PLANETS

Assessing the Content and Instructional Needs of Out-of-School Time (OST) Educators for Teaching Integrated Science and Engineering Curricula

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Acknowledgements

This needs assessment was conducted as part of work on the PLANETS (**P**lanetary **L**earning that **A**dvances the **N**exus of **E**ngineering, **T**echnology, and **S**cience) project. PLANETS is an interdisciplinary and cross-institutional partnership to develop and disseminate out-of-school time (OST) curricular and professional development (PD) modules that integrate planetary science, technology, and engineering. The Center for Science Teaching and Learning (CSTL) at Northern Arizona University (NAU), the U.S. Geological Survey (USGS) Astrogeology Science Center (Astrogeology), and the Museum of Science (MOS) Boston are partners in developing, piloting, and researching the impact of three out-of-school time planetary science and engineering curriculum and related PD units over the life of the project. The purpose of *PLANETS* is to increase public awareness and use of NASA resources by highlighting the relationship between science, technology, engineering, and mathematics (STEM) in the context of planetary science in out of school time settings. This project is supported by NASA under cooperative agreement NNX16AC53A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration.

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PLANETS Background

Science, Technology, Engineering and Mathematics (STEM) research and products influence and inform nearly every facet of modern society including sustainable living, health and medicine, communication, transportation, and environmental changes. Yet, too few Americans have the scientific and engineering literacy to make informed decisions about important societal issues, much less contribute significantly to the STEM workforce. Students in many other countries outscore US students in international comparisons of STEM learning (Kelly et al., 2013) and research indicates that the competitiveness and innovative capacity of the US is decreasing overall.

To respond to poor scientific literacy and inadequate participation in the STEM workforce, engaging youth in high quality STEM learning experiences is critical to improve interest and knowledge in these areas. However, many schools are already overextended with a focus on language arts and mathematics, leaving little time for science, let alone integrated STEM learning opportunities. To respond to this need, Out-of-School Time (OST)[1] programming has shifted to include more opportunities for science and STEM learning (National Science and Technology Council, 2013; Noam & Shah, 2013a). OST programs also offer more flexibility than the traditional school setting and allow more time for exploration and decision making (Noam & Shah, 2013a), both critical for authentic STEM learning. Programming in these informal OST environments, such as after school and camp programs, often place a high value on 21st century skills, such as fostering teamwork, community building, and creativity, which are also important attributes for STEM learning. Concurring with this trend, NASA's Education Design Team noted, the informal learning environment plays an important role in engaging and inspiring learners (National Aeronautics and Space Administration [NASA], 2011). As an OST leader contends,

> Science is really ideal for the after-school setting because…it's 'segue' science that is fun and engaging. It encourages youth to be more involved in science, to think about science careers, to get interested in answering questions (Freeman, Dorph & Chi, 2009).

Participating in quality OST STEM experiences has also been identified as leading to positive gains in students' attitudes towards science, including STEM interest, STEM identity, STEM career interest (Allen et al., 2017), and gains in 21st Century Skills (Afterschool Alliance, 2011, Allen et al., 2017). Participation may also lead to learning gains (Afterschool Alliance, 2011). OST programs serve significant populations of youth underrepresented in STEM fields, thus STEM enrichment may be able to reduce the opportunity gap of these students (Afterschool Alliance, 2011). However, leveraging these environments to develop STEM and 21st century skills in a way that promotes STEM thinking requires the development of high quality STEM activities and programs that are appropriate for the OST setting. Such programs engage learners, respond to their backgrounds and interests, and connect with home and communities (National Research Council, 2015).

[1] Definitions of commonly used terms are on page 12.

In addition to high quality curricular materials, effective OST educators are also critical in order to facilitate successful OST STEM learning experiences for youth. OST educators shape the learning environments and the educational experiences of learners, which are especially important for effective STEM learning for girls (Davies, 2009; Fancsali, 2002) and underserved populations (McClure, Rodriguez, Cummings, Falkenberg & McComb, 2007). Effective facilitators can inspire learning in youth, through supporting curiosity and sense-making, without offering too much guidance, which can stifle learning (Fenichel & Schweingruber, 2010, p. 77). Many OST educators, however, do not have the scientific or pedagogical background to facilitate STEM learning in these environments. As Freeman et al., (2009) identify, "transforming the existing cadre of afterschool instructors into effective facilitators of STEM learning will require significant attention to and investments in staff development" (p. 5).

With funding from NASA, Planetary Learning that Advances the Nexus of Engineering, Technology, and Science (*PLANETS*) is a five year project designed to meet this need by inspiring youth interest in planetary science and STEM through activities focusing on improving awareness, interest and habits of mind. The PLANETS project is also developing and piloting PD for OST educators to expand their capacity for STEM teaching and learning, and to prepare them to teach the newly developed science and engineering curricula for youth in their programs. This effort is being spearheaded by the Center for Science Teaching and Learning (CSTL) at Northern Arizona University (NAU), the U.S. Geological Survey (USGS) Astrogeology Science Center (Astrogeology), and the Museum of Science (MOS) Boston. Since 2016, these groups have been working together to develop, pilot and investigate the impact of three out of school time planetary science and engineering curriculum and associated PD in OST settings at the elementary and middle school levels.

Assessing the needs of (OST) staff and supervisors for better PD products

Planning the PD for the PLANETS curriculum is a complex and multifaceted task. A literature review identified that little is known about how prepared OST educators are to teach STEM or what their content or pedagogical professional needs are to be effective facilitators of science and engineering design. In order to better understand these needs and structure and design the PD accordingly, the PLANETS team conducted a comprehensive needs assessment, using several lines of evidence. Our goal for the needs assessment was to identify the gaps between the self-identified skills and abilities of OST educators, and the desired skills and abilities that effective OST educators should have. In order to deliver PD that OST educators can access and use, a second goal for the needs assessment was to identify current PD opportunities for OST educators and what strategies and platforms for PD would be most effective for their continued professional learning. From these goals we identified four critical questions:

- **What are the current conditions in OST programs, who teach in these programs and what professional development do they use?**

- **What instructional support do OST educators need to facilitate high quality STEM instruction?**

- **What content support do OST educators need to implement high quality STEM instruction?**

- **What are the best ways to meet these needs through professional development design, accessibility & utility?**

Sources and methods

Data from multiple sources and methods was collected to enhance the depth of the needs assessment, triangulate results, and confirm findings (Creswell & Plano Clark, 2007). Data included:

1. **Literature review:** To identify current conditions of OST educators and their PD opportunities, we conducted a literature review in the spring of 2016.

2. **National survey:** To identify the breadth of experiences and needs of OST staff and supervisors, we conducted a national survey in the fall of 2016 with OST educators nationwide.

3. **Supervisor interviews:** To identify the depth of experiences and needs we conducted interviews with a selected group of OST supervisors in December 2016.

Executive Summary

With an increasing emphasis on STEM learning and a great need for Out-of-School Time (OST) opportunities for youth, the demand for high-quality STEM programming in OST will grow. Both high-quality curricular materials and effective professional development (PD) are critical in order for OST educators to enact successful STEM learning experiences for youth.

Since 2016, the Center for Science Teaching and Learning (CSTL) at Northern Arizona University (NAU), the U.S. Geological Survey (USGS) Astrogeology Science Center, and the Museum of Science (MOS) Boston have been working together to develop, pilot and investigate the impact of three OST planetary science and engineering curricula and associated PD at the elementary and middle school levels.

In order to develop effective PD for OST educators, the PLANETS project researchers conducted this needs assessment. The study had two goals: 1) to identify the gaps between self-identified abilities of OST educators and the abilities that effective OST educators should have, and 2) identify current PD opportunities and platforms that would be most effective. The needs assessment included a literature review, a national on-line survey with a convenience sample of 314 OST staff and supervisors, and in-depth interviews with 12 supervisors.

Study findings indicate that there is a strong interest to increase STEM programming. However, there are few opportunities for professional learning for OST staff, particularly in STEM content areas, including planetary science, or in the use of NASA educational resources. While staff felt confident to teach many of the areas important for STEM OST, supervisors reported that most OST staff lacked preparation in these areas. The literature review points to the need for supervisors to also participate in the PD. OST staff will benefit from PD that supports their understanding of science and engineering practices, and strategies to most effectively facilitate learning experiences for youth. PD should 1) help educators connect STEM learning with other youth development goals, 2) be aligned with the curricular goals or philosophy of the learning environment, 3) help educators connect STEM learning to real world contexts and career paths, and 4) help educators to be responsive to the specific needs of OST youth from a range of backgrounds and environments. Evaluation of both the OST programs and the PD itself are important areas, not only for formative purposes but also to provide evidence of effectiveness.

Because of the nature of the OST environment, it is important for OST PD to be useful and directly applicable. Participants in our study identified that PD is most useful when they learn about activities to immediately use with youth, expand their content knowledge and/or learn about relevant resources. PD must also be accessible to staff in a variety of different settings, including rural locations. Because many staff are from both formal and informal education backgrounds, with a variety of different content and instructional needs, participant customization and self-selection of PD sessions is a suggested design for the PD. Our survey and interviews suggest that OST educators are willing to use on-line or hybrid methods for PD, particularly video.

Recommendations for PD for OST educators are offered, including suggestions for PD that meets the needs of youth learners, meets the content and instructional needs of OST educators, and supports staff as well as supervisors.

Methods

Literature review

Keyword searches of education research and engineering education databases, EBSCOhost, Scopus, Google Scholar, and Engineering Village, utilized the following key words: out-of-school time, after school and STEM, professional development, and engineering. Published articles from 2000-2016 that were based on research and described the needs of OST staff and supervisors in STEM OST programs were included to reflect the current conditions in these programs.

National survey

A national survey was conducted in order to garner information from OST educators nationwide (Appendix A). The survey was built upon the literature review and other published needs assessments. Survey questions were developed that aligned with the identified research questions. A validation process was conducted using feedback from seven educational researchers and key educators in the field who provided feedback in order to confirm that the survey questions were designed to answer the research questions, and to improve the survey questions overall. The survey was then piloted with five supervisors and staff who were currently working in OST programs and modified according to their feedback.

To encourage survey participation, a final question on the survey asked respondents to submit their contact information in order to enter a raffle for one of thirty financial incentives. Another question asked OST supervisors who were interested in participating as project advisors to enter their contact information.

Convenience sampling was utilized. An invitation to participate in the survey was sent to OST groups nationwide and to listservs. Program partners also posted the survey invitation to listservs. A partial list of OST groups who were asked to participate include:

- Statewide Afterschool Networks
- Boys and Girls Club of America
- Association of Science and Technology Centers
- National Summer Learning Association
- Every Hour Counts

The survey was open from September 21 through November 4 2016, and 314 OST educators participated.

Descriptive statistics were calculated for responses and open-ended responses were analyzed using open-coding, a constant comparative approach.

Supervisor interviews

Survey respondents who identified as supervisors in survey responses and provided their contact information were invited to participate in foll0w-up interviews. These in-depth interviews were designed to garner detailed information about OST staff, and staff professional needs as well as to illuminate specific survey responses. Twelve supervisors participated in these short phone interviews in December 2016 and received a small stipend for their time. Interview questions are included in Appendix B.

Limitations

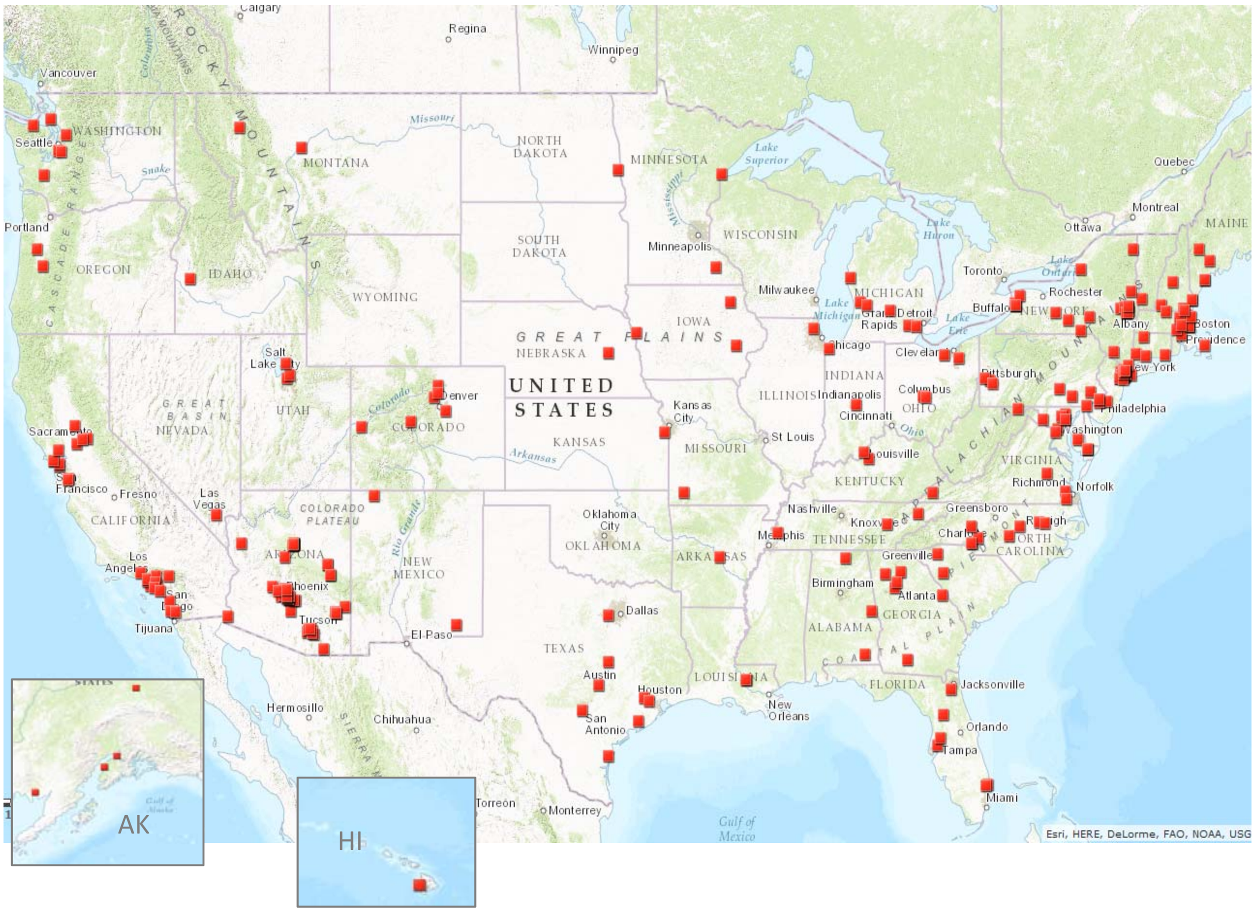
Participants for both the survey and interviews were recruited using non-probability methods. This survey was not designed to provide representative information of all OST educators or to generalize to other educators. Participants were a convenience sample of OST educators involved in OST list-servs or organizations who were particularly interested in the topics or were willing to participate for a small incentive. Therefore respondents are not representative of the population of OST educators at large and their demographics and responses are not representative of all OST educators. It is likely that respondents were also particularly interested in and/or involved in OST STEM education, and their responses could be considered typical for OST educators interested in or involved in STEM education.

Participants

Survey respondents

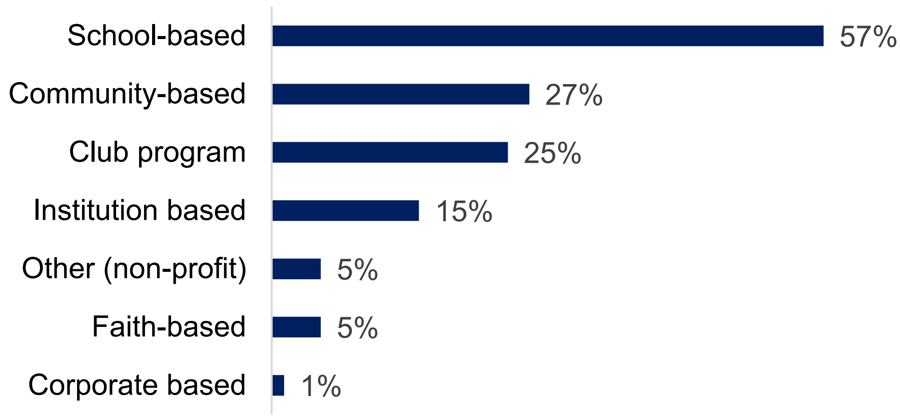
A total of 314 OST educators answered the survey, identifying affiliation with OST settings across the United States, as well as from Australia and Israel (Figure 1).

Figure 1. Program locations of participating OST educators



Respondents worked for a variety of different organizations, primarily school-based (Figure 2). Some Respondents worked for more than one type of organization.

Figure 2. OST setting of survey Respondents



Tables 1-3 describe the demographics of participating educators. The majority of educators were female and white or Caucasian. Most educators were over 30.

Table 1. Gender of survey Respondents

Gender	Percent
Female	87%
Male	13%

Table 2. Race or ethnicity of survey Respondents

Ethnicity	Percent
White or Caucasian	77%
Hispanic or Latino(a)	9%
Black or African American	8%
Asian	2%
American Indian or Alaska Native	1%
Native Hawaiian or Other Pacific Islander	1%
Other	2%

Table 3. Age range of survey Respondents

Age range	Percent
21-30	15%
31 -40	26%
41-50	29%
51-60	22%
61-70	7%
70+	1%

Interview participants

Interview participants primarily identified that they worked in school-based settings, Figure 3. Some participants worked for more than one type of organization. Demographics are listed in Tables 4-6. The majority of participants were female and all who provided race/ethnicity information identified as white or Caucasian (one participant did not provide race/ethnicity information).

Figure 3. OST setting of interview participants

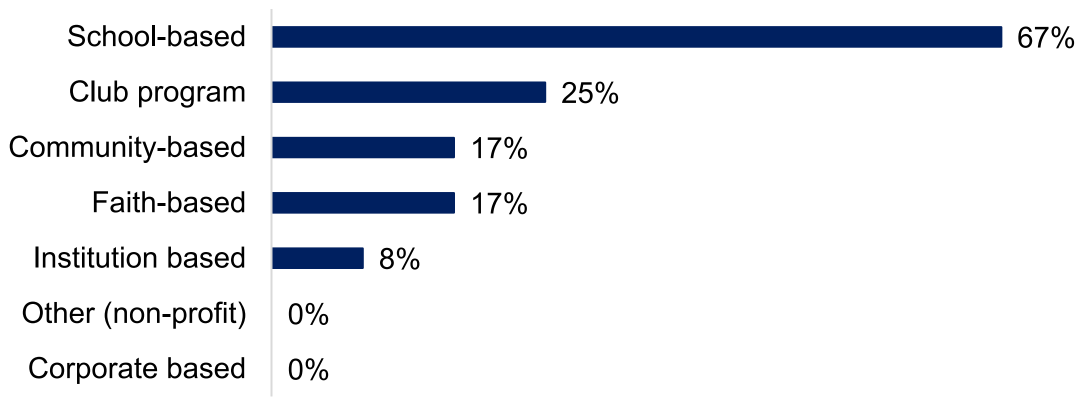


Table 4. Gender of interview participants

Gender	Percent
Female	83%
Male	17%

Table 5. Race or ethnicity of interview participants

Ethnicity	Percent
White or Caucasian	100%
Hispanic or Latino(a)	0%
Black or African American	0%
Asian	0%
American Indian or Alaska Native	0%
Native Hawaiian or Other Pacific Islander	0%
Other	0%

Table 6. Age range of interview participants

Age range	Percent
21-30	8%
31 -40	25%
41-50	42%
51-60	25%
61-70	0%
70+	0%

Definitions

- ✓ **Character education:** A range of approaches, including whole child education, service learning, social-emotional learning, and civic education (character.org).
- ✓ **Frontline staff (also called educators, facilitators or youth workers):** Staff who work directly with youth.
- ✓ **Out-of-school time (OST):** Afterschool, before school, during school breaks, summer camps, and other, non-standard times and formats.
- ✓ **Out-of-school time (OST) educators:** Staff and program administrators who work in an out-of-school capacity.
- ✓ **Professional development (PD) [also called professional learning, staff development or staff training]:** "A spectrum of activities, resources, and supports that help practitioners work more effectively with or on behalf of children and youth" (Peter, 2009, p.36).
- ✓ **Project based learning (also called project based instruction):** youth work over time to investigate and respond to an authentic and engaging question, problem, or challenge (Buck Institute for Education, 2017).
- ✓ **Social and emotional learning (SEL):** "learning to be aware of and manage emotions, work well with others, and work hard when faced with challenges" (Walker, Olsen & Herman, 2017, p.3).
- ✓ **STEM:** an acronym referring to integration of science, technology, engineering and math.

Current Knowledge of the OST Environment

A literature review of the current working conditions that influence OST and OST STEM educators starts with a broad look at the landscape of OST programming. First, the research on the background of OST educators and students, including potential gaps in knowledge, is identified. Then, the general context and best practices of PD is summarized, emphasizing what is known about best practices in PD for OST Educators. Several example of programming and PD implementation from the literature are provided. Finally, a summary of the key findings that are applicable to the PLANETS needs assessment are provided.

OST education is a significant component of the educational system. In *America after 3PM*, the Afterschool Alliance (2014) reported that 10.2 million children (18% of the total youth population) in the U.S. participated in after school and youth development programs across the country. Additionally, they estimate that almost twice that many youth would participate if more programs were available. Due to this growth and seemingly unmet demand, as new programs are established and existing programs are increasing their capacity, the need for qualified staff also increases. Efforts at both the national and state levels to support OST staff and build their capacity are a priority for a number of initiatives. It is important to understand the makeup of the OST workforce to respond to their professional needs appropriately.

Student demographics

The Afterschool Alliance (2014) provides a recent comprehensive picture of the demographics of youth in afterschool settings. This study identifies that most youth attending afterschool programs are elementary school-age (61%), with middle school aged youth making up about one-quarter (23%) of the population. Participation by boys and girls are approximately equal in proportion, and the dominant ethnicity is Caucasian (71%). About one-quarter of students in these programs are from underrepresented populations (African-American, Native American and Hispanic). Relative to the national population, Hispanic, African-American and Asian children are more likely to participate in afterschool programs than Caucasian children. According to this study, roughly half of the children served in afterschool programs are from low-income homes. This suggests that socio-economic factors may influence demographics of OST youth.

Educator demographics

Several groups have worked to identify the typical backgrounds of the OST workforce. Nee, Howe, Schmidt and Cole (2006), representing the National Afterschool Association [NAA], conducted a nationwide survey to identify typical demographics of this group as part of their efforts to provide policy and practice recommendations. The results identified that OST respondents were about evenly distributed among age categories, most respondents were female (86%) and most were white (73%). Other groups have also studied the workforce in their region. For instance, School's Out Washington, a statewide organization in Washington State, surveyed and conducted focus groups with the workforce in their state. They found the demographics of the workforce similar, at 80% female and 75% white (School's Out Washington, 2008).

Yohalem, Pittman and Moore (2006) surveyed the front-line youth workforce in cities across the United States, including San Diego, New Haven, Washington D.C., Jacksonville, Chicago, Baltimore, Kansas City, and Hampton, cities that varied dramatically in overall demographics. Noting that their findings were not generalizable, they found their respondents much more diverse than other studies, with 59% of respondents identifying as African Americans, 27% white, and 7% Hispanic/Latino(a). In almost every city surveyed, African Americans were more represented in the youth work workforce than they were in the general population.

Asher (2012) conducted an action research study of site mangers for afterschool programs in King County, WA. The age and education of these site managers tended to be higher and more educated than the typical "front-line" staff. Although the sample size was small, the bimodal distribution of comparatively young and relatively old site managers suggests that workers tend to enter the afterschool workforce young, and then leave to raise families or pursue professional opportunities, etc. The older workers often enter the workforce after a career change. From these data, the author argues that PD resources should be focused on site managers rather than staff, due to the high level of staff turnover that most afterschool programs experience.

Education of OST staff

Nee et al. (2006) found that the OST workers were more educated than expected, with over half having a bachelor's degree or higher. Other studies also confirmed that workers were highly-educated (Schools Out Washington, 2008; Yohalam et al., 2006). Despite a generally well-educated workforce overall, other studies have identified that staff may not have preparation in science. For instance, Chi, Freeman and Lee (2008) found that less than one-third of programs had staff who specialize in science. There is no current literature base that describes staff training and specialization in engineering specifically. However, educators in this area describe that most staff do not have backgrounds in engineering fields or experience with the engineering design process. Some backgrounds in or knowledge of STEM fields are critical for positive student outcomes as facilitators who have greater confidence and ability in their STEM facilitation and knowledge and practice in STEM may also support greater gains in youth science and math confidence and proficiency (Allen et al, 2017).

Professionalism in the OST workforce

Nee et al. (2006) concluded that there are two primary workforces in afterschool settings. One workforce is mostly full-time, better educated, better compensated, less prone to turnover, and view after school work as a profession. The other group is part-time, paid hourly, often less educated, and more likely to view OST work as a job, not a profession.

From these results, Nee et al. (2006) concluded that the afterschool field would benefit from a more professional workforce, and recommended the establishment of core competencies, and PD in these identified competencies. They also recommended expanded quality training and PD opportunities for all workers. They suggested approaches such as distance learning to increase access in rural areas. To respond to "two workforces", they suggest promoting ways to share the knowledge of experienced afterschool staff, such as mentoring younger staff. Others, such as Garst, Baughman and Franz (2014), propose the need for benchmarking PD practices across organizations.

Examples of benchmarking they propose include standardizing content, length, and formats for PD for OST educators.

The National Afterschool Association (2011) in collaboration with the National Institute on Out-of-School Time has created Core Knowledge and Competencies (CKCs) for Afterschool and Youth Development Professionals. These describe the “knowledge, skills, and dispositions needed by professionals to provide high-quality afterschool and youth development programming and support the learning and development of children and youth” (p. 4).

Professional development for OST staff

A growing body of literature identifies personal and professional benefits of PD for OST staff, as well as benefits for youth in associated programs (Bowie & Bronte-Tinkew, 2009; Metz, Burkhauser & Bowie, 2009). Noam, Dahlgren, Larson and Dorph (2008) argue that staff capacity, training and relational care are critical areas for emphasis, to create quality OST programming.

In some OST subgroups, PD for staff is a prominent area. Garst et al. (2014) provide a comprehensive overview of the state of PD for youth workers. They describe that many national organizations have identified competencies for youth workers and how PD opportunities are used to develop these competencies in youth workers. They also describe both traditional (i.e. conferences or workshops) PD approaches and the growing use of non-traditional (i.e. online, massive open online courses [MOOCs], or communities of practice) approaches. To illuminate the PD needs of OST workers in various settings and the PD practices different organizations have utilized to meet these needs, these authors describe a number of recent studies. For instance, Lambur conducted a national PD needs assessment of Cooperative Extension Educators across all programmatic areas (as cited in Garst et al., 2014). The author suggests that identifying needs through such studies can identify important topics for national benchmarking.

The American Camp Association also used surveys to identify and establish industry benchmarks for accredited camps. The American Camp Association’s 2013 review of PD for summer camp staff (as cited in Garst et al., 2014) identify that 61% of responding camps require their full-time staff to undergo two hours of PD annually, but the specialty seasonal frontline staff had to complete an average of 12 hours of PD each year before camp began. PD for full-time staff was a combination of on-site by internal staff or external consultants, off-site and online resources, and PD for seasonal staff was primarily provided on-site by internal staff.

Garst et al. (2014) also identified a study of 21st Century Community Service Learning Centers conducted by Khashu and Dougherty, in which researchers found a correlation between higher quality programs and PD for staff, with high quality program staff receiving more training and participating in training on a wider variety of topics than staff from lower quality programs. Administrators from higher quality programs also supported staff participation in PD, in which 60% of staff reported that administrators paid for training, 50% reported administrators informed the staff of PD, and 19% reported administrators rewarded staff for PD.

Nevertheless, many OST staff still do not have access to PD. For instance, Nee et al. (2006) identified that only 40% of OST respondents in urban settings, 38% in suburban settings, and 23% in rural settings reported access to paid time for PD. Studies focusing on science specifically identified that less than half of OST programs offer PD in science for their staff (Noam et al., 2008). In a nationwide study, Chi et al. (2008) found that a lack of staff training in science was identified by 40% of programs as a barrier to providing regular science activities to youth in their programs. More than half of respondents identified that increasing staff development opportunities were important to increase the quality and/or quantity of science activities in after-school program. Respondents identified barriers to providing PD in science, including insufficient funding (24%), other content focus (22%), and lack of science-related staff development in their area (17%). In a national survey of OST staff, Allen et al. (2017) identified that 92% of respondents wanted more PD in STEM, with the support in programming ideas, program management, and connecting afterschool programming to the school day identified as top priorities.

High quality professional development for OST educators

Although little research about the impact of PD on OST educators has been conducted, some information has begun to clarify the field. Hill (2012) conducted a literature review of research in this area to identify the impact of PD on OST youth and to establish a set of characteristics that define effective PD. Hill concluded:

> Though no clear link between professional development and youth outcomes has been established in either the in-school or the OST literature, a research-based consensus establishes the characteristics of high-quality professional development: It is sustained over a period of time, coherent, content focused, and based in a community of learners (p.6).

Bradshaw (2015) also offers implementation guidelines for planning, and implementing PD program design for OST educators. For instance, working from the TEARS (Time, Expertise, Access, Resources, Support) framework defined by Leggett and Persichitte (1998) in their work on educational technology implementation, Bradshaw recommends that PD be customized for the site context and need, and suggests the following guidelines: adequate time for learning, planning and evaluating PD, expertise, requirements needed for the OST site, easily accessible PD, accessible resources including curricula and finances, and administrative support.

Peter (2007) suggests first to identify and establish fundamental PD goals and objectives, then work backwards from an evaluation framework, such as Guskey's 1998 evaluation framework for PD. This framework identifies five-levels for evaluating PD programs: 1) Participants' Reactions; 2) Participants' Learning; 3) Organization Support and Change; 4) Participants' Use of New Knowledge and Skills; and 5) Student Learning Outcomes. Peter's organization, the Out of School Time Resource Center (OSTRC), adds a sixth level for evaluating PD, *extension*. Extension highlights the importance of expanding the learning through sharing new information learned with colleagues or students. Peter also suggests other factors to consider when planning, implementing and evaluating OST PD, including considering the format of the PD, evaluation instruments, staff development standards, and resources for developing PD.

Metz et al. (2009) link staff training with improved implementation of evidence-based practices in OST programs. They suggest the importance of training newly hired staff, to strengthen the mentoring abilities of staff, to help teachers who work in informal environments understand the critical difference between formal and informal environments, and to support a positive work culture. They identify five important features of effective training for front line staff: 1. Introduce the program philosophy, 2. Demonstrate the new practice or skills required to implement the program, 3. Provide opportunities to practice the practice or skill, 4. Provide follow-up support, and 5. Provide sufficient time for staff training. They also recommend that supervisors and administrators are included in training.

Bowie and Bronte-Tinkew (2006) provide a broad review of the importance of PD for youth workers for both the workers themselves as well as the field, identify core competencies for workers in the field, and identify different training delivery models for youth workers. They suggest two steps for programs embarking on PD: 1. Develop an effective PD system that includes core competencies, training opportunities, approved systems, a professional registry for tracking training and a career framework and identified pathways for advancement, 2. Identify and access PD opportunities, referencing other entities that provide PD for OST educators[2].

Building off the consensus concerning effective PD for OST educators synthesized by Hill (2011), other authors have argued for the specific importance of OST educators having networking opportunities within PD. Peter (2009) suggests that peer-networking is a valuable component of effective PD for OST educators, and should be incorporated into the PD design.

Systematization of professional development for OST educators

Efforts to provide effective models for OST PD in science on a national level are evident in the National Partnership for Afterschool Science (NPASS) project (http://npass2.edc.org/). Vaughan, Manning, Goodman, Hutchison and Zubrowski (2009) evaluated this initiative in its third year and drew conclusions that informed the design of the NPASS2 model. In this model, professional science trainers provided long term training and technical assistance to afterschool programs in their state or region. Their network included 1,000 NPASS science trainers who led science workshops for groups of afterschool sites once a month. There were over 500 NPASS afterschool locations in nine states. The NPASS2 program had nine state partner organizations that provided and utilized the existing PD infrastructure in each state. Examples included: California School-Age Consortium, Minnesota School-Age Care Alliance, and the University of New Hampshire Cooperative Extension.

As the field of afterschool and out-of-school time programming grows, many states are beginning to identify core competencies for OST Educators, as well as develop pilot programs for both professionalizing and standardizing the OST/After school profession. Hall and Gannett (2010) describe two credentialing programs for OST educators in the state of Massachusetts: The School-Aged Youth Development Credential (SAYD) and the Professional Youth Worker Credential (PYWC). Their findings suggest positive outcomes for credentialing programs, as long as they are

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[2] Organizations include Youth Policy Institute of Iowa (YPII), Achieve Boston, The Massachusetts School-Age Coalition (MSAC), The City University of New York (CUNY), The National Training Institute for Community Youth Work, The National 4-H Youth Development Practitioner Apprenticeship (YDPA), the National Youth Development Practitioners Institute, The National Institute on Out-of-School Time (NOIST), and the Out-of-School Time Resource Center.

effectively linked to effective PD practices. Gannett, Mello, and Starr (2009, p.11) provide an overview of credentialing the after school work force and have identified patterns in what is considered the core competences for OST educators in eight or more different frameworks. These competencies illustrate possible topics for effective PD design to consider:

- Curriculum
- Professionalism
- Connecting with Families
- Health, Safety, and Nutrition
- Child and Adolescent Development
- Cross-cultural Competence
- Guidance
- Professional Development
- Program Management
- Connecting with Communities
- Environment

Vance (2010) adds to the concept of core competencies, and offers a synthesis of more than eleven different competency frameworks for staff in the OST field. The author suggests that future research should try to link positive outcomes and specific competency frameworks with respect to student age, while describing competencies for each mastery level. The author also identified a lack of competency guidelines for mid-level management and administrators. Starr, Yohalem, and Gannett (2009) provide a similar overview with a synthesis of core competencies for OST and after school youth development workers.

STEM Professional Development for OST Educators

Much of the existing research on PD for OST educators in STEM fields comes from youth development organizations, such as 4-H and Girl Scouts. Lingwood and Sorensen (2014) describe experiences providing PD on the Exploratorium's *Fundamentals of Inquiry* curriculum modified to also teach youth development to Girl Scout volunteer leaders. Science inquiry and youth development share key foci on learner choice, experiential learning, and cooperative learning strategies. They found that the majority of volunteers who participated in the training used the inquiry activities when working with youth and used inquiry science facilitation strategies generally with youth. To extend the reach of OST STEM programs, they next used a train the trainer model to train volunteers to facilitate the curriculum with other volunteers.

A national organization, 4-H is one of the leading entities for youth development that reaches six million young people in the United States (What is 4-H?, 2017). Currently, a broad range of activities and subjects exist within 4-H programming, including STEM programming such as robotics, rocketry, environmental science, agriscience, biotechnology, and veterinary science. 4-H based programs have documented attempts at addressing PD needs for OST staff in STEM areas. For instance, in a "train the trainer model" with adult volunteer leaders, facilitators used specific educational strategies (e.g., coaching, effective questioning, promoting group interactions, and encouraging independent investigation and thinking) to develop competence in adult leaders to train teen volunteers in a science outreach curriculum (Smith, Meehan, Enfield, George & Young, 2004). Results indicated that adult leaders learned how to use open-ended questions and facilitate the inquiry approach effectively. Adult leaders identified the importance of practicing and understanding the curriculum activities before training others, and found it useful to observe other trainers and discuss methods.

Junge and Manglallan (2001) demonstrated a link between PD and increased confidence, understanding of their important role as a facilitator of effective science, engineering and technology (SET) and knowledge of core aspects of quality SET programming in OST educators learning to use a 4-H curricula program with youth. PD was aligned with a facilitation guide that focused on science, engineering, and technology processes, inquiry and experiential learning, SET abilities, SET-rich environments, using fiction and non-fiction SET text, and introduction to SET in afterschool. Inquiry, experiential, and hands-on strategies were cited as the most important strategies learned for use in their own program.

As science, engineering and technology programs have developed and grown in importance within the 4-H curricula, Barker, Grandgenett, and Nugent (2009) identified that these programs have had challenges providing the staff capable of facilitating these complex and content-heavy science programs. To address this challenge, the organization has shifted from the traditional adult volunteer delivery model, to paid staff with deeper expertise. The authors also identified a need to change from the one-time, short-duration and synchronous training that was delivered either face-to-face or on-line, to a new training model that could address competencies more incrementally. In this new blended approach, traditional short duration face-to-face trainings were offered along with, asynchronous on-line training modules on specific topics, and synchronous web-based meetings. Volunteers were encouraged to use self-directed learning for their PD.

Barker, Nugent, and Grandgenett (2014) also examined STEM-curriculum program fidelity in out-of-school settings. With significant STEM-related cognitive gains in youth participating in a program when facilitated by program developers, the developers wanted to know if such gains could be replicated by other educators, and how educators were implementing the program. Their findings suggested that for STEM programs to be implemented as intended, it depended significantly on the perceptions, competency and confidence of the educator. An implication of the study is that further PD, with time for both skill development and reflection on the curricula as an educator and a learner, is important for fidelity of implementation of the curriculum.

Recommendations in STEM PD for OST educators

Freeman et al. (2009) provide specific recommendations for implementing STEM specific PD for OST programs in order to help increase program effectiveness, increase educator confidence, and aid in program fidelity. They recommend providing flexibility and less structure within staff development, to align with the informal educational experiences of OST learning. Other recommendations include: recognizing challenges (such as educator fear of science) in the content of PD, modeling engagement and relevance of OST STEM experiences, targeting the audience in the PD design (for instance addressing different needs of teachers and non-teachers), providing a focus on process, methods, and/or approaches to teaching science, and providing exposure to materials, supplies, equipment, and curricular resources.

A National Research Council report (2015) identifies the importance of preparing staff to value cultural and ethnic diversity in participating youth, to interact with families, schools, and communities, and to serve as professional role models.

In helping to address the need for effective PD and to insure program fidelity, several authors have synthesized PD opportunities for STEM OST educators, particularly in the 4-H extension system framework. Garst et al. (2014) also propose the need for benchmarking PD practices across organizations.

Specific examples of PD for STEM educators is offered in: Kalson, Lodl, and Greve (2005), Konen and Horten (2000), Lobley and Ouellette (2013), Smith et al. (2004), and Worker and Smith (2014). Common themes include the need for and difficulty in training front line staff without significant science or engineering background knowledge, as well as suggestions and case studies on the format for the PD. For example, the Maine 4-H Afterschool Academy provides 10 hours of sequenced and blended on-line and face-to-face PD, which included webinars, self-paced modules and in-person sessions to experience activities first-hand and opportunities to learn how to manage these experiential activities for youth (Lobley & Ouellette, 2013). A post-program survey indicated that participants increased their knowledge of and confidence with youth development concepts and ability to integrate STEM into their own programs.

Evaluation of Professional Development for OST Educators

Several groups have identified strategies for evaluating PD efforts for OST educators. Bouffard and Little (2004) promote Kirkpatrick's four level framework for evaluation (1998): (1) reaction to the training, (2) learning of information and practices from the training, (3) transfer of this knowledge into practice, and (4) results for key stakeholders, and provide examples of evaluations that have used this framework. Although they do not address STEM educators specifically, they offer broad considerations for evaluation, identifying that OST programs should have clear objectives and outcomes, so that PD also can be measured and evaluated against these factors. This requires that evaluation planning happens at the same time as PD design.

Wilkerson and Haden (2014) provide evaluation guidance from their work with STEM OST programs specifically. They suggest starting with defining program activities and expected outcomes, and identifying evaluation as a continuous process throughout each phase of the development and implementation of the program. They also identify that for designing an effective evaluation, it is critical to take into account a program's intended outcomes, phase of development, duration, and budget.

The National Research Council (2015) considers OST STEM programs from an ecosystem perspective, that learning is a "dynamic interaction among individual learners, diverse settings where learning occurs, and the community and culture in which they are embedded" (p. 5). Thus, they recommend evaluating OST STEM programs at three interrelated levels, the individual-level, the program-level and the community-level.

On a large scale, a recent evaluation of OST STEM programs nationwide has identified important program factors and positive outcomes for youth (Allen et al., 2017). The authors recommend continued evaluation and research in these fields for understanding, improving and spreading effective OST STEM.

Specific tools and common measures for measuring the effectiveness of OST programs have been suggested by Papazian, Noam, Shah, and Rufo-McCormick (2013) and Noam and Shah (2013b) including the Dimension of Success (DoS) Observation Tool (Shah, Wylie, Gitomer & Noam) and the Common Instrument Suite. This framework also can help guide PD needs. Other tools for measuring youth outcomes in informal environments are described in Shields, Greenwald, Bell, Crowley & Ellenbogen (2014), the website informalscience.org, and in the database Assessment Tools for Informal Science (ATIS) (pearweb.org/atis).

Professional Development for Formal Science Educators

Because little research on effective PD for OST educators is available, particularly in STEM fields, literature on science PD for traditional classroom teachers was also reviewed to identify recommendations for PD content, design and implementation. Joyce and Showers (2002) explain the four components of effective training: developing knowledge, exploring theory behind skill or strategy for better understanding, demonstration or modeling of the skill or strategy, and finally practice skill and coaching from a peer. Luft and Hewson (2014) provide a comprehensive review of more than 50 research studies of PD for science teachers. Their suggestions to those developing PD programs for science teachers are as follows:

1. Incorporate adequate support for varying levels of teacher change during professional development
2. Provide opportunities for collaboration
3. Provide a program that is coherent with national or local standards
4. Provide a content focus

Whitworth and Chiu (2015) also offer a comprehensive review on the research on PD for science teachers and come to many of the same findings as Luft and Hewson (2014). The authors synthesize studies that identify benefits of PD on teacher and student learning and teacher change. The authors identify the importance of school district leaders and subject-area coordinators to support positive outcomes for teachers and students. The authors conclude that leadership involvement in PD is critically important for changing beliefs, understanding and/or practices.

Guskey (2002, 2014) provides rationale for the importance of evaluating PD programs for teachers and identifies critical levels of evaluation of these efforts. The author outlines the need for a "backward-design" model for planning effective PD, in which student learning outcomes are established first to direct and focus all other planning around this important outcome. The author argues that without first establishing these learning goals, many planners of PD may fall into what he calls the "activity trap." Guskey and Yoon (2009) call for those who design and implement PD to assess and evaluate their work, and recommend more rigor in the study of effective PD in order to strengthen the literature base about the benefits of PD.

PLANETS OST Needs Assessment Survey and Interview Results

Current conditions

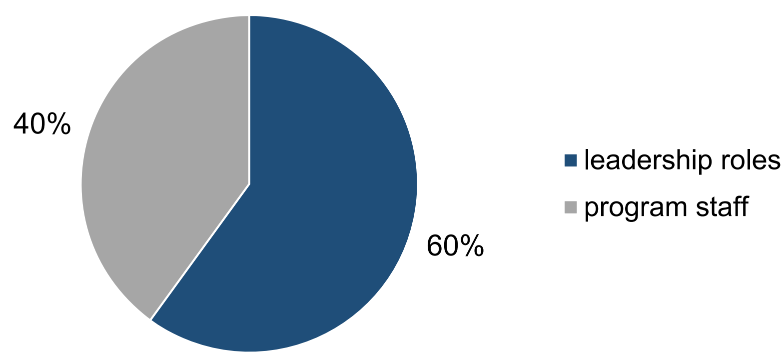
Demographics of survey respondents and interview participants are provided on pages 9-11. Survey respondents identified their years of experience working in OST programs. Most respondent had worked in OST programs for one to five years (Table 7). However, almost half (48%) had extensive experience, working in OST for six to twenty years. The average amount of time working in OST programs was eight years.

Table 7. Number of years working in OST programs

Years	Percent
<1	7%
1-5	40%
6-10	25%
11-20	23%
20+	5%

Sixty percent of survey respondents identified as in leadership roles (site supervisors, program coordinators, or statewide or national coordinators), and 40% identified as program staff.

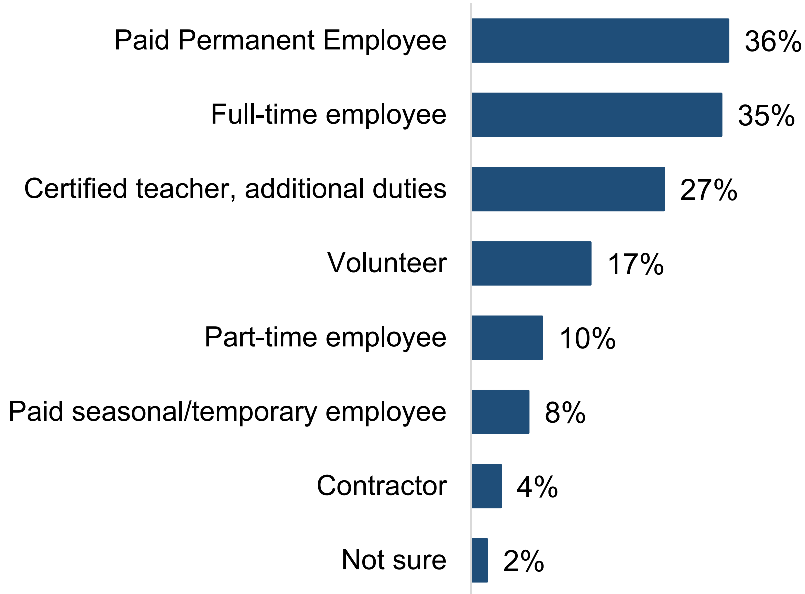
Figure 4. Role in out-of-school time program



Current status of OST educators

The largest group of respondents were full-time and permanent employees or certified teachers (Figure 5). Fewer respondents were volunteers or part-time staff. Some respondents identified with multiple roles.

Figure 5. Employment status



Formal educational background

Survey respondents identified their formal educational background. Responses about education background of staff and supervisors were separated to identify if respondents had similar education as identified by Nee et al. (2006), who described two different populations in OST, one is mostly full-time professionals (supervisors) and the other is part-time job employees (staff). In this study education was similar between staff and supervisors, except that a higher percentage of staff had Master's degrees. Over half of respondents from each group had a Master's degree (Table 8), more educated than the literature identifies (Nee et al., 2006).

Table 8. Highest degree earned

	Staff	Supervisors
High school degree/GED	3%	8%
College degree (AA/BA/BS)	31%	36%
Master's degree	61%	52%
Doctoral degree	5%	4%

Half (50%) of staff and about one-third (31%) of supervisors had a teaching certificate. Most certified teachers had elementary certification (Table 9).

Table 9. Teaching certification

	Staff	Supervisors
Elementary teaching certificate	64%	68%
Secondary teaching certificate	16%	18%
Elementary and secondary teaching certificates	21%	14%

Formal teaching experience

The majority of both staff and supervisors had formal teaching experience at the K-12 level, but a higher percentage of staff had taught in a K-12 classroom (72%) than Supervisors/Coordinators (56%).

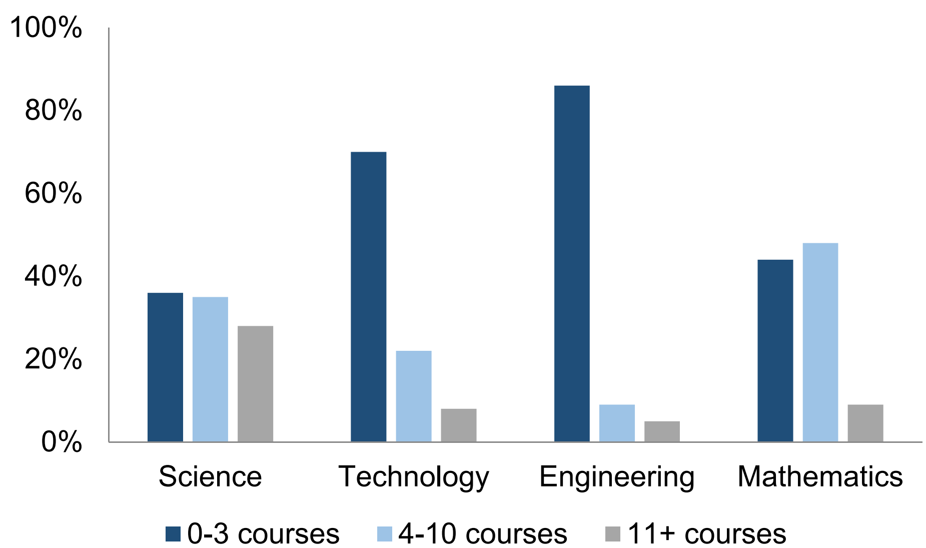
Table 10. Experience in formal classrooms

	Staff	Supervisors
Yes	72%	56%
No	28%	44%

College level courses

To gauge content background, respondents were asked about the number of courses they had taken at the college level in each STEM area (Figure 6). Few respondents had much coursework in engineering, or technology at the college level. The majority of respondents had at least four courses in both science and math, indicating significant backgrounds in these fields.

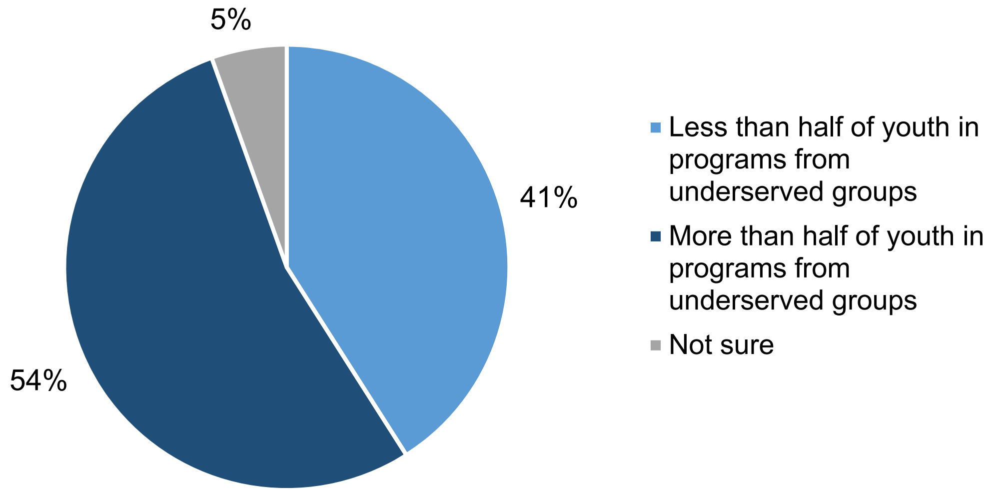
Figure 6. Amount of science, technology, engineering or math coursework



Demographics of youth served

Survey respondents were asked to describe demographics of respondents in their programs (Figure 7). The youth in over half of the programs were primarily from underserved groups, defined in the survey as low-income, youth with disabilities, English language learners, underrepresented minorities, and first-generation college.

Figure 7. Underserved youth in respondents' programs



Recent findings from Afterschool Alliance (2014) describe a similar trend that many youth in OST programs are from underserved populations, with roughly half of the children served in afterschool programs from low-income homes and about one-quarter of youth in these programs from populations underrepresented in STEM fields (Black/African American, American Indian or Latino(a)/Hispanic). According to the study, Hispanic and African-American children are at least two times more likely to participate in afterschool programs than white children. Additionally, this group describes is an unmet demand for afterschool programs for youth, particularly for youth from low-income, Hispanic and African American families.

Youth come from similar percentages of urban (39%), suburban (36%) and rural (25%) environments (figure 8). More than two-thirds of youth in these programs are in elementary school, K-5th grade (figure 9).

Figure 8. Percentage of youth from different environments

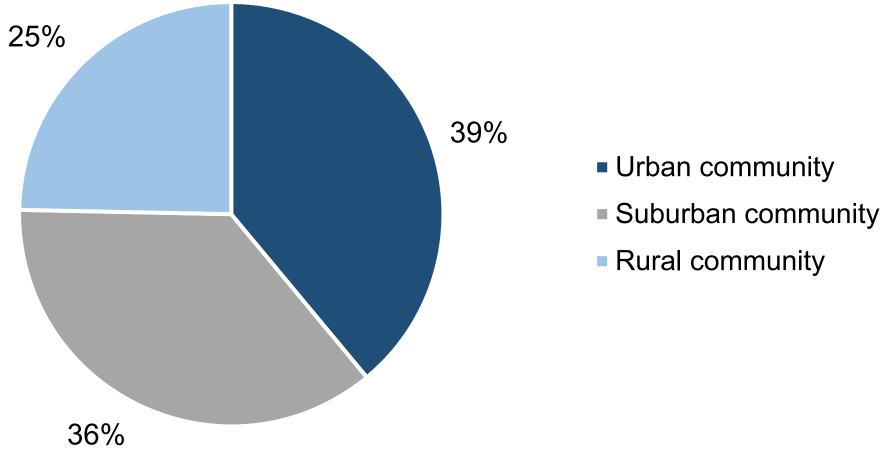
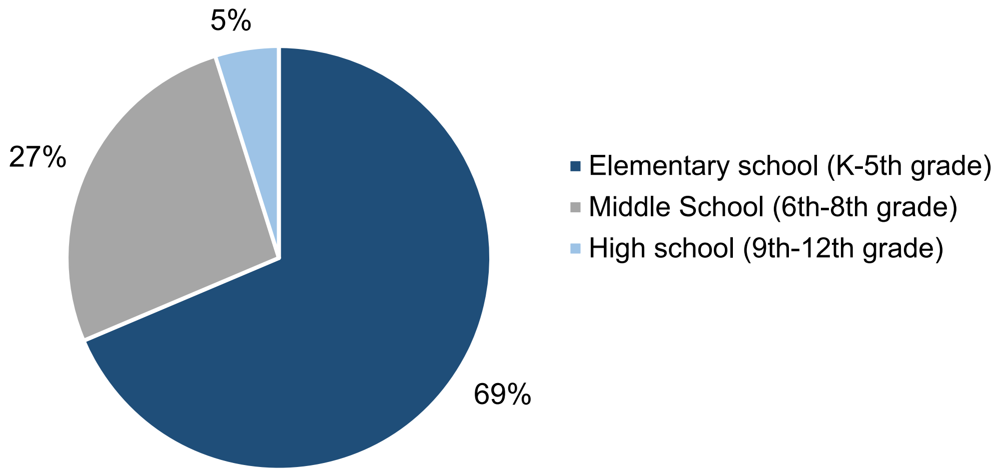


Figure 9. Percentage of program youth at each grade band.

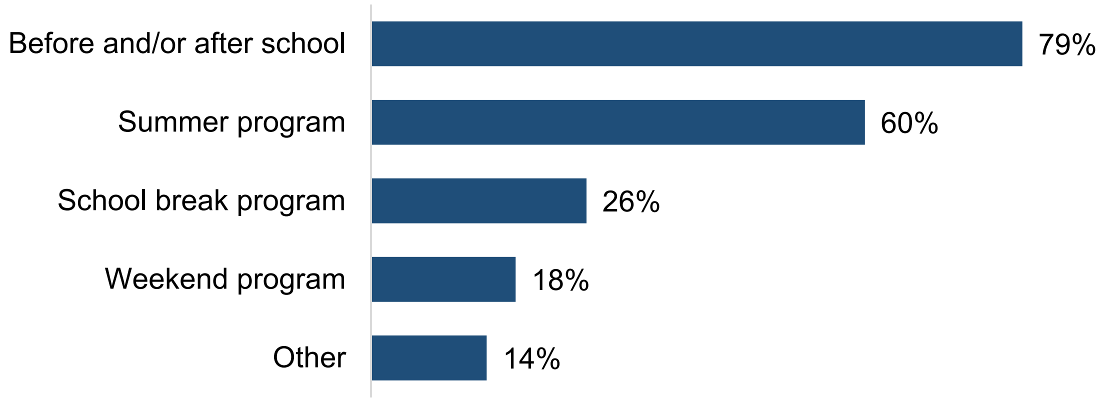


These demographics are in-line with the Afterschool Alliance (2014) report that most students attending afterschool programs were elementary school-aged (61%) with a lesser amount of middle-school aged (23%).

Program characteristics

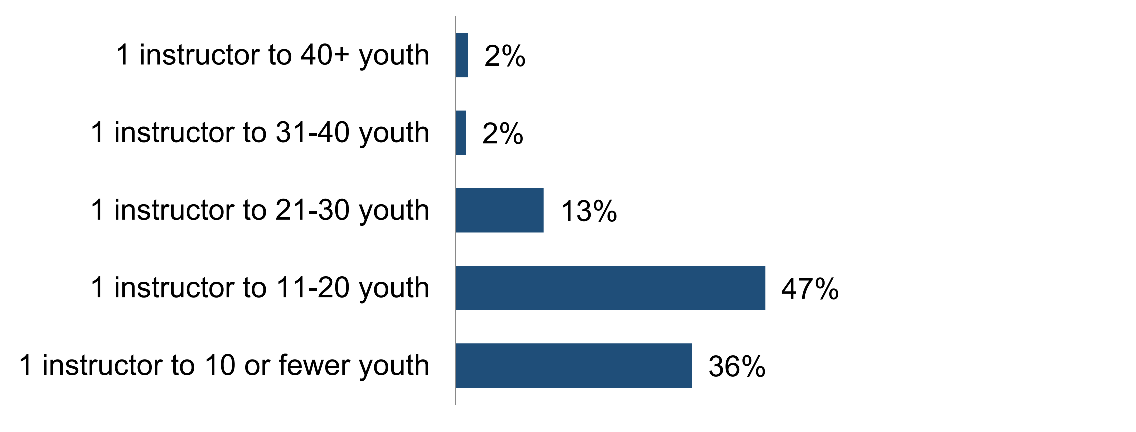
Most programs take place before or after school, or during the summer, with some programs taking place during more than one time frame.

Figure 10. Time frame of OST program



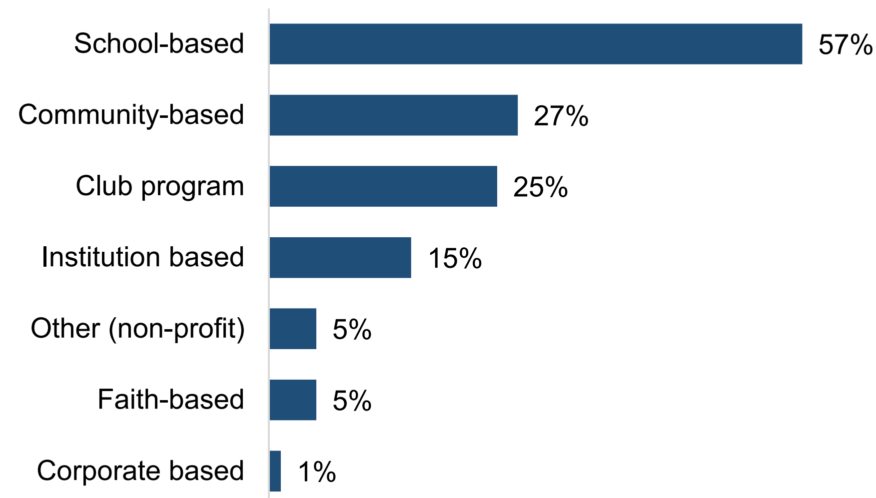
Most programs had a ratio of one instructor to 11-20 students, with more than one-third of programs providing a ratio of one instructor to 10 or fewer students, indicating significant opportunities for individual student interaction.

Figure 11. Approximate ratio of instructor to youth participating in out-of-school time program



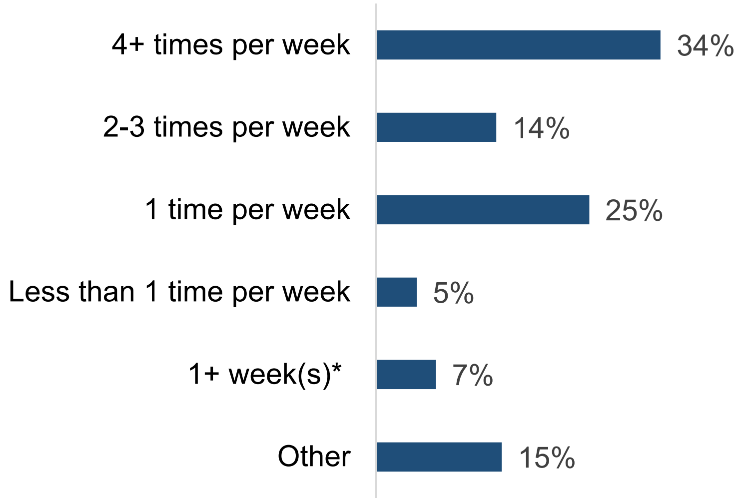
Most programs were school-based, with about one-quarter each community-based or club-based (Figure 12).

Figure 12. Type of out-of-school time program



About half of programs meet with the same group of students more than once per week, considered high frequency. About one quarter of programs met one time a week. Fifteen percent of respondents (identified as "other") included those who responded that they meet with students less frequency, such as monthly or 3 or 4 times per year.

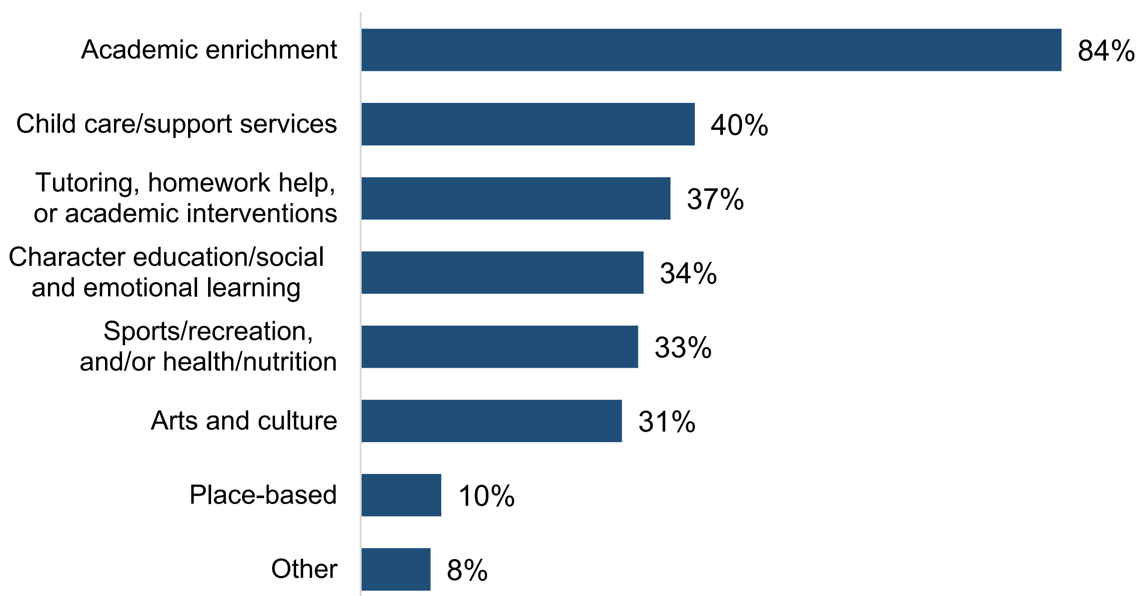
Figure 13. Approximate frequency of meeting with the same group of youth



*Programs that meet 1+week(s) represent intensive school break programs (e.g. Spring break or summer camps).

According to OST educators, youth participate in OST programs for multiple reasons, with academic enrichment being the most identified reason (Figure 14). More than one third of respondents perceive that youth participate for character education/social and emotional learning (SEL), tutoring/homework help/academic interventions, recreation, and/or child care services.

Figure 14. Reasons youth participate in OST programs



Educators elaborated on program goals in open-ended responses. For instance one educator commented that the goal of the program was:

> *To get [youth] interested in STEM and show them that math and science can have many different looks, not just what they see in school.*

Another educator commented:

> *To excite, inspire and promote creativity…Opportunities to explore different fields of science and technology.*

Program goals were coded using an inductive process to thematically identify program goals. Most identified themes are below:

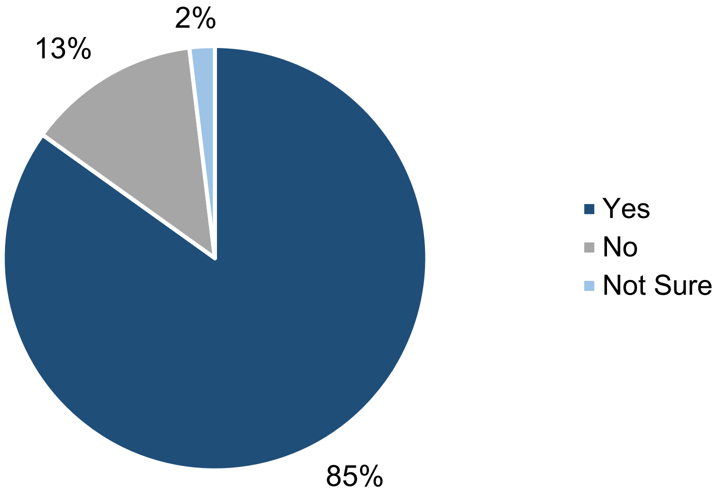
- **Exposure to STEM careers**
- **Learn 21st century skills**
- **Increase STEM skills**
- **Increase STEM content**
- **Increase interest, attitude or engagement with STEM**

Commonly identified goals indicate that many programs are focusing on enrichment in STEM areas and fields, and related skills. Other program goals that were identified less frequently were to broaden participation in STEM, to have fun, to develop socio-emotional learning or to make real-world connections.

Computers with internet access in OST programs

Most OST programs (85%) had access to at least one computer with internet use for instructional use.

Figure 15. Program access to internet for instructional use

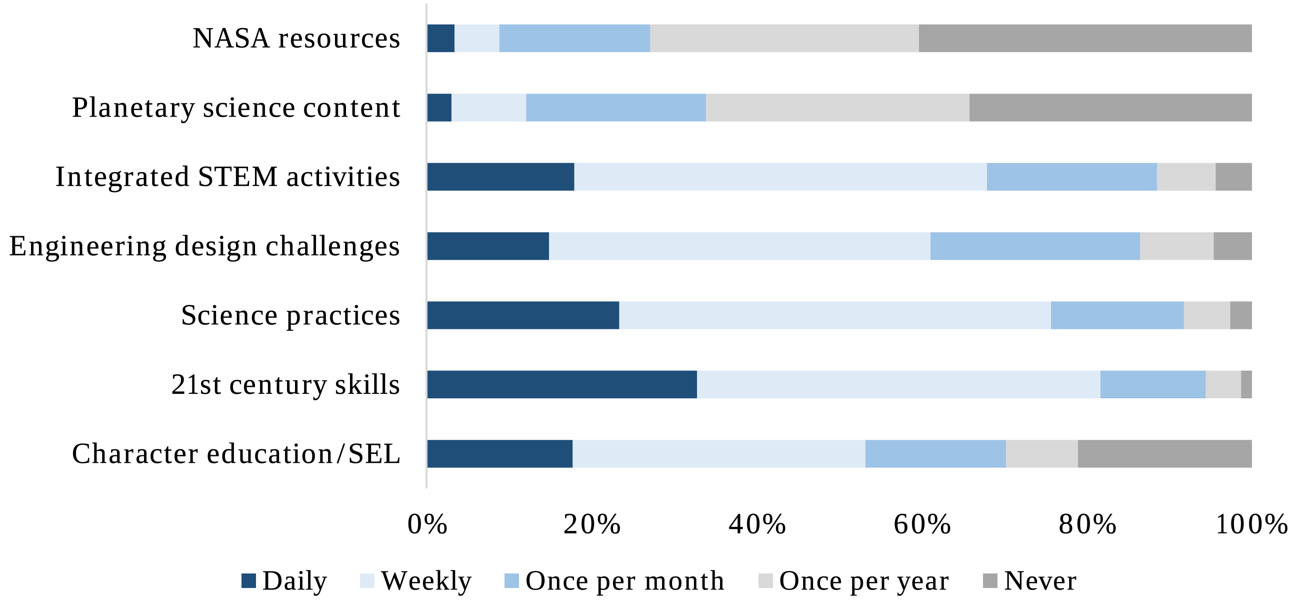


Current content in OST programs

Respondents were asked how often different content areas are currently integrated into their programs (Figure 16). They identified that there is a lot of STEM incorporated in these OST programs. Most respondents identify that programs include science practices (e.g. asking questions, defining problems, developing and using models, etc.), and integrated STEM activities weekly or daily. Sixty-one percent incorporate engineering design challenges at least once per week. Most respondents (82%) identified that their programs frequently include 21st century skills (e.g. critical thinking, creativity, communication, problem solving etc.), with a little more than half of programs including character education frequently.

However, there is currently little planetary science content or NASA resources included in programs. Only 12% teach planetary science at least once per week and only 8% teach with NASA resources at least once per week.

Figure 16. Content areas in OST programs



STEM activities

Respondents were also asked if they teach STEM in their programs. Most program (89%) currently provide STEM programming (Figure 17). Although STEM is frequently taught, many (89%) would like to add more STEM activities at their site (Figure 18).

Figure 17. Programs currently providing STEM and/or integrated STEM programs/activities

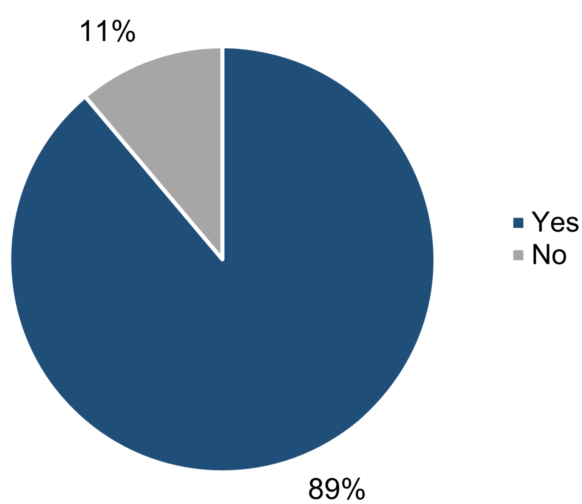
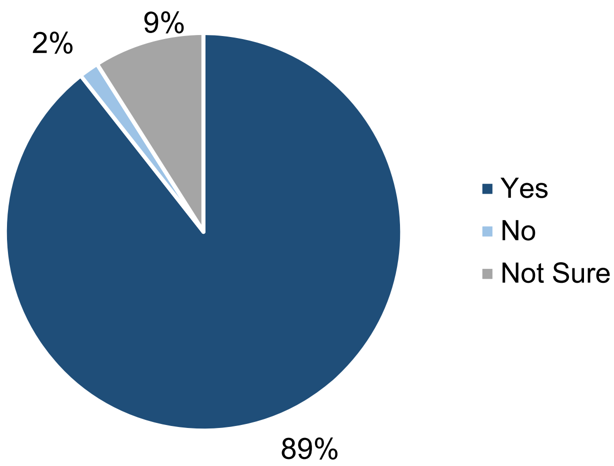
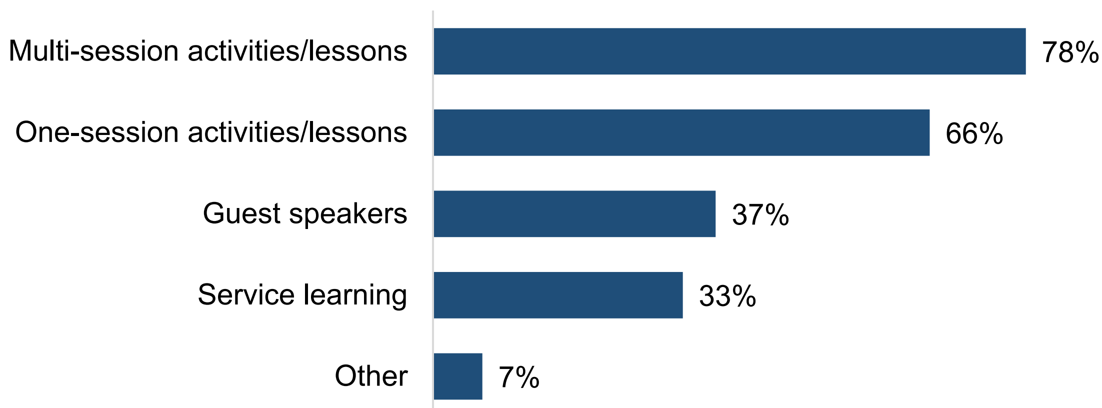


Figure 18. Interest in adding or expanding science, technology, engineering, math and/or integrated STEM programs/activities at OST site



Two-hundred seventy six respondents whose programs provide STEM content in their programs responded to a subset of questions. Respondents identified that most STEM programs include multi-session and stand-alone activities. More than one-third of these programs bring in guest speakers (37%), and 33% provide service learning opportunities.

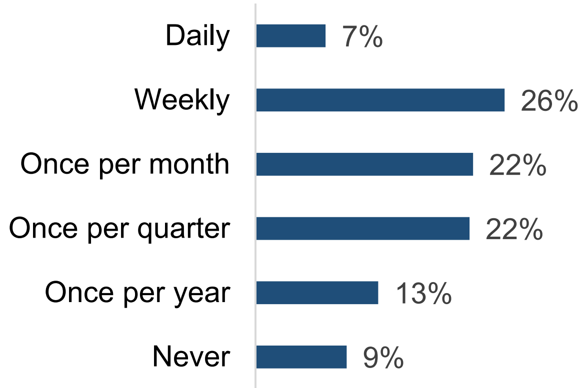
Figure 19. Type(s) of activities currently provided in STEM program



STEM career information

Youth do have opportunities to learn about STEM careers through OST programs. One-third of programs are providing opportunities for youth to learn about STEM careers at least weekly and the majority (55%) of programs are providing these opportunities to students at least monthly.

Figure 20. Frequency of learning opportunities about STEM careers



Professional development

Respondents were asked about PD opportunities. Almost three-quarters (72%) of educators indicated they are required to participate in some PD for their position (Figure 21). However, less than half participate in PD with any frequency (Figure 22).

Figure 21. Required participation in professional development

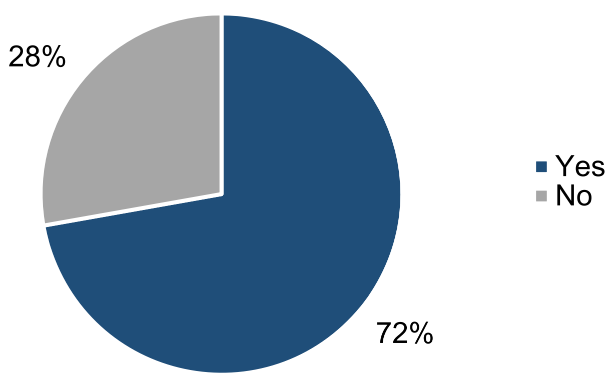
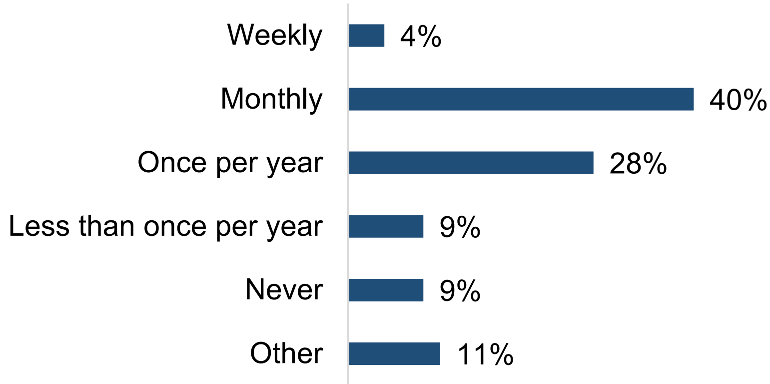
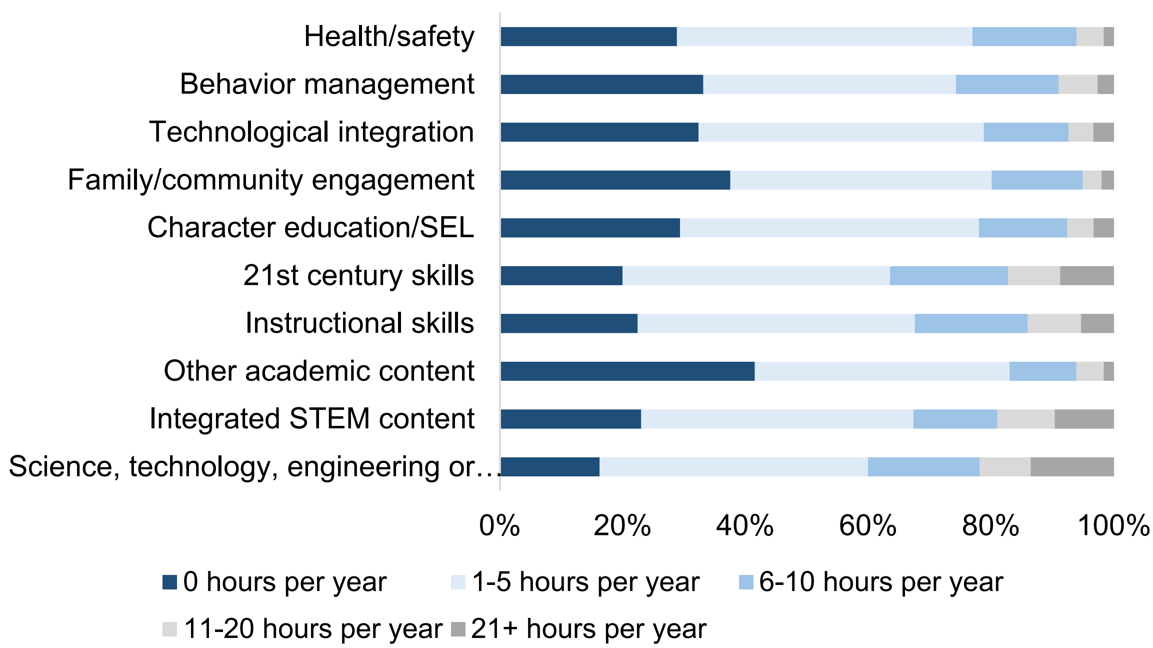


Figure 22. Frequency of participation in professional development



Respondents were asked about frequency of participating in PD on a variety of topics important in the OST environment. Most participated in less than 6 hours of PD per year (Table 23) about each topic, including integrated STEM content.

Figure 23. Hours of professional development/training per year



Respondents were asked how they receive STEM PD (Figure 24), how they hear about PD (Figure 25) and any limitations to participating in PD (Figure 26). STEM PD is provided primarily through an outside workshop or with a consultant (42%), with about one-quarter of current STEM PD received through online learning. Respondents primarily find out about PD through email/mail, and many also receive this information from colleagues or administrators. Most were aware of PD opportunities (Figure 26).

The biggest barriers to participation in PD is limited time and funding. Few respondents indicated that they had no interest in PD.

Figure 24. STEM professional development/training

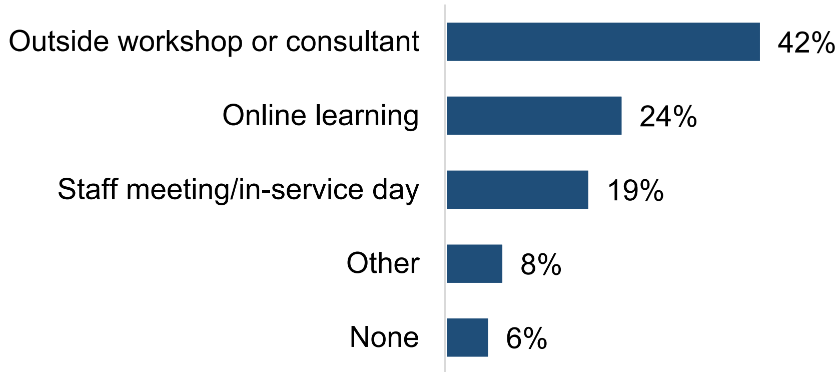


Figure 25. How respondents learn about professional development/training opportunities

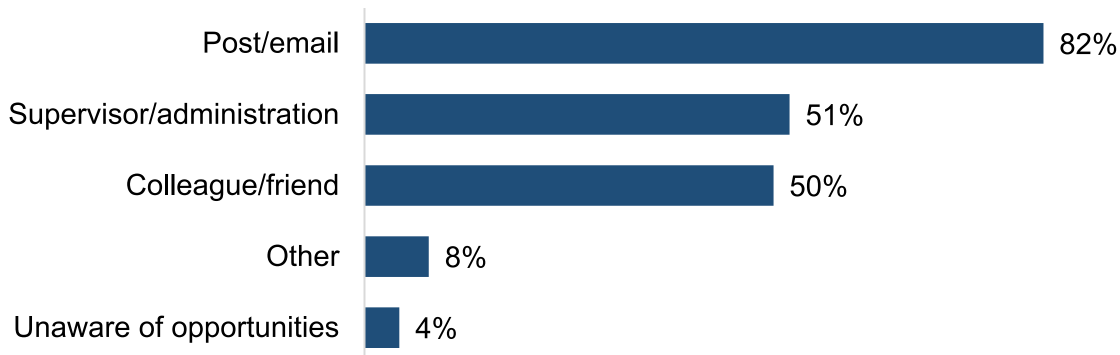
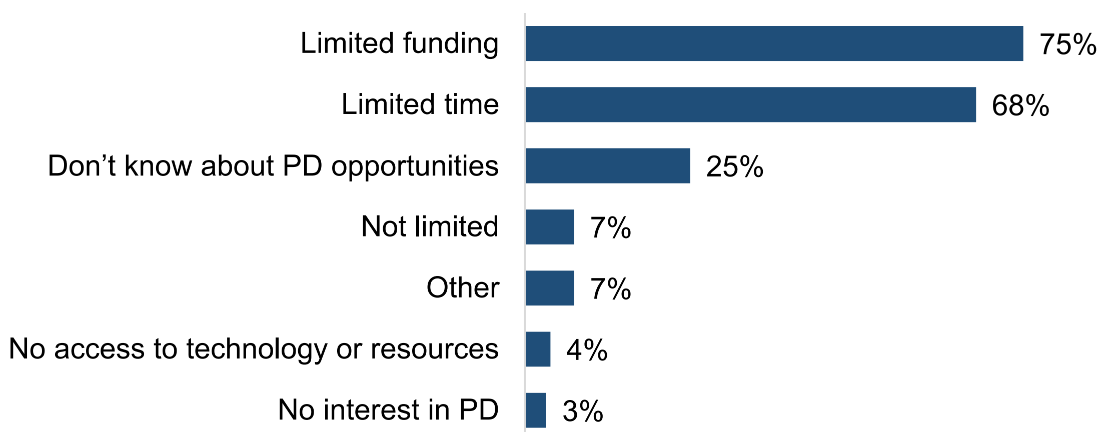


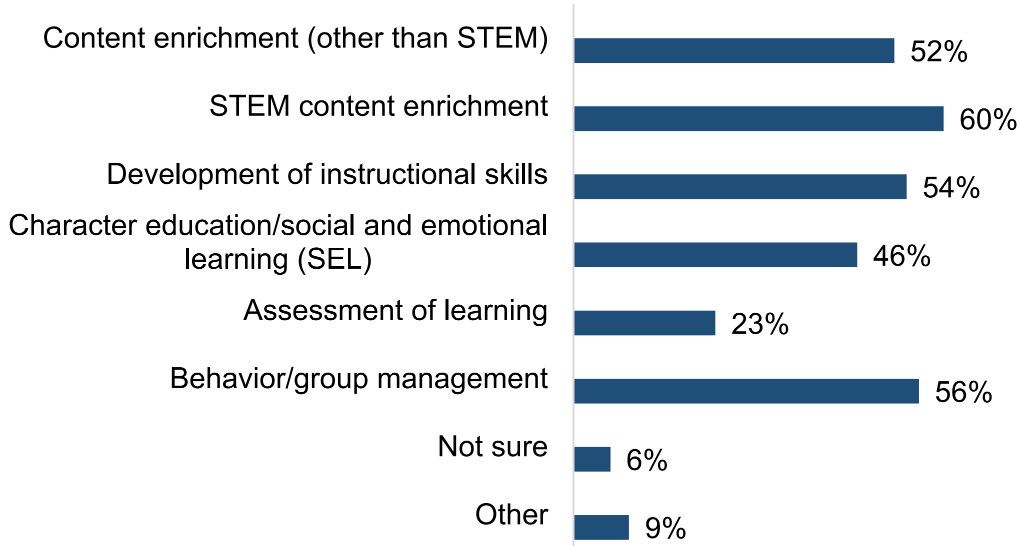
Figure 26. Limitations to participation in professional development



Supervisor perspectives on professional development for staff

Supervisors were asked what topics are currently included in PD for staff (Figure 27). STEM content enrichment is well-represented in current PD offerings.

Figure 27. Current topics in staff PD



In follow-up interviews (see methods used to conduct interviews on page 7 and interview questions in Appendix B), twelve supervisors were asked a variety of questions about what they provide to their OST staff for staff training/PD.

Supervisors identified that PD is provided through both internal and external sources, including on-site sessions provided by staff, on-site sessions provided by outside groups, and conferences or other external sources. Whereas one supervisor prefers to use outside sources, often working with other programs in other districts to bring in experts, others use internal expertise. One supervisor goes to PD herself and then provides the PD to staff using garnered resources. For other programs, expertise is identified by staff "in-house," and then sessions are developed and offered for the team. When staff identify special topics that match their interest, they then seek out PD at conferences or workshops, such as a recent Vex IQ Robot training.

Several groups provide regular PD programs for staff, including monthly trainings, summer programs, and summer programs with monthly follow-ups. For some groups the focus is a training about a specific curriculum unit. Other topics included a mix between content, pedagogy, and learning about the student population, such as poverty, overcoming adversity in childhood, science notebooks, cultural engagement and safety protocols. For one program a minimum amount of PD is required by the state and includes specific required topics. As the budget allows, staff then are encouraged to complete more PD, including PD on STEM topics.

Other programs had little to no PD availability for staff. For instance, one supervisor provides web-based resources for staff to review on their own time. Another supervisor commented that whereas she participates in two Professional Learning Communities (PLCs) per year and robotics training through a grant, there is no clear structure for providing PD for the staff, but she shares what she can. Two supervisors describe they sought out PD for themselves as needed.

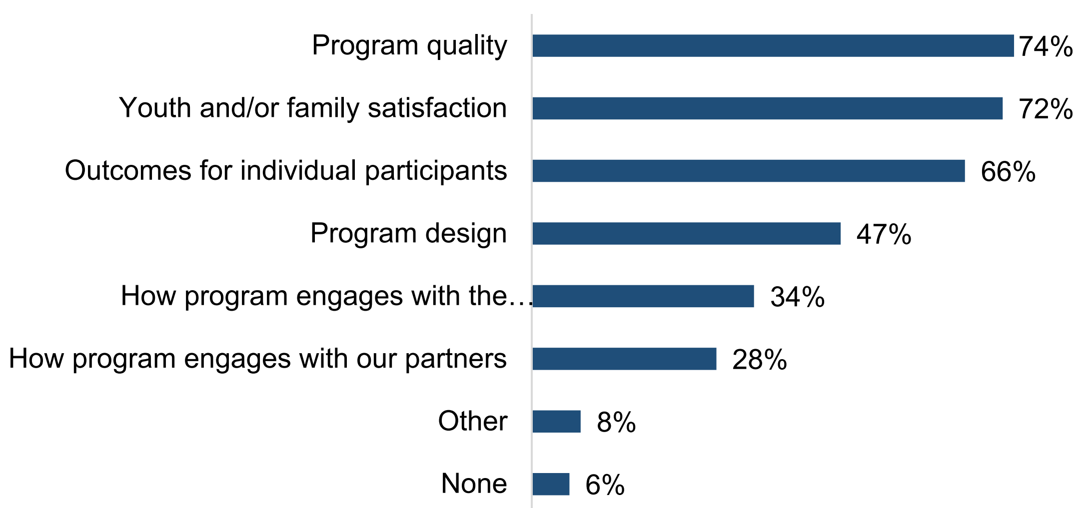
Supervisors identified factors affecting their decisions in choosing PD. From the twelve respondents the top responses were: budget/cost (8), program needs (5), interest of staff or supervisors (5), proximity/location (4), requirements (3), and national trends (2). One respondent (each) identified, flexibility, research-based content, needs identified from performance reviews, parent feedback and time.

Supervisors identified if they would change any aspect of the PD currently used. Few respondents had specific examples of what to change in their current PD, except to have more opportunities for PD, including more convenient times and mechanisms to get more educators involved. One educator commented that most PD offered is focused on math, and would like to offer planetary science PD to staff. One supervisor would like to follow up with the summer PD for her staff with observations with feedback, but identified that this is very time consuming with a large staff.

Supervisors described staff strengths. Supervisors with younger staff (college students) describe that their strengths are often their energy and ability to connect with youth (which can vary with the individual). Often programming is selected from staff interests and abilities, since they may bring in a special skill or talent. Supervisors with older staff and/or teachers described strengths as their experience adjusting to new situations, their teaching expertise and their collaborative nature working with each other informally or through PLC's to fill in content needs. Several supervisors identified that either they themselves or a staff member had advanced degrees in science, or high level expertise in coding and other engineering topics, that expands the programming they are able to provide.

Supervisors described how they evaluate their programs. Most supervisors do evaluate their program, and many evaluate multiple aspects of the program (Figure 28).

Figure 28. Areas in which supervisors evaluate their programs



National trends in OST programming

A majority of supervisors identified STEM programs as a national trend. A focus on 21st century (or soft) skills and social and emotional learning (SEL) were also frequently identified national trends. Often supervisors mentioned these areas in the context of providing career and future development opportunities for students. As one OST supervisor commented:

> *[OST] also just feeds into 21st century business skills and education skills, enhancing what they're getting from the school day, basically. And being able to contribute to the youth growth and development, [so] that they'll be able to function productively in the work field, whatever that may be.*

Several educators identified Maker Spaces, dedicated spaces often with tools, as a current trend. Others mentioned project-based instruction (PBI) or self-guided learning as a trend. In addition to describing the content or structure of program activities, one educator identified the importance of OST, to build on school day instruction with fewer restrictions than traditional instruction. As one supervisor commented,

> *I really think school is just trying to force through so much information that the kids lose the freedom, kind of, to explore their own interests and figure out who they are. Especially in their junior high and senior high areas. So, I see that as a real opportunity in the out of school time* [environment] *and STEM is a big part of that.*

Another supervisor described the importance of having different groups in a community integrate their offerings as a way to strengthen student experiences. Several supervisors also identified areas in which they see needs, such as the provision of more math and more math integrated with engineering in programs.

Needs of OST educators

In order to determine professional needs of OST educators, a series of questions were asked to staff about their needs and to supervisors about the needs of their staff.

Staff level of comfort and preparation

The majority of staff feel comfortable teaching with NASA resources, planetary science, engineering design or integrated STEM (Figure 29). Their supervisors, however, identify that staff are not prepared in many of these areas (Figure 30).

Figure 29. OST Staff comfort level teaching skills, subjects or activities

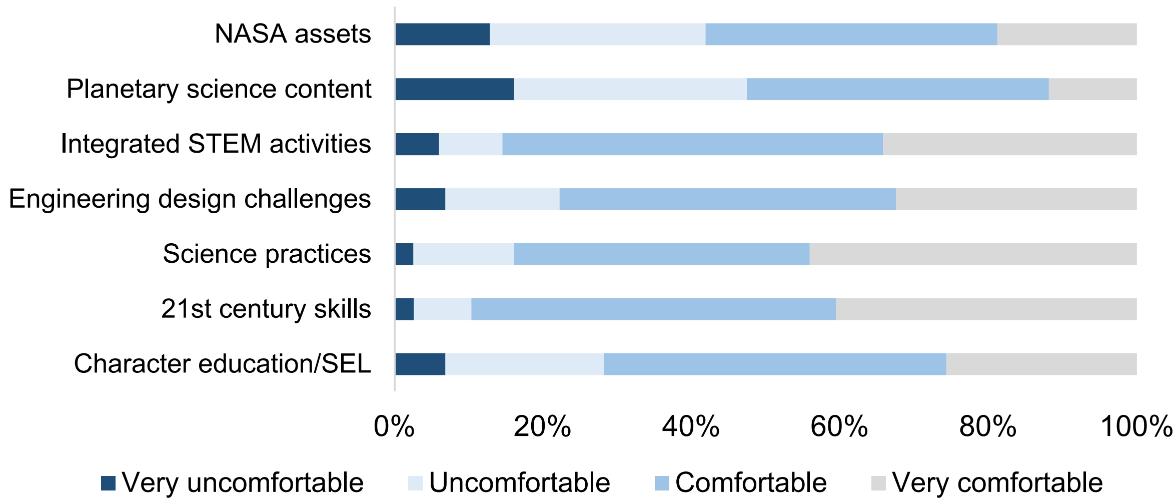
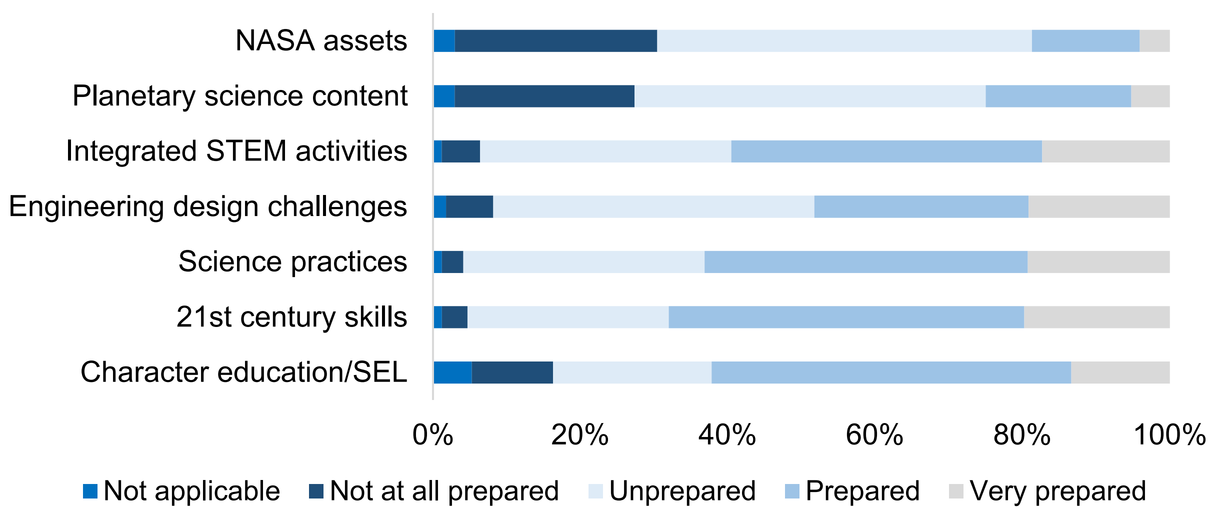
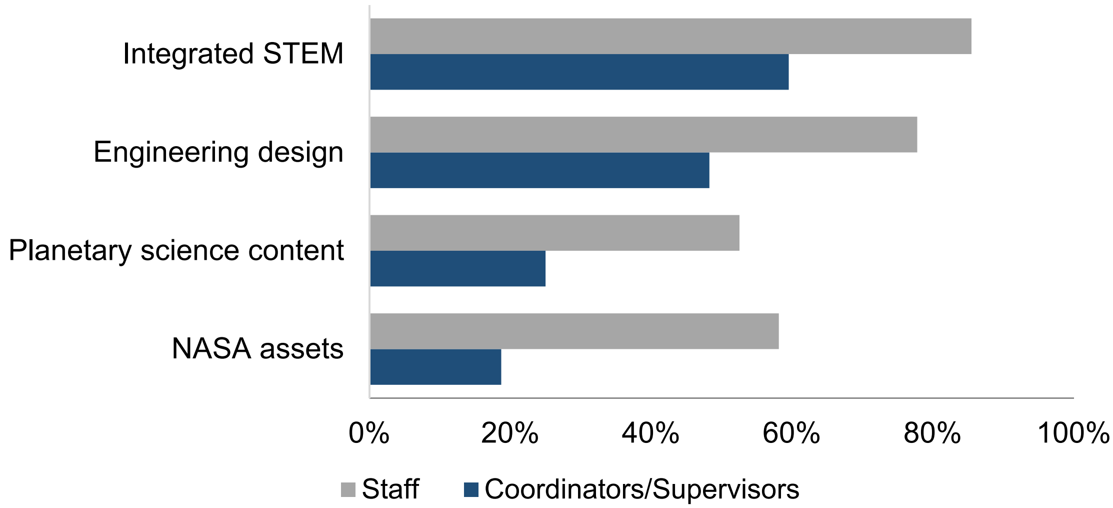


Figure 30. Supervisor perception of OST staff preparation to teach skills, subjects or activities



Comparing perceptions between staff and supervisors identifies disconnect in some areas (Figure 31).

Figure 31. Staff who identify they are comfortable teaching these areas and supervisors who feel their staff are prepared in these areas



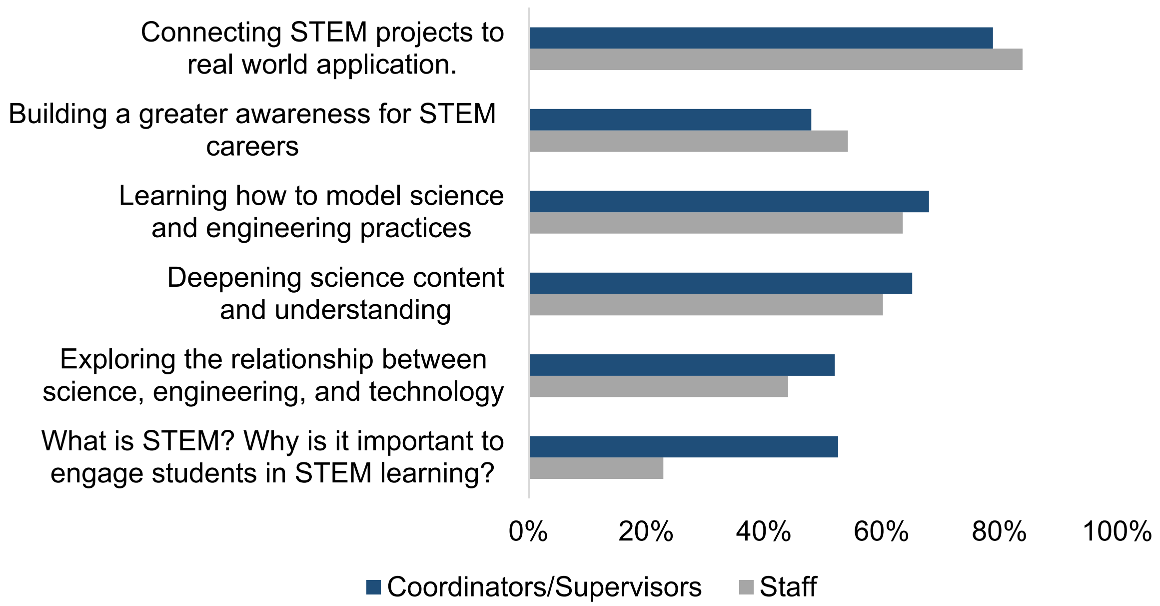
In order to understand this disconnect, in the interviews supervisors were asked to identify interpretations of the difference between the perceptions of staff and supervisors. Supervisors identified two different interpretations for these data. One interpretation is that staff responses are accurate and they are more prepared for teaching specific content areas than their supervisors perceive. With this interpretation, supervisors are not aware of the depths of their staff's knowledge because they are not in the learning environments often enough to observe the teaching abilities of staff, or are less well-versed in STEM topics than their (frequently) younger staff. The other interpretation is that staff overestimate their abilities. With this interpretation, supervisors identified that staff know less than they think, that supervisors are more aware of the importance of educator development and continued improvement, or that supervisors have higher standards for quality teaching than staff.

Overall, supervisors identified that staff either are not broadly prepared in STEM curricular topics or can always use more preparation. Several supervisors identified that staff particularly need more professional support with questioning strategies and science and engineering practices. Supervisors also commented that regardless of previous preparation, it is important for staff to experience the curricula before teaching it. As the selectors, developers and at times implementers of curricula, several supervisors commented that they themselves felt prepared for teaching the content of the curricula.

Content needs

In order to determine self-identified content needs and interest areas, staff survey respondents were asked to identify from a list of potential sessions, which PD session they would be most interested in attending, and supervisors were asked to identify which PD sessions they would be most interested in their *staff* attending. A majority of respondents were interested in many of the sessions identified (Figure 32). Respondents were most interested in the session "*Connecting STEM projects to real* *world application*." Responses were similar between staff and supervisors except for the session, "*What is STEM? Why is important to engage students in STEM learning?*", in which supervisors were much more interested in their staff attending than staff were interested in attending, and staff were actually least interested in attending. Potential reasons for this difference could be that staff feel they are more aware than supervisors about basic STEM concepts, or that supervisors are more interested in understanding the importance of engaging youth in STEM learning.

Figure 32. Professional development sessions staff would like to attend and supervisors would like their staff to attend to enhance knowledge of STEM



In interviews with supervisors, STEM content was identified as a content need for staff, since either staff do not have the background, or that individuals can always learn more, and "go deeper" into content. One supervisor commented that engineering, in particular, was an area of weakness, compared to other areas in STEM. One supervisor commented that the staff in particular struggle with STEM terminology and fear of not knowing enough to answer youth questions. Thus, content-focused PD was also identified as a need. One supervisor identified that with background provided through PD, staff then can explore the content area further and deeper.

Instructional needs

Staff respondents were asked to identify their three highest instructional needs, and supervisors were asked to identify their staff's three highest instructional needs. Respondents identified how to implement hands-on/minds-on learning, how to promote problem solving and open-ended challenges, and how to manage youth behavior and logistics as top needs.

Figure 33. Biggest instructional needs of staff

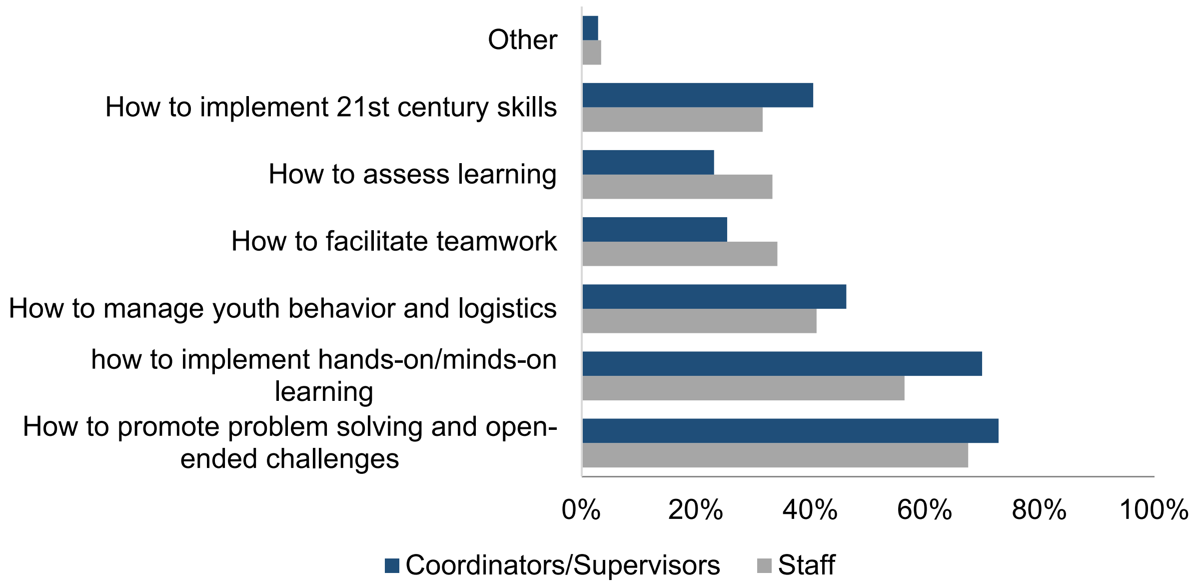
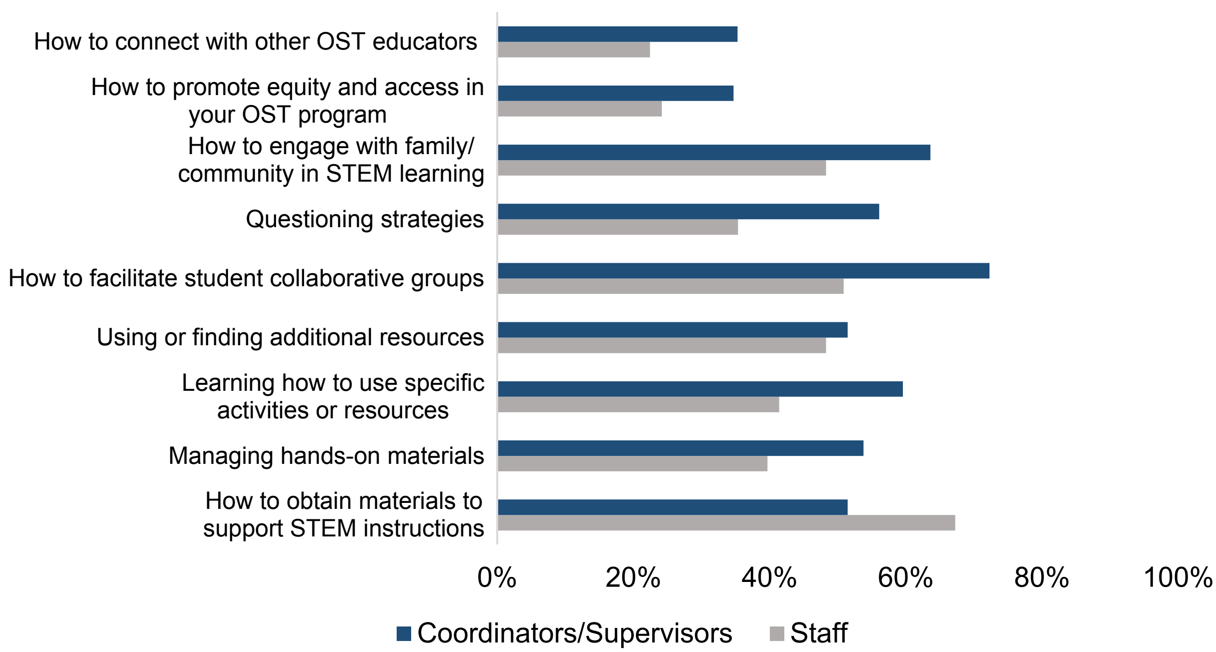


Figure 34. Professional development sessions staff would like to attend and supervisors would like their staff to attend to enhance instructional practice

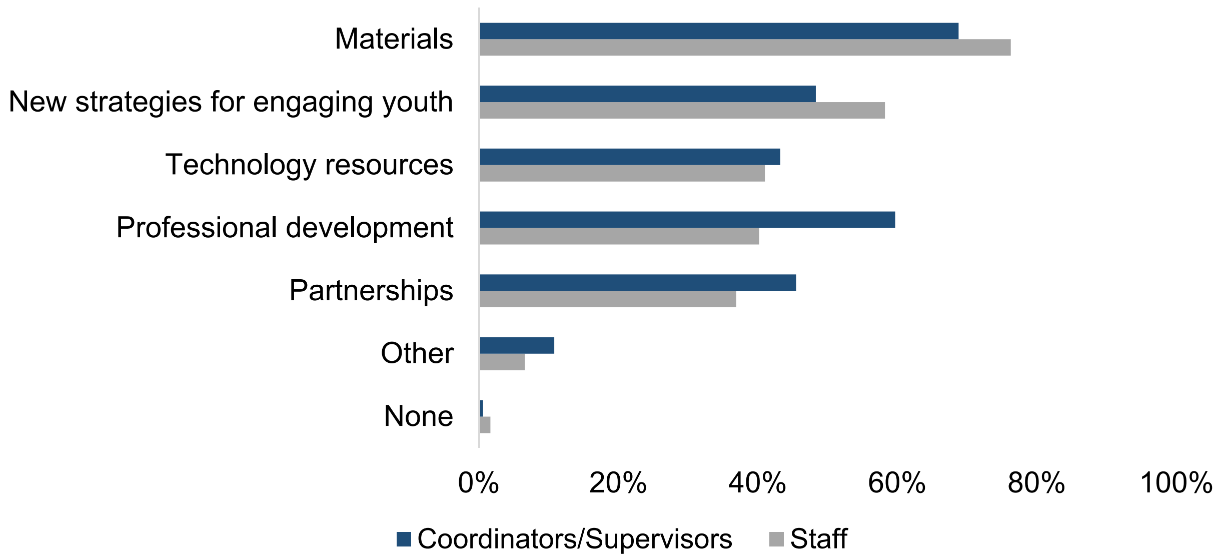


In interviews, supervisors identified instructional needs of staff, including behavioral support and keeping kids “engaged.” Specific areas of need for formal teaching staff was support with how to transfer traditional educational experiences to an informal environment. One supervisor specifically suggested that learning about PBI/PBL was an instructional need, because for some formal educators, they have “*been* *so programmed to teach for the [standardized test]... to get them out of that box has been challenging*." One supervisor who teaches the program herself needed strategies for teaching middle school as well as how to teach OST students who only participate irregularly.

Program needs

Respondents were asked about the top three critical needs of their programs (Figure 35). Almost three quarters (72%) identified materials as a top need, and about half (52%) identified new strategies for engaging youth and PD as top needs.

Figure 35. Top identified program needs



In order to clarify responses, in interviews supervisors were asked why "new ways to engage youth" was identified as a programmatic need by about half of each group. Respondents commented that this identified program need was referring to the need for new ways to interest and involve students in programs. A number of respondents identified that youth populations have changed, and either youth have a short attention span due to access to constant information through hand-held technology, or have become passive learners. Several respondents indicated that middle school students, in particular, can be difficult to engage. Other respondents disagreed with the statement, and commented that youth continue to be interested in programs. One respondent commented that the problem is not with the youth but with the way that STEM activities are often taught, "like they would [teach] a craft project. 'Okay kids, here's the stuff for the craft project. Let's do this craft project,'" rather than in a way to support their curiosity. Others identified that lack of funding for resources can lead to low-interest pencil and paper activities.

Getting students to think critically, therefore, was identified as a way to engage youth. Regardless of the reason, participants identified that programming needs to shift to stay dynamic, to align with the flexibility that OST environments afford, to align with current research, and to interest the sub-set of youth that participate year after year. As one participant commented,

> As a program director we're always trying to find new ways to increase engagement that goes with best practices and trends, emerging trends, and I know my staff are ... trying to find ways that are also interesting, to engage [youth].

Participants commented that they are looking for activities in which students get to make choices, which provide applicability to students' lives, and are hands-on, include visuals and high quality resources. When identifying activities, several commented that it is important to consider student interest, not just the interests of the staff, and for youth to perceive value in what they do. Two respondents specifically identified PBI/PBL as a great way to engage youth, but it is important to "set the scope of it really well for them and that's the challenge."

Respondents indicated that program staff need to have both personal and professional skills to implement programs in engaging ways. As one commented,

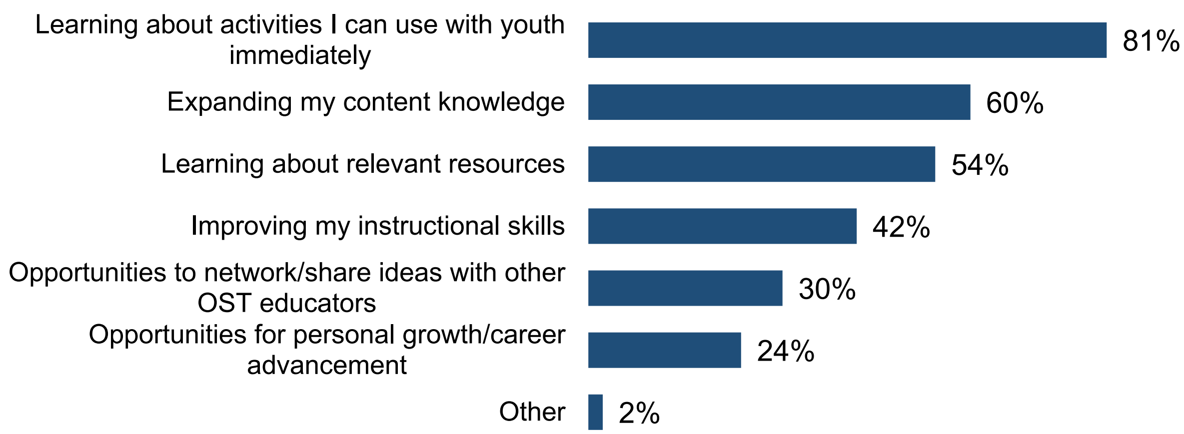
> "[The youth] may not see the value in what they do. And we need to somehow... help them see value in learning and help it to be interesting to them."

Another respondent commented that relationship building with students during activities is critical.

Utility of professional development

OST staff and supervisors provided insight about what makes effective PD based on preferred content and delivery. They identified that PD was most useful when they learn about activities to immediately use with youth (81%), expand content knowledge (60%) and/or learned about relevant resources (54%). Fewer respondents found PD important for personal growth/career advancement, improving instructional skills or to network with other educators.

Figure 36. Top factors that make PD useful for staff



In interviews supervisors identified flexibility, cost and relevancy of PD as important considerations for designers when creating accessible and useful PD. Supervisors identified ideal content in PD experiences. They were most interested in PD that would help them implement activities/lessons with students, rather than focus on their own learning. Several educators identified the importance of "relevant" learning experiences, ones that reviewed a student lesson or provided a "takeaway." They described the importance of hands-on experiences for helping them learn how to implement, robotics, engineering and other hands-on activities they planned for their students. This focus led several to question if these types of experiences would be possible in an online environment. Several respondents reiterated that it was critical for them to provide activities that engaged students in learning or exploring, with the implication that professional preparation focusing on these types of programs would be ideal.

Several educators identified that they would like PD on teaching strategies, such as a model for how work together to solve a challenging problem, or how to facilitate open-ended learning such as when students deviate from the written curriculum. Because the latter supervisor identified that many staff in OST settings do not have a strong knowledge base, they feel less confident in open-ended environments. They need to learn it is "Ok to say to students, 'I don't know.'" Respondents identified that different strategies for working with youth, such as including cultural enrichments, student behavior, how to work with middle school students specifically, or "knowing how to teach NASA resources and planetary sciences [in a way] that make students engaged" as ideal PD learning opportunities.

Professional development format

In the survey, respondents ranked their preference for PD format, with the number one preference a face-to-face format.

However, most respondents would use on-line formats. In an online environment, staff identified that they would use the following format for their PD:

- ✓ 79% Videos
- ✓ 70% Webinars
- ✓ 65% Presentations
- ✓ 61% Articles/readings

In interviews supervisors provided the pros and cons of an online format. Online formats provide important time flexibility and fitting in with tight budgets for PD. However, a number of supervisors identified knowing and tailoring PD to the audience as important factors, with the implication that this could be a challenge in an online environment. Supervisors identified the importance of reviewing curricula materials, ideally in a hands-on environment, as important for PD. Supervisors also identified the importance of providing opportunities to communicate, process, and share learnings within PD. One supervisor identified that in general the type of PD that has the most impact on learning, "aren't what I call 'drive by trainings'... [Effective PD] gets deeper and the learning gets there."

One supervisor identified a potential barrier to online PD, that districts might block online platforms or tools. Another supervisor commented that online PD would be tough because the staff have no access to computers. Another supervisor identified that increasingly, more interactive tools/models are available that can support online learning. Regardless of platform several supervisors also identified the importance of PD that is engaging and not "dry."

Most supervisors identified that face-to-face PD is ideal, with an emphasis on interactivity. A number of supervisors specifically commented on the importance of participating in PD with peers or in a group. One supervisor described a powerful recent learning experience which included learning circles, and in which all participants shared ideas, then used ideas and brought back their experiences to the group and had further discussions. A number of supervisors identified the benefits of online PD, but provided caveats. For instance, if PD were to be online, it should include synchronous opportunities to share learning and get feedback, as communicating with other professionals online can be powerful. Several supervisors gave examples for effective PD in online environments. Video clips rather than just readings were identified by several as preferred within an online environment. One suggested that providing monthly offerings with different formats, a variety of resources over time and earning badges for completion could be an effective strategy. One supervisor had participated in NASA Educators Online Network, which was "Ok."

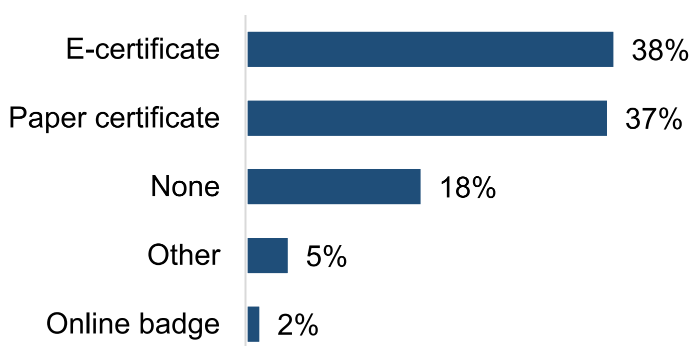
Platform for PD

In the survey, three-quarters of staff indicated would be willing/able to use a social media platform (Facebook, Twitter, Google+, etc.) for PD. This was confirmed by supervisors and coordinators, many of whom think their staff would be willing to use such a platform. Most (86%) of program staff would be willing/able to use an online platform (Skype, Edmodo, Blackboard Learn, etc.) for PD, and 80% of supervisors/coordinators concur.

Documentation of PD

Staff identified that they do require documentation of their PD participation, and prefer either a paper or e-certificate over an on-line badge (Figure 37).

Figure 37. Staff documentation need or preference for professional development



Implications

With an increasing emphasis on STEM learning, and a great demand for OST opportunities for youth, **STEM programming in OST will continue to grow**. OST educators confirmed a demand for OST programming. In this study, 89% of study respondents are already offering STEM programs at their sites and **89% would also like to add more STEM programs**. This finding highlights the good news that there is already a significant amount of STEM offered in OST programs. However, although many programs frequently provide integrated science activities, science practices and/or engineering design, few provide planetary science content or NASA resources with any regularity. It is particularly critical to build these opportunities in OST because there is little planetary science content in science standards classroom teachers are required to follow, which is an obstacle to teaching planetary science lessons in the traditional school day. Additionally, few classroom teachers have opportunities to provide engineering curricula in the current school day. Therefore, opportunities to add exemplary planetary science programs and NASA educational resources into OST are timely. The take away message for NASA and other planetary science educators is to continue to examine OST opportunities and consider how to add a planetary science focus, highlighting NASA resources and related important content. The PLANETS project has taken on this challenge, integrating planetary science content with engineering design challenges and linking in other NASA resources, to provide engaging lessons that have the potential to increase youth interest in planetary science and knowledge of STEM.

The next challenge to providing exemplary planetary science programs for youth is to **support educators** to facilitate these opportunities. Understanding the background and context of these educators is important to identify how to best meet their needs. The literature provides a general understanding of OST staff. Educators in this field have a range of educational backgrounds, but infrequently have science or science teaching experience. Therefore in many cases PD provides an important opportunity to prepare staff to implement high quality STEM programs.

Unfortunately there is **little availability of professional learning opportunities for OST staff**, as financial resources are often limited for PD. Because of high staff turnover, some in the field also question investing in PD for staff (Asher, 2012). Results in this study concurred with both a lack of specific preparation and few PD opportunities for staff. Many of the participating educators have had teaching experience in formal or informal settings, but few have STEM backgrounds, particularly in engineering. Whereas many staff felt prepared to teach STEM, supervisors were less convinced about the level of staff preparation. Most respondents identified they had less than 5 hours of STEM or integrated STEM PD a year. Identified barriers to participation in PD were time and money, not lack of awareness of opportunities, thus designing PD that are low cost and efficient are critical for this group.

It is important for the **OST field to improve PD opportunities for staff**. Quality staff training boosts competency and increases content understanding, particularly for staff without a science background (Donner & Wang, 2013). Supervisors in this study concurred that more PD was a top program need. To best support youth learning and implementation of STEM programs as intended, it is important to develop both the competency and confidence of the educator (Barker et al., 2014). Also when PD aligns with staff interest, engaged staff will also be more motivated to stay in the profession (Barker et al., 2014).

The literature indicates that **PD considers both content and instruction**. Based on identified needs and interest in this study, OST staff will benefit from PD that supports not only their science and engineering content knowledge, but also understanding of science and engineering practices and instructional strategies to most effectively facilitate learning experiences for youth. For instance, participants identified that an important program need included new strategies for engaging youth, such as providing open-ended challenges. This type of facilitation, may require educators to learn new and different strategies for group and behavior management. Supervisors also identified that facilitating open-ended challenges is most challenging for inexperienced staff.

Participants in the study also identified a need to learn about how to **connect STEM learning to real world contexts**, and how to **expose students to STEM careers**. In addition to considering important topics for PD, this may also be an opportunity for NASA to provide real-world examples of the work NASA scientists do, thus building a greater awareness for STEM careers and how scientists and engineers work together. There are also opportunities to highlight careers in planetary science through providing guest speakers or other opportunities for scientists and engineers to engage with OST programs.

In thinking through other ways to effectively meet the professional needs of OST educators, we investigated the **current conditions of OST educators**. We found that many staff are already teaching multi-session activities, rather than solely stand-alone activities. Therefore it should be possible to build upon this context and encourage them to utilize the multi-unit PLANETS curricula. As identified in other studies, many OST settings have high percentages of underserved youth, therefore it is critical to **be responsive to the specific needs of these youth and environments.** Although most programs have access to computers with internet access, this means that that there are still a significant number of programs without this access, likely in the most underserved communities. It is important, therefore, to consider strategies for providing programming that does not require this access. To be responsive to underserved communities also requires consideration of ELL and underrepresented minorities, including American Indian and Hispanic youth.

When considering limitations of time and money for providing PD, designers must identify how to **make the PD most effective for youth learners**, the ultimate beneficiaries of PD. Guskey (2002, 2014) suggests to first identify youth learning outcomes, a backwards design approach, which directs and focuses all other planning around this important outcome, so that designers do not fall into the PD "activity trap." Including this critical focus on student learning within the PD also helps educators to understand program goals and the importance of implementing the program with integrity to these program goals. Because OST learning outcomes are often a blend of youth development and STEM content, both important for changing attitudes towards the importance of STEM in daily life and for career awareness, focusing on both areas and areas of overlap is essential (Noam & Shah, 2013a).

Another important consideration is for **OST PD to be useful and directly applicable for the OST educator**. Participants in our study identified that PD is most useful when they learn about activities to immediately use with youth, expand their content knowledge and/or learn about relevant resources. The literature also identifies the importance of skill development for fidelity of implementation of the curriculum. Freeman et al. (2009) concur that OST STEM educators need opportunities to learn processes, methods, and/or approaches to teaching science, and to have exposure to materials, supplies, equipment, and curricular resources.

Freeman et al. (2009) identify that PD should meet the needs for the many different educators in OST and target the audience in the PD design. They also indicate the importance of providing flexibility and less structure in the PD, in order to match the less formal environment of OST. This study identifies a range of OST educators, from certified teachers, to volunteers, and from those with significant science and engineering backgrounds, to those new to the STEM field. Thus, a suite of non-linear offerings, in small time allotments provides lots of opportunity and free choice for educators.

PD must be accessible to staff in a variety of different settings. Although most educators identified in the current study that they prefer face-to-face PD, this is not always practical or affordable, particularly for rural communities. Distance learning for PD is a format adopted for practicality, particularly for programs with a national reach, such as PLANETS. Online learning also provides opportunity for customization or personalization of PD for the individual. Many educators in the study were willing to utilize an online PD format, and identified their preferences for this type of learning, including the use of video. When considering how to integrate other powerful PD strategies identified in the literature and by supervisors in this study such as collaborative learning and reflection on the curricula as an educator and a learner (Barker et al., 2014), program designers can consider providing self-guided reflection questions and strategies for group work within the online format. Because follow-up support is also identified as important (Barker et al., 2014), designers can provide an email contact or consider monthly follow-up synchronous webinars for educators. For documenting their time in PD, an electronic certificate can be provided, so staff can have an electronic version or print it for their files, both preferred options.

Studies identify the importance of **leaders or supervisors participating in the PD** so they understand the program, and know how to support their staff (Metz et al., 2009). Including leadership also supports changing beliefs in educators and provides leadership with an understanding of any necessary structural change in the learning environment (Whitworth & Chiu, 2015). How to evaluate OST programs is a particular important focus for PD for OST leaders (Wilkerson & Haden, 2014) and a variety of instruments are available to help with program evaluation (Shan et al., 2014).

When considering next steps for OST PD, designers should keep an eye on the horizon. Supervisors have identified **national trends in the OST environment**, and this includes Makerspaces, project based instruction, and further opportunities for STEM. Designers and providers must also incorporate evaluation of the PD they provide, to not only support refinements of PD but also provide evidence of the impact of this important endeavor for staff, and ultimately student, learning.

Recommendations for design of PLANETS professional development

To meet the needs of OST educators teaching the new PLANETS units, the designers should create PD that:

Supports youth learners

- ✓ Supports educators to be responsive to needs of underserved audiences.
  - Alternatives to internet and computer-based resources are identified.
- ✓ Identifies how the professional learning meets the learning goals of each unit.
- ✓ Identifies how the professional learning meets the learning goals of the overall project.
- ✓ Provides the philosophy of the program, helps educators understand the intentions behind each activity, and provides guidance and purpose for facilitating activities with higher fidelity.
- ✓ Connects STEM learning and other youth development goals, such as social and emotional learning and 21st century skills.

Supports OST educators

- ✓ Offers efficient options and accessible distance learning formats for all educators.
  - Utilizes video.
  - Provides short segments that are not required to be experienced linearly.
  - Targets the audience by addressing needs of different learners.
- ✓ Is directly applicable to OST settings, is context rich and is specific to the units themselves.
- ✓ Demonstrates the activity or skill; provides exposure to materials, supplies, equipment, and curricular resources.
- ✓ Builds in time for reflection, through addition of self-reflection questions.
- ✓ Optional follow-up support provided, through inclusion of an email address for PLANETS.
- ✓ Provides suggestions for group or collaborative staff learning opportunities.
- ✓ Engages participants as facilitators and learners.
- ✓ Addresses fears or concerns about teaching science and engineering.
- ✓ Provides real-world context of OST STEM experiences.

Meets content needs of OST educators

- ✓ Develops understanding of planetary science concepts.
- ✓ Develops understanding of science practices and engineering design processes.
- ✓ Supports use of NASA resources.

- ✓ Review important background knowledge and context for the engineering challenges.

Meets instructional needs of OST educators

- ✓ Uses effective pedagogical strategies e.g. facilitation/management for open-ended challenges.
- ✓ Address instruction of science practices and engineering design process.
- ✓ Connect with other OST PD that includes broader education and behavioral management skills[3] as a supplement.

Supports leadership

- ✓ Recommends supervisor inclusion in PD.
- ✓ Provides specific content for supervisors.
- ✓ Provides information about how to evaluate OST program.

[3] 4-H, National Partnership for After School Science, and the National Institute on Out of School Time. Effective online resources have been created including Click2SciencePD, "Tools of the trade," and Youth for Youth Online Professional Learning and Technical Assistance for 21st Century Community Learning Centers, and Cypher Works.

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Appendix A

Out-of-School Time Needs Assessment

Online Survey Consent

You are invited to participate in a research study titled Planetary Learning that Advances the Nexus of Engineering, Technology, and Science (PLANETS). This study is being conducted by Nena Bloom and Joëlle Clark from Northern Arizona University.

The purpose of this research study is to identify both the experiences and professional development needs of out-of-school time (OST) educators for providing effective science and engineering programs to youth. If you agree to take part in this study, you will be asked to complete an online survey. This survey will ask about your background, your existing experience, professional development opportunities that are available to you, as well as your perceived needs for teaching effective science and engineering programs. It will take you approximately 20 minutes to complete.

Upon completing the survey, you can submit your name in a drawing to win an Engineering is Elementary Teacher Guide (a value of $50). Participation in the research study is not required to enter the drawing. Entries are limited to one entry per person -subjects under age 18 must have written consent from a parent or lawful guardian. Participation is void where prohibited by law. Contact Nena Bloom for more information.

Although you may not directly benefit from this study, we hope that your participation will contribute to the design of effective science and engineering professional development for out-of-school time educators.

We believe there are no known risks associated with this research study; however, as with any online related activity, the risk of a breach of confidentiality is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by storing your responses on a password protected computer and only sharing findings in grouped form with no names attached.

Your participation in this study is completely voluntary and you can withdraw at any time. You are free to skip any question that you choose. If you choose not to participate, it will not affect your relationship with Northern Arizona University or result in any other penalty or loss of benefits to which you are otherwise entitled.

If you have questions about this project, or if you have a research-related problem, you may contact the researchers, Nena Bloom at 928-523-7163 or Joëlle Clark at 928-523-8797. If you have any questions concerning your rights as a research subject, you may contact Northern Arizona University IRB Office at irb@nau.edu or 928-523-9551.

By submitting this survey, I affirm that I am over 18 years of age and agree that the information may be used in the research project described above.

Out-of-School Time Needs Assessment

Background Information

This survey asks about your background, your existing experience, professional learning opportunities that are available to you, as well as your perceived needs as an out-of-school time staff member or program coordinator/supervisor.

1. Identify how long you have worked in out-of-school time programs:

Years [ ]

Months [ ]

2. Identify your formal educational background (mark ALL that apply):
   - ☐ High school degree/GED
   - ☐ College degree (AA/BA/BS)
   - ☐ Teacher certification - elementary
   - ☐ Teacher certification - secondary
   - ☐ Master's degree
   - ☐ Doctoral degree
   - ☐ Other, please specify

3. Do you have formal teaching experience in a K-12 classroom?
   - ○ Yes
   - ○ No

4. Please check/indicate the selection that best describes the number of college level courses you have taken in the following content areas:

	0-3 courses	**4-10 courses**	**11+ courses**
Science	○	○	○
Technology	○	○	○
Engineering	○	○	○
Mathematics	○	○	○
Education/teaching	○	○	○

Out-of-School Time Needs Assessment

Current Out-of-School Time (OST) Programs

Please answer the following questions about your current out-of-school time position (or most recent position if you are between positions).

5. Please identify the type of position you hold in your out-of-school time program (mark ALL that apply):
   - ☐ Paid permanent employee
   - ☐ Paid seasonal/temporary employee
   - ☐ Full-time employee
   - ☐ Part-time employee
   - ☐ Certified teacher, additional duties
   - ☐ Volunteer
   - ☐ Contractor
   - ☐ Not sure

6. Identify the type of out-of-school time program in which you are currently employed (mark ALL that apply):
   - ☐ Before and/or after school
   - ☐ Summer program
   - ☐ Weekend program
   - ☐ School break program
   - ☐ Other, please specify

7. Categorize the out-of-school time program in which you are currently employed (mark ALL that apply):
   - ☐ School-based program
   - ☐ Community-based program (e.g. recreation center, library, etc.)
   - ☐ Club program
   - ☐ Institution-based program (e.g. museum, nature center, etc.)
   - ☐ Corporate-run program (e.g. Intel math)
   - ☐ Faith-based program
   - ☐ Other, please specify

8. In which zip code(s) are your program(s) located?

9. What is the approximate ratio of instructor to youth participating in your out-of-school time program?
   - ◯ 1 to 10 or fewer
   - ◯ 1 to 11-20
   - ◯ 1 to 21-30
   - ◯ 1 to 31-40
   - ◯ 1 to 40+

10. Approximately how often does your out-of-school time program meet with the same group of students?
    - ◯ Less than 1 time per week
    - ◯ 1 time per week
    - ◯ 2-3 times per week
    - ◯ 4+ times per week
    - ◯ 1+ week(s) summer school or school intersession camp
    - ◯ Other, please specify (e.g. occasional play/home group, vacation or other type of camp)

11. What is the grade band of the MAJORITY of students in your out-of-school time program?
    - ◯ Preschool
    - ◯ Elementary school (K-5th grade)
    - ◯ Middle School (6th-8th grade)
    - ◯ High school (9th-12th grade)

12. Approximately what percentage of the youth that participate in your program are from underserved populations (e.g. low-income, youth with disabilities, English language learner, underrepresented minority, first-generation college, etc.)?
    - ◯ 0%-25%
    - ◯ 26%-50%
    - ◯ 51%-75%
    - ◯ 76%-100%
    - ◯ do not know

13. Please select the community in which your out-of-school time program is located:
    - ◯ Rural community
    - ◯ Suburban community
    - ◯ Urban community

14. Select reasons youth participate in your out-of-school time program (mark ALL that apply):
    - ☐ Child care/support services
    - ☐ Sports/recreation, and/or health/nutrition

- ☐ Arts and culture
- ☐ Academic enrichment (science, technology, engineering, math, reading, etc.)
- ☐ Tutoring, homework help, or academic interventions
- ☐ Place-based (e.g. nature center, zoo, archaeology site)
- ☐ Character education/social and emotional learning (SEL)
- ☐ Other, please specify

15. Please identify who teaches in your out-of-school time program (mark ALL that apply):
- ☐ Paid permanent employees
- ☐ Paid seasonal/temporary employees
- ☐ Volunteers
- ☐ Full time employees
- ☐ Part time employees
- ☐ Classroom teachers
- ☐ Not sure
- ☐ Other, please specify

16. Do you have an Internet enabled computer/tablet/smartphone at work or home to access professional resources?
- ○ Yes
- ○ No
- ○ Not sure

17. Does your out-of-school time program have at least one computer with Internet for instructional use?
- ○ Yes
- ○ No
- ○ Not sure

18. On average, how often does your out-of-school time program include the following?

	Never	**Once per year**	**Once per month**	**Weekly**	**Daily**
Character education/social and emotional learning (SEL) skills	○	○	○	○	○
21st century skills (critical thinking, creativity, collaboration, communication)	○	○	○	○	○
Science practices (e.g. asking questions, planning and carrying out investigations, etc.)	○	○	○	○	○
Engineering design challenges/design process	○	○	○	○	○
Integrated STEM activities	○	○	○	○	○
Planetary science content	○	○	○	○	○
NASA resources (e.g. videos, activities, posters, etc.)	○	○	○	○	○

19. Is your organization interested in adding or expanding science, technology, engineering, math and/or integrated STEM programs/activities at your site?
   - ◯ Yes
   - ◯ No
   - ◯ Not sure

20. Does your out-of-school time program currently provide any science, technology, engineering, math and/or integrated STEM programs/activities?*
   - ◯ Yes
   - ◯ No

Out-of-School Time Needs Assessment

Current Out-of-School Time (OST) STEM Activities

21. Please identify the type of STEM activities that your out-of-school time program currently provides (mark ALL that apply):
   - ☐ One-session activities/lessons (e.g. stand-alone activities like "egg drop")
   - ☐ Multi-session activities/lessons (e.g. theme-based projects)
   - ☐ Service learning (e.g. community gardening, nature trail signage, etc.)
   - ☐ Guest speakers
   - ☐ Other, please specify

22. About how frequently do youth learn about STEM careers in your out-of-school time program?
   - ◯ Never
   - ◯ Once per year
   - ◯ Once per quarter
   - ◯ Once per month
   - ◯ Weekly
   - ◯ Daily

23. Briefly describe the goals or learning outcomes for youth in your program during STEM activities/lessons (e.g. increasing interest in STEM, understanding STEM content, engaging in STEM practices, please specify other, etc.):

Out-of-School Time Needs Assessment

Current Professional Development Experiences

24. Are you required to attend professional development/training as part of your job?

- ◯ Yes
- ◯ No

25. How often do you participate in professional development/training for your out-of-school time program?

- ◯ Never
- ◯ Less than once per year
- ◯ Once per year
- ◯ Monthly
- ◯ Weekly
- ◯ Other

26. For each of the following categories, about how many hours of professional development/training do you participate in per year?

	0 hours per year	**1-5 hours per year**	**6-10 hours per year**	**11-20 hours per year**	**21+ hours per year**
Science, technology, engineering or math content	◯	◯	◯	◯	◯
Integrated STEM content	◯	◯	◯	◯	◯
Other academic content (e.g. history)	◯	◯	◯	◯	◯
Instructional skills (e.g. questioning)	◯	◯	◯	◯	◯
21st century skills (critical thinking, collaboration, communication, and creativity)	◯	◯	◯	◯	◯
Character education/social and emotional learning (SEL)	◯	◯	◯	◯	◯
Family/community engagement	◯	◯	◯	◯	◯
Technological integration	◯	◯	◯	◯	◯
Behavior management	◯	◯	◯	◯	◯
Health/safety	◯	◯	◯	◯	◯

27. Other than above, please identify other professional development/training in which you participate:

28. In what context do you receive the majority of your science, technology, engineering, and/or math (STEM) professional development/training?

- ◯ Staff meeting/in-service day
- ◯ Outside workshop or consultant
- ◯ Online learning
- None

- ◯
- ◯ Other, please specify

29. Please identify how you learn about professional development/training opportunities (please mark ALL that apply):
- ☐ Colleague/friend
- ☐ Supervisor/administration
- ☐ Post/email from professional organizations or groups
- ☐ I am unaware of professional development available to me
- ☐ Other, please specify

30. What kind of documentation do you need/prefer for your professional development/training?
- ◯ Paper certificate
- ◯ E-certificate
- ◯ Online badge
- ◯ None
- ◯ Other, please specify

31. Select the THREE most important factors that make professional development most useful to you:
Select no more than 3.
- ☐ Learning about activities I can use with youth immediately
- ☐ Opportunities to network/share ideas with other OST educators
- ☐ Expanding my content knowledge
- ☐ Improving my instructional skills
- ☐ Learning about relevant resources
- ☐ Opportunities for personal growth/career advancement
- ☐ Other (please elaborate)

32. Please identify what limits your ability to participate in professional development/training (mark ALL that apply):
- ☐ Limited funding for professional development
- ☐ Limited time for professional development
- ☐ Do not know about professional development opportunities
- ☐ Do not have access to the technology or resources needed for professional development
- ☐ Do not have interest in the professional development that is offered
- ☐ I am not limited
- ☐ Please describe any other limitations/barriers to your participation in professional development:

33. Please identify your main role in your out-of-school time program:*
- ◯ Program staff/non-supervisor
- ◯ Site supervisor/program coordinator/statewide coordinator

OST Program Staff Professional Development Needs

34. What do you think are your program's THREE most critical needs?
Select no more than 3.

- ☐ Staff professional development/training
- ☐ New strategies for engaging youth
- ☐ Technology resources
- ☐ Materials/curricula/resources/activities
- ☐ Partnerships with other organizations
- ☐ None
- ☐ Other, please specify

35. How comfortable are you teaching the following in your out-of-school time program?

	Very uncomfortable	Uncomfortable	Comfortable	Very comfortable
Character education/social and emotional learning (SEL) skills	○	○	○	○
21st century skills (critical thinking, creativity, collaboration, communication)	○	○	○	○
Science practices (e.g. asking questions, planning and carrying out investigations, etc.)	○	○	○	○
Engineering design challenges/design processes	○	○	○	○
Integrated STEM activities	○	○	○	○
Planetary science content	○	○	○	○
NASA assets (videos, simulations, animations, activities)	○	○	○	○

36. Given the opportunity, which of the following professional development sessions would you like to attend to enhance your knowledge of STEM (mark ALL that apply)?

- ☐ What is STEM? Why is it important to engage students in STEM learning?
- ☐ Exploring the relationship between science, engineering, and technology
- ☐ Deepening science content and understanding
- ☐ Learning how to model science and engineering practices
- ☐ Building a greater awareness for STEM careers and how scientists and engineers work together
- ☐ Connecting STEM projects to real world applications

37. Select your THREE most important INSTRUCTIONAL needs as an out-of-school time educator:
Select no more than 3.

- ☐ How to facilitate teamwork
- ☐ How to promote problem solving and open-ended challenges
- ☐ How to manage youth behavior and logistics
- ☐ How to implement hands-on/minds-on learning
- ☐ How to implement 21st century skills
- ☐ How to assess learning

☐ How to implement other instructional skills, please specify

[ ]

38. Given the opportunity, which of the following professional development sessions would you like to attend to enhance your instructional practice (mark ALL that apply)?
   - ☐ Questioning strategies
   - ☐ How to facilitate student collaborative groups
   - ☐ Learning how to use specific activities or resources
   - ☐ How to obtain materials to support STEM instruction
   - ☐ Managing hands-on materials
   - ☐ Using or finding additional resources
   - ☐ How to connect with other OST educators to plan, implement, and reflect on instructional practice
   - ☐ How to promote equity and access in your out-of-school program
   - ☐ How to engage with family and community in STEM learning

39. Rank the format for professional development that you are most willing/able to use, with "1" being your top choice:
   Rank the items below, using numeric values starting with 1.

Face-to-face	[ ]
Synchronous online (instructor led, e.g. webinar)	[ ]
Asynchronous online (self-directed, e.g. tutorial)	[ ]
Blended synchronous and asynchronous (instructor led and self directed)	[ ]
Blended face-to-face and online	[ ]

40. Please identify which of the following formats for online professional development you are willing/able to use (mark ALL that apply):
   - ☐ Articles or other readings on the internet
   - ☐ Blogs
   - ☐ Audio
   - ☐ Video
   - ☐ Podcasts
   - ☐ Electronic presentation (PowerPoint, Prezi)
   - ☐ Massive Open Online Course (MOOC)
   - ☐ Online community (Discussion board)
   - ☐ Webinar
   - ☐ Other, please specify

     [ ]

41. Would you be willing/able to use a social media platform for professional development (e.g. Facebook, Twitter, Google+, etc.)?
   - ○ Yes
   - ○ No

42. Would you be willing/able to use an online platform for professional development (e.g. Skype, Edmodo, Blackboard Learn, etc.)?
   - ○ Yes
   - ○ No

43. What is your gender:

   [ ]

44. Please specify your race/ethnicity (mark ALL that apply):

- ☐ White or Caucasian
- ☐ Hispanic or Latino(a)
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ Asian
- ☐ Other

45. Please specify your age range:

- ◯ 18-20
- ◯ 21-30
- ◯ 31-40
- ◯ 41-50
- ◯ 51-60
- ◯ 61-70
- ◯ 71+

46. If you are interested in entering a drawing to win one of 30 Engineering is Elementary out-of-school time curriculum guides, please leave your name and email address here:

[ ]

Out-of-School Time Needs Assessment

Site Supervisor / Coordinator Professional Development Needs

47. Please identify your main role in out-of-school time programming:

- ◯ Site supervisor/program coordinator
- ◯ Statewide coordinator

48. About how many staff are in your program?

Total paid staff:	
Total unpaid staff/volunteers:	
Other, please specify:	

49. What topics are currently included in the professional development/training for your staff? (mark ALL that apply)

- ☐ Content enrichment (other than STEM)
- ☐ STEM content enrichment
- ☐ Development of instructional skills
- ☐ Character education/social and emotional learning (SEL)
- ☐ Assessment of learning
- ☐ Behavior/group management
- ☐ Not sure
- ☐ Other, please specify

[ ]

50. What are your program's THREE most critical needs?
Select no more than 3.

- ☐ Staff professional development/training
- ☐ New strategies for engaging youth
- ☐ Technology resources
- ☐ Materials/curricula/resources/activities
- ☐ Partnerships with other organizations
- ☐ None
- ☐ Other, please specify

51. How prepared are the MAJORITY of your staff to teach the following in your out-of-school time program?

	Not at all prepared	**Unprepared**	**Prepared**	**Very prepared**	**Not applicable**
Character education/social and emotional learning (SEL) skills	○	○	○	○	○
21st century skills (critical thinking, creativity, collaboration, communication)	○	○	○	○	○
Science practices (e.g. asking questions, planning and carrying out investigations, etc.)	○	○	○	○	○
Engineering design challenges/design processes	○	○	○	○	○
Integrated STEM activities	○	○	○	○	○
Planetary science content	○	○	○	○	○
NASA assets (videos, simulations, animations, activities)	○	○	○	○	○

52. Given the opportunity, which of the following professional development sessions would you encourage your staff to attend to enhance their knowledge of STEM (mark ALL that apply)?

- ☐ What is STEM? Why is it important to engage students in STEM learning?
- ☐ Exploring the relationship between science, engineering, and technology
- ☐ Deepening science content and understanding
- ☐ Learning how to model science and engineering practices
- ☐ Building a greater awareness for STEM careers and how scientists and engineers work together
- ☐ Connecting STEM projects to real world applications

53. Select your staff's THREE most important INSTRUCTIONAL needs (mark ALL that apply):
Select no more than 3.

- ☐ How to facilitate teamwork
- ☐ How to promote problem solving and open-ended challenges
- ☐ How to manage youth behavior and logistics

- ☐ How to implement hands-on/minds-on learning
- ☐ How to implement 21st century skills
- ☐ How to assess learning
- ☐ How to implement other instructional skills, please specify

54. Given the opportunity, which of the following professional development sessions would you encourage your staff to attend to enhance their instructional practice (mark ALL that apply)?
    - ☐ Questioning strategies
    - ☐ How to facilitate student collaborative groups
    - ☐ Learning how to use specific activities or resources
    - ☐ How to obtain materials to support STEM instruction
    - ☐ Managing hands-on materials
    - ☐ Using or finding additional resources
    - ☐ How to connect with other OST educators to plan, implement, and reflect on instructional practice
    - ☐ How to promote equity and access in your out-of-school program
    - ☐ How to engage with family and community in STEM learning

55. Rank the formats for professional development that you think your staff would be most likely to use, with "1" being the most likely:

    Rank the items below, using numeric values starting with 1.

Face-to-face	
Synchronous online (instructor led, e.g. webinar)	
Asynchronous online (self-directed, e.g. tutorial)	
Blended synchronous and asynchronous (instructor led and self-directed)	
Blended face-to-face and online	

56. Please identify which of the following formats for online professional development you think your staff would be most likely to use (mark ALL that apply):
    - ☐ Articles or other readings on the internet
    - ☐ Blogs
    - ☐ Audio
    - ☐ Video
    - ☐ Podcasts
    - ☐ Slides (PowerPoint, Prezi)
    - ☐ Massive Open Online Course (MOOC)
    - ☐ Online community (Discussion board)
    - ☐ Other, please specify

57. Do you think your staff would be willing to use a social media platform for professional development (e.g. Facebook, Twitter, Google+, etc.)?
    - ○ Yes
    - ○ No

58. Do you think your staff would be willing to use an online platform for professional development (e.g. Skype, Edmodo, Blackboard Learn, etc.)?
    - ○ Yes
    - ○ No

59. Please identify how you evaluate your program (mark ALL that apply):

- ☐ We evaluate program design.
- ☐ We evaluate outcomes for individual participants (interest, attitude, knowledge, etc.).
- ☐ We evaluate youth and/or family satisfaction.
- ☐ We evaluate program quality.
- ☐ We evaluate how our program engages with the community.
- ☐ We evaluate how our program engages with our partners.
- ☐ None
- ☐ Other (please specify)

60. What is your gender:

61. Please specify your race/ethnicity (mark ALL that apply):
    - ☐ White or Caucasian
    - ☐ Hispanic or Latino(a)
    - ☐ Black or African American
    - ☐ American Indian or Alaska Native
    - ☐ Native Hawaiian or Other Pacific Islander
    - ☐ Asian
    - ☐ Other

62. Please specify your age range:
    - ○ 18-20
    - ○ 21-30
    - ○ 31-40
    - ○ 41-50
    - ○ 51-60
    - ○ 61-70
    - ○ 71+

63. Please provide your email address if you would like to be considered for our out-of-school time STEM professional development advisory group:

64. Please provide your name and email address if you are interested in entering a drawing to win one of 30 Engineering is Elementary out-of-school time curriculum guides:

Appendix B

Needs Assessment Interview Questions

General Overview

1. Briefly describe your out-of-school time program (who attends, content, purpose etc.):
   If not mentioned in their description of their program:
   How are STEM/engineering topics integrated into your program's curricula?

   Probes: What STEM/engineering topics are taught in your program?
   If not, would you be interested in incorporating STEM/engineering into your program?

Staff

2. Who do you hire to staff your program(s)? Probes: high school/college students, teachers, other staff. How long does the staff typically stay?
3. How prepared are your staff to teach the content from your program's curricula?
   Probes: What are staff strengths? Staff struggles? What are staff content needs? Staff instructional needs? There is a difference in the perceived preparation between staff and their supervisors. Do you have any thoughts about why these difference interpretations exist?

Program needs

4. When asked about the top needs in OST programs 50% of survey respondents identified that "new strategies for engaging youth" was a need. Can you expand on why "new strategies for engaging youth" are considered a critical need?

Staff training/professional development information

5. What do you provide in terms of staff training/professional development?
6. What factors affect your decisions in choosing professional development?
7. Would you change any aspect of the professional development you currently use?
8. What would the ideal professional development experience look like for you and your staff?
   Probes: What type of content would be ideal? What type of format would be ideal (self-paced, online, etc.)?

9. What should designers consider to make PD accessible and useful to OST educators and program coordinators?

Big picture

10. What do you perceive as the national trends in OST education?