Assessing The Effectiveness of an Engineering Summer Day Camp

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ASSESSING THE EFFECTIVENESS OF AN ENGINEERING SUMMER DAY CAMP

Abstract

This paper describes a five session summer camp, for rising seventh-grade students, which employed an engineering design process in basic circuitry and laser cutting projects. This document discusses results from an assessment of the camp's effectiveness in increasing general engineering knowledge and fostering an affinity towards the engineering fields. The 2015 camp targeted females for the first three sessions, and both males and females for the last two sessions. This camp was a collaboration between the University of St Thomas and St. Paul Public Library system. This camp model emphasized hands-on learning experiences and featured lessons on circuitry, computer design, and machining. Data was gathered through formative assessments, where nearly 80% of camp participants filled out pre- and post-surveys inquiring about their individual attitudes, knowledge, and experiences with engineering. For example, 88.5% of students noted either no change or an increase in confidence in their engineering skills from the pre- to post- surveys. The following paper will present the lessons taught at the camp, a detailed demographic of the camp and the results from the participant surveys.

Summary and History

For the last 16 years, the University of St. Thomas School of Engineering has offered STEPS camps which stand for Science, Technology, and Engineering Preview Summer camp [1 2 3]. This summer camp is aimed at introducing middle school students from various backgrounds to basic aspects of engineering with hands-on, engaging materials and methods. At the 2015 STEPS camp, participants were a mix of rising 7th-grade male and female students who expressed an interest in learning science and/or engineering concepts on their application form. At each of the five 13-hour camp sessions offered, 20 students worked in two small groups learning about circuits and vector drawings, this was followed by a trip to the University of St. Thomas engineering labs. The camp educators and student researchers drew from Dewey, Piaget, Vigotsky and similar educational philosophers rooted in constructivist epistemology when constructing the STEPS program. Constructivist learning theory dictates that learners construct their own knowledge and meaning from their experiences through accommodation and assimilation. The goals of this camp, with an eye to constructivist learning theory, are:

1. Build enthusiasm for STEM (science, technology, engineering, and math) at a critical stage in an educational experience;
2. Target campers from underrepresented groups and lower socioeconomic populations;
3. Motivate campers to take STEM courses in their middle school and secondary education;
4. Energize campers to pursue STEM degrees and STEM related careers;
5. Encourage campers to learn about engineering and the engineering design process;
6. Increase understanding of what engineers do at work; and
7. Allow for campers to visualize themselves succeeding in a college setting.

The researchers measured the success of meeting these goals through anonymous pre- and post-surveys from 70 of the 99 camp participants on the days they attended the camp. These surveys included ranking, short answer, and multiple choice questions. Goals 1, 2, 4, 6, and 7 were addressed using these anonymous surveys, but after reviewing the 2015 camp, it has been determined that goal number 3 was not explicitly addressed.

The 2015 STEPS camp featured a variety of changes from the last 15 years of the camp. Two of the largest changes involve the camp duration and expansion of participant demographics. For the first time, STEPS camp was no longer offered as a residential, 4-day camp. Additionally, the 2015 STEPS camp welcomed male students for the first time. Of the five daily camp sessions, three were offered to female students, while the last two camps were open to students of all genders. The decision to no longer host students overnight was made in an effort to broaden the population participating in the STEPS program. Cultural barriers to the residential program were increasingly discerned and partnering with a cultural broker was undertaken. The new format allowed for a critical mass of non-dominant groups of students. Additionally, by offering the camp for a single day instead of multiple days, we hoped to be able to reach more students, as the demand for the program outpaces capacity. The decision to allow male participants, with the purpose of appealing to young men of color, was based on the Minnesota achievement gap disparities, one of the greatest gaps in the United States [4,5].

This new camp model proved successful in making advances in six of the seven goals. While some gains were not substantial, other goals, such as "build enthusiasm for STEM (science, technology, engineering, and math) at a critical stage in an educational experience" were met with outstanding results. The method for achieving (or not achieving) these goals as well as lesson learned will be discussed later in the paper.

Camp Locations and Staff

The 2015 STEPS Camp took place at Arlington Hills Community Center, a branch of the St. Paul Public Library system, and on the St. Paul campus of the University of St. Thomas. The partnership, specifically with the Arlington Hills Community Center, allowed for an increase in resources available to STEPS participants, including the Createch Studio (a Maker space). The time spent at the University of St. Thomas allowed for an exploration of a college environment for the young campers, as well as an experience with technologies not available at the Createch Studio, such as CNC machining. The time spent at different locations offered a variety of perspectives of engineering, making, and resources for the campers. Additionally, the diversity of the camp instructors provided an array of perspectives regarding learning, making, and engineering. The three camp instructors were female, one identified as African American and two identified as white. Instructors were STEM education and engineering undergraduate students at the University of St. Thomas. While on campus, two male engineering students of color led STEPS student tours. Having an array of diversity within camp staff was intentional, as we hoped to model for young students that a wide variety of people are successful engineers.

A follow-up survey completed by campers, who chose to participate in the research at the end of the camp, revealed 100% of students answered favorably the question "did you like having college students at the camp," while a variety or respondents mentioned either the undergraduate students directly (both student researchers and tour guides), the University itself, or an activity done at the University of St. Thomas in response to the question "What parts and aspects of the camp were helpful to you." Using this data, we have determined that it is beneficial for these young students to visit the University and interact with university students as a part of the program design.

Camper Demographics and Recruitment

Recruitment efforts were focused on expanding representation from underserved and underrepresented populations in the STEM fields, with an intentional focus on populations underrepresented in engineering disciplines. These populations include women, who received 19.5% of engineering bachelor's degrees in 2014, Black/African American students who received 3.5% of engineering bachelor's degrees in 2014, and Hispanic students who received 10.1% of engineering bachelor's degrees in 2014 [6]. To recruit students, library staff members visited three schools in the Arlington Hills Community Center neighborhood, all of which have populations consisting of less than 15% of white students and over 80% of the student population eligible for Free and Reduced Lunch [7]. The number of available spaces was 100; 257 local rising middle school students applied for the STEPS Camp. Students were given the option to apply online or turn in a hard copy of the application form, which was available at the Arlington Hills Community Center. The percentage of hard copy applications received was much lower than expected. Of the 257 applications turned into the St. Paul Public Library System and the University of St. Thomas, only two were hardcopies; less than 1% of application forms were received in hardcopy form. Because there was such a low percentage of hard copy applications received, we cannot conclude that a specific demographic is more or less likely to use a hard copy application. Therefore, the most effective way to receive camp applications is via an online process. Campers selected were mailed a hard copy of their acceptance, while campers not accepted were also notified via mail.

Camp participants were chosen in a semi-random fashion. To accommodate the goal of reaching underrepresented students, students were selected based on their neighborhood first, and then by a computer generated random number system. The process of randomly selecting participants and mailing out forms was accompanied by some unanticipated side-effects. The first unanticipated side effect was that multiple campers were not made aware of their acceptance (or rejection) to the program because the address on file of the electronic application system was inaccurate. Therefore, for the 2016 camp we suggest asking for an additional address, or for the address to be entered twice on an online form. Additionally, while camp acceptances were granted first to students from the target neighborhood, the participants at all camps were not an accurate representation of the diversity of these surrounding neighborhoods. This leads us to believe that although we recruited in low income neighborhoods, the majority of applications came from other students out of the area. Furthermore, for the two co-ed camps, there was an over-representation of male students due to random computerized participant selection based on the participants' neighborhood, and neglect of gender. Female applicants had already been removed in the first round of earlier camps. We suggest accounting for this effect and reviewing the 2016 acceptance list before mailing/emailing out acceptance forms. When participants were unable to attend, due to extenuating circumstances, every effort was made to fill openings with participants who indicated that they would like to remain on a waiting list.

Why are rising seventh grade leaders motivated to attend STEPS? Of the 256 applicants, salient themes arose when students and parents responded to the open ended question "Why do you want to attend STEPs camp?" The most often cited theme, with 70% applicants' identifying, is "the desire to supplement the applicant's interest in STEM with fun, hands-on engineering experiences." Other salient themes identified by applicants, in order of respondents interest, 27% identifying an interest in "STEM career exploration", 11% identifying "UST program construction and word of mouth endorsement of previous STEPS camps excellence", 5% signaling that participants were interested in the "social interaction with peers who have similar interests", and 3% indicated that they were seeking a "girl only" experience. Applicants shared the following:

I am really interested in chemistry. My parents have always talked to me about science and technology and engineering. I know my family can't afford camps like these in the summer so my mom tries to make summers fun with some learning for me and my brothers and sister. I just want to learn more and find out what I like and what I can do. Thank you.

I am very interested in engineering but we do not have much exposure to it in school.

I want to attend STEPS camp because I would like experience in a technical field and I like to work with my hands. I would like to see myself in a technical career someday.

I have heard from many prior camp members what a great experience this is. I love science and especially like doing labs and activities. I think it would be a lot of fun to spend time with other kids who love science. Someday hope to be a scientist of some sort.

My daughter will learn about technology and engineering in a safe learning environment. She would like to become more comfortable with experimenting and trying new things without fear of failure or getting things wrong.

In order to better understand the participants' experience, participants were invited to complete a pre- and post-survey of their STEPs experience.

Receiving Consent

When campers were accepted, research students mailed families a parent consent form as well as a child assent form with letters explaining the nature of the research and expectations, should the student choose to participate. Additionally, a return envelope was included with the goal that parents would mail back completed forms before attending camp. Out of all 99 camp participants, 74 students and parents provided assent and consent, and data was collected from 70 students. Although return envelopes were mailed out to students with the consent and assent forms, a large portion of research consent was obtained the day of each camp at check-in. Many people were willing to participate in the research, but they had forgotten the forms when they arrived for check-in. At the first camp session, extra consent and assent forms were not present at check-in, and therefore, there is a lack of participants from that day. However, the researchers provided copies of both consent and assent forms as well as the letter explaining the nature of the research at check-in at subsequent camp sessions, which resulted in much higher research participation rate. Having forms present at check-in increased research participation from 16% to

100% from the first to second week of camp.

Research Instruments

The research data for this project was gathered using anonymous surveys and voluntary consent. Campers who agreed to participate in the research were each given a folder at the beginning of camp. Each folder had a number on it from 1-23, depending on how many campers were present that day, and how many chose to participate in the research. In the folders were two surveys- a pre and a post. (See attached). Each survey had a number corresponding to the folder number written on them. The folder mechanism provided participants with anonymity. When students checked in, their consent and assent forms were stapled together and given a number 1 through 23, which matched up with a folder. Student number 4 from the first camp session, for example, would have 4.1 written on their assent form, consent form, pre, and post surveys and everything was kept in the folder for the day. Following the end of the camp, their consent/assent forms and data were removed from their folders. Consent and assent forms are kept locked in an office on the University of St. Thomas property away from the surveys themselves, to allow for continued anonymity. Upon completion of all five camp sessions, student researchers entered the data into an excel spreadsheet, using the numbering system as identifiers. While the researchers were able to use all data collected, it is suggested that in the future, the surveys be taken online rather than with pencil and paper. This is because it is believed that students can still answer the questions in the same manner, but it will allow for the researchers to spend less time entering data, and more time analyzing it.

Camp Schedule and Methods

Campers began their day at check-in around 8:00 am at the Arlington Hills Community Center. From 8:00-8:30, students were encouraged to chat with one another, decorate their name tags with markers, and eat the breakfast provided by the program as their fellow campers arrived. Following the completion of check-in, students and instructors participated in a variety of ice breakers. The instructors had a binder of ice breaker ideas with them at all times, and chose an ice breaker each day depending on the group of students present. The majority of icebreakers in the morning focused on getting to know one another in a safe setting. The choice of ice breakers was made based on the participants age and social development. Following an ice-breaker and name game, a student researcher discussed the research protocol and expectations with the participants using a brief, 5-minute presentation followed by guided questions which were answered verbally by students with their neighbor. This was done in order to gauge student understanding of the research. Students that had chosen to participate in the research and had provided both necessary consent/assent forms were given their folder at this time, while students who were not participating were given a logic puzzle to complete. This system worked well, and no notable issues were encountered.

Following completion of the introduction and the pre-surveys, campers were then divided into two equal groups. Groups were randomly chosen by one of the student researchers. Groups were divided using a “1, 2” numbering system but on the weeks when males were present at the camp, the groups were modified after the initial division to allow for female students to have the opportunity to work with other female students. This step of dividing the groups was necessary because of the greater number of male students at the co-ed camps. At 9:00, students in group one joined one undergraduate research student to work on vector software and laser cutting, while group two joined another research student to learn about circuits using Squishy Circuits and creating Art Bots. Campers remained in these groups for 2.5 hours, until 11:30. Students then went outside of the community center to eat a catered lunch and participate in free time and team building activities until 12:30. This break was a necessary element for maintaining a strong positive teacher attitude as well as allowing for students to unwind and then refocus attention.

Following lunch, the two groups of students switched projects and worked on the second design for 2.5 hours. Upon completion of the projects, students were escorted to a bus in front of the community center for a trip to the University of St. Thomas, a ten-minute bus ride away from the community center. Students started their afternoon at the University of St. Thomas with a social experience involving snacks and bowling in the campus student center. Next, students divided into their two groups and spent one hour each on a tour of the engineering building and labs and working on a CNC project with University staff. During this time, University of St. Thomas undergraduate students as well as faculty joined the campers to answer questions, lead the tour, and spend time with the students. 100% of students that filled out the surveys noted that they "like[d] having college students at the camp." The camp concluded with dinner on campus, surveys during dinner and a bus ride back to the community center and an award/graduation ceremony in the Createch studio at the Arlington Hills Community Center.

Important trends were observed during the thirteen-hour camp days that are important to note. First, it was important that the researchers transport the surveys back and forth from the community center to the university, in order collect data at the end of the camp. Additionally, students appeared to greatly enjoy the team building aspect that accompanied bowling with their peers. Many students were observed making new connections and joking around with both their peers and college mentors. It was a very intentional decision to bring the students to the University of St. Thomas, and to have undergraduate engineering students present during the time there. Being on the college campus and having students present was intended to provide the students with an idea of what college is, what engineering is really like, as well as what engineering students are like, and diversity within the engineering fields (the engineering students present were white, black, male, and female). Finally, family members were encouraged to attend the ceremony at the end of the camp where students were presented with a certificate and a Makey Makey kit, from JoyLabz.

Lesson Descriptions

The two lessons taught at the camp were each taught by one undergraduate research student studying STEM education and one library staff member assisting, all overseen by a middle school math teacher. The first lesson was a lesson on laser cutting, using graphic design software (Adobe Illustrator) to create a picture frame. The frame was cut out of thin birch sheets with a laser cutter. The students first discussed what a laser cutter might be used for, as well as how it worked. Students responded well to this open group discussion, where all students as well as instructors sat in a discussion circle on the floor. Campers received five minutes of instruction on how to use the software and then were handed a print out with a frame template on it. The instructor engaged students in discussion when the instructor noticed a design that would fail in the laser cutting process, for example a frame that would be cut in half. Students were asked questions like "What do you think might happen at if you were to cut this piece out?" Students responded well to this guided instruction which also focused in on discovery and experimentation. The goal of the laser cutting, as well as, the circuit lesson was for students to learn by using the materials, and learn from teaching and asking questions of each other, instead of the instructors. After students completed at least two sketches, they all were given a laptop with the software open. Basic tools were reviewed, such as a shape tool, eraser, and line tool. Students were first asked to experiment and play with the software for 15 minutes before they were allowed to work on their frame. Exploration time was intentional so that students would be familiar with the software before starting in on their project; fewer instructor questions were asked; the preliminary play and practice time allowed for low stakes mistakes; and students built communication and collaboration skills with peers active in the same pursuit. The objectives of the laser cutting lesson were:

- Students will be able to understand what a laser cutter is and what it can do
- Students will participate in an active group discussion before the activity and during the project while watching the laser cutter
- Students will understand the importance of brainstorming and creating multiple designs as a part of the engineering design process
- Students will learn the basic computer control shortcuts and the basic tools in Adobe Illustrator which was achieved by using direct instruction and student/peer exploration

A University of St. Thomas engineering student was hired to run the laser cutter, on loan from a local high school.

The second lesson of the camp was focused on learning about the basics of circuits using Squishy Circuits [8] and ArtBots [9]. Students were able to work on two different projects which involved physics and creativity. In the first project, students worked with Squishy Circuits. This exploratory activity enabled students to play with a conductor, conductive play dough, and create a circuit with LED lights and a battery pack. Students were checked for circuitry understanding with a brief 5-7 minute lesson on what a circuit is, components of a circuit, and examples of circuits in the room. Once the ideas were grasped, the campers were let loose to explore how to make their own circuit. They were challenged in their teams of two to design an intricate circuit design with the LED lights and play dough. Students were given an ample amount of time of about 30 minutes to do so. The ability to have their circuit function properly was a formative assessment of how they were understanding the concept. When the allotted time ended, teams displayed their functioning circuits. Students' circuit designs ranged from bees to dogs to cupcakes and hamburgers to a cave of wonders and a performance stage.

The second activity was a simple robot called an ArtBot. The STEPS ArtBot consisted of the following materials: a paper cup, googly eyes, at least 4 markers, a toothbrush motor and a battery pack. By this point of the session, instruction on circuitry was no longer necessary. Students were given about a two minute instruction on an offset motor and how an ArtBot functions and the appropriate steps on what was available to decorate their ArtBot. This was an independent activity which allowed each student to make the ArtBot their own by decorating with the colored duct tape, googly eyes and craft sticks. Once the students were finished decorating and attaching the legs, students were given an offset motor from a dollar store electric toothbrush. Once students connected the battery pack and motor to the body of the cup, students tested their robot's motion and art abilities on a sheet of paper.

Success in Meeting Goals and Questionnaire Review

Restated below are the camp goals used to guide the 2015 STEPS camp construction:
1. Build enthusiasm for STEM (science, technology, engineering, and math) at a critical stage in an educational experience
2. Target campers from underrepresented groups and lower socioeconomic populations
3. Motivate campers to take STEM courses in their middle school and secondary education
4. Energize campers to pursue STEM degrees and STEM related careers
5. Encourage campers to learn about engineering and the engineering design process
6. Increase understanding of what engineers do at work
7. Allow for campers to visualize themselves succeeding in a college setting.

As previously described, research participants filled out pre- and post-surveys which probed for their engineering knowledge as well as their camp experience. One half of the survey questions were administered using a Likert scale, where research participants circled one answer on a scale from Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD). Multiple choice questions were used to for demographic information, and short answer questions were used to help researchers have a deeper understanding of students' camp experience. This comprehensive data shows us how we achieved our goals using the entire research population as a whole, but does not evaluate individual shifts in responses. For example, it will tell us if x% of students increased their answer to a question, but it will not tell us if those students who increased were students that previously had a very different response. Additionally, the data summarized here will not tell us if the answers with a 0% change are because the same students didn't change their answers from the pre- to post- surveys, or if the same amount of students answered that question on the post-survey as did on the pre-survey.

Below, each goal set for the STEPS 2015 program is restated, followed by the survey questions we felt best helped to show movement within those goals. The data from all five camp sessions has been combined, and is included below each corresponding question. Note: x% means an increase in that response from the pre to post surveys, while –x% indicates a decrease in that response from the pre to post surveys. After each question and data report, a short summary details the data and what it means for the corresponding goal.

Goal #1: Build enthusiasm for STEM (science, technology, engineering, and math) at a critical stage in an educational experience
Corresponding question pre-survey versus post-survey ranking: "I can see myself pursuing a career with some sort of engineering":

Strongly Agree	Agree	Neutral:	Disagree:	Strongly Disagree
6%	10%	-16%	0%	0%

This data shows that 6% of the campers were more likely to see themselves pursuing a career with some sort of engineering after the camp than before. 0% of campers ranked themselves as disagreeing with the statement "I can see myself pursuing some type of career in engineering."

Goal #2: Target campers from underrepresented groups and lower socioeconomic populations.
Corresponding questions and results:
Pre-survey multiple choice question 1: “I identify as a (boy, girl, prefer not to answer)”. Participants were 66% female and 44% male.

Pre-survey multiple choice question: “I most closely identify with the race: (white/Caucasian, black/African American, Hispanic or Latino/a, Asian or Pacific Islander, American Indian, Other, prefer not to answer)”. Participants self-identified as 63% white/Caucasian students, 1% black students, 13% Asian students; 4% Pacific Islander students; 6% Hispanic students; 1% Native American students; and 5% of students identified the category “prefer not to answer, other, or no response”

Pre-survey versus post-survey ranking: “I have male/female models in engineering and/or science.”
a. “I have male models in engineering”:

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
-3%	6%	-1%	1%	3%

b. “I have female models in engineering”:

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
0%	-2%	-6%	1%	3%

The data for this ranking question, “I have male/female role models in engineering and/or science” is considered to be inconclusive, as no answers changed significantly. Therefore, it is suggested that in the future, this question not be asked as a comparative question, from before and after attending the camp, because it is unlikely that students would have a stronger male or female role model in engineering after just one day at camp, especially since this was not a primary goal of the camp. Therefore, it is suggested that this question is either left out completely, or the data is simply evaluated once, most likely at the end of the camp.

Goal #3: Motivate campers to take STEM courses in their middle school and secondary education settings
This goal was not addressed due to a lack of time. In the future, we would like to offer a follow-up camp, where one of the questions would address this goal.

Goal #4: Energize campers to pursue STEM degrees and STEM related careers
Pre-survey versus post-survey ranking: “I can see myself pursuing a career with some sort of engineering”:

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6%	10%	-17%	0%	0%

This question shows significant advances in achieving the goal “Energize campers to pursue STEM degrees and STEM related careers.” When looking at the data from all of the camps, it is clear that many students agreed or strongly agreed with the statement when they had previously had ranked themselves as neutral. There is 0% change of students that ranked themselves disagreeing or strongly disagreeing with this statement. When reviewing the data, 5% of students ranked themselves as disagreeing or strongly disagreeing with the statement, “I can see myself pursuing a career with some sort of engineering" on both pre- and post-surveys.

Goal #5: Encourage campers to learn about engineering and the engineering design process

Pre-survey versus post-survey ranking: "In order to be at good engineering, I have to be good at math and science":

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
-1%	11%	-3%	0%	0%

The question, "In order to be at good engineering, I have to be good at math and science" shows inconclusive evidence. There is an increase of students stating they agree with this statement, however, there is a slight decrease in students strongly held view and neutral view of this statement. Therefore, this data as a whole is not useful, and the independent surveys need to be evaluated.

Pre-survey versus post-survey ranking: "In order to be good at engineering, I have to be good at art and design":

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6%	-4%	-3%	-3%	3%

The second question, "In order to be good at engineering, I have to be good at art and design" provides interesting insight. We included this question because we hoped to educate students on the creative aspects of engineering, and the 6% decrease of students that previously had no opinion or disagreed with the statement, and 6% increase of students that strongly agreed with the statement shows that we reached this goal. The 3% increase of responses to "strongly disagree" however shows that there is still work to be done. The next step will be for researchers to evaluate the other questions on the surveys that chose "strongly disagree" to this question, in order to improve future camps.

Goal #6: Increase understanding of what engineers do at work

Pre-survey versus post-survey ranking: "In order to be at good engineering, I have to be good at math and science":

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
-1%	11%	-3%	0%	0%

Participants indicate that mathematical and science achievement are correlated but not exclusively correlated to engineering success.

Pre-survey versus post-survey ranking: "In order to be good at engineering, I have to be good at art and design":

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6%	-4%	-3%	-3%	3%

While some participants left the experience with a sense that creativity is a positive attribute of an engineer, the participants belief of this component was not overwhelming changed.

Goal #7: Allow for campers to visualize themselves succeeding in a college setting.

This goal was not explicitly answered with the survey instruments, but participants volunteered their experiences which were formed by spending a portion of the camp at a college setting, surrounded by university students. The short answer question "What parts and aspects of the camp were helpful to you?" Seemed to reinforce success in achieving this goal. Many students responded to this question stating that they enjoyed being on a college campus, and/or being led by college students around campus. Additionally, many students answered “yes” in some form to the short answer question “Did you like having college students at this camp?”

Short answer questions are helpful in evaluating what changes should be made in the future. Most importantly the short answer questions served as pilot questions for further qualitative research. The qualitative research component holds great promise for further understanding how students learn and how their natural affinities and interests intersect with the STEPS program goals and learning potential. Goals and corresponding short answer questions are the following.

Goal #1: Build enthusiasm for STEM (science, technology, engineering, and math) at a critical stage in an educational experience
Post-survey short answer: “What aspects of the camp were helpful to you?”
Post-survey short answer: “Would you recommend this camp to a friend?”

Goal #5: Encourage campers to learn about engineering and the engineering design process
Post-survey short answer: “What did you learn at this camp?

Goal #6: Increase understanding of what engineers do at work
Pre-survey short answer: “What do you think it means to be an engineer?”
Post-survey short answer: “What do you think it means to be an engineer?”

The short answer questions provided the research team with an insight into what students enjoyed and found beneficial about the camp. In future research, short answer questions may be phrased in such a way that would indicated a change from the beginning to end of the camp. For example, goal #4 “Energize campers to pursue STEM degrees and STEM related careers” was addressed in the pre-survey, but without this question also being asked on the post questionnaire, it is not possible to determine whether or not we made gains on this objective. Additionally, some modifications will be made on future short answer questions to allow for more concrete answers from participants. A question that we would like to modify from the pre-survey is *What career do you see yourself pursuing?* We would like to add this question to the post-survey as well, asking if they would now consider a STEM career in an effort to answer goal #2.

Some of the free response questions from the pre-survey and post-surveys provided the research team with valuable information regarding the structure of the camp, including the following. *What do you think it means to be an engineer?* This question was asked at the beginning and end of the camp, and by comparing student answers, we are able to determine if we were effective in meeting goals #1 and #5. *What did you learn at this camp?* Students provided thoughtful answers to this question, that have allowed the research team the opportunity to discover what learning objectives they would like to include in the curriculum next year. While explicit learning objectives were noted on the lesson plans concerning laser cutting and circuitry, answers to this question, such as “how the CNC machine works” and the lack of answers regarding an engineering design process allow us to determine what broad learning objectives need to be established for future camps, and how to achieve them.

Questions that we would like to modify from the post-surveys include: *Did you like having* *college students at the camp?* This question comes right after the question "What parts and aspects of the camp were helpful to you?" The research shows that many students noted that having college students present at the camp were a helpful aspect, making the direct question about do you like having college students at the camp unnecessary. *Did your understanding of what an engineer does change after attending this camp? If so, how so?* This is an unnecessary question because questions on both the pre- and post-surveys ask "What do you think it means to be an engineer?" and the difference in answers allow researchers to determine if their understanding of what an engineer is/does has changed after attending the camp.

An additional note on the research surveys involves the ranking questions. The research questions draw from the NSF project "Assessing Women and Men in Engineering" [10]. The ranking questions are identical from the pre- and post-surveys in order to determine if significant changes in self-efficacy were made. These questions include, "I consider myself to be good at science" and "I consider myself to be good at math". However the camp does not focus on teaching any specific aspects of these subjects or explicitly building self-efficacy in these areas. These questions are useful if choosing to examine if the researchers are interested in whether or not males and females have different answers to these questions or if there is a correspondence between any of the other questions, however, none of the initial goals of the camp ask for this.

Clearly, the preliminary quantitative data is only a preliminary exploration of the success or lack thereof the STEPS program goals. Future research should include a qualitative research component, perhaps semi-structured interviews, in order to better understand the following: how students constructed new knowledge through their participation in the STEPS program; what is experience of the STEPS participants; and what meaning do they connect to their experience.

Summary and "Next STEPS"

The reconstruction of the STEPS program was essential to recruit underrepresented students. The new format was well received and shows great promise. Key lessons learned in delivering the new curriculum and key lessons learned in extending the population participating in the informal engineering outreach program will be incorporated in successive offerings of the program. The revamped 2015 STEPS offering follows a 2014 STEPS offering in which the content and delivery of STEPS was significantly updated to reflect current pre-college science and engineering education research. Specifically, engineering design, engineering practices, engineering habits of mind, and best practices for engineering career exploration, as currently established in educational research, including Next Generation Science Standards, National Science Foundation publications, and National Engineering Academy publications were incorporated into the 2014 STEPS program design. Lesson plans were revamped to include the application of the engineering design process, creativity and Making experiences. These lessons also facilitated the incorporation of a wider range of engineering role models. And importantly the STEPS reconstruction expanded what participants would be able to do on their own after the STEPS experience. The first offerings of the STEPS program, over sixteen years ago, provided for what at the time was a technologically innovative experience but was one that did not lend itself to replication nor was constructivist learning theory as an element of the program. By allowing students the time and space to construct their knowledge of core content including circuits, as well as the role that science and engineering practices play, students are leaving with an understanding of how to do engineering.

The key changes made for the 2015 STEPS offering is partnering for the cultural competence and established relationship which a standalone outreach program cannot achieve. The revamped 2015 STEPS format leverages partnerships between a university engineering program and informal education provider, who has built a strong positive supportive relationship with non-dominant groups. The informal education partner is also able to offer a sustained support system for students and their families. The informal education providers gained insight into new innovative curriculum, research and higher education talent which might supplement current staffing. The university programs benefited from the student and family connections and trust that the informal education provider provides for the diverse communities which they work with on a daily basis. The synergies of the university and library partnership format is a win-win for the cooperating partners, but more importantly the format provides participants with an engaging, safe and inspiring experience which would not be available with only one of the partners. The participants build a stronger relationship with an informal education library program. The informal education library program is also available to provide a library, Maker space and community center which will support young STEM learners and their families as interests grow and expand. This service dovetails perfectly the mission of the library system which is to connect people with the imperative and joy of learning through a lifetime. The university engineering program provides a broader population with the opportunity to Make and engineer. Students "can't be it, if they can't see it". By taking engaging, fun and curiosity driven engineering and Making programs to students in arenas where they and their families live, we are able to reveal the joy and opportunities of Making and engineering to students in a safe space where they can build their competence with successful experiences. Then by providing students with a university visit with fun social components and innovative engineering lab activities we can provide a second opportunity for students to begin envisioning themselves in the role of future college student and maybe even a future engineer.

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Appendix – Survey Instruments

Pre-Camp Questionnaire

This questionnaire is to help us learn a little bit about you and what you know about engineering before camp starts. We would like to have this information so we can determine if our camp is effective, and if your background has anything to do with your feelings and knowledge about engineering. There are no right answers! If there is a question you are not comfortable with, you do not have to answer it.

1. Please check the appropriate boxes below

I identify as a:
- ☐ Boy
- ☐ Girl
- ☐ Prefer not to answer

I heard about STEPS camp from a:
- ☐ Teacher
- ☐ Friend
- ☐ Library
- ☐ Other:________
- ☐ Prefer not to answer

I most closely identify with the race:
- ☐ White/Caucasian
- ☐ Black/African American
- ☐ Hispanic/Latino/a American
- ☐ Asian/Pacific Islander
- ☐ American Indian
- ☐ Other
- ☐ Prefer not to answer

In the Fall of 2015, I will attend school at:
- ☐ Farnsworth
- ☐ Community of Peace
- ☐ Washington Tech Magnet
- ☐ Other:________
- ☐ Prefer not to answer

2. Please circle the response that best describes how you feel about the statements below:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I can see myself pursuing a career with some sort of engineering	SD	D	N	A	SA
I consider myself to be good at math:	SD	D	N	A	SA
I consider myself to be good at science:	SD	D	N	A	SA
I consider myself to be good at engineering:	SD	D	N	A	SA
I have female role models in engineering and/or science	SD	D	N	A	SA
I have male role models in engineering and/or science	SD	D	N	A	SA
In order to be good at engineering, I have to be good at math and science:	SD	D	N	A	SA
In order to be good at engineer, I have to be good at art and design:	SD	D	N	A	SA
I am encouraged in math and science at my school:	SD	D	N	A	SA
I am encouraged in art and design at my school:	SD	D	N	A	SA
I consider myself to be good at art	SD	D	N	A	SA
I would consider myself to be good at design	SD	D	N	A	SA

3. Please answer the following questions in the spaces provided. Remember there is no correct answer!

1. What do you think it means to be an engineer?

____

2. What is your favorite subject in school?

____

3. What career do you see yourself pursuing?

____

4. What are you hoping to gain or learn from this camp?

____

Post-Camp Questionnaire

This questionnaire is to help us learn a little bit about you and what you know about engineering before camp starts. We would like to have this information so we can determine if our camp is effective, and if your background has anything to do with your feelings and knowledge about engineering. There are no right answers! If there is a question you are not comfortable with, you do not have to answer it.

1. Please check the appropriate boxes below

I identify as a:
- ☐ Boy
- ☐ Girl
- ☐ Prefer not to answer

I heard about STEPS camp from a:
- ☐ Teacher
- ☐ Friend
- ☐ Library
- ☐ Other:__________
- ☐ Prefer not to answer

I most closely identify with the race:
- ☐ White/Caucasian
- ☐ Black/African American
- ☐ Hispanic/Latino/a American
- ☐ Asian/Pacific Islander
- ☐ American Indian
- ☐ Other
- ☐ Prefer not to answer

In the Fall of 2015, I will attend school at:
- ☐ Farnsworth
- ☐ Community of Peace
- ☐ Washington Tech Magnet
- ☐ Other:________
- ☐ Prefer not to answer

2. Please circle the response that best describes how you feel about the statements below:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I can see myself pursuing a career with some sort of engineering	SD	D	N	A	SA
I consider myself to be good at math:	SD	D	N	A	SA
I consider myself to be good at science:	SD	D	N	A	SA
I consider myself to be good at engineering:	SD	D	N	A	SA
I have female role models in engineering and/or science	SD	D	N	A	SA
I have male role models in engineering and/or science	SD	D	N	A	SA
In order to be good at engineering, I have to be good at math and science:	SD	D	N	A	SA
In order to be good at engineer, I have to be good at art and design:	SD	D	N	A	SA
I am encouraged in math and science at my school:	SD	D	N	A	SA
I am encouraged in art and design at my school:	SD	D	N	A	SA
I consider myself to be good at art	SD	D	N	A	SA
I would consider myself to be good at design	SD	D	N	A	SA

3. Please answer the following questions in the spaces provided. Remember there is no correct answer!

1. What do you think it means to be an engineer?

____

2. What did you learn at this camp?

____

3. Would you recommend this camp to a friend? (Why or why not?)

____

4. Did your understanding of what an engineer does change after attending this camp? If so, how?

____

5. What parts and aspects of the camp were helpful to you?

____

6. Did you like having college students at the camp?

____

7. If you could change one thing about camp, what would it be and why?

____