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Philly Scientists: Blending Professional Development for In-School and Out-of-School Educators

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Abstract

In the fall of 2016, a team of Pennsylvania STEM educators received a generous grant from the National Science Foundation to provide STEM education to middle-school students in the Philadelphia Promise Zone. Entitled "Philly Scientists" and targeting both classroom teachers and out-of-school time (OST) staff, this grant combined biodiversity curriculum development, teacher training, career access activities, and modern technology to address the following three research questions:

1. What coherent set of experiences effectively support fourth, fifth and sixth grade students' knowledge development (e.g., biodiversity content knowledge blended with science practices), motivation and career awareness about STEM-related work and jobs of today and the future? What are characteristics of their knowledge, motivation and career awareness competencies? 2. What professional development models and recognition systems can effectively engage teachers and OST providers in demonstrating Next Generation Science knowledge, pedagogy, and career awareness for fourth through sixth grade students? 3. How effective is the activity of Promise Zone fourth-sixth grade students as information providers and Urban Scientists interacting with scientist mentors towards increasing career awareness and understanding characteristics of STEM work?

Our partners in this initiative were Drexel University, The Philadelphia Education Fund (PEF), The Academy of Natural Sciences of Drexel University (ANS), and the Pennsylvania Statewide Afterschool/Youth Development Network (PSAYDN). The project also engaged Research for Action (RFA) as the external evaluator.

Staff from the Philadelphia Education Fund were primarily tasked with designing, implementing, and evaluating the professional development component of this initiative. The team recognized that in-school and OST teachers have different skill-sets, needs, and schedules - but that each group of educators also has a great deal to offer one another. For instance, we hypothesized that classroom teachers may have more experience connecting lessons to national standards and local educational initiatives; while OST providers may be more versed in working with families, with communities, and with blending social work and education. For these reasons, we were interested in both the logistical and pedagogical results and implications of our study. And while there is a great deal of research pertaining to STEM professional development for both in-school and out-of-school staff, we found little literature that referenced blending PD for both populations.

Keywords

STEM, science, professional development, teacher training

Disciplines

Curriculum and Instruction | Education | Science and Mathematics Education

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Project Summary

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Literature Review

STEM Education

Over the past twenty years, science, technology, engineering, and math (STEM) education have become a major area of focus on a local, national and international level. There are several reasons for this increased attention to STEM education (Peter, 2018). They include:

1. Students need to be academically proficient in STEM subjects to compete and succeed in middle school, high school, and college.
2. Environmental understanding, responsibility, and stewardship have become increasingly serious issues for global sustainability
3. Adults need basic science, engineering, technology, and math skills to thrive in our twenty-first century world to do everything from understand their bank balance to recognizing the ingredients in their groceries, drugs, and cleaning supplies.
4. Many for-profit and nonprofit organizations seek job applicants with comprehensive STEM skills –for STEM occupations and as well as for occupations that require a degree of STEM competence.

This final factor – STEM workforce development – has had an especially significant impact on the growth of STEM education. On both national and international levels, career-orientated STEM education is emphasized for several key reasons, including the following three professional/financial considerations (US Bureau of Labor Statistics, 2017):

1. Ninety-three out of 100 STEM occupations offer wages above the national average. The national average wage for all STEM occupations is $87,570, nearly double the national average wage for non-STEM occupations ($45,700). Ninety-three out of 100 STEM occupations offer wages significantly above the national average for all occupations of $48,320.

2. The projected growth rates for STEM occupations, from 2014 to 2024, are 6.5%. Job growth rates are even higher for certain STEM groups, such as mathematical science occupations - that are projected to grow 28.2%.
3. Industries with higher percentages of STEM occupations typically have higher wages. These include STEM occupations comprised of over one-third of employees engaged in professional, scientific, and technical services - including activities such as computer systems design, engineering tasks, and research and development services.

STEM Education in In-School and OST Settings

Institutions have been devoting noticeably large amount of effort into STEM education pedagogy, STEM education models, and integrative STEM education in classroom settings. Schools approach STEM education through different pedagogical strategies. In conventional school settings, students take specific classes for certain subjects such as science and mathematics. Each subject might not have much interconnection. In schools that adopt integrative STEM education pedagogy, students are placed in contexts where multiple disciplines are intended to be addressed consistently and authentically (Kloser et al, 2018).

Although STEM education is critically important to K-12 populations, classrooms and school buildings are no longer the only environments in which STEM teaching and learning can take place. According to the National Research Council (2015), “Over the past decade there has been a fundamental change in the way that learning is organized, and supported. As family work patterns shift, children and youth are spending more time in supervised educational programs before and after school, on weekends, and during summers and other holidays. At the same time, more children and youth regularly access on demand digital learning resources and opportunities, including online communities and resource collections. Thus, education can no longer be defined solely by what happens in a schoolroom. Indeed, a substantial body of research demonstrates that deep learning develops across multiple settings and timeframes. What happens outside the classroom directly affects what is possible inside the classroom and vice versa.”

Independent of where STEM education occurs, there are several promising practices associated with quality STEM instructors and instruction. According to Education Week- Teacher (2014), these include:

1. STEM lessons focus on real-world issues and problems.
2. STEM lessons are guided by the engineering design process.
3. STEM lessons immerse students in hands-on inquiry and open-ended exploration.
4. STEM lessons involve students in productive teamwork.
5. STEM lessons apply rigorous math and science content that students are learning.
6. STEM lessons allow for multiple right answers and reframe failure as a necessary part of learning.

And while these teaching principles may be intuitive to some, other individuals may require professional development to cultivate the content knowledge, teaching skills, and self-confidence necessary to be effective in-school and OST STEM instructors.

Professional Development

The National Staff Development Council (2009) defines professional development as "a comprehensive, sustained, and intensive approach to improving teachers' and principals' effectiveness in raising student achievement." Professional development for staff refers to a variety of education, training, and development opportunities (Bouffard & Little, 2004). Peter (2009) defines PD as:

"A spectrum of activities, resources, and supports that help practitioners work more effectively with or on behalf of children and youth. Professional development formats include workshops, conferences, technical assistance, apprenticeships, peer mentoring, professional memberships, college coursework, and additional diverse offerings. Practitioners can be full-time staff, part-time staff, volunteers, teenagers, parents, or other non-staff members, provided that the PD experience culminates in supporting youth participants. Because youth impact is always the ultimate goal, staff development is indistinguishable from professional development (Peter, 2009; p. 36).

Both definitions – those pertaining to classroom teachers and to OST staff – emphasize that professional development is a comprehensive collection of meaningful experiences designed to support and enrich staff and ultimately benefit youth. Research further demonstrates that there is a concrete connection between the caliber of adult/youth relationships and degree of youth achievement (Stone, Garza, & Borden, 2006). Lastly, research indicates that teachers who have experienced some type of professional development program, or have continuous professional development, are more likely to continue learning on the job, to have good collaborative strategies with colleagues, and to generate better student outcomes. (Owston et al, 2008).

Research also guides us in defining characteristics of successful STEM professional development. Peter (2007) states that professional development for STEM practitioners must integrate promising practices such as an organized and knowledgeable facilitator; an environment that promotes respect and collaboration; adult learning principles and strategies; opportunities for participants to share their experience and perspectives; and real-world applications. The National Research Council (2015) suggests these additional components:

"Effective professional development for STEM facilitators and instructors should cover many areas: presenting ideas and concepts with a clear rationale for their importance; demonstrating new practices, taking advantage of staff experience and expertise, offering opportunities for practice and feedback, providing ongoing support and follow-up training, linking staff members with mentors, using planning time to cultivate collaboration among staff, and augmenting training time with resources and materials. In addition, effective professional development provides educators with opportunities to learn about STEM disciplinary content and practices, as well as theories of child and youth development, in order to develop positive relationships with and empower youth, to decrease risk factors and maintain safe learning environments, and to implement age-appropriate activities."

How do practitioners and researchers identify promising practices in professional development; or know that their PD has had the desired impact on staff, programs, and students? There has been significant progress in evaluating PD (including STEM PD) beyond levels of participant satisfaction. In their 2004 article entitled “Promoting Quality Through Professional Development: A Framework for Evaluation,” Bouffard and Little build upon the work of Guskey (2000) and Killian (2002) to suggest a 5-level approach to evaluating professional development, beginning with staff satisfaction and ending with youth impact. Bouffard and Little also suggest a series of steps for preparing and implementing the evaluation, such as planning the evaluation before the professional development begins, planning a timeline for the evaluation, using “backward planning” (proceeding from outcomes to activities), choosing outcome indicators based on the goals of the program, collecting data from appropriate sources, assessing long-term outcomes, and basing professional development activities on strong theory and research.

Professional Development Implementation

Intended Activities

To support the Philly Scientists project, PEF intended to design, implement, and evaluate three types of professional development offerings targeted at direct-service and administrative in-school and out-of-school time staff. Our specific offerings were to include:

- Needs Assessment: In the first six months of the project, the team planned to create, distribute, and analyze the data from a comprehensive online PD survey targeted at the in school teachers and OST providers within and just outside the Promise Zone. This survey would gather information on PD needs, wants, requirements, current providers, and current availability; as well as serve as a recruitment tool and resource to locate optimal dates and times for upcoming PD. This activity would also help to shape the PD aspects of the intervention and ensure that it was convenient, relevant and useful.

- Single-session workshops to focus specifically on Next Generation science knowledge, pedagogy, and technology (Philly Scientists mobile app, spreadsheet/maps and student badges). These sessions would be offered bi-monthly, three times per year.

- Three-session workshops designed to build upon and dig deeper into science content and pedagogy, including common fourth through sixth grade students' misconceptions in developing Next Generation science knowledge. These workshops would be offered three times per year.

- Peer Networking Meetings would be offered monthly and modeled after the Out-of-School Time Resource Center's Peer Networking Meetings, which were offered in the Philadelphia area since 2005; and the Philadelphia Youth Sports Collaborative's Networking Seminars, which have been in existence since 2010. Peer Networking Meetings feature introductions, announcements, a peer panel discussion, questions and answers, small group discussions, and informal networking.

Actual Activities

For a variety of reasons, the professional development elements of this project were altered significantly once the project began. The following section describes the actual activities and their rationale.

- Needs Assessment: To inform all PD offerings, PEF staff completed a literature review of educator-specific PD needs assessments, created and tested a draft online needs assessment instrument, and implemented and analyzed the results of these needs assessments prior to all PD sessions.

- Pilot Workshops: Because the Philly Scientists project began later than expected, we used the summer of 2017 to offer two pilot (identical) workshops. PEF staff recruited a total of 40 in-school and out-of-school staff who did not necessarily work in the Promise Zone but did teach middle school students. The attendees provided feedback on the PD delivery model and on the project overall; and received free professional development, free curriculum materials, and a $75 stipend.

- Seasonal Workshops: When the Promise Zone schools and staff had been identified, we offered either group or individual PD workshops each season. The group sessions were held at a central location and covered the project logistics, the biodiversity content, the Next Generation Science Standards; the technology aspects of the project, the individual curriculum modules, the career-focused elements of the project; and tips on engaging students in hands-on science exploration. The delivery methods included PowerPoint slides, opportunities to use the iPads and website, and outdoor data collection. The individual sessions were held at the teachers' own workplaces and included the same content and activities described above. We decided to offer both group and individual sessions to accommodate the teachers' schedules and to adjust to last minute staff additions.

- Ongoing Technical Assistance: In contrast to our original assumptions and program design, this project engaged a limited number of teacher participants who had vastly different degrees of expertise and confidence. Therefore, instead of implementing multi-session workshops and Peer Networking Meetings, we provided staff with ongoing, personalized technical assistance. For example, we routinely participated in their classroom lessons and field trips, to help problem-solve teaching challenges and model instructional strategies. Between classes, we were available to answer questions, address technological issues, suggest ways of modifying the curricula, and provide similar supports.

As a result of the interventions and modifications described above, we believe we were able to adapt the professional development offerings in ways that were optimally beneficial to the teachers, to their students, and for the research elements of this project,

Methods and Materials

Participants

The project team provided professional development to a total of 58 in-school and out-of-school time educators. These educators attended at least one of 7 workshops facilitated over years 2 and 3 of the grant. The initial group of participants included any instructors from the School District of Philadelphia who were interested in the biodiversity curriculum, in the related use of technology, and/or in the career awareness aspects of the project. The target population was later narrowed down to only in-school teachers and OST staff from schools within the Philadelphia Promise Zone.

Instruments

As mentioned previously, the team created an online survey to ascertain participants' experience and expertise ahead of time. The survey included questions about teachers' STEM teaching experience; familiarity with national, state and local standards (e.g. Next Generation Science Standards, Pennsylvania's Common Core Standards, and The School District of Philadelphia's Science Scope and Sequence); comfort with biodiversity content and concepts; experience teaching in outdoor environments; and awareness of careers in STEM. The team analyzed the results of the needs assessment and used this data to develop the content of subsequent PD sessions.

At the end of each workshop, participants provided verbal feedback and were asked to complete an online follow-up survey. The results of both activities helped the team make changes to subsequent PD sessions, and to restructure elements of the in-class support.

Data

The following two figures summarize the teachers' opinions regarding workshop time allotted to each section/topic:

Figure 1: Distribution of time per section in Workshop #1:

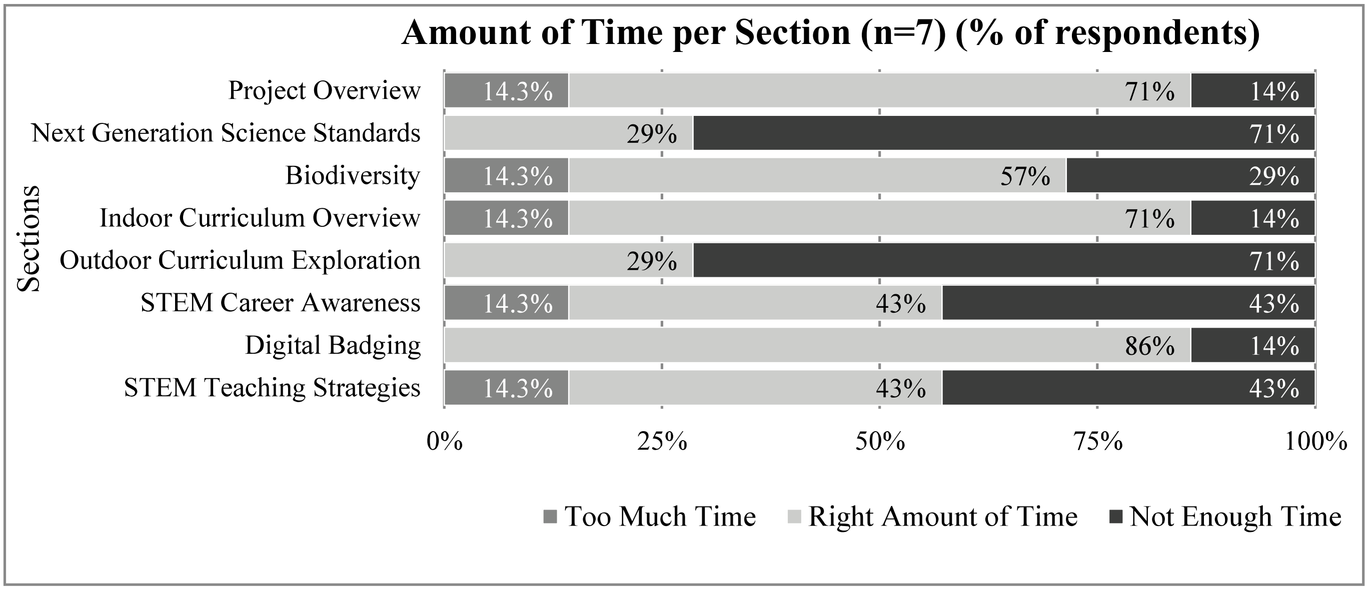
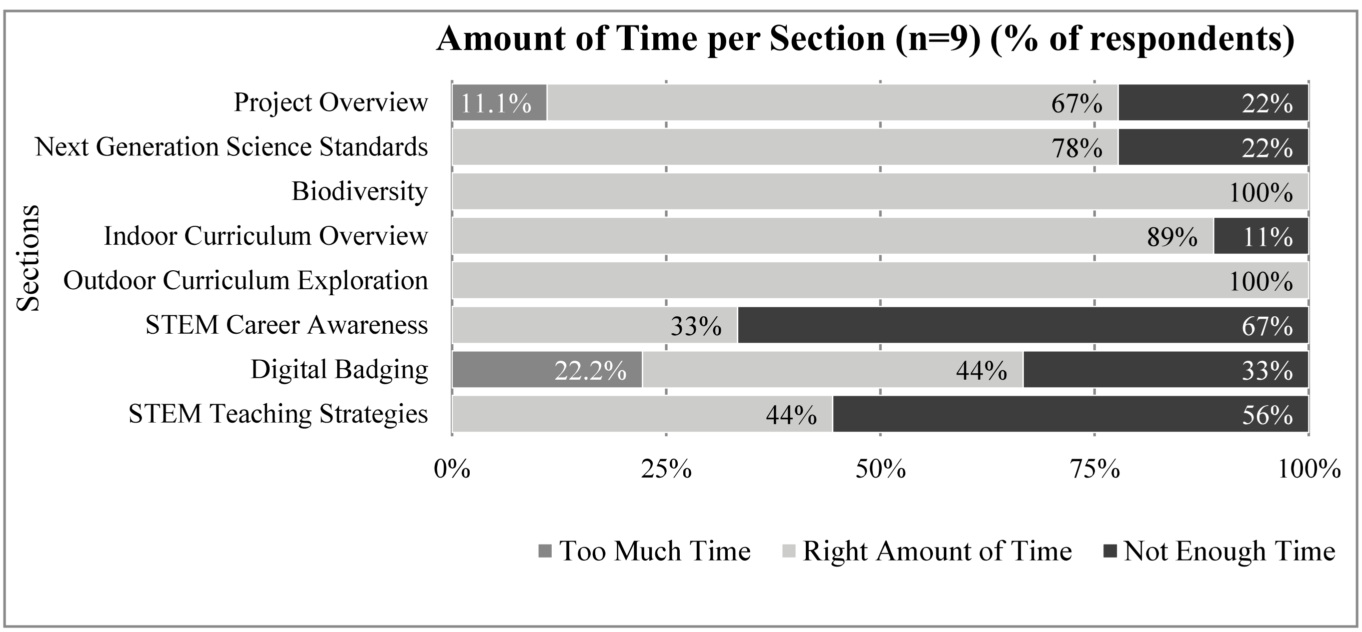


Figure 1: Distribution of time per section in Workshop #2:



The following three tables summarize the teachers' opinions regarding improvements to the workshops, student curriculum, improvements to the PD workshops, and the general feedback:

Table 1: Teacher feedback on improving the student curriculum (Workshops #1 and #2)

Session	Participant	Feedback
1	1	Collect student input online
1	2	Edits to app
1	3	Hold workshop as if the participants are students in the classroom to see the entire program
1	4	Conclusion activity
1	5	Provide teacher resources
1	6	Collect student input online
2	1	Adaptations to lessons
2	2	More activities that encourage exploration and inquiry and connect it back to their lives Workshops to help students prepare for presentations and develop skills
2	3	Adaptations to lessons
2	4	Culturally relevant and interdisciplinary material
2	5	More hands on
2	6	Adaptations to lessons

Table 2: Teacher feedback on improving the PD sessions (Workshops #1 and #2)

Session	Participant	Feedback
2	2	More time reviewing curriculum
2	2	Train facilitators on how to implement STEM programming (student centered, not standards driven)
2	2	Resources on contacting STEM professionals
2	2	Brainstorming session
1	5	Provide teacher resources

2	1	More hands on interspersed throughout
2	3	Provide teacher strategies
2	4	Breakout sessions
2	5	More info on STEM
2	6	More time reviewing lessons

Table 3: Open-ended teacher feedback (Workshops #1 and #2)

Session	Participant	Feedback
1	1	Too much on agenda for 3 hours
1	2	Good conference/networking
2	1	Learned a lot and will use materials
2	2	App could feature example of career title that performs that scientific activity
2	3	PhD from Drexel was fantastic
2	4	Especially liked hands on experience

Discussion

One of the four primary objectives of our study was to create, provide, and evaluate professional development for in-school teachers and OST educators. These populations often have different needs, schedules, and background knowledge. As such, we developed a blended professional development model that we hoped would benefit both of these audiences, regardless of their prior experience with STEM and STEM education.

Based on the teachers' written and verbal participant feedback, we identified areas for improvement and used these to continually modify the PD activities in years two and three.

These areas included: offering more time for participants to explore the technology, curriculum, and outdoor activities; providing a better and more evenly dispersed balance of PowerPoints and hands-on lessons; and distributing additional STEM resources - including how to contact the scientists directly. That said, we believe we succeeded overall for the following reasons:

Usefulness of Instruments. Although our needs assessments and follow-up surveys were based on previously published tools, we continued to customize them for this specific project. Based on the information collected by each set of instruments, we believe our tools were an effective way with which to gage participants' experience prior to the workshops, to gather their feedback immediately after implementing the PD, and to assist us in making subsequent changes to our PD offerings.

Content of PD Sessions: Each team member contributed his or her expertise and facilitated a different element of the PD workshops. For example, a scientist from the Academy of Natural Sciences provided an overview of Philadelphia-area biodiversity, and our technical partners introduced the app and website. To complete the offerings, the three project PIs offered presentations on aligning the project with academic standards, on STEM career pipelines and pathways, and on simple ways through which to teach STEM lessons. The verbal and written feedback we received after each workshop indicated that our team offered an optimal amount of time to explore the biodiversity content, the NGSS standards, the technology needed for the project, the STEM career opportunities, the STEM education pedagogy, and the outdoor exploration activities. Through every phase of teacher feedback, we were able to adjust the amount of time devoted to each element of the PD, and improve on and offer an effective blend of each.

Ongoing Technical Assistance. As explained previously, the team replaced the Peer Networking Meetings with ongoing, site-specific technical assistance. In years two and three of the project, one or more team members attended Philly Scientists classes each week, and assisted with activities ranging from students completing pre-and post-tests to supervising small groups during the outdoor explorations. Team members also provided helpful (but not intrusive) coaching throughout the lessons; and spoke with the teachers immediately or shortly after each lesson and discussed successes, challenges, and suggestions for improving future sessions. Every teacher verbally expressed his or her appreciation of this ongoing technical assistance; and in this way, the project team was able to simultaneously support the teachers, support the students, and gather information for enhancing both the curriculum and future PD activities.

Blended Professional Development. Based on formal and informal educator feedback, we believe we were successful in blending effective professional development for classroom teachers and out-of-school time staff. Through trial and error, the project team learned two valuable and scalable lessons:

1. We anticipated that scheduling blended PD would be challenging – given that classroom teachers work during the day and OST staff often work afternoons, evenings, and weekends. However, using the right set of incentives, we easily achieved full attendance at all formal workshops. These incentives included the

no-cost curricula and materials, the promise of ongoing technical assistance, modest participant stipends, a continental breakfast, and Act 48 (continuing education) credits. Moreover, since the workshops were hosted by the Academy of Natural Sciences, we were also able to provide free museum admission to the teachers and their families, at the conclusion of the formal workshops.

2. Both sets of educators genuinely appreciated learning alongside and learning from one another. While some were initially unfamiliar with the other group's work, they readily offered reasons why it was helpful to participate in PD together. These reasons included learning teaching tips from one another, seeing the students from a different perspective, and being exposed to possible, new career opportunities themselves,

Suggestions for Future Activities

The team was generally pleased with the professional development component of the Philly Scientists project. Given the low number of teacher participants in the project, we wisely substituted onsite technical assistance for ongoing Peer Networking Meetings. However, if future initiatives were able to recruit a larger number of teachers, we would recommend the following three peer support mechanisms:

- <u>Host quarterly in-person Peer Networking Meetings</u>. Through these sessions, teachers could learn from peer panelists, be exposed to new research and resources, share successes and challenges with one another, and establish a strong network of mutual support.

- Host seasonal webinars. Since accommodating in-school and OST staff schedules can be challenging, the project leads could host regular webinars in which educators could share triumphs, concerns, and tips for implementing the Philly Scientists curriculum.

- Create an online Community of Practice. All teacher participants were given and had access to one another's' contact information. However, future program administrators could establish a formal online community of practice/portal through which participants could continually communicate with and support each other.

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