STEM Out-of-School-Time

IMLS Museums for America Grant

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Summative Evaluation Report

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PACIFIC SCIENCE CENTER

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EXECUTIVE SUMMARY

With support from the Institute of Museum and Library Services (IMLS), Pacific Science Center (PSC) continued and expanded the Science Technology Engineering and Math Out-of-School Time (STEM-OST) program with the purpose of delivering programs to stem the summer learning loss. Specifically, the project expanded to new venues in the Puget Sound (Washington) region; modified the lessons and activities so they also served students in grades K-2; aligned the curriculum with the Next Generation Science Standards (recently adopted by the Washington State Legislature) and increased the number of Family Science Days and Family Science Workshops offered to enhance parent involvement in STEM learning. The mentorship model of program delivery was also expanded to include college volunteer interns along with teen interns and staff educators.

Three audiences –high school and college interns, students going into grades K-8, and parents or caregivers of students– were served by a variety of year-round programs. In the summer, five-session workshops were offered free of charge to youth at day camps around the Seattle region. The Series were taught by a team of Science Center outreach staff along with a STEMed college intern as well as a Discovery Corps teen intern. Then, three times throughout each summer, families were invited to a celebratory exposition of hand-on science activities that were taught to youth during the workshops. Throughout the school year two hour Family Science Workshops kept parents engaged in their child's learning.

Outcomes for the participants ranged from knowledge and understanding, to increasing interest, as well as growing skills.

	Intended Outcomes	Outcome Category
Interns will…	• Develop a deeper understanding of STEM content including physics, astronomy, math and engineering.	Awareness, knowledge or understanding
	• Increase their comfort and confidence in delivering STEM activities to younger children. • Gain greater self-awareness of their role/contribution to informal science education	Attitude
	• Increase their leadership, communication and teaching skills.	Skills or abilities
Students will…	• Increase their content knowledge of STEM content including physics, astronomy, math and engineering.	Awareness, knowledge or understanding
	• Increase their interest in learning more about STEM content.	Engagement or interest
	• Identify themselves as science learners.	Attitude
Parents will…	• Increase their understanding of the importance of STEM literacy.	Awareness, knowledge, or understanding
	• Increase their comfort and confidence in discussing STEM with their children.	Attitude
	• Increase engagement in their child's learning.	Behavior

STEM-OST achieved nearly every goal outlined in the proposal, sustaining a level of engagement in most schoolchildren and generating extremely positive responses from parents. The learning opportunities were dynamic for teens and college volunteers alike. This evaluation report covers the second year of implementation.

Highlights of the findings for interns include:

- Ten interns helped deliver Summer Series workshops, six from the Science Center's Discovery Corps youth development program and four from science and science-education college programs around the country. All interns increased their scores on Series content tests by 5-20% after ten weeks. There was also a correlation between the number of lessons of a subject an intern taught and their post-summer content test score – those who taught more lessons of a topic generally saw higher increases in test scores.

- Both teens and college interns rated themselves one point higher (on a 5-point scale) on comfort teaching kids in their post-survey. There were instances of teens both over and underestimating their comfort teaching kids at the start of the summer. College interns were more sure of themselves at the start of the summer and at the same time were hesitant to score themselves as "extremely comfortable" (i.e. 5) citing that there is always more to learn.

- At the end of the summer, all five observed teens were rated as "above expectations" for interacting confidently with individual students (an increase from just one "above expectations" in the first week of summer). Three were also rated as "above expectations" for interacting confidently with small groups.

- Both age bands of interns identify themselves as important links in the tired mentorship model that STEM-OST strove to create. They said they were able to provide advice and mentorship to everyone younger than themselves. Most poignantly, several teens identified a new found sense of appreciation for their own formal education teachers.

- Teaching was the most discussed as well as observed skill set. Each of the 14 behaviors in the rubric saw improvement with almost no displays of "above expectations" behavior early in the summer and at least one, and often three displays of superior ability by the end. This is notable as teens are functioning as part of a team of at least three instructors.

Highlights of the findings for students include:

- Students across all three grade bands showed improvements in most of the content questions they were asked. Those in grades K-2 excelled in particular at the two multiple response options, choosing more correct options and fewer incorrect options on the post-survey. Third through fifth graders had a difficult time with the engineering content questions. Middle school-aged students did well on all three content questions and saw increases of up to 20% from pre to post.

- During findings reviews with staff, there was much discussion about whether all educators present the same content to students. While they are given much latitude in how information is delivered, concerns about consistency lead to renewed efforts to be clear and intentional about what the learning goals are for each class before evaluation begins and make efforts to eliminate references to conflicting information.

- Most 3-5 graders (91%) were interested in learning more about engineering "some" or "a lot." There was slightly less interest from 6-8 graders in learning more about computer science (79%) but this was still the majority.

- The STEM-OST Summer Series appears to have grown, or at least maintained, science identity for the majority of the paired data sample – based on students' interest in doing or having a job that uses science or math. Over half of students in grades 3-8 did not report a backslide in interest in doing science or math, nor did the majority report backslides of interesting in having jobs that use math and science. Additionally, increases were seen amongst all groups and across topics:, 21% or more for doing science, 9% or more for having a job that uses science, 12% or more for doing math and 16% or more experienced increases in interest in having a job that uses math.

Highlights of the findings for adults include:

- Questions on the summative evaluation did not address whether and to what extent parents believed STEM literacy was important. Anecdotally, however, the Family Science Workshop that was observed was highly appreciated.

- Family Science Workshops were very successful at providing parents with a comfortable environment and therefore increasing their confidence discussing science with their children. Over three-quarters (76%) of respondents reported the highest level of comfort (extremely comfortable) during the Workshop.

- All respondents gained at least a little bit of confidence as a result of the Workshop. As many said they were "a lot more confident" as those who said they were "a little" or "moderately more" confident, combined.

- Nearly two-thirds (64%) of parents reported that this was their first time attending an event where they did science *with* their child, suggesting that STEM-OST was successful in reaching under-engaged audiences.

- Survey respondents indicated a high degree of engagement with their children's science learning, both subjectively through their survey response as well as objectively during the timed observations. Most respondents shared the ways they supported the children in their group during the Workshop.

- Working together was the second most common behavior observed during the final Workshop. Overall, about half of the time (53%) was dedicated to hands-on activities and fully 50% of the time adults were observed collaborating with their children.

STEM-OST brought science and family learning to dozens of underserved communities in the Puget Sound region. Youth and their parents and caregivers have been positively impacted by the efforts and enthusiasm of the Science Center's staff, teens and college volunteers.

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INTRODUCTION

Project Background and Goals

In 2014, Pacific Science Center (PSC) was awarded a Museums for America grant from the Institute of Museum and Library Services (MA-10-14-0235-14) with the purpose of delivering programs to stem the summer learning loss. Specifically, the project expanded the successful STEM (Science, Technology, Engineering and Math) Out-of-School-Time (STEM-OST) Science On Wheels (SOW) outreach model to new venues in the Puget Sound (Washington) region; modified the lessons and activities so they also served students in grades K-2; aligned the curriculum with the Next Generation Science Standards (recently adopted by the Washington State Legislature) and increased the number of Family Science Days and Family Science Workshops offered to enhance parent involvement in STEM learning.

STEM-OST **activities** were targeted to three interrelated audiences:

- *Young adults:* Discovery Corps teen interns and STEM education college volunteers who were paired with Science Center outreach educators and assisted with lesson delivery and classroom management

- *Students entering grades K-8*: Participants in summer day programs

- *Parents and caregivers*: Adults who accompanied their children to intensive two-hour workshops or casual showcases of what students learned over the summer

STEM-OST **programs** included:

- *STEM-OST Summer Series*. Took place during the summer in community centers in underserved areas of Seattle. These programs introduced students from low-income and diverse neighborhoods to STEM topics and provided them with the opportunity for hands-on exploration, problem solving and making real-world connections. Science On Wheels educators delivered Summer Series Workshops as part of a team, with one Discovery Corps intern and one college-level intern. During workshop sessions, teams worked with up to 29 students per class to ensure impactful learning. They delivered five workshop per series, typically visiting a partner site one day per week for five weeks.

  Summer Series subjects for all students included: engineering, physics and astronomy. Only grades K-2 received animal lessons; students in grades 3-8 learned about math instead. Only 6-8 grade students had computer science lessons.

- *Family Science Workshops*. Events designed to facilitate parents and their children (about ages 6 and up) working together to learn about a novel science topic such as forensics (code-breaking and invisible ink), sustainability (making recycled paper and solar ovens), or animals (dissecting owl pellets and identifying skulls). They were held on Saturdays from 11am to 1pm and consisted of a 45-50 minute lesson followed by a half hour snack break and a second 45-50 minute lesson. They were held during the school year at community centers that had previously hosted a STEM-OST Summer Series and were mainly marketed to families who had attended the Series, though all who heard about them were welcome.

- *Family Science Days*. Events that took place during the summer, following each of the five-week sessions in the gymnasiums at community centers that had hosted a Summer Series (two events) and at Pacific Science Center (one event). They featured exhibit sets from the outreach vans, tables highlighting activities taught during the series, a live stage show put on by educators, and snacks. Participation was free-choice but many Science Center staff were present to assist with hands-on play.

The **outcomes** of the project were varied and addressed by different activities for different audiences and are summarized in **TABLE 1** below.

TABLE 1. STEM-OST outcomes by audience

	Intended Outcomes	Outcome Category
Interns will…	• Develop a deeper understanding of STEM content including physics, astronomy, math and engineering.	Awareness, knowledge or understanding
	• Increase their comfort and confidence in delivering STEM activities to younger children. • Gain greater self-awareness of their role/contribution to informal science education	Attitude
	• Increase their leadership, communication and teaching skills.	Skills or abilities
Students will…	• Increase their content knowledge of STEM content including physics, astronomy, math and engineering.	Awareness, knowledge or understanding
	• Increase their interest in learning more about STEM content.	Engagement or interest
	• Identify themselves as science learners.	Attitude
Parents will…	• Increase their understanding of the importance of STEM literacy.	Awareness, knowledge, or understanding
	• Increase their comfort and confidence in discussing STEM careers with their children.	Attitude
	• Increase engagement in their child's learning.	Behavior

Evaluation Questions

Formative evaluation took place during Year 1 for the Family Science Days and Workshops, which were new programs for the Science Center, and with the college interns – a new audience. Summative evaluation, which is the focus of this report, looked at the programs that took place during Year 2. This evaluation report covers the second year of implementation.

The study explored the effectiveness of the Summer Series, Family Science Workshops, and Family Science Days as Science Center outreach programs as well as the impact of the program on schoolchildren, their families and on the Discovery Corps teen and college volunteer interns. To that end, the study focused on the following evaluation questions:

1) To what extent has participation in STEM-OST impacted the growth and development of interns, both Discovery Corps teen and college volunteers?

2) To what extent are the intended outcomes of STEM-OST achieved with outreach audiences—schoolchildren and their families?

Study Limitations

The drop-in nature of the programs offered presented the largest limitation to the study. Though it is hoped that students attend workshop lessons all five days that the Summer Series is offered at their site the reality was often different, with students attending for only one or two days per Series. While attendees most often stayed for the duration of the Family Science Workshops, attendance overall was often low resulting in small sample sizes.

Family Science Days, on the other hand, were sometimes simply not attended by adults. For the second year of the project they were reimagined as celebratory events and evaluation plans were scaled back.

Though lower elementary-level programs have been offered by PSC in the past, this was the first time students in grades K-2 were surveyed on content knowledge and interest in science. Though the questionnaires were tailored for this age group and utilized pictures and graphics to help increase comprehension, it is unclear how many of the students were able to understand the questionnaire. This limitation could have impacted how well the survey was able to test for changes in content knowledge and interest in science.

METHODS

Due to the multitude of audiences and programs involved in the project, a mixed-methods approach was used to evaluate the effectiveness of STEM-OST. Surveying was the main method of gathering data, but interviews and focused observations were also used.

Quantitative data were analyzed using descriptive statistics and measures of central tendency. Qualitative data were analyzed deductively when there existed correct responses to questions and inductively when the feedback was more subjective in nature. A summary of the methods and the timing of their implementation is shown in **TABLE 2** below. Reproductions of all the instruments are included in the Appendices.

TABLE 2. Evaluation methods by audience

Audience	Method	Timing
Interns	Post-interviews with corresponding pre-surveys	At orientation & during week 9 or 10
	Early and late structured behavioral observations (conducted by SOW staff)	During week 1-3 & 8-10
	Paired pre and post content tests	At orientation & during week 9 or 10
Students	Unpaired pre and post-surveys	At start of Lesson 1 & end of Lesson 5
Parents	Workshop exit surveys	Final 15 minutes of Workshop
	Workshop timed observations	During Workshop 6 of 6

Methods for Interns

Post-interviews with corresponding pre-surveys (all interns) During orientation and after the Summer Series, intern's goals and expectations of the program were recorded. The purpose of these Expectations surveys and the paired Feedback Interviews was to ascertain whether participant's goals and expectations of the program were achieved, as well as to understand the impact of their participation on their expected career path. The pre-survey responses were not analyzed separately but rather used as talking points during the post-interview. The evaluator also referred to supervisor notes from the intern's interviews for the STEM-OST position.

Early and late behavioral observations (teens only) STEM-OST coordinators and educators conducted observations using a pen-and-paper observation form that evaluated teens on their communication, teamwork, leadership and teaching skills. Observations took place early in the program (weeks 1-3), and near the end of the Series (weeks 8-10).

Pre and post content tests (teens only) Changes in content knowledge were measured using identical pre- and post-tests; with pre-tests administered during each years' orientation and post-tests at the conclusion of the Summer Series. This span of time allowed Discovery Corps interns to learn, synthesize, practice and deliver the content to schoolchildren.

Methods for Students

Unpaired pre and post-surveys Children were asked to complete a short questionnaire on the first and last day of the Series (referred to as "Lessons" rather than workshops in this report in order to differentiate from the Family Science Workshop programming). Students in grades K-2 were asked about their interest in science before and after their program experience. Students in grades 3-8 were asked about their interest in math and science before and after their program experience, whether they would be interested in jobs that use math and science before and after their program experience, and their impressions after the program experience, including whether or not they liked the activities, and how interested they were in learning more about the topics that were taught.

Schoolchildren were also quizzed on their content knowledge of the Series they attend, with identical content on pre- and post-questionnaires in order to determine the extent to which they learned new information. Content questions were developed appropriately for different grade levels (i.e. questions aimed at students in grades K-2 were simpler than questions aimed at students in grades 3-5 or 6-8).

Methods for Parents

Family Science Workshop exit survey A single-sided questionnaire was distributed to all participating adults (see Appendix C). Family members who were present in the room but never participated were not surveyed. The survey questions asked about children's ages, past participation and parents' support of children, comfort during and satisfaction with the event, and potential degree of confidence and strategies to help when assisting children with science in the future.

Family Science Workshop timed observation An observation study was conducted to further enhance the understanding of the nature of Family Science Workshops. An evaluator started a stopwatch the moment the lead educator began the final workshop. It ran continuously and whenever the primary behavior of the group changed, the time was noted and the behavior recorded on a data sheet (see Appendix C). This allowed for the calculation, to the second, of the total duration of each of the behaviors throughout the workshop.

Based on formative findings, and in recognition of significant staff turn-over on the project, the goals of **Family Science Days** were re-evaluated prior to development of summative materials. Based on conversations with program staff, the following outcomes for the events were articulated:

- Celebration: attract families of children that participated in the Summer Series
- Excitement: create enthusiasm for science by presenting a half-hour live science show involving audience volunteers and highly engaging experiments
- Extended Engagement: three hourly raffle drawings and a mid-point snack encourage families to stick around for the entire three hour event
- Showcase: provide opportunities for children to show and tell their adults what they learned at the Summer Series workshops
- Promote Togetherness: encourage grown-ups to have fun while engaging *with* kids
- Membership: provide complimentary Pacific Science Center Memberships so families have opportunities to continue exploring science together

These goals diverged considerably from the measurable adult impacts that were originally envisioned. An attempt at surveying participants at the first summative Family Science Day was unsuccessful, especially as the outcomes were metrics-based (attendance, Membership sign-ups, etc.) so further plans to formally evaluate the program were abandoned.

RESULTS

Primary Audience: Interns (DC Teens and STEMed Volunteers)

Ten interns participated in the STEM-OST Summer Series in 2016; six from Pacific Science Center's Discovery Corps youth development program and four from science and science-education programs located at four geographically diverse universities (Cascadia College, Pacific Lutheran University, University of Hawaii at Manoa, and New York University). Interns participated to varying degrees, teaching as few as 21 lessons or as many as 85. Occasionally due to personal preference, but mostly due to scheduling, they taught more of some subjects than others (see **TABLE 3** and **TABLE 4**).

TABLE 3. Number and type of lesson taught by Discovery Corps interns

	Intern 1	Intern 2	Intern 3	Intern 4	Intern 5	Intern 6	Lesson total
Animals	1	4	1	2	5	2	15
Math	2	4	1	2	5	2	16
Astronomy	4	4	10	3	5	4	30
Engineering	5	5	26	12	4	11	63
Physics	12	17	12	18	12	2	73
Computer Sci.	35	20	6	4	8		73
DC Teen total	*59*	*54*	*56*	*41*	*39*	*21*	*270*

TABLE 4. Number and type of lesson taught by STEMed interns

	Intern 7	Intern 8	Intern 9	Intern 10	Lesson Total
Animals	9	6	1		16
Math	3	7	2		12
Astronomy	14	10			24
Engineering	20	6	6	17	49
Physics	10	1	15	8	34
Computer Sci.	29	10	10	4	53
STEMed total	*85*	*40*	*34*	*29*	*188*

The intern experience and effects that their participation may have had were assessed by three methods: a post interview (with pre-survey for comparison), structured supervisor observations early and late in the summer, and content tests. Results from each method are discussed in detail below. See Appendix A for all instruments.

POST-INTERVIEW (WITH PRE-SURVEY FOR COMPARISON)

During weeks 9 or 10 of the STEM-OST Summer Series program, interns participated in a roughly 20 minute interview with a Science Center Evaluator. They answered questions about their motivations, skills gained, and the impact of the program on their comfort, confidence, and future plans. During the interview, responses to a survey (and for teens, the notes from their interview for the position) they completed during orientation, which included many of the same questions, were referenced. See the interview guides in Appendix A.

Ten interns participated this summer; four from college STEM education programs (STEMed) and six from the Science Center's Discovery Corps youth development program (DC teen). Across the two age groups, the general patterns of responses were sometimes similar and sometimes diverged quite a bit. For some questions, every intern had a unique answer.

This year marked just the second summer that college students were brought in to serve as an intermediary level of instructor, bridging the gap between high school teens and the Science On Wheels education staff. Whenever possible, a member from all three groups was part of the teaching team that delivered Summer Series programming at sites in various communities around Seattle. The nature of this multi-tiered mentorship model is of particular interest to program staff. Analysis of interview findings was conducted with an eye towards defining those relationships.

ASKED OF ALL INTERNS

You said you wanted to join this program because ___. Did that happen?

STEMed interns participated because they wanted experience teaching science topics and either wanted experience with, or already enjoyed working with kids. DC teens expressed a couple of motivations in addition to teaching: public speaking and visiting new sites that they had never been to before. Regardless, all heartily agreed that the program delivered the practice they were looking for.

What skills did you gain? (DC teens only: What did you gain from this experience? What did you gain that you couldn't have gotten from school or working on the floor at PSC?)

STEMed interns were fairly specific when describing the skills they both desired and were eventually successful in growing: pacing the delivery of information and framing concepts well for different age groups. One skill that several hoped to build on but did not have much opportunity to work on was designing lesson plans and curriculum.

DC teens practiced teaching skills as well but seemed to focus on the more introductory or foundational concepts of holding kids' attention and sharing information slowly as opposed to forcing learning upon the group (as may be done in formal school settings). Additionally, teens improved their presentation/public speaking skills and increased their knowledge of scientific concepts. One teen desired to work on collaboration but as they were only able to participate for three of the ten weeks, they fell short of that goal.

Later in the interview teens were asked to describe what they gained from the experience – not necessarily skilled-based or something that they began the program hoping to work on. Here, their takeaways were varied. They said they got experience talking to crowds, increased their confidence in public speaking, met new people, visited new sites or areas of the city, taught different ages of kids, and were inspired to continue to pursue teaching.

When teens were asked what they thought they got from the internship that they couldn't get at either school or working with guests at the Science Center, responses varied. On paper, some of these practices (learning science content, how to ask good questions, and how to keep an audience) seem well suited to occurring on-site or at school, but clearly something about the STEM-OST internship program helped these concepts stick. Other unique takeaways from the summer were interacting with students, learning behavior management, seeing new parts of the city and perhaps most poignantly, having a ton of appreciation for teachers, including their own at school.

Program impact on comfort teaching kids

Ratings from all interns increased from pre-survey to post-interview by an average of one point on a five-point scale (with anchors labeled 1=not at all comfortable and 5=extremely comfortable). There was variability in what they thought of their survey rating from the start of the summer; there were instances of both over- and under-estimation in both teens and young adults. STEMed interns indicated hesitation in scoring themselves as "extremely comfortable" citing that there is always more to learn when working with young children.

Program impact on confidence in content knowledge

STEMed interns also hesitated to rate themselves, both before and after the program, as "extremely confident" in their personal knowledge of the content. They qualified their ratings of 4 (on the 5-point scale) by acknowledging that they hadn't taught all the lessons and thus couldn't be confident in something they hadn't practiced. When encouraged to discuss within the scope of what they had taught, extreme confidence was expressed.

DC teens also rated themselves a point below "extremely confident" although they indicated gains from pre to post of one or two points (on the five-point scale). They cited rote practice of information as key to learning new topics and just one teen thought they should have marked themselves lower on the scale at the start of summer. Otherwise, all agreed with their degree of improvement from pre-survey to post-interview.

Program impact on awareness of STEM careers (DC teens only)

All but one teen said they were extremely aware of the STEM careers out there and almost all displayed a two-point increase in that awareness. The two that didn't report an increase cited school or other extracurricular activities as the main source of their awareness. Still, all were enthusiastic about the breadth of opportunities that were discussed, both in lessons and with their mentors, and most also admitted that there were probably many, many more careers that they still hadn't heard of.

Program impact on future plans

When asked about whether their future plans were affected by their summer work, most teens said, "not really" and a couple said they were now interested in working with kids. STEMed interns reported expansion of their previous ideas, for example, "to include teaching;" or the contraction of options, "I learned I don't want to work in a classroom."

The unique contribution of your age group to the program

Teens most often explained that they were better able to relate to youth due to the reduced age gap between themselves and the students they were teaching. They explained that kids might be more comfortable asking them questions and they might better understand slang that was used.

College interns cited their being comfortable with themselves – "past that whole hormone stage" – as well as with the process of teaching with several saying they were comfortable jumping in immediately and helping whenever needed. One also shared that being closer in age to the high school students might make them more relatable to the teen interns (as opposed to SOW staff).

The small sample of STEMed interns each thought they personally brought something unique to the team whether that was experience teaching young kids, expertise with science topics, bringing ideas for lesson improvement or simply being willing to do anything needed to keep busy and help the program.

STEMED ONLY QUESTIONS

On working with kids

STEMed interns were pleasantly surprised at how capable their young pupils were. The tone with which this question was answered suggested they were deeply affected by their experience with K-8th graders. They did not note major challenges but rather focused their comments on how observant, honest, and sassy kids could be. They also identified their own personal preferences for working with certain age groups. Minor challenges were logistical: knowing how many kids and of what age would be at any given site, along with behavioral, dealing with rowdy boys and ever-present cell phones.

On working with teens

Young adults overwhelmingly praised the teens as "really great." They were impressed and one even admitted, intimidated, by the quality of teaching they observed. They described working well with their younger counterparts, as well as occasionally providing advice and enjoying watching them grow.

On working with SOW Educators

College interns had a good experience working with staff and said it was good to have someone closer to their age. They appreciated the educator's flexibility and willingness to answer questions and they reported learning a lot. One thought it was great to be exposed to a wide variety of teaching styles, another said they were glad staff were there to help with kids that were harder to keep on task, and another admitted that sometimes it felt like "we didn't need them." There were mixed opinions on whether interns got enough feedback from staff.

EARLY & LATE OBSERVATIONS

During weeks 1-3 and 8-10, Science On Wheels coordinators and educators conducted extensive, structured observations of DC teen interns. The tool is broken out into three sections: communication, teamwork & leadership, and teaching. For the complete observation instrument, see Appendix A. One teen intern had extremely limited participation this summer and the tool was not used for STEMed interns so just **5 intern observations were completed**.

Communication

Six communication behaviors were measured on a frequency basis (never, sometimes, always). No interns received marks of "never" on early or late observations and improvements were seen in every category with most interns demonstrating good communication skills all the time. (see **TABLE 5**).

On the early observations, supervisor notes were minimal – suggestions included were to speak louder or slower or to maintain eye contact. There were a few compliments as well including that interns, "got down to student level," "had excellent story reading," or "had a nice, calm demeanor."

At the end of the summer the only suggestion was that one intern, "rehearse explanations." An example of praise in this category was, "great at interacting formally and informally with students."

TABLE 5. Number of interns that demonstrated communication behaviors, by frequency

Behavior	Never		Sometimes		Always	
	EARLY	LATE	EARLY	LATE	EARLY	LATE
Smiles and looks friendly	-	-	1	-	4	5
Confident body language and eye contact	-	-	2	1	3	4
Speaks with appropriate volume	-	-	2	-	3	5
Speaks articulately	-	-	2	2	3	3
Models enthusiasm and positive attitude	-	-	3	1	2	4
Respects students and shows caring	-	-	-	-	5	5

Teamwork & Leadership

Seven teamwork and leadership behaviors were also measured on a frequency basis (never, sometimes, always). Just one intern received a mark of "never" on the early observation and they also received one mark of never for a different behavior at the end of the summer. No behavior was demonstrated "always" by all the interns. Occasionally, there was no opportunity for an intern to display a particular behavior and those instances are noted in the table below along with frequency (see **TABLE 6**).

There were many more comments provided for interns in this section but they all varied by intern and behavior. In general, by the end of the summer, teens were advised to prepare materials before class, give all instructions before passing out supplies, and take initiative to get involved even if they didn't have a specific assigned task. Teens excelled at involving everyone, asking for help when they needed it and handling off-task behavior with authority.

TABLE 6. Number of interns that demonstrated teamwork and leadership behaviors, by frequency

Behavior	No opportunity		Never		Sometimes		Always	
	EARLY	LATE	EARLY	LATE	EARLY	LATE	EARLY	LATE
Understands lesson plan	-	-	-	-	2	3	3	2
Initiates conversations and offers help	-	-	-	-	2	4	3	1
Takes initiative	1	-	-	1	2	2	2	3
Shares tasks fairly with colleagues	1	1	-	-	3	1	1	3
Checks in with colleges	-	-	1	-	3	2	1	3
Responds calmly to unexpected situations	3	1	-	-	1	-	1	4
Careful and organized with materials	-	-	-	-	1	1	4	4

Teaching

Fourteen teaching skills were measured on a three-point scale of competence (needs improvement, satisfactory, above expectations). As with teamwork, there were occasionally times when there was not a chance to display a particular behavior and those instances are noted in the table below (see **TABLE 7**). During their early observations, four of the five interns "needed improvement" on anywhere from one to five teaching tasks. After a couple months, just one intern had two items left that they needed improvement on.

Many interns progressed from satisfactory to above expectation teaching as the summer progressed. In particular, everyone excelled at working one-on-one or with pairs of students. More often than not they were above expectations at encouraging students –whether they were displaying good or bad behavior– as well as using kid-friendly language and giving equal attention to everyone.

One teen was noted for "using language that [they] had heard kids use before in this lesson to help them understand." Another was praised for using "varied questioning types" and was great at using questions to help lesson flow as well as "demonstrating a variety of strategies for dealing with off-task behavior."

TABLE 7. Number of interns that demonstrated teaching behaviors, by competence

Behavior	No opportunity		Needs improvement		Satisfactory		Above expectations	
	EARLY	LATE	EARLY	LATE	EARLY	LATE	EARLY	LATE
Clear instructions and appropriate pace	3	-	1	1	1	3	-	1
Models activities	2	1	-	-	3	3	-	1
Checks for student comprehension	2	-	3	-	-	4	-	1
Uses kid-friendly language	1	-	1	-	3	2	-	3
Asks open-ended questions	2	1	1	-	2	3	-	1
Asks series of questions to guide students	3	1	2	-	-	2	-	2
Answers clearly, honestly, variety of styles	3	1	-	-	2	3	-	1
Encourages struggling students	-	-	1	-	4	2	-	3
Encourages good behavior	-	-	-	-	5	2	-	3
Responds appropriately to off-task behavior	2	1	1	-	2	3	-	1
Gives equal attention to all students	1	-	-	-	3	2	1	3
Interacts confidently with individuals/pairs	-	-	-	-	4	-	1	5
Interacts confidently with small groups	-	1	-	-	3	1	2	3
Interacts confidently with large groups/whole class	2	1	1	1	2	2	-	1

CONTENT TESTS

Along with their pre-surveys, teen interns also completed subject matter tests on five topics of the series (animals, math, astronomy, physics, and engineering); there was no content test associated with computer science. At the end of the summer, they took an identical content test. **TABLE 8** below shows each intern's post test score and the percentage each score changed from the pre-test. The test had 48.5 points possible with sections varying from 7.5 to 13 points each (see Appendix A).

TABLE 8. DC teen intern post-test score and change from pre-test

Intern	Animals		Math		Astronomy		Physics		Engineering		OVERALL	
	POST	chg.	POST	chg.	POST	chg.	POST	chg.	POST	chg.	POST	chg.
Intern 1	80.0%	0.0%	66.7%	0.0%	31.6%	-10.5%	63.2%	26.3%	61.5%	7.7%	59.8%	5.2%
Intern 2	66.7%	13.3%	66.7%	11.1%	21.1%	5.3%	63.2%	21.1%	65.4%	-11.5%	56.7%	6.2%
Intern 3	53.3%	-13.3%	50.0%	0.0%	42.1%	30.9%	57.9%	31.6%	61.5%	11.5%	53.6%	14.4%
Intern 4	66.7%	13.3%	77.8%	44.4%	47.4%	42.1%	47.4%	0%	73.1%	3.8%	62.9%	19.6%
Intern 5	40.0%	-13.3%	77.8%	11.1%	36.8%	15.8%	52.6%	10.5%	90.4%	28.8%	62.4%	12.9%
Intern 6	93.3%	-6.7%	94.4%	16.7%	78.9%	0.0%	89.5%	26.3%	88.5%	-3.8%	88.7%*	6.2%

*Although Intern 6 did not teach many lessons, they were a returning intern from last summer and likely remembered much of the content.

As shown earlier in **TABLE 3**, teen interns taught from 1 to 35 lessons in each Series. Most interns ended up teaching one Series more than others. For example, Intern 1 taught the computer science Series 35 times, while Intern 3 taught engineering 26 times. A higher number of lessons taught correlated with an increase in test scores on average, though this trend did not always hold on an individual level.

As an example, the topic where teen knowledge improved the most overall was physics, with an average increase of 20%; individual changes ranged from 0-32% increases. It was taught 73 times – tied for the most with computer science.

The topic where knowledge increased least was animals, where the average score actually decreased by 1%. In this case, it was the least taught Series, with just 15 lessons total delivered by teens. No teen taught more than five lessons about animals. Changes in test scores ranged from -13.3% to 13.3%.

Teen mastery of content varied with a low topic score of 21% in astronomy, to a high topic score of 94.4% on the math section. All demonstrated improvements ranging from a 5% to 20% increase from pre to post.

Secondary Audience: K-8 Students

In total, 500 Summer Series workshops were delivered to 2,032 students across 43 sites in summer 2016. Surveys were only distributed at the 35 sites which booked a five-session Series. Analysis was only conducted when pre (Lesson 1) and post (Lesson 5) surveys could be paired. Sets of data that had less than 20 pairs were not analyzed.

This left data for all four K-2 Series, two 3-5 Series, and one 6-8 Series. One set of topical findings is presented for each grade band as the results were mostly similar across subjects. Likewise, just one example of a post survey, corresponding with the subject for which findings are discussed below, is provided for each grade band in Appendix B.

All surveys included three questions relating directly to content taught during the lessons; efforts were made to write questions that related to concepts mentioned in more than one lesson. For grades 3 and up, surveys included questions on enjoyment and interest in math and science. Post-surveys additionally had items on whether students enjoyed the activities presented in the lessons and whether they were interested in learning more about the topics taught. Finally, there were one or two questions addressing careers that were related to the topic of the Series.

Testing for grades K-2 was extremely simplified. Pre and post surveys were identical and had one question about whether the respondent liked science followed by three content questions.

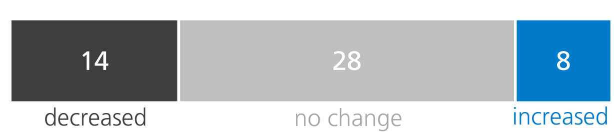
K-2 GRADE STUDENTS

Sites with students in grades K-2 could book animals (unique to this grade band), astronomy, physics or engineering lessons. The topic that was booked most, and therefore resulted in the largest paired sample, was physics. All topics were taught often for grades K-2; data for all topics was analyzed and the profile of the findings was similar to that of the physics lessons. Therefore, for ease of explanation and in order to streamline the results, only physics findings will be presented in this section. There were **53 pairs of physics surveys** for K-2 students.

Most students did not change whether they liked science from Lesson 1 to Lesson 5 although more indicated decreases than increases (see **FIGURE 1**).

For the first content question, students had to circle the three items that have a lens in them from a bank of five (glasses, window, stoplight, clock, and lighthouse). Most students (87%) correctly identified the glasses before and after the Series. They showed greater gains in learning with the other four items, marking those

FIGURE 1. About three-quarters of K-2 students' enjoyment of science stayed the same or increased.
n=50



with a lens more often (lighthouse 13% more and stoplight 23% more) and marking the clock and the window less on the post-survey (4% and 26% less, respectively) (see **FIGURE 2**).

The second content question was more straightforward. Students had to circle the pair of magnets that would attract each other. There were just two choices. On the pretest, 42% of students got this item correct and four or 8% circled both images. Afterwards, 49% got it right but more than previously, 13% or seven, circled both pictures.

Finally, students were asked to circle one picture, from three, of what would happen to cabbage juice when an acid or base is added (see **FIGURE 3**). After the Series most (81%) answered correctly with very few students circling the wrong response. Additionally, whereas during the pretest, 10 students circled two or all three pictures, only one student circled two items on the posttest.

FIGURE 2. Students marked more items with a lens and fewer without a lens after Lesson 5. n=53

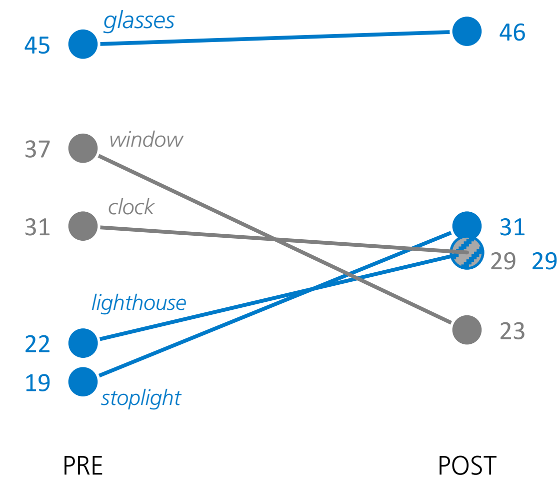
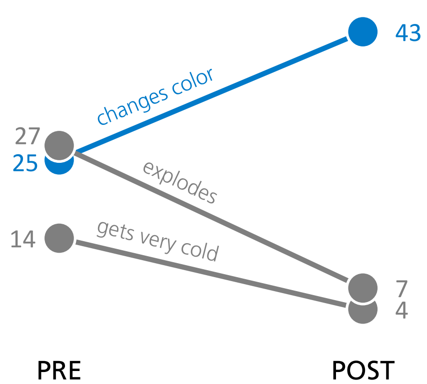


FIGURE 3. One-third more students correctly indicated that cabbage juice would change color in the presense of an acid or base. n=53

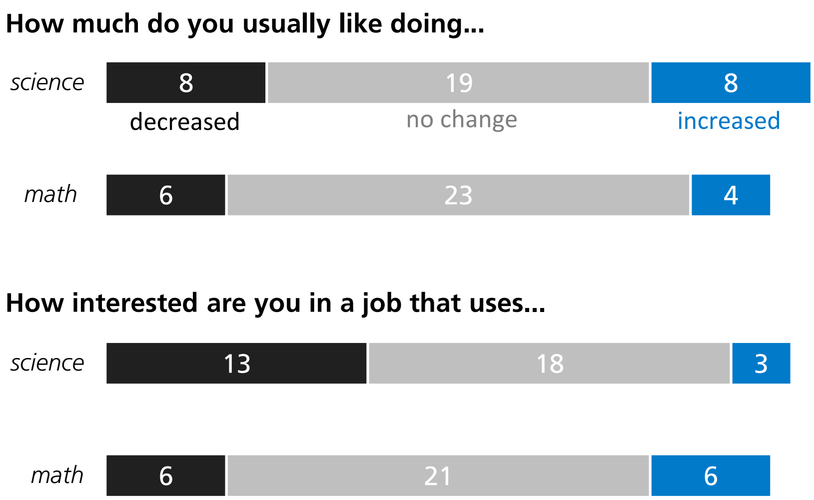


3-5 GRADE STUDENTS

Sites with students in grades 3-5 could book math, astronomy, physics, or engineering lessons. The topic that was booked most, and therefore resulted in the largest sample, was engineering. Math and astronomy had paired samples of less than 20 each so data were not analyzed. Physics data were analyzed and the profile of the findings was similar to that of the engineering lessons. For ease of explanation, and in order to streamline the results, just engineering findings which are based on **36 pairs of surveys**, will be presented in this section.

Students indicated mostly no change in their enjoyment of science or math as well as mostly no change in their interest in having a job that uses science or math. Slightly more indicated decreases than increases in doing math and having a job that uses science (see **FIGURE 4**).

FIGURE 4. Most students expereinced **no change** in enjoyment or interest in math and science. n varied from 33-35



On the pre-survey 29 of 36 (81%) correctly identified gravity as the name of the force that pulls a marble down a slope. The remaining 7 indicated thrust. On the post-survey, 28 marked gravity (78%), and while fewer (n=4) marked thrust, additionally one student marked drag and three more indicated friction.

Just one student correctly identified "test" as the second step in the engineering process on the pre-survey. Seven wrote it down as the third step, however, always preceded by the word "build." An additional nine provided variations of building or making models. Their ideas for the third step usually logically followed what they wrote for step two, even if they were incorrect. For example, "get the tools" and "build" or "imagine" and "create."

On the post-survey, 18 of 34 students (53%) identified "test" as the second step while eight indicated "build." There was much less variation in the responses after the fifth engineering lesson. The same went for step 3 with 21 (60%) writing variations of "re-design" or "re-build." Six students wrote "test" as the third step.

The third content question on the Engineer It! questionnaire required students to choose two projects an engineer might work on (from a bank of four) and match the work to a civil and an electrical engineer. Six students left this question blank on the pre-survey and another three wrote in two responses. The remaining 27 responses were fairly evenly split amongst the four project options for civil engineers and divided amongst two options for electrical engineers (see **FIGURE 5** and **FIGURE 6**). By the end of Lesson 5, responses were just as spread out among the civil engineer choices and still divided for electrical engineers.

FIGURE 5. Most students did not know what project **civil engineers** would work on (designing a bridge) - pre or post.

n=27 pre, n=24 post

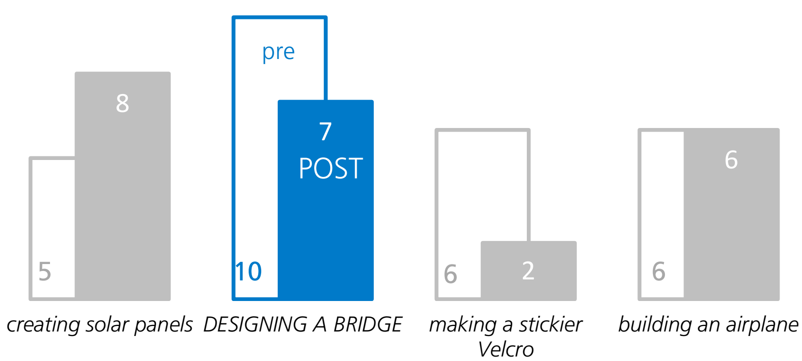
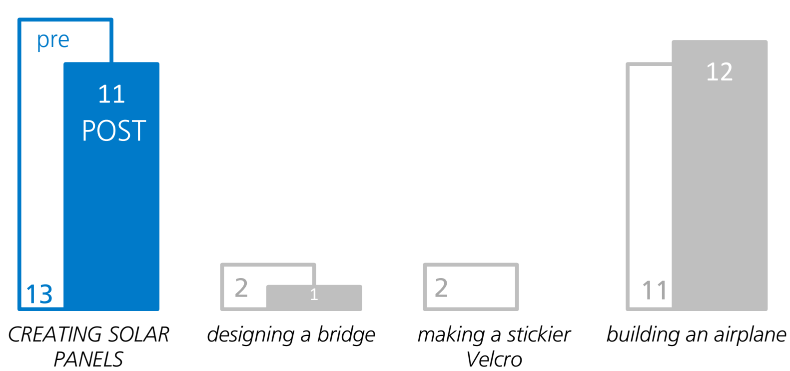


FIGURE 6. Students were divided on what project **electrical engineers** would work on (creating solar panels) - pre and post.

n=28 pre, n=24 post



The career question simply asked students to write one more career that involves engineering. Responses were incredibly varied and for the most part, correct. They listed occupations like: architect, construction worker, house builder, inventor, and scientist. They also provided examples of things engineers might build such as: a microwave, spaceship, airplane, cars, bridge, elevator, Velcro, robots, roller coasters, and video games.

Some industrious students may have copied from the word bank in the previous question; seven wrote in airplane, bridge or Velcro. Only a handful wrote something not connected to occupations or objects but their words were still related to engineering, such as: create, design, and test.

Third through fifth grade participants in the engineering Series enjoyed the activities greatly with over three-quarters (79%) indicating they liked them a lot. They were less enthusiastic about learning more about the topics that were taught but the majority (91%) still indicated interest (see **FIGURE 7** and **FIGURE 8**).

FIGURE 7. All but one student liked the **activities** Some or A lot. n=36

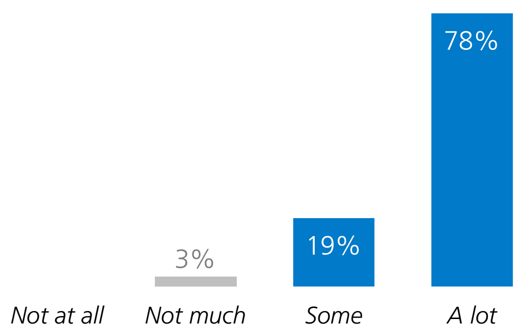
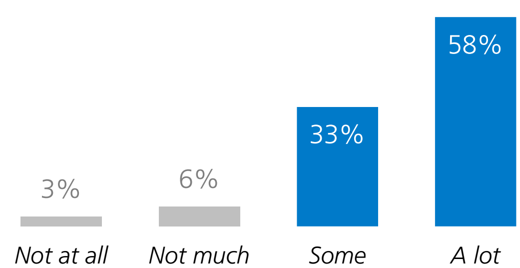


FIGURE 8. Almost all students (91%) are Some or A lot interested in **learning more** about the Series topic. n=36

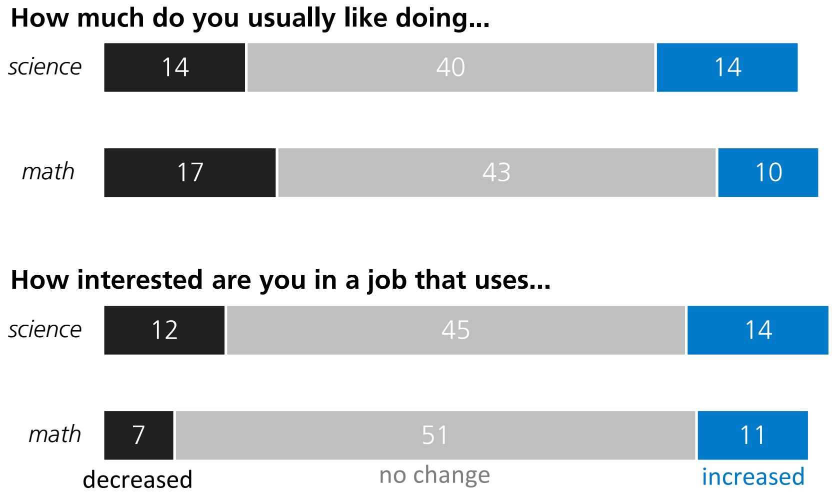


6-8 GRADE STUDENTS

Sites with students in grades 6-8 could book math, astronomy, physics, engineering, or computer science (unique to this grade band) lessons. The topic that was booked most and therefore resulted in the largest sample was computer science. No other topics had paired sample sizes greater than 20 and so analysis was only conducted on the computer science data and those findings are presented here. A total of **68 pairs of surveys** were analyzed.

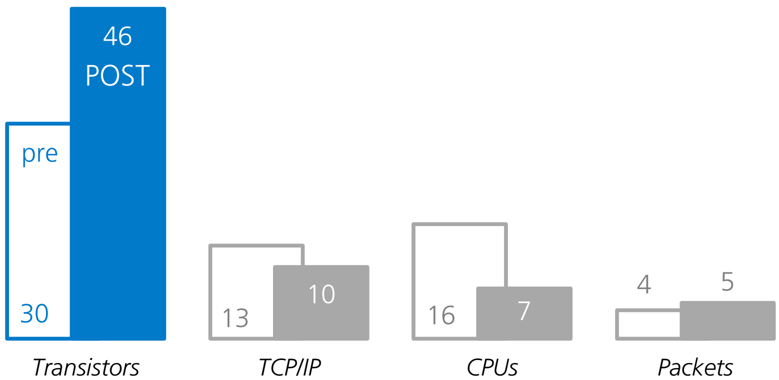
Students indicated mostly no change in their enjoyment in doing or interest in a job that uses science or math (see **FIGURE 9**).

FIGURE 9. Most students expereinced **no change** in enjoyment or interest in math and science from Lesson 1 to Lesson 5. n varied from 68-71



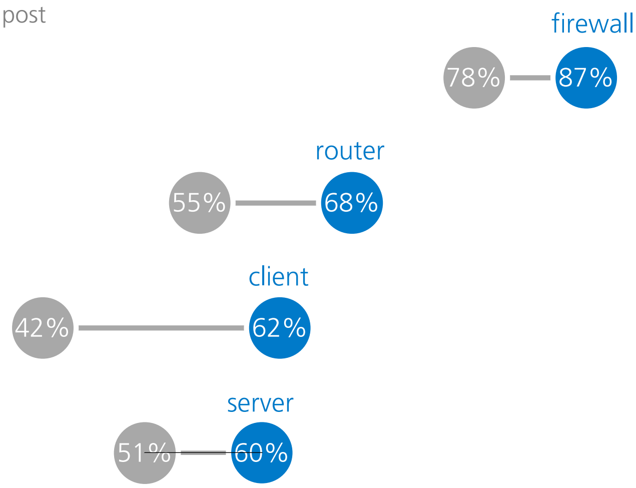
The first content question asked students to choose from a list of four items, the correct word for the microscopic electronic switches that digital devices use to communicate. Instances of the correct response increased after the series, from 48% correct (n=30) to 68% correct (n=46) (see **FIGURE 10**).

FIGURE 10. Students increasingly identified **transisitors** as the microscopic switches that digital devices use to communicate.
n=63 pre, 68 post



The second computer science content question was matching four definitions with four hardware-related vocabulary words. The percentage of correct pairings increased from Lesson 1 to Lesson 5 as shown below in **FIGURE 11**. Students were already fairly knowledgeable on the function of a firewall at the start of the Series; the largest increase was seen in understanding the function of a client.

FIGURE 11. Correct identification of hardware components increased, especially for "**client**."
n=66 pre, 68 post



For the final content question, students were asked to choose two commands from a bank of five in order to complete a series of steps instructing a robot how to navigate to an end-point. Student application of their knowledge of algorithms was high to start, with 71% getting the first command correct and 69% getting the second command correct. At the end of the Series, the percentage of correct responses increased a bit to 73% and 77% respectively (increases of 2% and 8%).

Computer science Series participants were asked to list two careers that would require a person to use computer programming. Nearly three-quarters (73%) of students provided two responses and another seven listed one. Ten students either did not know or left the question blank. All responses were correct and ranged from "computer programmer" or "computer scientist" to "game designer or creator" and "robot programmer." A few listed large companies in the tech field such as Apple, Microsoft, Boeing, Google, or Nintendo.

Finally, most middle school students indicated that they both enjoyed the activities from the Series as well as indicated interest in learning more about computer science (see **FIGURE 12** and **FIGURE 13**).

FIGURE 12. Most students (88%) liked the **activities** Some or A lot. n=69

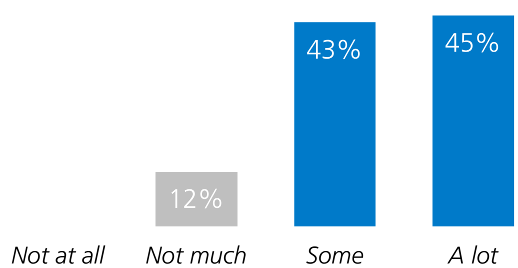
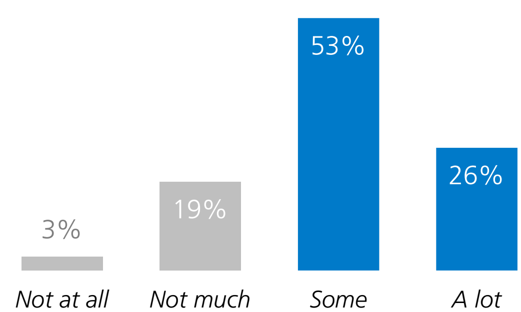


FIGURE 13. Most students (79%) are Some or A lot interested in **learning more** about the Series topic. n=70



Tertiary Audience: Parents

Parents, or adult caregivers, were the tertiary audience for this study. Their involvement occurred at two types of event: Family Science Workshops and Family Science Days (see **TABLE 9**). During the summative period of the project, four Workshops were held during the school year and three Days were held over the summer, concurrent with Summer Series programming. As mentioned above in the Methods section, the outcomes for the Days were modified heavily prior to summative evaluation and an attempt at an exit survey with adult attendees was unsuccessful. Additionally, an informal observation was conducted and the resulting data was inadequate for analysis. Therefore, this section only presents results from the two methods used to evaluate the Family Science Workshops: exit surveys and timed observations.

TABLE 9. Family events and dates

		Event Type	Date	Location	Evaluation
Summative 2016	6	Workshop	Sat, Mar 19	Seattle's Union Gospel Mission	Exit Survey
	7	Workshop	Sat, May 7	High Point Community Center	
	8	Day	Sat, Aug 13	Seattle's Union Gospel Mission	1 Observation
	9	Day	Thurs, Aug 18	Rainier Vista B&GC	
	10	Day @ PSC	Sat, Aug 27	Pacific Science Center	
	11	Workshop	Sat, Oct 8	Seattle's Union Gospel Mission	Survey cont'd (n=25)
	12	Workshop	Sat, Oct 22	High Point Community Center	1 Timed Observation

EXIT SURVEY

Family Science Workshops were events designed to facilitate parents and their children working together to learn about a novel science topic such as forensics (code-breaking and invisible ink), sustainability (making recycled paper and solar ovens), or animals (dissecting owl pellets and identifying skulls). They were held on Saturdays from 11am to 1pm and consisted of a 45 minute lesson followed by a 25 minute snack and a second 45 minute lesson. They were held during the school year in community centers that had previously hosted a STEM-OST Summer Series and were mainly marketed to families who had attended the Series, though all who heard about them were welcome.

Throughout the two year grant, six Workshops were held, the first two being the subject of formative study. This portion of the evaluation report presents the findings from the summative study, which was conducted over the final four events, all of which occurred in 2016. A single-sided questionnaire was distributed to all participating adults (see Appendix C). Family members who were present in the room but never participated were not surveyed. The survey questions asked about children's ages, past participation and support of children, comfort during and satisfaction with the event, and potential degree of confidence and strategies to help when assisting children with science in the future. **In total, 25 completed surveys were collected.** **TABLE 10** summarizes the summative study sites.

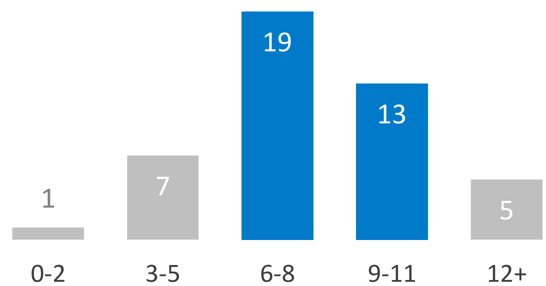
TABLE 10. Family Science Workshop summative study sites

Date	Site	Attendees	Completed surveys
March 19	Seattle's Union Gospel Mission, Burien	22 adults, 33 children	15
May 7	High Point Community Center	8 adults, 6 children	2
October 8	Seattle's Union Gospel Mission, Burien	8 adults, 11 children	3
October 22	High Point Community Center	5 adults, 5 children	5

Little demographic or contextual information about participants was collected as the focus of the study was limited. Further, small sample sizes were expected, making generalizations about audiences less helpful. We do know that most parents did not have previous experience with programs where they were expected to work with their children (see **FIGURE 14**). We also saw that the majority of youth that attended were elementary school age, or between six and 11 years old (see **FIGURE 15**).

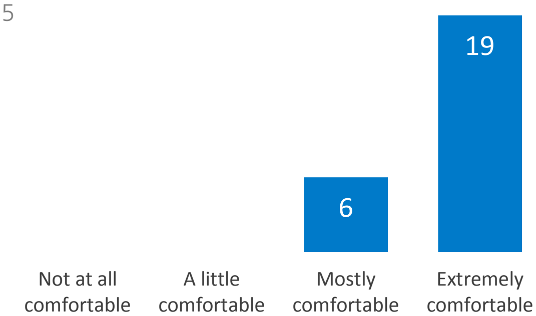
FIGURE 14. For two-thirds of respondents (64%), this was **the first time they were attending** an event where they did science with their child.
n=25

FIGURE 15. Nearly three-quarters (71%) of children were **elementary school aged**.
n=45



Project staff indicated that parent comfort during the event was a high priority; facilitators were extremely successful in creating an atmosphere that supported that goal (see **FIGURE 16**).

FIGURE 16. Three-quarters (76%) of repondents reported the **highest possible level of comfort** while doing science with their child at the workshop.
n=25



They attributed this mainly to staff and activities (see **TABLE 11**). Twenty-two respondents left comments that were coded 26 ways.

TABLE 11. Ways parents felt welcome

What did we do that made you feel welcome?	Number of comments	Example comments
Staff	13	- Led us to a table with space and personally caught us up with the activity. - Greeting when we walked in. Offering chairs and snack. - Nice, inviting, parents able to participate - Very nice, friendly, helpful
Activity	8	- Good pacing of activities - Dissecting pellets - You provided materials for everybody.
Atmosphere	3	- Relaxed atmosphere - It was great for the kids, very relaxed and fun. Very welcoming.
Snacks	2	- Snacks and exploring and learning about the owl.

There were few suggestions for how we might improve the program in the future: "have some games," "more activities," "more kids!" were general. Perhaps the most actionable request was to "introduce one another." The remaining seven comments were all variations on "Everyone seemed very comfortable. I'm not sure if improvement is needed."

Most respondents shared the ways they supported the children in their group during the workshop. Twenty-three comments were coded 33 ways and are summarized in **TABLE 12**.

TABLE 12. Ways parents supported children at workshops

In what ways did you support the kid(s) in your group today?	Number of comments	Example comments
Help, do activity with them	12	- Helped with the paper and kept them involved - Participating/engaging with them - Sat with and [did the] hands on [activity]
Ask questions	6	- Asked leading questions to keep them on task, encouraged involvement and bravery. - Encouraged him, listened, asked questions
Encourage	6	- Encouraged them that it was ok to touch the owl's pellet when they were directing them. - Help with project. Encourage them to try things
Explain	3	- Explain to them how the concept [works]. And help them by hand how to finish the task. - Advise, supervise, repeat.
Other	6	- Gave them space to explore - Intense hand washing and sanitizer.

Parents reported thinking that they feel a lot more confident doing science with their children at home (see **FIGURE 17**).

Parents provided evidence of their reinforced self-reliance by providing strategies that they might use to help their kids with homework even if they didn't already know the answers. They focused on looking for more information, providing encouragement and doing things together (see **TABLE 13**). Eighteen comments were coded 22 ways.

FIGURE 17. All repondents reported at least a little **gain in confidence**.
n=24

TABLE 13. Ways parents can help their kids in the future

What is one thing you can do to help your child with homework, even if you don't know the content?	Number of comments	Example comments
Look for more info	11	- Helping her find more information online or at the library - Get science books - Use the internet (google)
Encourage them	5	- Encourage them to try and explore - Give them encouragement. - Help her to help herself… by finding her own conclusion.
Be involved	3	- Be involved with them and ask questions. - Research and engage with them; make it a family activity. - Work together to find the answer. Cooperative learning. Ask someone, explore websites/topic related.
Ask questions	3	- Research, ask questions

Finally, overall, parents thought the event was great or excellent. They mostly provided very short comments but some elaborated on their experience:

> *"Nice experience for my children. The hands-on experiment was great. This is something that we don't have the opportunity to do every day."*
>
> *"Great. Awesome way to engage with kids of different ages. Owl pellets, great idea."*
>
> *"The event was excellent. ALL the kids were involved and happy,"*
>
> *"Wonderful and engaging for this age group."*
>
> *"Very fun and educational."*

Family Science Workshops, though not as highly attended as hoped, were very effective in providing an opportunity for parents to work *with* their elementary school-aged children. They also reinforced important strategies that adults can continue to use such as asking their kids questions and looking for more information, especially together. The hands-on activities were captivating and out of the ordinary and more importantly, staff provided exceptional experiences for participants by smiling, and welcoming and including everyone in the fun. The Workshop may have been a highly influential experience for some groups, as it was the first event that many had been to where they were expected to work together and they enjoyed the afternoons greatly.

TIMED OBSERVATION

A timed observation study was conducted to further enhance the understanding of the nature of Family Science Workshops. An evaluator started a stopwatch the moment the lead educator began the final workshop. The stopwatch ran continuously and whenever the primary behavior of the group changed, the time was noted and the behavior recorded on a data sheet (see Appendix C). This allowed for the calculation, to the second, of the total duration of each of the behaviors throughout the workshop. *More than one behavior could be observed at once so in all cases, percentages total more than 100.*

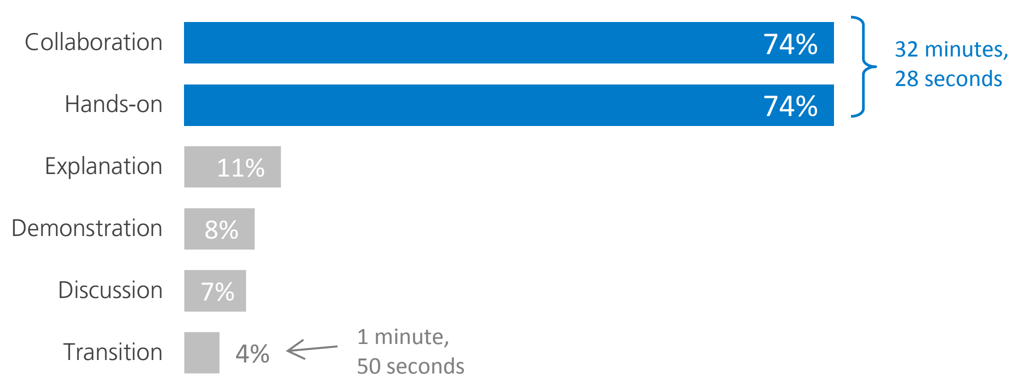
The theme of the final Workshop was sustainability. The first lesson introduced the concept of sustainability with a fun, novel, and messy activity - making recycled paper with leftover STEM-OST summer surveys. After using a toy recycling truck made of 100% recycled plastics to prompt discussion, everyone got involved tearing, soaking, straining, and pressing paper pulp.

This Workshop was led by one Science Center educator who was assisted by two additional staff members and a Discovery Corps Intern. Two families were present at the start of the lesson, each consisting of a mother, father, and two kids. Early on in the lesson, one child left the group table to build a structure with toys in a different part of the room. In the classroom, the ratio of staff to participants was 1:2.

FIGURE 18 presents a breakdown of the percentage of time the group (both staff and participants) spent doing each of six main behaviors. Participant behaviors included: collaboration, hands-on, discussion, and transition. Staff behaviors included: explanation, demonstration, discussion, and transition. For this lesson, adults and youth were *always* seen working together when there was a hands-on component. After nearly 44 minutes, each family had produced many small sheets of recycled paper and the products were moved outside to dry in the sun.

FIGURE 18. During the first activity, families were observed working together whenever there was opportunity for hands-on learning.

Paper making lasted 43 minutes and 48 seconds.



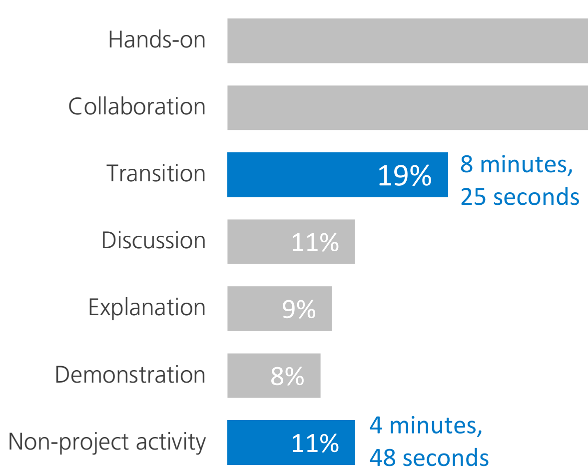
Around noon, everyone took a break to socialize and have a bite to eat. A third family, a mother-daughter pair, joined the group at the beginning of snack bringing the total number of participants to five adults and five children.

After snack, participants explored the idea of where energy comes from, with an emphasis on solar energy. Everyone was given a small solar powered fan and challenged to find the limits of the conditions that got the fan to run. At the conclusion of this hands-on activity, a mother-daughter pair from one of the larger families had to leave for another event, bringing the participant total back down to four adults, four kids.

After a short transition, solar ovens – and the properties that make them successful – were introduced. Staff passed out materials and all four kids participated; the child who was not interested in making paper earlier was extremely absorbed in this activity. Parents were encouraged to help their kids fold, tape, and otherwise modify the solar ovens but in this case, most of them held back, jumping in only to assist with a particularly difficult bit of taping, such as affixing cling wrap to the cardboard box. Staff worked on their own ovens and modeled behavior or ideas for youth but otherwise their assistance was not needed as much to construct the ovens either.

Quite a bit more time was spent transitioning between activities for the oven lesson. Also, some time was siphoned from hands-on time as children became extremely excited by an impressive pile of leaves in the courtyard where the ovens were set up. Still, solar ovens were a highly hands-on and collaborative lesson (see **FIGURE 19**).

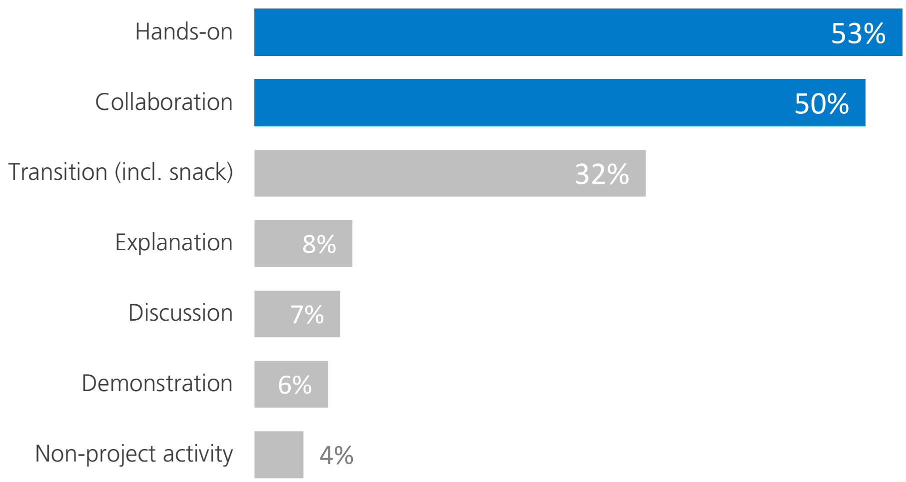
FIGURE 19. The second lesson involved **more transition** as well as **non-lesson activity** (i.e. jumping in leaves when the group went outside the classroom).
Solar ovens lasted almost the exact same amount of time: 43 minutes and 51 seconds.



It was important to look at each lesson separately in order to identify any differences, of which there were a few (different participants, amount of parent involvement, amount of transition time and a bit of distraction). It was also helpful to consider the entire workshop as a whole; that view is presented in **FIGURE 20**. The primary goal of the program was for families to work together and it is clear that that was happening nearly every moment of the afternoon. Further, learning by doing is clearly the focus; staff explanations, or talking to rather than talking with, were kept to a minimum. Snack time was always planned to take up 20% of the program and there were three discrete activities to shepherd participants through, so the fact that transition time took a-third of the time makes sense.

FIGURE 20. Overall, the entire sustainability workshop was **highly hands-on**, with **families working together** for most of the activities.

Overall the entire workshop lasted 1 hour, 49 minutes and 11 seconds.



DISCUSSION

Intern Outcomes

As a result of their participation in the STEM-OST Summer Series, interns were anticipated to grow in three categories –knowledge, attitude, and skills– as defined by four specific outcomes listed below. Each will be discussed in turn, using evidence from the results of the three evaluation methods used with this audience: content tests, post-interviews, and structured observations.

	Intended Outcomes	Outcome Category
Interns will…	• Develop a deeper understanding of STEM content including physics, astronomy, math and engineering.	Awareness, knowledge or understanding
	• Increase their comfort and confidence in delivering STEM activities to younger children. • Gain greater self-awareness of their role/contribution to informal science education	Attitude
	• Increase their leadership, communication and teaching skills.	Skills or abilities

STEM CONTENT KNOWLEDGE

Teen interns were tested on five of the six topics taught this summer (computer science was a late addition to the outreach lessons and a pre and post content test was not prepared). All interns increased their overall scores on the content test by 5-20% by the end of the summer.

Average score changes on individual subjects varied. For the least taught Series (animals: just 15 lessons or an average of 3 per intern) scores changed from -13% to +13% and the net change across all six interns was -1%. On the other hand, for the most taught Series (physics: 73 lessons or an average of 12 per intern) individual test scores increased from 0-32% and the net change across all interns was +19%.

Individually, interns' scores increased on specific subjects anywhere from 0-44%. Two interns also experienced declines on specific topics; one intern only participated for three weeks of the summer and the other saw a decline in their scores of two subjects that they only taught four or five times.

As students were not in school during the Summer Series, it is likely that the STEM-OST program was the reason for their increased knowledge, especially in the topics of physics, astronomy, and engineering. There was also a correlation between the number of lessons of a subject an intern taught and their post-summer content test score – those who taught more lessons of a topic generally saw higher increases in test scores.

COMFORT AND CONFIDENCE DELIVERING STEM

Both teens and college interns rated themselves one point higher (on a 5-point scale) on comfort teaching kids in their post-survey. During the exit interview, while looking back on their intake survey responses about comfort, there were instances of teens both over and underestimating their comfort teaching kids at the start of the summer. College interns were more sure of themselves at the start of the summer and at the same time were hesitant to score themselves as “extremely comfortable” (i.e. 5) citing that there is always more to learn when teaching children. Either way, both groups indicated improvement.

Likewise, interns indicated increases in confidence in their own knowledge. When asked only to consider the content for lessons they had taught repeatedly, STEMed interns were “extremely confident” in their knowledge. They stated that they were generally aware of the content already and also felt at ease handling any questions students had. Teens rated themselves a point below the maximum at the end of the summer and indicated one to two-point gains since the beginning of the summer.

At the end of the summer, all five observed teens were rated as “above expectations” for interacting confidently with individual students (an increase from just one “above expectations” in the first week of summer). Three were also rated as “above expectations” for interacting confidently with small groups. These observations corroborate the self-assessments discussed above. Considering the limited duration of the Series (10 weeks) it seems reasonable that not all teens would have had a chance to exceed expectations at teaching an entire class of students, though as a group they made large improvements.

ROLE IN INFORMAL SCIENCE EDUCATION

Both age bands of interns identify themselves as important links in the tired mentorship model that STEM-OST strove to create. Interns were asked what they thought their age group (teens or college) brought to the Summer Series that the education staff didn’t or couldn’t. All acknowledged that their ages and life experience were unique and more relatable to their younger counterparts (teens with students and college folks with teens). They also said they were able to provide advice and mentorship to everyone younger than themselves. Most poignantly, several teens identified a new found sense of appreciation for their own formal education teachers.

College volunteers were not asked about their awareness of STEM careers but teens were enthusiastic about the opportunities they learned about. Four of the six reported two-point increases, resulting in these interns being “extremely aware” of the breadth of options.

Teen’s did not report that their future plans were affected by their summer internship experience. College interns, however, were able to dial in their interests, with participants confidently declaring that because of this experience they either did or did not look forward to a future teaching youth or were more or less attracted to formal education settings.

LEADERSHIP, COMMUNICATION, AND TEACHING SKILLS

Teen interns increased their skill sets in teaching and communication both subjectively and objectively. They first described the skills they gained in terms of foundational teaching abilities such as maintaining kids' attention and group management. Later, when they described what they gained (though not necessarily skill based) they usually referred to communication skills such as speaking in front of groups or meeting new people. They did not address leadership, suggesting that may be a secondary set of skills that are either more subtle to recognize and/or talk about than teaching and communication. Or possibly the skill set is slower to develop and may require either a more solid foundation in the other skills or longer than ten weeks to practice before significant advancement can take place.

Teaching was the most discussed as well as observed skill set. Each of the 14 behaviors in the rubric saw improvement with almost no displays of "above expectations" behavior early in the summer and at least one, and often three displays of superior ability by the end. This is notable as teens are functioning as part of a team of at least three instructors. The ability to observe multiple college interns as well as SOW educators is likely to have influenced their improvement. In their exit interviews they cited many practices that seem well suited to occurring in their duties at the Science Center or at school (i.e. learning science content, how to ask good questions, how to keep an audience) but these things clearly "clicked" for them during STEM-OST.

Teens were almost always observed displaying appropriate communication behaviors even early in the summer. Only a few displayed certain abilities "sometimes" as a few struggled with maintaining confident body language and speaking articulately.

Corroborating the lack of self-assessed leadership development, SOW staff mostly observed teens displaying strong leadership and teamwork skills "sometimes" rather than "always" like they did for communication. For some interns, there was no opportunity to display abilities such as "responding calmly to unexpected situations," because no unexpected situations occurred, again suggesting that leadership requires more time to develop and grow.

College volunteers were not observed but when asked, they focused on the development of technical teaching skills, for example, pacing of information delivery and framing concepts appropriately. They were successful in practicing these skills but left desiring more experience with designing curriculum and building lesson plans.

Student Outcomes

As a result of their participation in the STEM-OST Summer Series, students going into grades K-8 were anticipated to grow in three categories –knowledge, interest, and attitude– as defined by the three specific outcomes listed below. Each will be discussed in turn, using evidence from the results of the pre and post Summer Series surveys.

	Intended Outcomes	Outcome Category
Students will…	• Increase their content knowledge of STEM content including physics, astronomy, math and engineering.	Awareness, knowledge or understanding
	• Increase their interest in learning more about STEM content.	Engagement or interest
	• Identify themselves as science learners.	Attitude

STEM CONTENT KNOWLEDGE

Students across all three grade bands showed improvements in most of the content questions they were asked. Those in grades K-2 excelled in particular at the two multiple response options, choosing more correct options and fewer incorrect options on the post-survey. Seven percent more students got the third content question correct after Lesson 5 but this was still less than half (49%) of paired responses.

Third through fifth graders had a difficult time with the engineering content questions. Two percent fewer answered the first question about gravity correctly; the suspicion is that they increasingly circled new vocabulary words that they may have learned, such as friction.

Correct responses to the second of three steps in the design process (test) increased from 3% (just one responded correctly) to 53%. Sixty percent of students got the third step (redesign) correct after the Series as opposed to none before. This question was clearly asking about a concept taught in a very specific way in Science On Wheels programming but students clearly learned it well; many of those who did not provide the exact correct words on the post-survey did write in responses that were in the correct vein such as “re-build” or “do it again.”

Finally, engineering Series students were asked to match two types of engineers with the projects they might work on. This question was difficult for students as their responses for the civil engineer item were just as spread out after the lessons as before with only 29% getting it correct on the post-survey. Additionally, their responses for the electrical engineer items were just as divided between the correct and an incorrect response from pre (46% and 39%) to post (46% and 50%) with fewer getting this item correct on the post-survey.

Middle school-aged students did well on all three content questions. Twenty percent more students got the first question about transistors correct on the post-survey (from 48% to 68%).

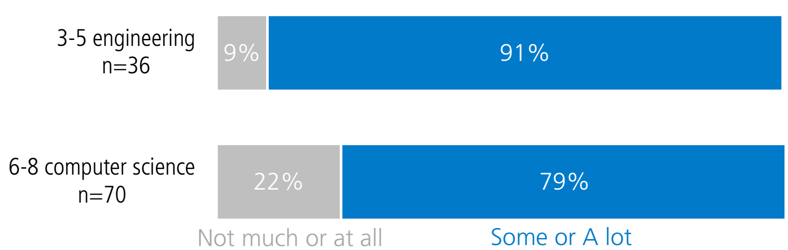
On the second question, definition-matching, correct pairings of vocabulary words with definitions all increased from 9% more correct matches (firewall and server) to 20% more correct matches (client). The third question required knowledge of algorithms and spatial awareness in order to move a robot around obstacles to an end point. Well over two-thirds were already competent at this before Lesson 1; for the two instructions that students needed to choose, the percent that answered correctly after Lesson 5 increased by 2% and 8%, respectively.

In findings review sessions (of other topics) with outreach staff, it has come to light that the content that is delivered sometimes varies by educator (who emphasize some concepts more than others) or outreach site (where sometimes there isn't time to cover each day's learning objectives). Or, after closely comparing lesson plans with evaluation questions, students may be selecting responses (from among multiple choices) that were discussed more or are more familiar terms than rather than those that are correct. These disclosures have inspired both outreach and evaluation staff to re-examine the development process for content questions. More effort will be made to vet responses against what is actually being delivered during lessons and even further, to be clear and intentional about what the learning goals are for each class in the first place and take effort to eliminate references to confusing or conflicting information.

INTEREST IN LEARNING MORE

Most 3-5 graders (91%) were interested in learning more about engineering "some" or "a lot." There was slightly less interest from 6-8 graders in learning more about computer science (79%) but this was still the majority (see **FIGURE 21**).

FIGURE 21. Most students are interested in learning more about the topic that was taught.



SCIENCE IDENTITY

The STEM-OST Summer Series appears to have grown, or at least maintained, science identity for the majority of the paired data sample – based on students' interest in doing or having a job that uses science or math.

The percentage of 3-8 grade students (K-2 did not have this question) whose rating of how much they usually like doing science **increased** after participating in a Series was healthy; 23% for 3-5 grade engineering students and 21% for the 6-8 computer science students. For doing math, the rates of increase were more moderate: 12% for engineering and 14% for computer science.

In the spirit of preventing loss of learning and interest, the percentage of students who experienced **no change** in enjoying science or math was also calculated. Over half (54%) of engineering students did not report a backslide in interest in doing science, nor did 59% of computer science students. For interest in doing math, there was no backslide for 70% of engineering students or for 61% of computer science students.

Likewise, the percentage of 3-8 grade students (K-2 did not have this question) whose rating of how much they are interested in job that uses science **increased** after participating in a Series was moderate; 9% percent for 3-5 grade engineering students and 20% for the 6-8 computer science students. For having a job that uses math, the rates of increase were 18% for engineering and 16% for computer science.

Likewise, the percentage of students who experienced **no change** in interest in having a job that uses science or math was also calculated. Over half (53%) of engineering students did not report a backslide in interest in having a job that uses science, nor did 63% of computer science students. For interest in having a job that uses math, there was no backslide for 64% of engineering students or for 74% of computer science students.

Parent Outcomes

As a result of their participation in supplemental STEM-OST programming (Family Science Workshops), parents and care-takers were anticipated to grow in three categories –knowledge, attitude, and behaviors– as defined by the three outcomes listed below. Each will be discussed in turn, using evidence from the results of the two evaluation methods employed during the Workshops: exit surveys and timed observation.

	Intended Outcomes	Outcome Category
Parents will…	• Increase their understanding of the importance of STEM literacy.	Awareness, knowledge, or understanding
	• Increase their comfort and confidence in discussing STEM with their children.	Attitude
	• Increase engagement in their child's learning.	Behavior

IMPORTANCE OF STEM LITERACY

Questions on the summative evaluation did not address whether and to what extent parents believed STEM literacy was important. Anecdotally, however, the Family Science Workshop that was observed was highly appreciated. An adult from each group asked when the next workshop was and they were all visibly disappointed to hear that it was the final one. They expressed thanks for an enjoyable afternoon and hoped to see the Science Center out in the community again in the future, lending a small amount of evidence that participants do indeed value the opportunity to practice science with their children. Unfortunately, we do not have findings that are able to support the outcome of increasing understanding of the importance of STEM.

COMFORT AND CONFIDENCE DISCUSSING STEM

Family Science Workshops were very successful at providing parents with a comfortable environment and therefore increasing their confidence discussing science with their children. Over three-quarters (76%) of respondents reported the highest level of comfort (extremely comfortable) during the Workshop. The remaining parents said they were "mostly comfortable." Staff were cited at the main reason why, by greeting and seating everyone as well as smiling and being helpful. They also appreciated that the activities were good and that there were supplies for everyone (adults included).

Most did not provide suggestions on how we could create an even more comfortable environment. A couple respondents wanted more kids to attend or to have more activities in the workshop. The most astute suggestion was for everyone to introduce themselves to that they could be comfortable between groups as well as within them.

All respondents gained at least a little bit of confidence as a result of the Workshop. As many said they were “a lot more confident” as those who said they were “a little” or “moderately more” confident, combined.

ENGAGEMENT IN CHILD’S LEARNING

Nearly two-thirds (64%) of parents reported that this was their first time attending an event where they did science *with* their child, suggesting that STEM-OST was successful in reaching under-engaged audiences.

Survey respondents indicated a high degree of engagement with their children’s science learning, both subjectively through their survey response as well as objectively during the timed observations. Most respondents shared the ways they supported the children in their group during the Workshop. About half explained that they helped and did the activity with their child. One-quarter said they asked their kids questions and another quarter provided encouragement. These were the main behaviors that staff were hoping to see.

Slightly fewer parents internalized the behaviors, at least as they were considering their exit survey responses, but about two in ten reported that they would ask questions and research/work together. One in five intended to continue to encourage their children in the future and half said they would help them look for more information.

Working together was the second most common behavior observed during the final Workshop. Overall, about half of the time (53%) was dedicated to hands-on activities and fully 50% of the time adults were observed collaborating with their children. This left just over three minutes of the nearly two hour Workshop where adults, parents and staff alike, stepped back and let the children run the show.

CONCLUSION

This summative evaluation of the STEM Out-of-School-time project set out to answer two evaluation questions:

1) To what extent has participation in STEM-OST impacted the growth and development of interns, both Discovery Corps teens and STEMed college volunteers?
2) To what extent are the intended outcomes of STEM-OST achieved with outreach audiences—schoolchildren and their families?

The short answers are: greatly and mostly. STEM-OST achieved nearly every goal outlined in the proposal, sustaining a level of engagement in most schoolchildren and generating extremely positive responses from parents. The learning opportunities were dynamic for teens and college volunteers alike.

Interns experienced great growth especially in their comfort and confidence as well as in the areas of communication and teaching. It may be unreasonable to expect that leadership skills can exceed expectations in the short span of 10 weeks but gains were made in most behaviors of that category as well. Discovery Corps teens increased their content scores in all the subject areas that they taught frequently, highlighting the importance of extended or repeated exposure to topics as well as the benefits of explaining said information to others. STEM education college volunteers honed their teaching skills, gaining valuable exposure to teaching contexts and situations; by participating in this internship they were able to better dial in to what sort of science education path they were interested in pursuing in the future (grade of student, formal versus informal, etc.).

For outreach audiences, the outcomes were mostly achieved, based on evidence from paired samples for each grade band of student and exit surveys from adults who participated in Workshop exit surveys. Students increased content knowledge in most areas though 3-5 graders struggled with differentiating engineering careers. Three-quarters to 91% of students reported interest in learning more about the Series topics. Science identity came across as the majority of students (two-thirds to three-quarters) reported no change or increased interest in doing math and science as well as having jobs that use math or science.

Parents who participated in a Family Science Workshop reported extremely high comfort levels and all indicated some degree of increase in confidence in doing science with their children as a result of the program. As many were doing activities about science with their children for the first time, by being present they were increasing engagement. Further, they were observed collaborating with their kids for nearly the entirety of the Workshop and afterwards identified ways they felt they supported youth, such as asking questions and working together. Most reported that they could continue to be engaged in their child's learning by providing support even if they didn't know specific subject matter.

STEM-OST brought science and family learning to dozens of underserved communities in the Puget Sound region. Youth and their parents and caregivers have been positively impacted by the efforts and enthusiasm of the Science Center's staff, teens and college volunteers.

APPENDIX A: INSTRUMENTS USED WITH INTERNS

IMLS STEM-OST Discovery Corps Intern PRE survey

Name: ______________________________ **June 27, 2016**

Before you begin your summer with the Science On Wheels program, we want to learn more about you and your interest and expectations for the program. Your responses are confidential and will not be shared with anyone outside the program.

→ At the end of the summer, you will sit down with a Science Center Evaluator to reflect on the responses you write here so please be honest and thorough even if some of them are difficult to answer. Susie will follow up with anyone that misses a question or needs extra prompting or explanation of the question.

---

1. Why are you interested in participating in this program?

2. a) In the interview for this program you were asked what skills you already had that would help you in the internship. Now, share some of the skills you hope to gain or improve on from this experience.

   b) *Why do you want to gain or improve those skills*?

3. As of today, how **comfortable** do you feel delivering STEM activities to younger children?

   ☐ 1: Not at all comfortable ☐ 2 ☐ 3 ☐ 4 ☐ 5: Extremely comfortable

   Why did you choose that response?

4. As of today, how **confident** do you feel in your personal knowledge of the STEM content that you might deliver this summer?

   ☐ 1: Not at all confident ☐ 2 ☐ 3 ☐ 4 ☐ 5: Extremely confident

   Why did you choose that response?

TURN OVER →

IMLS STEM-OST Discovery Corps Intern PRE survey

IMLS STEM-OST Discovery Corps Intern PRE survey

5. As of today, how **aware** do you feel you are of the variety of STEM careers that are available to you and the schoolchildren you will be teaching?

☐	☐	☐	☐	☐
1: Not at all aware	2	3	4	5: Extremely aware

Why did you choose that response?

6. What do you think teens bring to the Summer Series that adults don't?

Feel free to leave a drawing or note for yourself down here.
Think of it as a 10 week time capsule.

IMLS STEM-OST Discovery Corps Intern PRE survey

IMLS STEM-OST Discovery Corps Intern POST interview

Name: ______________________________ **Date:** ______________

Hi, I'm [xxx], an exhibit and program evaluator here at the Science Center. I'm going to spend the next 20 or so minutes with you asking you some questions about your summer internship. What will make this process different from a standard evaluation interview is that we'll also be looking at what you wrote on your PRE survey 9 or10 weeks ago and on your interview for the position before that to see how your opinions may have changed.

ORIENTATION

1. You said you were interested in participating because _____. Do you feel that happened?

2. Let's look at the skills you wanted to gain or improve on. How do you think you did?

3. As of today, how **comfortable** do you feel delivering STEM activities to younger children?

☐	☐	☐	☐	☐
1: Not at all comfortable	2	3	4	5: Extremely comfortable

   Why did you choose that response and what do you think of your Orientation response?

4. As of today, how **confident** do you feel in your personal knowledge of the Summer Series STEM content?

☐	☐	☐	☐	☐
1: Not at all confident	2	3	4	5: Extremely confident

   Why did you choose that response and what do you think of your Orientation response?

5. As of today, how **aware** do you feel you are of the variety of STEM careers that are available to you and the schoolchildren you taught?

☐	☐	☐	☐	☐
1: Not at all aware	2	3	4	5: Extremely aware

   Why did you choose that response and what do you think of your Orientation response?

IMLS STEM-OST Discovery Corps Intern POST interview

6. What do you think the teen interns brought to the Summer Series that adults didn't?

INTERVIEW

7. In your interview you thought you would be most challenged by _____. Were you? Why or why not? Were you challenged by anything you didn't expect?

8. a) You were also asked what you hoped to gain from the experience and you wrote _____. Did that happen?

   b) What did you gain that you couldn't have learned in school or working floor positions?

9. Has your experience this summer impacted your thinking about your future plans? For example, did you learn about different careers or areas of study you might be interested in pursuing or learning more about?

10. Finally, in the interview back in June, you shared one of your most memorable moments presenting a cart or working on the science center floor. Now, share one of your most memorable moments from the STEM-OST internship.

IMLS STEM-OST College Intern PRE survey

Name: ____ June 27, 2016

Before you begin your summer with the Science On Wheels program, we want to learn more about you and your interest and expectations for the program. Your responses are **confidential** and will not be shared with anyone outside the program.

→ At the end of the summer, you will sit down with a Science Center Evaluator to reflect on the responses you write here so **please be honest and thorough** even if some of them are difficult to answer. Use the back of this sheet if you need more room.

---

1. Why are you interested in participating in this program?

2. a) In the interview for this program you were asked what skills you already had that would help you in the internship. Now, share some of the skills you hope to gain or improve on from this experience.

   b) *Why do you want to gain or improve those skills*?

3. a) As of today, what are your career goals?

   b) *How do you see this internship fitting in with those goals?*

4. As of today, how **comfortable** do you feel delivering STEM activities to younger children?

   ☐ 1: Not at all comfortable ☐ 2 ☐ 3 ☐ 4 ☐ 5: Extremely comfortable

   Why did you choose that response?

5. As of today, how **confident** do you feel in your personal knowledge of the STEM content that you might deliver this summer?

   ☐ 1: Not at all confident ☐ 2 ☐ 3 ☐ 4 ☐ 5: Extremely confident

   Why did you choose that response?

IMLS STEM-OST College Intern PRE survey

IMLS STEM-OST College Intern POST interview

Name: _______________________________________ Date: ________________

Hi, I'm [xxx], a program evaluator here at the Science Center. I'm going to spend the next 20 or so minutes with you asking you some questions about your summer internship. What will make this process different from a standard interview is that we'll also be looking at what you wrote on your PRE survey 9 or 10 weeks ago and on your interview for the position before that to see how your opinions may have changed.

1. You said you were interested in participating because _____. Do you feel that happened?

2. Let's look at the skills you wanted to gain or improve on. How do you think you did?

3. As of today, how **comfortable** do you feel delivering STEM activities to younger children?

☐	☐	☐	☐	☐
1: Not at all comfortable	2	3	4	5: Extremely comfortable

   Why did you choose that response and what do you think of your Orientation response?

4. As of today, how **confident** do you feel in your personal knowledge of the Summer Series STEM content?

☐	☐	☐	☐	☐
1: Not at all confident	2	3	4	5: Extremely confident

   Why did you choose that response and what do you think of your Orientation response?

5. What do you think the **unique contribution** of college interns was to the Summer Series?

   a. What did you *personally* bring to the program?

IMLS STEM-OST College Intern POST interview

6. Describe your **experience working with each of the other levels** of STEM-OST. What did you like most and least? What were the main benefits and biggest challenges of interacting with each level? Did you experience anything that you didn't expect?

    a. School children

    b. Teen interns

    c. SOW Educators

7. How has your experience this summer impacted your thinking about your **career plans**?

8. Share one of your most **memorable moments** from the STEM-OST internship.

Summer Science Intern Evaluation Tool

☐ Follow up: Init._____ Date_______
☐ Data Entry: Init._____ Date_______

Date: ____________________

Intern Name: ________________________________ Series: ________________________________ Lesson #______ of_______

Observed by: ________________________________ Site: ________________________________

COMMUNICATION	Never	Some times	Always	Comments:
Smiles and looks friendly and approachable	☐	☐	☐	
Shows alert and confident body language and eye contact	☐	☐	☐	
Speaks with appropriate volume and tone of voice (depending on audience size and age)	☐	☐	☐	
Speaks articulately (good speed, pauses are comfortable, not too many fillers)	☐	☐	☐	
Models enthusiasm for the subject and a positive attitude about learning	☐	☐	☐	
Respects students and shows caring (with appropriate boundaries)	☐	☐	☐	

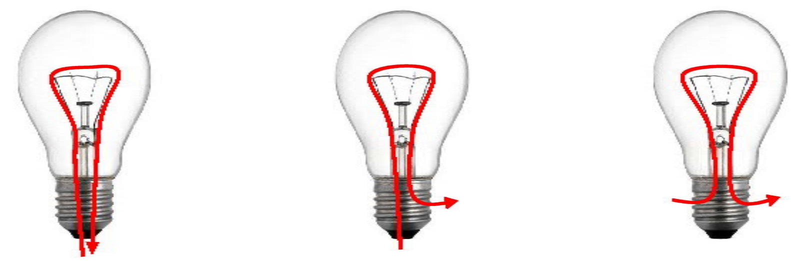
TEAMWORK & LEADERSHIP	No Opport unity	Never	Some times	Always	Comments:
Understands lesson plan: Knows what to expect, follows order of activities, manages time well	☐	☐	☐	☐	
Initiates conversations with students and offers to help them	☐	☐	☐	☐	
Takes initiative: Uses 'down time' or unscripted time productively	☐	☐	☐	☐	
Shares tasks fairly with colleagues by offering to help, delegating tasks, etc.	☐	☐	☐	☐	
Checks in with colleagues in a professional way when confused or needing help	☐	☐	☐	☐	
Responds to unexpected situations calmly and helps to resolve the situation responsibly	☐	☐	☐	☐	
Handles materials and supplies carefully and keeps them organized	☐	☐	☐	☐	

TEACHING	No Opport unity	Needs Improve ment	Satis factory	Above Expecta tions	Comments:
Gives clear instructions at an appropriate pace	☐	☐	☐	☐	
Models activities for students	☐	☐	☐	☐	
Checks to see if students understood	☐	☐	☐	☐	
Uses kid-friendly language (PG word choice, analogies that relate to kids' lives, appropriate vocabulary level, etc.)	☐	☐	☐	☐	
Asks open-ended questions	☐	☐	☐	☐	
Asks a series of related questions to guide students to discovering on their own	☐	☐	☐	☐	
Answers student questions clearly, honestly, and with a variety of explanation styles	☐	☐	☐	☐	
Positively encourages students who are struggling or need help	☐	☐	☐	☐	
Compliments and encourages students who show good behaviors or who accomplish a task well	☐	☐	☐	☐	
Responds appropriately and proactively when a student is off-task or misbehaving	☐	☐	☐	☐	
Strives to include and give equal attention to all students regardless of their backgrounds, personalities, or previous knowledge	☐	☐	☐	☐	
Interacts confidently with individual students or students in pairs	☐	☐	☐	☐	
Interacts confidently with small groups of students	☐	☐	☐	☐	
Interacts confidently with large groups of students or with the class as a whole	☐	☐	☐	☐	

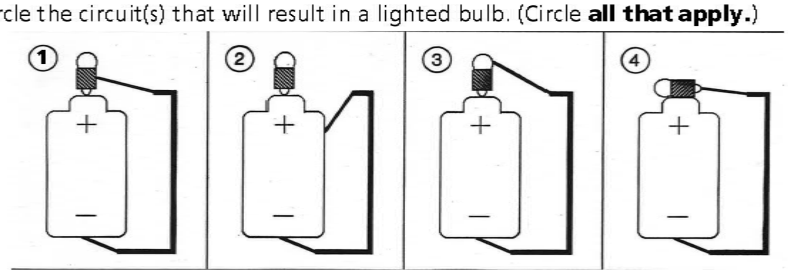
STEM-OST DC Intern Content Evaluation – Summer 2016

Section 1: Physics (9.5 pts)

1. Circle the picture that depicts the flow of electricity through a light bulb.



2. Circle the circuit(s) that will result in a lighted bulb. (Circle **all that apply.**)



Are the working circuits closed or open circuits?

3. Describe how a hand generator makes electricity.

4. Key parts of a generator include: (Circle **all that apply.**)

a. copper coils
b. motor
c. batteries
d. aluminum wire
e. magnets

5. How does *frequency,* or speed of a vibration, affect the characteristics of sound? (Circle **all that apply.**)

a. Higher frequency results in a louder sound.
b. Higher frequency results in a higher pitch.
c. Higher frequency results in a faster moving sound.
d. Higher frequency results in a higher decibel level.

6. Name 2 musical instruments that use a sounding board.

a)

b)

How does a sounding board affect sound?

7. What type of wave is a sound wave?

8. What is *buoyancy*? (Circle **one.**)

a. the force of a boat pushing down on the water.
b. the force of the wind pushing on a boat's sails.
c. the force of propellers pushing a boat forward.
d. the force that pushes a boat up and keeps it from sinking.

9. What type of simple machine is a catapult?

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Section 2: Engineering (13.0 pts)

1. Which geometric shape is best for supporting weight (for example, in the frame of a bridge)?

   Why?

2. Name 4 types of engineers and what they work on.
   a)
   b)
   c)
   d)

3. Describe how science and engineering are related.

4. You are an engineer, tasked with building a bridge. What are 4 characteristics that you would want to know or questions you would want to ask before building your bridge?
   a)
   b)
   c)
   d)

5. Define **2** of the following properties and how you would test if Silly Putty had them.
   a) Stretchability:
      Test for Silly Putty:
   b) Elasticity:
      Test for Silly Putty:
   c) Strength:
      Test for Silly Putty:

6. Draw wires connecting the battery and two light bulbs to make a closed ***series*** circuit:

7. Draw wires connecting the battery and two light bulbs to make a closed ***parallel*** circuit:

8. What is the name of the force that would pull a marble down a slope?

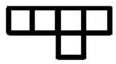
9. What are 2 resources humans use to produce electricity? Describe the process to make that electricity.

a)

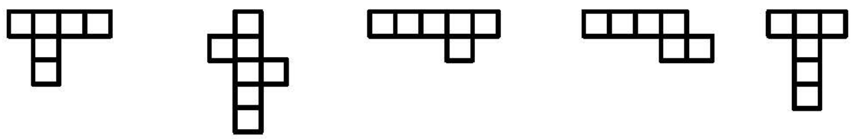
b)

Section 3: Math (9.0 pts)

1. The figure below is a pentomino. Draw 3 more examples of *pentominoes*.



2. A net is a 2D plan for a 3D solid shape. Which of the following is a net of a cube? (circle **all that apply**)



3. On the platonic solid below, label a *face*, a *vertex* (plural: *vertices*) and an *edge*.

4. A grocery store has 80 boxes of cereal. 20 of them contain a prize. You purchase 1 box of cereal. What is the *probability* that it contains a prize? Write this probability 2 different ways.

5. What are 3 examples of codes used every day?

a)

b)

c)

6. Describe how you would use *frequency analysis*—the frequency that letters or words occur in the English language—to help you crack a cipher.

7. The chart below contains data from a class experiment. Find the *mean, median,* and *mode* time that it took the marble to reach the end of the ramp.

Trial	Time to reach end of ramp
1	7 sec.
2	5 sec.
3	4 sec.
4	6 sec.
5	4 sec.
6	4 sec.

Mean: ____________ Median: ____________ Mode: ____________

Section 4: Animals (7.5 pts)

1. Describe one way a fossil might be made.

2. What is comparative anatomy?

3. Give an example of how form and function are related in living organisms.

4. Which of the following shows the correct order of energy flow within a food chain?
   a. mice→plants→owls
   b. plants→mice→owls
   c. owls→plants→mice
   d. mice→owls→plants

5. What role do earthworms play in an ecosystem?

6. Name two beneficial things that insects do for humans.
   a)

   b)

Section 5: Astronomy (9.5 pts)

1. Stars are made mostly of:
    a. Helium
    b. Argon
    c. Nitrogen
    d. Hydrogen

2. What are 3 things an astronomer can learn about a star by using a spectroscope?

    a)

    b)

    c)

3. What is the name of the force that pushes a rocket upwards?

4. What is the name of the constellation that contains the North Star?

5. What are 2 constraints NASA scientists may consider as they plan a rover mission to Mars?

6. What are 2 requirements for becoming a NASA astronaut?

    a)

    b)

APPENDIX B: INSTRUMENTS USED WITH STUDENTS

Grade K-2 physics survey. Only the post (lesson 5) instrument is included but the pre-survey was identical.

PACIFIC SCIENCE CENTER **STEM-OST K-2 Feedback** (Physics, Lesson 5)

What is your name? ______________________ **How old are you?** ________

Do you like **science**? (circle one)

Yes

Not sure

No

Circle the three (3) things that have a **lens** in them.

glasses

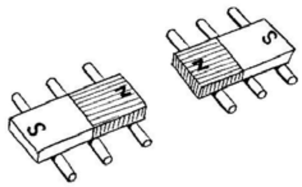
window

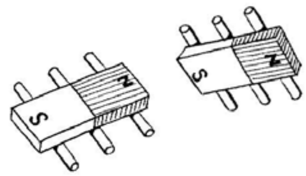
stoplight

clock

lighthouse

Circle the pair of magnets that will **attract** each other.





What happens to cabbage juice when an **acid** or **base** is added? (**circle** one)

Changes color

Gets very cold

Explodes

Grade 3-5 engineering survey. Only the post (lesson 5) instrument is included. The pre-survey did not include questions 3, 4, or 8.

STEM-OST: Youth Feedback 3-5 (Engineer It!, Lesson 5)

Your name: ______________________ **Your grade in fall:** __________

1. **How much do you usually like doing:**
(circle one answer on each line)

MATH:	A lot	Some	Not much	Not at all
SCIENCE:	A lot	Some	Not much	Not at all

2. **In the future, how interested are you in having a job that uses:**
(circle one answer on each line)

MATH:	Very	Some	Not very	Not at all
SCIENCE:	Very	Some	Not very	Not at all

3. **How much did you like doing the Pacific Science Center activities?**

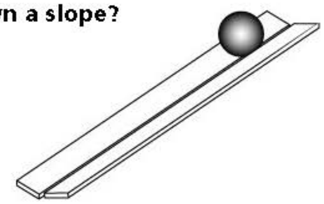
A lot Some Not much Not at all

4. **How interested are you in learning more about the topics that the Science Center taught?**

A lot Some Not much Not at all

TURN OVER ➔

5. **What is the name of the force that pulls a marble down a slope?** *(circle one)*



   a. gravity
   b. thrust
   c. drag
   d. friction

6. **List the second and third steps of the engineering process.**

   1) **design**
   2) ____________________________
   3) ____________________________

7. **Match the engineer to the project they might work on.** *(write one letter from the word bank on the right next to each career on the left)*

	A. creating solar panels
_____ Civil engineer	B. designing bridge
_____ Electrical engineer	C. making a stickier Velcro
	D. building an airplane

8. **List one more career that involves engineering.**

____

Grade 6-8 computer science survey. Only the post (lesson 5) instrument is included. The pre-survey did not include questions 3 or 4. This lesson was only offered to grades 6-8.

PACIFIC SCIENCE CENTER **STEM-OST: Youth Feedback 6-8** (Digital World, Lesson 5)

Your name: ______________________ **Your grade in fall:** ________

1. **How much do you usually like doing...**
   (circle one answer on each line)

MATH?	A lot	Some	Not much	Not at all
SCIENCE?	A lot	Some	Not much	Not at all

2. **In the future, how interested are you in having a job that uses:**
   (circle one answer on each line)

MATH?	Very interested	Somewhat interested	Not very interested	Not at all
SCIENCE?	Very interested	Somewhat interested	Not very interested	Not at all

3. **How much did you like doing the Pacific Science Center activities?**

   A lot   Some   Not much   Not at all

4. **How interested are you in learning more about the topics that the Science Center taught?**

   A lot   Some   Not much   Not at all

5. **Computers and other digital devices function, communicate and calculate using a large amount of microscopic electronic 'switches' known as...** (*circle one)*
   a. TCP / IP
   b. Transistors
   c. Packets
   d. CPUs

TURN OVER →

6. How does a network work? Match the **network component** on the left with its function in the definition bank on the right.
(Write each letter in the bank next to the component that it describes.)

_____ 1. Firewall

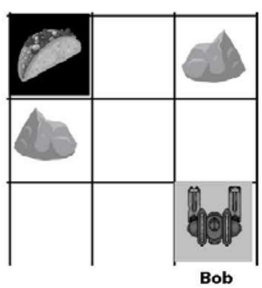
_____ 2. Router

_____ 3. Server

_____ 4. Client

a) A computer or device that requests information from a network
b) Destroys any packet that is infected with a virus, or that is otherwise corrupted
c) Connects devices to a network and "directs traffic" of data
d) A computer or device that hosts data and other information on a network.

7. Bob the robot needs help navigating around the rocks to get to his taco! Complete the set of programming steps below to help him achieve his goal.
Write the missing steps in the program, choosing from the options in the bank on the right.
Note: Bob is currently facing up.



PROGRAM

1	*Repeat **2** times*
2	Move Forward
3	______________
4	______________
5	Turn Right
6	*End repeat*

Step Options

Move Forward
Move Backward
Turn Right
Turn Left
Turn 180 degrees

8. List two (2) careers that would require a person to use computer programming.

______________________________ ______________________________

APPENDIX C: INSTRUMENTS USED WITH PARENTS

STEM-OST Family Science Workshop – Adult Feedback

Please tell us a bit about your experience today. Your feedback will help us make the next Family Workshop better!

1. How many young people, in each of the age ranges below, were in your group today?

0-2 years old	3-5	6-8	9-11	12 years or older
________	________	________	________	________

2. Have you ever attended an event like this where you worked with your kiddo to do science?

3. In what ways did you support the kid(s) in your group during the workshop today?

4. How comfortable did you feel exploring science with the children in your group today?

   Not at all comfortable | A little comfortable | Mostly comfortable | Extremely comfortable

   a) What things did we do today that made you feel welcome and that we should definitely do next time?

   b) What can we do next time to make your whole group feel more comfortable?

5. Overall, what did you think of the event today?

6. After attending this workshop, how much more confident do you think you might feel doing science with your children at home?

   No more confident | A little more confident | Moderately more confident | A lot more confident

7. What is one thing you can do to help your child with science homework (or any subject) even if you don't know the content?

THANK YOU!

Family Science Workshop Observation

Date ________ Program ______________________ Instructor_______________

TIME	CODE	NOTES/Description

 # Staff ___________

 # Youth __________

 # Adults __________

CODES

EXP – Explain

DIS – Discussion

ACT – Hands On/Active

COLL – Collaborate

TRAN – Transition

DEMO – Demonstrate

EE