 affiliates and preliminary data from the recent full scale-up of Build IT to 21 affiliates (33 program sites in the U.S. and Canada) show that the program is building capacity and proving sustainable and scalable in an after school network. The majority of organizational leaders surveyed said that the program meets the needs of the community, aligns with their organization's goals, and they believe that their staff are comfortable implementing Build IT. All of the affiliates indicated interest in continuing to offer Build IT beyond the initial funding, with 78% definitely planning to continue and 22% indicating they were unsure if they would be able to (e.g. concerns about funding, having staff to implement the program).

In this paper, we examine data on the after school educators specifically. We focus on their growth in being able to offer Build IT in relation to the goal of building staff capacity, and their own interests in learning and pursuing STEM careers. More than half indicated that their experience facilitating Build IT had influenced their career or educational paths and indicated interest in STEM careers. These women as well as the girls are the target audience for the program.

METHODOLOGY

Research Questions

The work of developing, implementing and evaluating Build IT has been guided by three research questions:

- Are girls engaged, achieving IT fluency, and interested in pursuing IT careers, including taking high school mathematics and computer science courses necessary to pursue these careers?
- Is staff capacity at each site increased and supported in order to offer this IT fluency programming?
- Is this curriculum sustainable in different settings?

In the course of answering the research question about staff capacity, we found that some staff were indicating interest in or pursuing careers in STEM fields. As detailed below, in response to those initial findings, we developed additional instruments (surveys of after school educators who work directly with youth) and delved further into existing data to answer the following research questions, which are the primary focus of this paper:

- Does the program have an effect on after school educators' comfort with facilitating technology and STEM activities with the girls? To what degree?
- Does the program have an effect on after school educators' own STEM education and career interests and plans? To what degree?

While we focus on the after school educators for the rest of the paper, we provide an overview of the participants, data collection, and analysis for the girls' data to provide a context for the influence of the curriculum on the after school educators.

Participants

After school Educators. The primary sample for this research is the adult after school educators who participated in the full scale-up of Build IT from 2010 to 2012. Of the 31 people who facilitated during the full scale up of Build IT, all are women and 55% are women of color, primarily African American and Latinas, women who are underrepresented in STEM professions. Though we do not have reported ages for all after school educators, the training manager at the national organization who met regularly with the 31 educators, both in person and on the phone, estimates that only 5 of the 31 women are older than 39 years of age. In other words, the women who participated are in transitional jobs (after school educator) and are at a time in their lives when they are considering career options.

These after school educators facilitated Build IT for one year, each completing three of the six units that make up Build IT. Two of the 31 facilitators led Build IT at more than one site. All facilitators received a three-day training on Build IT followed by three webinars and email or phone communication with training staff throughout the year.

Data were collected from interviews with staff, observations of professional development sessions, staff implementation reports, and surveys completed immediately prior to and immediately after the three-day professional development sessions. (See Table 1 for details on these instruments.) From this data, we know that most of these educators were not familiar with computer science concepts when they began the program. For example, at one professional development session, nine of eleven after school educators said they had never done any coding, fewer than half thought they could explain how a computer worked, and only two thought they could describe how information travels through the Internet. At the majority of sites, however, the staff willingly volunteered to take on the new role of facilitating this computer science program, and they all shared the belief that learning about computers was important and would give girls more career choices.

Girls Participating in the Program. While the primary participant for the research reported in this paper is the after school educator, the girls participating in Build IT are the target audience for the curriculum. The data and findings shared on their participation provides context on the impact of the Build IT program.

The majority of the girls participating in Build IT are from minority backgrounds (35% African American, 19% Latina, 3% Asian American/Pacific Islander, 2% Native American, 8% multiracial); 56% of the girls come from families with annual incomes of less than US$25,000; ages range from 10 to 14. Almost all of the participants in this technology program join a larger after school and summer program, rather than signing up for the technology program specifically. Thus, the participants are not likely to be predisposed to have positive attitudes toward technology, access to computers or the Internet, or interest in IT careers. According to after school staff, for many of the girls, this program is one of the few ways they have regular access to technology, opportunities to design technological solutions, and exposure to IT careers.

Data Collection

Researchers used a mixed-methods approach to evaluate the scale up of Build IT. The evaluation has included both quantitative and qualitative components, led by evaluation teams in different organizations. The qualitative evaluation was internal, conducted by a research team from SRI's Center for Technology in Learning, the learning science organization who developed the program, and by evaluators contracted to SRI, often graduate students in the social sciences who lived or worked near the implementation sites. The researchers leading the evaluation trained these local evaluators and maintained close contact with them throughout the process. External evaluators from a separate organization conducted the quantitative evaluation.

To gather quantitative data, the evaluators surveyed girls and administered assessments to examine changes in their self-reported perceptions of and interest and confidence in STEM fields, their computer usage and skills, and their assessed understanding of IT concepts. Both the attitudes survey and the IT concepts assessments were developed for Build IT and have been refined throughout the piloting and scaling of the program. There is an assessment for each of Build IT's units, allowing evaluators to focus their attention on those concepts girls are expected to learn in each section of the curriculum. Concepts assessed include understanding of the design process (5 items), communication tools and the Internet (4 items), redesigning the web (4 items), networks and networked applications (4 items), and designing and programming a game (4 items).[1] Items were four-option multiple-choice items.

The IT Attitudes Survey applied across units of the curriculum, and included subscales focusing on mathematics usefulness and confidence (6 items), frequency of computer use (12 items), computer skills (9 items), confidence with computers (3 items), attitudes toward computers and computer work (6 items), and gender-neutral views of careers (4 items). The subscales are five-point Likert-type scales and internal consistency ranges from .721 to .865.[2]

To capture qualitative data, researchers from the internal evaluation team interviewed and observed girls participating in Build IT, focusing on girls' interest and engagement in IT learning and careers. The internal evaluation team also interviewed, observed, and collected implementation reports from staff. External evaluators also conducted annual interviews with both program and management staff. Finally, 25 after school educators and 22 affiliate leaders completed online surveys to document their impressions of how well Build IT met girls' and organizational needs, how well Build IT addressed professional development needs, their plans to continue or discontinue implementing the program, and after school educators' self-reported individual IT learning and career interests. Response rates to the survey were fairly high; 83% of the after school educators responded and at least one director or manager from 87% of the affiliates responded. Table 1 provides details on the data sources for these after school staff.

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[1] A sample item from the Design Process assessment: *Sandra thinks software engineers get their software designs right the very first time. Donna thinks they don't. Which girl is right and why*? Answer choices: *A. Sandra, because engineers think about everything that needs to be designed ahead of time. B. Sandra, because engineers have to do their work before users can give input. C. Donna, because software engineers usually try out multiple designs with users before settling on a final design. D. Donna, because engineers can't plan ahead of time how to program the software*. A sample item from the Redesigning the Web assessment: *You are a web designer and you just found a really cool website. You want to use some of their code. What would you do?* Answer choices: *A. Call the website designer. B. Go to the library and get a book on HTML. C. Bookmark the web page. D. Use View Source in your Internet browser*

[2] Sample items, which had five point Likert scale response options, included: *I can learn mathematics*, *I can tell someone how to use a computer program (like Microsoft Word) or perform a particular function (like open a new file)*, *I am good with* computers, and *Knowing how to work with computers will give me more job choices.*

Table 1. Data Sources for After school Staff

Data Source	Frequency	Focus
Staff Interviews	One interview at the end of each curricular unit	Implementation of the curriculum, supports for implementation, perceived outcomes for participants and staff
Observations of sessions	Two observations per unit	Girls' learning and engagement, implementation fidelity, staff proficiency with the curriculum
Observations of professional development sessions	Approximately three times annually	Implementation fidelity, staff learning and comfort with the curriculum, formative suggestions for future professional development sessions
Staff professional development survey	Before and after PD sessions	Short surveys to capture staff members' prior technology experience, comfort with technology, expectations for the PD, understanding of and comfort facilitating the curriculum, and whether or not PD met expectations. Used formatively by PD providers to ensure that PD and ongoing support met staff needs.
Staff implementation reports	Weekly	Staff comfort with the curriculum, impressions on how sessions had gone, suggestions for future iterations of the program
Staff Survey	Once at end of program duration (3 units). Response rate: 83% (25 respondents)	How well the program met the girls' and organizational needs, professional development needs, plans to continue or discontinue implementing the program, and staff's individual IT learning and career interests
Affiliate Leaders Survey	Once at end of program duration (3 units). Response rate: at least one leader from 87% of affiliates (22 respondents)	Affiliate leaders' impressions of how well the program met the girls' and organizational needs, staff professional development needs, and their plans to continue or discontinue implementing the program.

Evaluators took field notes during interviews and observations. After each interview or observation, they cleaned their notes and used the notes to respond to a series of prompts on topics of importance to the evaluation. Relevant to this research, topics included outcomes for staff capacity to implement the curriculum.

Data Analysis

Qualitative data—implementation reports and written notes and responses from interviews and observations—were analyzed using both an emergent coding scheme in the tradition of grounded theory (Glaser & Strauss, 1967) and predefined codes based on Build IT's goals, such as girls' interest in IT careers. The researchers leading the formative evaluation, two junior researchers who had spent time in the field and a senior researcher advising the project, developed the codes. These researchers read and coded the data iteratively, coming to agreement on the meaning of the codes prior to coding any data separately. Most data were read by at least two researchers in the course of development of the codes and coming to agreement on code meanings. Following coding, two researchers read the data by code, typically each taking a section of codes for analysis and memo writing, then reading and critiquing the memos written by the other researcher. These memos serve as the basis for the research reported on here.

Additionally, quantitative data including girls' survey responses and assessments were coded and descriptive statistics were computed for each item as well as the composite scales by an external evaluator. Descriptive statistics included estimating means and frequencies. Paired sample t-test analyses were used to statistically compare the responses from pre and post administrations of the IT concepts assessment. For the IT Concepts assessments, Chi-square analyses were also utilized to statistically compare the responses from pre and post administration on each item.

Annual interviews of staff involved in the Build IT program conducted by external evaluators serve as an important data source, and also allow us to triangulate formative evaluation findings. The external evaluator's analysis of these interviews serves as a data source for the research reported here.

Finally, we analyzed after school educators' and affiliate leaders' survey responses for this research. For quantitative items, we use basic descriptive statistics for analysis, calculating percentages of responses. Written responses to open-ended items provide further explanation of the quantitative data. Note that we did not link survey responses to individuals so we cannot aggregate data by age or race. We hope to be able to this further in future evaluations of the program.

RESULTS

We briefly describe the impact of Build IT on the girls to provide context of the program's effectiveness on its target audience, the girls, then describe the impact of the program on the after school educators who provide the program to the girls and are the focus of this paper

Impact on Girls

Build IT has had success in achieving intended outcomes for girls and for developing organizational capacity to sustain and scale the program.
The data show that the program motivates girls to explore IT and pursue IT careers. Girls who saw IT careers as solitary and boring began to see them as collaborative, fun, and intellectually stimulating; many participants started to see IT as a possible career. Girls in Build IT strengthened their technology fluency. In the pilot scale-up, girls reported an increase in their technology skills, and assessments showed improved IT knowledge. Their attitudes toward mathematics and computing also changed. We saw statistically significant improvements in girls' frequency of computer use, self-reported computer skills, perception of the usefulness of mathematics, and confidence in using mathematics. Similarly, in initial implementation at one affiliate, we saw a statistically significant change in participants' conceptual understanding, as compared to that of a similar group of girls not participating in the program.

In addition, girls who participated in two years of Build IT scored higher on assessments of IT conceptual understanding than girls with one year or less of participation. Finally, data from the initial implementation with one affiliate indicate that participants with multiple years of exposure to the curriculum increasingly planned to take computer-related courses and college-track mathematics courses.

Impact on After school Educators

After school educators have demonstrated increased staff capacity to offer Build IT, as well as growth in their comfort with facilitating technology and STEM activities with the girls. Many after school educators also credit the program with influencing their interest in and pursuit of their own STEM education and careers.

Building Staff Capacity

The data from implementation in 21 affiliates (33 program sites) show that Build IT is building capacity and proving sustainable and scalable in an after school network. The majority of the Girls Inc. affiliate leaders surveyed said that the program meets the needs of their community, aligns with their affiliate's goals, and they believe that their staff is comfortable implementing Build IT. The majority of these leaders plan to continue offering the program beyond the scale up grant from The Noyce Foundation.

Comfort with Technology

Through interviews and observations, we have seen increases in after school educators' comfort with technology, much of which they attribute to Build IT. In particular, they often become comfortable troubleshooting technical problems; it is not uncommon to see an educator rooting around their after school site's server closet. One said, "My Internet went down the other day and it said ISP and LAN and all that stuff…and I was like, 'Wow, I know what these things mean.'" Another said, "I can do HTML with my eyes closed now." She said it takes her less and less time to figure out what error is causing a girl's page not to work in the Web design unit.

After school educators described how they learned how to use more computer functions as well as different Web applications. One educator said, "Before I just checked my email; now I know there's much more," while another said, "You can go beyond MySpace, you can create an online journal, vote, and all these features." A third said, "Everything my girls learned, I learned."

Even those who were already comfortable with computers said they had grown from implementing the program. One said, "In Build IT I had a lot of 'Aha!' moments. I've always been comfortable with computers…but I think Build IT helped me take it to another level."

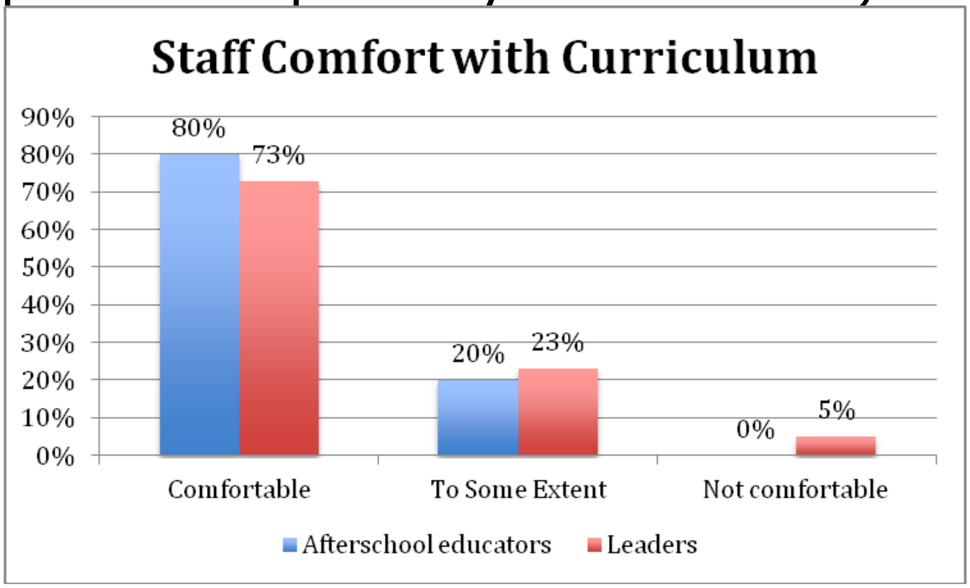
Comfort Facilitating STEM Curriculum Activities

Data from observations and interviews show increases in after school educators' confidence with the computer programming aspects of the curriculum, such as HTML and object-oriented programming. Though initially they tended to be reluctant to take on the more technical aspects of the curriculum, such as programming a game, we have seen that over time they begin to look forward to these challenges, rather than seeing them as a hurdle. One said, "I was a person who didn't really like computers…but Build IT really opened my eyes. I can do HTML now, I know all about hyperlinks, all kinds of things."

Asked if they were comfortable facilitating the curriculum, 80% of after school educators (20 of the 25 respondents) said they were comfortable, 20% (5 of 25) said they were comfortable to some extent, and none said they were not comfortable (see Figure 1 below). They were clear in their remarks that becoming comfortable had been an involved process: one mentioned "reading and re-reading the curriculum and attending implementation meetings," another said "I did have a lot to learn and prep[are] before facilitating," and a third said, "I feel I am learning along with the girls." One educator recommended that after school educators employ troubleshooting to get themselves through difficult spots and noted that she "enjoyed learning all this stuff, [be]cause I knew almost none of it before facilitating".

The affiliate leaders' survey responses correspond with their after school educators' responses. Seventy-three percent (16 of 22) said their staff were comfortable facilitating the curriculum; an additional 23% (5) said their staff members were somewhat comfortable; and one affiliate leader (5%) perceived their staff not to be comfortable. Several leaders said training had been critical; one noted, "Before the training, I would [have said] no [the staff were not comfortable with the material], but after participating in the training, I would definitely say yes." Another said her staff member "had to go out of her comfort zone several times, but that helped her understand." A third said, "Although our staff members were very unfamiliar with IT programming and the curriculum seemed intimidating at first, the Build IT philosophy that girls can do anything helped our staff feel more comfortable trying something new and mastering it."

Figure 1. After school educators' comfort with the curriculum (self-perceived and as perceived by their affiliate leaders)



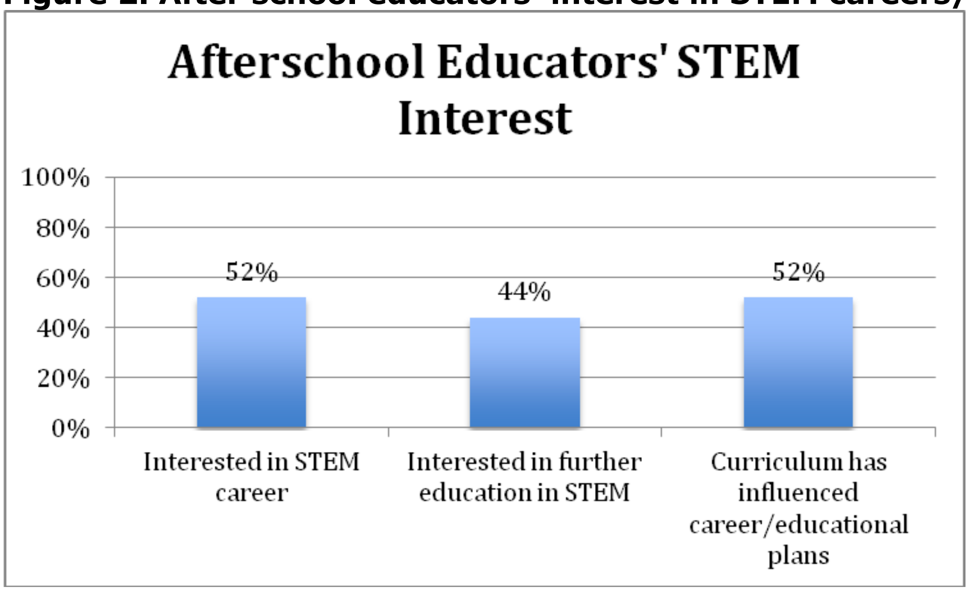
[25 of 31 after school educators and 22 leaders from 21 affiliates responded to the survey]

In addition to these positive signs of staff's comfort with STEM curriculum, we have also seen areas with room for growth. Specifically, we have noted that in the first year of implementation, staff may struggle with going beyond the teaching of technology skills to the teaching of IT concepts, such as understanding how the Internet works to aid in girls' design of Internet applications. In that first year, they also struggle with engaging IT professionals and doing the mathematics activities. Staff members need pointers on how to connect with IT professionals. In the first year, it helps to have a affiliate leader at the after school site brokering these relationships. Once the staff member connects with local professional organizations, universities, and their board members, even the most remote sites are successful in recruiting IT professional role models to participate in Build IT. For example, a rural Girls Inc. in Massachusetts connected with a local university. The university's professors were able to participate in the program as IT professionals themselves and also provide connections to local IT professionals who were former students or colleagues. Comfort with the mathematics takes time and professional development support. All of the above mentioned areas with room for growth continue to be a focus of the face-to-face professional development sessions as well as the ongoing professional development online. Experienced staff members in the network of sites have made themselves available for consultation via an online group in which all staff members participate.

Interest in STEM Education and Careers

Encouraging these after school educators to pursue careers in STEM fields was not an original goal of Build IT. Yet we have seen evidence in interviews with staff and in the staff survey that many staff are considering such careers, and some have take action, using the program as a jumping-off point for further educational and career opportunities. More than half of the after school educators who responded to the survey—52% (13)—said they were thinking of pursuing a career that involved STEM and 44% (11) said they were thinking of pursuing further education in STEM (see Figure 2 below). One staff member moved to a technology job; another entered an educational technology MA program. Others mentioned that they were considering going into web design, continuing to teach STEM programs, considering a tech college or a Masters in a tech-related field, and minoring in computer science. One woman said, "I realized that I missed my prior love for all things STEM. I am returning to my roots by pursuing a STEM related degree." Some after school educators have created roles within their organizations as coordinators for the curriculum, in effect building a career ladder for STEM-focused after school educators and a built-in support for the program. For example, some affiliates have established STEM coordinator or Build IT coordinator roles to support after school educators at multiple sites in their affiliate.

Figure 2. After school educators' interest in STEM careers/education



[25 of 31 after school educators responded to the survey]

The after school educators also indicated knowledge of the possibilities available in STEM fields, a curriculum component for the girls who participate, but evidently one that impacts staff as well. One after school educator, who is pursuing an MBA, said, "After facilitating Build IT and learning about many (very profitable) careers in the technology field, I have decided that my MBA focus will be technology." Another, thinking of going back to school, noted, "there are so many interesting, lucrative career opportunities in technology." A third said, "Build IT has helped me understand the importance of STEM in education systems today".

Though it is impossible to know all the influences on these young women's career plans, many—52% (13)—indicated that their experience facilitating Build IT had influenced their career or educational plans (see Figure 2). The ways the program influenced them varied, from simply increasing their interest in learning about technology, to helping them in their pursuit of other fields, to encouraging them to pursue STEM careers for themselves. One woman, for example, felt the Build IT had helped with her study of psychology by improving her understanding of mathematics. Another shared, "I feel confident now being able to design my own web-based business, which I probably would not have thought of much before Build IT. I also find that I give more thought to design principles in daily life."

DISCUSSION

After school educators who facilitate this computer science program overwhelmingly indicate that it has helped them become more comfortable with technology and other STEM concepts. They also indicate that Build IT has piqued their interest in STEM studies and careers This last outcome was unanticipated, but not unwelcome: it too accomplishes the programmatic goal of encouraging young women, particularly women of color, to consider and pursue STEM careers. Statements from staff and their managers indicate that Build IT had this unexpected outcome at least in part due to a comprehensive professional development model. Based on our research and the research literature, we speculate that the co-design process used to develop Build IT and the educative curriculum materials approach taken in the curriculum also encouraged the type of staff learning and increased STEM interest described above in the results section.

Professional Development

Research on youth development has documented the importance of a cohesive approach to developing and implementing curricular materials and professional development supports. Effective professional development for youth workers suggests that a system including standards, learning resources and materials, career ladders, and research and evaluation can improve program quality (Stone, Garza, & Borden, 2004). The After school Corporation in the United States examined high-performing after school organizations and found that such organizations had experienced site coordinators with a strong vision, held annual staff orientation sessions and periodic trainings throughout the year, offered mentoring for less experienced staff, incorporated formal and informal evaluations into their work, and had a collegial staff community (Birmingham, Pechman, Russell, Mielke, 2005). Research on STEM education programs indicates the importance of having educators—not just students—work with and learn from external STEM experts and taking advantage of training opportunities that come with the materials or program being used (Freeman, Dorph, & Chi, 2009).

Youth development organizations, such as Girls Inc. affiliates, experience high staff turnover; an organization may train staff to implement a program one year, only to lose those staff the next year, potentially losing their capacity to implement that program. To achieve sustainability of the program, an organization may train management level staff as well as the after school educators to encourage organizational memory for the program (Koch, Gorges, & Penuel, 2012). For Build IT, a program manager who supervised the staff implementing the program worked side-by-side with learning sciences researchers and program developers to design and deliver professional development. With the first implementation of a unit, research organization staff led the professional development; for the second implementation, the organizations co-led the professional development. By the third implementation, after school educators and their managers led the professional development, inducting staff new to the organization into Build IT. Through a similar process, the Girls Inc. national organization became a leader of the professional development for Build IT able to train affiliates new to Build IT.

Build IT is successful in part because ongoing professional development was already part of the Girls Inc. infrastructure, at each Girls Inc. affiliate and through the Girls Inc. national organization. Like many other youth-serving organizations, these affiliates experience frequent turnover in staff but they also have a relatively stable core of program managers who supervise these program staff. To promote organizational memory at each affiliate, an affiliate director or manager and an after school educator who works directly with girls are required to attend trainings. Using a teacher-as-student approach in the training sessions, after school educators are able to explore concepts as the girls would (Wei & Hammond et al., 2009) and then discuss the facilitation techniques they have just experienced that helped them with their own learning. Ongoing supports involving face-to-face sessions at affiliate sites and regional conferences, webinars, and online support continue this strategy of moving from after school educator as learner to reflections on facilitation strategies to support learning.

Co-design Process

The development team created the Build IT's professional development as well as the curriculum using a co-design approach to promote STEM learning in a youth development context. For Build IT, two organizations, one focused on research and development in the learning sciences, and one a provider of youth development programs for girls, worked together for three years to develop, implement, and refine Build IT. In later years, other affiliates of Girls Inc. implemented Build IT, with the national organization leading professional development. At first glance, engaging in co-design as a means to achieve sustainability may seem overly difficult: coming to agreement on curricular goals and how to achieve them, and following a structured process for curriculum iteration are time-consuming. Yet co-design can help develop greater ownership over designs, strengthen STEM content, and make it more likely that designs will be usable in real settings (Roschelle, Penuel, & Schectman, 2006).

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

Educative Curriculum Materials

Throughout this co-design process, the team incorporated educative elements into the curriculum that teach after school educators as much as they teach the girls. The embedded information and pointers help after school educators to understand and enact the curriculum. Educative curriculum materials increase educators' knowledge in specific instances of instructional decision-making and help them develop more general knowledge that they can apply flexibly in new situations (Ball & Cohen, 1996; Davis & Krajik, 2005). In Build IT, the educative elements include computer science and information technology concepts and research-based practices for engaging girls in these concepts. They help staff to access information, learn subject matter, anticipate and interpret what learners may think or do, understand the developers' pedagogical judgments by making them visible, and relate units and big ideas.

Together, the professional development and curricular materials continue to teach after school educators computer science concepts and encourage positive attitudes towards computer science careers.

CONCLUSION

Recent research and after school professional development efforts have focused on the importance of building STEM capacity in after school providers, particularly for those frontline staff who may have little STEM experience. This paper provides evidence that after school educators with little STEM background can facilitate STEM experiences for youth; and that they themselves can grow in their own STEM knowledge and interest from the experience. After school staff who facilitated the computer science program for middle school girls described here became more comfortable with technology and other STEM concepts, and many became interested in pursuing STEM studies, formally or informally, and pursuing STEM careers. Given that these staff members are primarily young women and many are women of color, these unexpected-but-welcome results help to achieve Build IT's original goal of encouraging women from minority backgrounds to feel confident with science, technology, engineering and mathematics and to consider careers for themselves in those fields. As one staff member said about the Build IT, "I'm ready to surf the technology wave of the future, thank you!"

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