STEM in Out-of-School Time Programs

This research brief examines the frequency with which science, technology, engineering and math (STEM) curricula are taught in out-of-school time (OST) programs and the comfort level that OST staff report when teaching STEM.

STEM education is a key component to the United States' efforts to remain a leader in innovation and a world economic frontrunner.[1] Accordingly, policymakers have advocated for STEM education in OST programming to supplement K-12 STEM efforts.[2] Studies point to negative impacts on achievement and superficial treatment of STEM lessons when teachers are not comfortable with STEM curricula.[3,4] Nadelson et al. elaborated that in focusing on "the nature" of teachers' discomfort with STEM,[4] policymakers must identify particular forms of professional development that can ameliorate discomfort and in turn enhance instruction.

The Survey

Responding to the national call for STEM in afterschool, the Pennsylvania Statewide Afterschool/Youth Development Network (PSAYDN), the Out-of-School Time Resource Center (OSTRC) and a workgroup of STEM stakeholders* surveyed OSTs in several Pennsylvania OST networks about the status of their STEM activities. The survey, administered in Spring 2013, was central to a grant from the NOYCE Foundation that promoted STEM in Pennsylvania, particularly the development of governance, collaboration and networks that support STEM in OST programs. Its purpose was to investigate the frequency of STEM activities, professional development related to STEM and other

areas. These data enable a statewide analysis of STEM instruction, STEM activities and OST characteristics.

Respondents

This research brief focuses on 133 direct service staff who responded to the survey. The respondents represent 28 Pennsylvania counties, with 42 percent of responses from Philadelphia and Allegheny counties. OST enrollment in these respondents' programs varied; about one-fifth have fewer than 30 students, about one quarter have between 31-50 students, another quarter have 51-100 students, while the remainder serve more than 100 students. K-5 and 6-8 graders are the most common age groups served by these OST programs. About 67 percent of all respondents had a bachelor's degree or higher, although only about 16 percent of respondents had a STEM-related degree. The majority of OSTs (65 percent) are situated in school-buildings (the most common location of OSTs), while others are located in community/recreation centers (15 percent) or religious organizations (11 percent).

This brief examines *relationships* between comfort teaching STEM in OSTs and staff/organizational characteristics. Given the sampling methods used for the survey, the analysis is not meant to be a definitive estimate of Pennsylvania's OST program population; however, this analysis begins to

uncover important *patterns* related to teaching STEM. Furthermore, while the analysis uses a smaller convenience sample, the respondents represent a diverse range of OSTs which helps to increase the sample's reliability.[5] Additionally, this analysis presents an important exploration of the instructional experiences of direct service staff.

Frequency and Type of STEM Instruction

Survey respondents made varying allocations of their program time to each STEM area. Respondents were permitted to report overlapping allocations of their time, because STEM subject areas overlap. Math and science were the most common STEM areas. About 62 percent of respondents dedicated more than one-fifth of their program time to math and 50 percent of respondents dedicated more than one-fifth of their program time to science. Technology and engineering were less common. About 43 percent of respondents dedicated more than one-fifth of their time to technology, while only 26 percent dedicated this amount of time to engineering. Finally, OST staff utilized a range of instructional activities in their efforts, most commonly hands-on activities (94 percent of respondents), small-group activities (85 percent), discussions (71 percent) and experiments (73 percent) (Figure 1).

While many staff were comfortable teaching STEM curricula, important proportions were not. For instance, 48 percent of all respondents indicated they were only "Slightly" or "Not At All Comfortable" teaching engineering curricula. Additionally, 19, 25 and 20 percent of respondents also reported they were "Not At All Comfortable" or only "Slightly Comfortable" teaching in science, technology and math curricula, respectively.

How "Comfort" Varies

Characteristics of respondents and their organizations help to explain the levels of discomfort among OST staff. Figure 2 presents six sets of bars, with each set exhibiting a different individual or organizational characteristic correlated with comfort teaching STEM curricula. The first and second set of bars shows that greater levels of comfort teaching STEM subjects were evident among respondents holding a STEM degree compared to those that did not. For example, when staff had a STEM degree

they were more likely to be comfortable teaching science (95 versus 79 percent), engineering (62 versus 50 percent) and math (91 versus 79 percent). Differences for technology were not statistically significant.

Characteristics of OSTs also related to the comfort staff had teaching STEM. Specifically, greater levels of comfort were associated with the frequency that STEM curricula were taught in an OST. For instance, the third and fourth set of bars show that when OST sites reported that they dedicated 50 percent of their programmatic time to at least two STEM areas ("two or more" in Figure 2), staff were more likely to report being comfortable teaching STEM curricula than those in the "one or no" category. The data show that respondents in the "two or more" category worked at sites with comprehensive approaches to STEM, where multiple STEM areas intersected frequently. Among staff in sites with more STEM programming, 96 percent of respondents were "somewhat" or "very" comfortable teaching

science while only 78 percent of respondents were as comfortable in OSTs teaching STEM less often. A similar pattern exists with technology, while for engineering about 80 percent were somewhat or very comfortable if their OSTs taught STEM frequently while only 45 percent were as comfortable in OSTs teaching STEM less often. Differences for teaching math curricula were not statistically significant.

Another organizational characteristic correlated with comfort teaching STEM is the frequency that OSTs form networks with different organizations (fifth and sixth set of bars). Greater levels of comfort teaching STEM were associated with more frequent networking with external organizations (such as with museums, businesses, environmental centers and higher education). For instance, 92 percent of respondents working with more networked OSTs were "somewhat" or "very" comfortable teaching science while 77 percent of respondents felt this way in less networked environments. About 92 percent of

Figure 1: Percentage of Respondents Reporting Activities Utilized in STEM Instruction
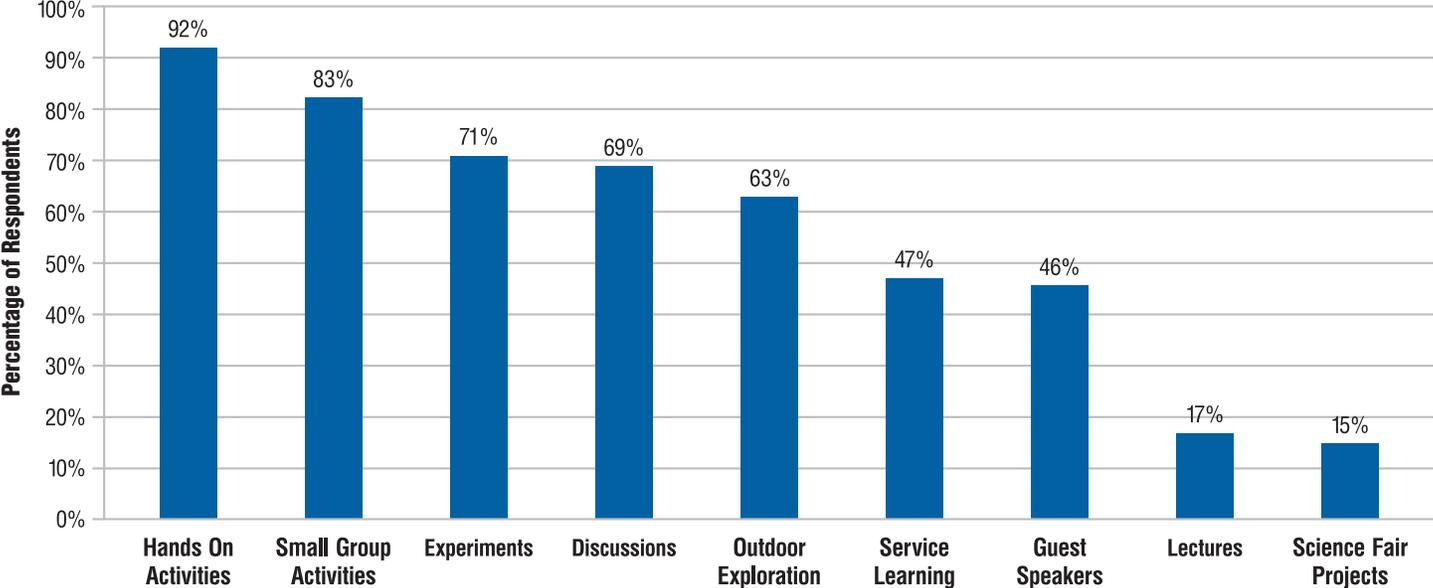
NOTE: Multiple response item.

respondents were similarly comfortable teaching technology in more networked organizations, while 69 percent were comfortable in less networked organizations. About 67 percent of respondents in more networked OSTs were comfortable with engineering while only 46 percent in less networked OSTs were. Differences for math were not statistically significant.

Implications for STEM in OST

National education STEM goals seek to grow the number of high quality scientists, and science literacy generally, in the United States. OST programs have been cited as one way to increase "child and youth literacy and engagement in science."[6] To win children's engagement and achievement in science, OST staff must have sufficient STEM knowledge and inquiry techniques, as well as the comfort to apply them.[7]

OST programs need to build staff confidence in teaching STEM curricula. To do so, Pennsylvania OST programs can take at least two key actions. First, Pennsylvania OST programs can designate specific training necessary for teaching STEM curricula based on program quality standards.[8] Such standards will provide OST administrators with guidance on how to recruit and train OST staff. Professional development that imparts STEM knowledge and related pedagogy is a prudent investment for OST staff,[9] given that one-fifth or more of respondents in this study were uncomfortable teaching STEM subjects, particularly in engineering. Indeed, 65 percent of survey respondents said that "more time to study STEM" and "time to attend STEM workshops" would be "very" or "highly" likely to impact STEM teaching at their OST. Second, OST programs can increase their networks with universities, museums and science centers to mentor OST staff about STEM. University networking also complements efforts to define quality standards because higher education faculty can assist OST staff with STEM assessment indicators and content. Future research should examine these recommendations with larger and more representative samples.
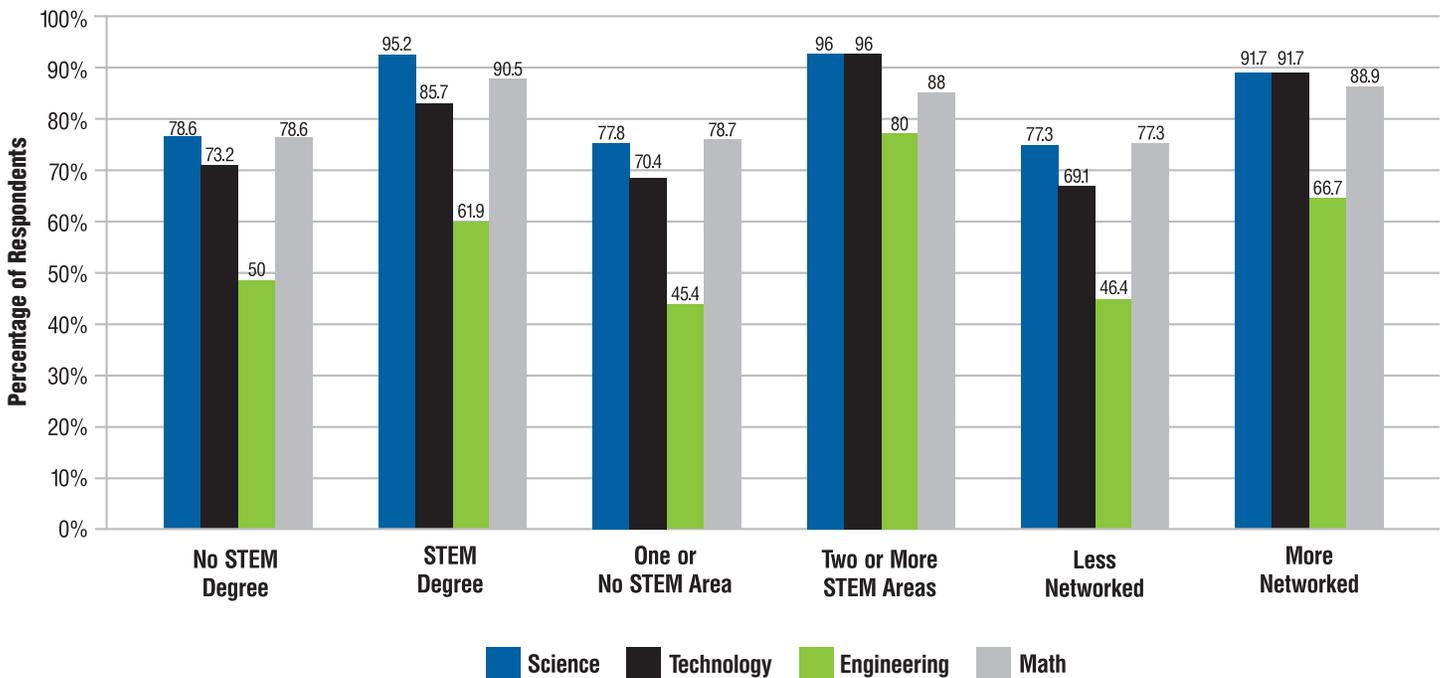
These recommendations need not yield STEM content experts for OST programs. However they can enable staff to balance their youth engagement skills with inquiry-based learning and enable students to use discovery and curiosity to build scientific aptitudes in the process.[10] Highly qualified staff are increasingly important as OSTs confront challenges of limited resources and meeting myriad other goals irrespective of STEM. Nonetheless, if OST programs are to play a role in growing more STEM college graduates, additional professional development, technical assistance and expanded networks are likely to be necessary.

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Figure 2: Percentage of Respondents Who Are "Somewhat" or "Very" Comfortable Teaching STEM

Bar chart. Y-axis: Percentage of Respondents (0% to 100%).

Category	Science	Technology	Engineering	Math
No STEM Degree	78.6	73.2	50	78.6
STEM Degree	95.2	85.7	61.9	90.5
One or No STEM Area	77.8	70.4	45.4	78.7
Two or More STEM Areas	96	96	80	88
Less Networked	77.3	69.1	46.4	77.3
More Networked	91.7	91.7	66.7	88.9

Legend: Science, Technology, Engineering, Math

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