

Designing Our World: **Public Audiences Front-End Evaluation Report**



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Executive Summary

Project Overview

The *Designing Our World* (DOW) project centers on science, technology, engineering, and mathematics (STEM) equity and addresses the need for more youth, especially girls, to pursue engineering and fill vital workforce gaps. DOW will integrate tested informal science education (ISE) programs and exhibits with current knowledge of engaging diverse youth through activities embedded in a social context. Led by teams of diverse community stakeholders and in partnership with several local girl-serving organizations, DOW will leverage existing exhibits, girls' groups, and social media to impact girls' engineering-related interests and identities.

This front-end evaluation study implemented at the beginning of the project was intended to help the project team learn more about the relationship of girls ages 9 – 14 to issues related to engineering and engineering careers. The DOW team sought information about girls' existing knowledge of engineering, perceptions of the engineering field and engineers, and potential methods of presenting engineering-related activities in ways that girls found appealing. In addition, the team pursued data about ways in which girls shared their learning experiences, particularly whether girls utilized social media technologies.

Objectives

The aim of the front-end evaluation was to gather information from our target audience about the following questions:

1. What are current perceptions of engineering?
2. What do girls find personally relevant about engineering?
3. What influences girls' self-perceptions regarding engineering?
4. What aspects of altruism are important to girls?
5. When and how do girls "share" as part of their own formal or informal learning experiences?

Methods

In an effort to gather a variety of perspectives from members of the project's target audience (girls and parents of girls ages 9 – 14), study participants were drawn from two pools: 1) Girls ages 9 – 14 who participate in a local after-school program for Latina youth, and 2) Girls and parents of girls ages 8 – 15 who are OMSI visitors. A total of 81 individuals participated in the study. OMSI evaluators coordinated four 45-minute focus groups with girls at the after-school program, which included 32 girls as participants. A total of 49 OMSI visitors (24 youth and 25 adults) were interviewed for 15 minutes during their visit to the museum.

Summary of Findings

Current perceptions of engineering

Overall, most respondents exhibited an understanding of engineering as a variety of types of activities and sub-fields. Most youth articulated engineering in terms of hands-on, physical processes, while most adults described imaginative, mental processes.

Engineering and its relevance to girls

Overall, girl respondents reported enjoying activities that involved creating, drawing, designing, and making objects, particularly if they contained artistic elements. Similarly, adults perceived their daughters as being interested in playing, drawing, and creating. Girls easily identified altruistic activities related to engineering, and such altruistic activities and issues appealed to most girls. In addition, girls preferred activities that they perceived being “good at” and disliked activities perceived to be difficult. These types of activities were preferred both in general and specifically related to engineering.

Sources of influence on girls regarding engineering

Engineering was generally understood to be a masculine field among respondents. Youth and adult respondents nearly all exhibited awareness of cultural stereotypes that promote beliefs in gender differences—differences that represent women as unfit for or unable to succeed in engineering fields. Such beliefs included perceptions of engineering as physically or intellectually difficult, taxing, or strenuous, combined with beliefs that girls/women were unwilling or unable to meet these challenges. The general association of engineering with men was mirrored by the fact that most youth describe learning about engineering from a male family member.

Altruism and its importance to girls

Altruism emerged as an important value and an attractive element of activities for youth respondents. Altruistic aspects of specifically engineering-related activities and projects were also seen as personally relevant and attractive by most youth. While a variety of factors may influence girls’ attraction to one engineering-related project over another, the type of activity (i.e., building, designing) and the technology involved (i.e., microchips, water filters) were seen as secondary to the possibility that someone might benefit from the results.

Methods of sharing information among girls

The ways in which girls share information about their lives and learning experiences varied widely, with text message, face-to-face conversation, telephone, and Facebook all well-represented in responses. Overall, adult and youth responses indicate that individual parents and children negotiate the details of such communication, and that parental limits on girls’ use of communication technologies are common. In addition, youth did not indicate frequent use of social media platforms other than Facebook. Use of more traditional methods of communication—via telephone or in person—appeared much more frequently among girls’ responses.

Introduction

Project Background

To drive innovation and compete globally, the U.S. needs a strong engineering workforce. However, the country is not currently training enough engineers (NSF 2006; NAE 2002, 2008; NSB 2010). Attracting underrepresented groups, including girls and Latinos, can help fill this gap while diversifying the field and maximizing innovation (NSF 2005, 2006, 2011; NAE 2008; NAS 2007; AAUW 2010; PCAST 2010; NSB 2010; Steinke 2004). The ***Designing Our World (DOW): A Community Envisioning Girls as Engineers*** project responds to this need by creating educational partnerships between the museum and the local community; supporting long-term, cross-context learning and engagement; and shifting attitudes of girls and their peers, families, and mentors. At the start of the project, proposed strategies to achieve intended impacts include:

- Reframing engineering as altruistic, personally relevant, and social to tie to girls' values
- Highlighting positive role models
- Showcasing activities that effectively engage girls, Latinos, and other youth of color
- Transforming a traditional engineering exhibit into a girl-friendly, community hub.

The project includes evaluation elements related to both a public audience and a professional audience. This report pertains to the public audience only.

The project deliverables to be developed for the **public audience** include:

- ***Creative Solutions programming*** will engage girls in group-oriented engineering activities that highlight altruistic, personally relevant, and social aspects of engineering. Existing community groups will use the activities in their regular meeting structure. Museum visits will reinforce messages.
- ***Design Your World***, a community hub and engineering experience at OMSI, will leverage existing NSF-funded *Engineer It!* exhibits redesigned to attract, engage, and mobilize a more diverse population by showcasing altruistic, personally relevant, and social aspects of engineering.
- **Digital engagement** through targeted use of social media will complement program and exhibit content and be an online portal for groups engaged in the project.

Front-End Evaluation Study

Conducted at the beginning of the project, this front-end evaluation study was intended to help the project team learn more about the relationship of girls ages 9 – 14 to issues related to

engineering and engineering careers. The DOW team sought information about girls' existing knowledge of engineering, perceptions of the engineering field and engineers, and potential methods of presenting engineering-related activities in ways that girls found appealing. In addition, the team pursued data about ways in which girls shared their learning experiences, particularly whether girls utilized social media technologies. The findings of this evaluation phase will inform concept development, exhibit schematic design, educational program development, and further development of other deliverables related to the project.

Research Questions

The aim of the front-end evaluation was to gather information from our target audience about the following questions:

1. What are current perceptions of engineering?
2. What do girls find personally relevant about engineering?
3. What influences girls' self-perceptions regarding engineering?
4. What aspects of altruism are important to girls?
5. When and how do girls "share" as part of their own formal or informal learning experiences?

Methodology

Evaluation Planning

Evaluation questions were developed in collaboration with the OMSI project team and the Garibay Group, an external evaluator charged with evaluation of professional audiences and the overall project summative evaluation. To kick-off the DOW project, OMSI hosted an Advisor's Meeting comprised of leaders and local community stakeholders in STEM education, girls' identity development, and leadership development in youth of color. Comments and input from the Advisor's Meeting informed revisions of the evaluation questions by the project team's Front-End Research Working Group (FERWG). This working group, which included DOW team representatives from education, programming, exhibits, evaluation, and research/development departments, surveyed existing literature and research about girls, youth of color, and engineering, to collaboratively develop a list of research questions for the front-end evaluation. Evaluation and other team members prioritized research questions to those for which the team had the least information. Members of the FERWG also collaborated on development and refinement of data collection instruments.

A member of the DOW Program team served as liaison with the after-school program community group involved in the front-end research activities to provide opportunity for their input on the research questions. The evaluation lead also worked closely with representatives from this community group throughout the planning and data collection process. All instruments used offsite at community organizations were reviewed and approved by their administration prior to use. Together, the evaluation lead and Program team liaison ensured that research activities at partner organization locations offsite were fun, beneficial, and minimally disruptive to normal activities for partner organization staff and participants. Indeed, given the iterative process through which research questions and evaluation instruments were designed and refined, the planning process proved to be a beneficial collaboration between cross-disciplinary DOW team members, community partners, and other stakeholders in engineering education among girls and youth of color.

Study Participants

In an effort to gather a variety of perspectives from members of the project's target audience (girls and parents of girls ages 9 – 14), study participants were drawn from two pools:

- 1) Girls ages 9 – 14 who participate in a local after-school program for Latina youth,
- 2) Girls and parents of girls ages 8 – 15 who are OMSI visitors.

OMSI evaluators coordinated 45-minute focus groups with girls at the after-school program. OMSI visitors were interviewed for 15 minutes during their visit to the museum. Detailed information on participant demographics is available below (see page 11). All youth participants were asked to respond to questions about themselves, while adults at OMSI were asked to respond to interview questions about their daughters/dependents. Other than this exception, interview and focus group questions and activities were nearly identical between all participants.

Data Collection: After-School Program for Latina Youth

After consultation with staff at the local after-school program, two specific schools were chosen as appropriate locations for data collection from girls who participate in the program. Program staff provided youth participants and their parents with information (a packet given to the children to take home) that described the study, its risks, and the voluntary nature of participation. These packets were provided in both Spanish and English languages. Youth program participants (and their parents) were given over one week to complete and return these consent forms. Parents were provided a copy of the consent document for their records. Youth participants were offered two free passes to OMSI as a small token of appreciation for participating in the focus group.

Four 45-minute focus groups were conducted with girls who participate in the after-school program at two of the ten schools where the programs are hosted. Two groups were held concurrently at an upper elementary school on one afternoon. Two additional focus groups were also held concurrently at a middle school on a separate afternoon. During the regularly-scheduled after-school programming at each location, one facilitator and at least one note-taker from OMSI led focus groups among the girls who had returned signed consent forms from their parents. At least one staff member from the after-school program was present during the duration of the focus groups. Notes were recorded with pen and paper during the focus groups; no audio or video recordings were taken. Written work and activities completed during the focus group were collected for analysis and recording at a later time.

Data Collection: OMSI Visitors

OMSI visitor participants were recruited by evaluators while visiting exhibits. Museum visitor participants were given information that described the study, its risks, and the voluntary nature of participation. Each participant provided verbal consent or assent prior to involvement in the study. . Evaluators were available to participants to answer any questions and address any concerns regarding the study. Given the time constraints of the evaluation, all OMSI interviews were conducted in English. OMSI visitor participants were offered two free passes to OMSI to be used during a future visit as a small token of appreciation for participating.

The data collectors and note-takers were on the OMSI floor on Fridays, Saturdays, and Sundays for two weekends in April. Data collection took place between the hours of 10:00 a.m. and 2:00 p.m. as these were anticipated to be times of high visitor traffic. Each shift included one interviewer and one note-taker who worked as a team. Notes were recorded with pen and paper during the interviews; no audio or video recordings were taken. Written work and activities completed during the interviews were collected for recording and analysis at a later time. Collectors generally completed at least 2 interviews per hour with the goal of interviewing one youth and one parent each hour. Collectors did not interview youth and parents in the same family or visiting group. Collectors interviewed a nearly equal number of youth and parents of youth between the age ranges of 9 – 11 and 12 – 14. Data on the actual ages of youth interviewed (or youth of parents interviewed) were tallied after each shift. Any age groups less represented in that shift's sample were targeted during the following shift. Although the DOW project's target audience is girls ages 9 – 14, two girls age eight and one parent of a girl age 15 were interviewed at OMSI. Their responses are included in this report.

Data Analysis

Data was hand-recorded using pen and paper by a dedicated note-taker during focus groups and interviews. These notes were input into a spreadsheet by an evaluation team member, hard copies were scanned into digital format, and both hard and digital copies were securely stored. Quantitative data was analyzed to determine frequencies using simple descriptive statistics. Qualitative data in the form of responses to open-ended questions was recorded into a spreadsheet and categorized into themes. These themes were assigned codes and each response was assigned at least one code. Coding reliability was tested by using a second coder and discrepancies were discussed and codes revised to ensure accurate interpretation of qualitative data. These codes were then analyzed using descriptive statistics to determine frequencies as well. Specific quotations were selected from open-ended responses in the data to illustrate common codes and themes in this report.

Limitations

Given that two different methods were used to gather data—in-person interviews and focus groups—the data collected will necessarily be influenced by the collection method used. A common limitation of focus groups is that answers provided by focus group participants may be influenced by other members of the group, and collected data may also reflect opinions only of the most outgoing, vocal group members. Alternately, as more intimate interactions, one-on-one interview responses may be influenced in nuanced ways by the demeanor of the interviewer. In addition, adults were asked to speculate about opinions and preferences of their daughters/dependents. While not the voices of girls themselves, this data provided an alternate point of view about girls' interests and preferences, as well as insight into parental attitudes and perceptions of their daughters. Finally, due to the order in which some questions were

asked by interviewers/facilitators, some participants' answers may have been influenced by the language and/or content of prior questions. Differences in the way in which specific questions were phrased by interviewers/facilitators also may have impacted responses. All facilitators and interviewers were trained in data collection techniques to avoid these limitations as much as possible. Even so, such limitations should be kept in mind when interpreting these findings. After accounting for limitations, the data and findings included in this report reflect only the most reliable and valid data available to the evaluation team.

Participant Demographics

A total of 81 individuals participated in the study. At OMSI, 24 youth and 25 adults were interviewed. Focus groups included 32 girls as participants. Data from a total of 57 youth were collected.

Table 1. Youth participant demographics

	OMSI youth (n=25)	Focus group youth (n=32)	Total youth (n=57)
Gender			
Female	25	32	100%
Age			
8 – 11	16	18	60% (n=34)
12 – 14	9	14	40% (n=23)
Race			
Hispanic	2	32	60% (n=34)
Caucasian	4	-	7% (n=4)
Native American	2	-	4% (n=2)
Asian/SE Asian	1	-	2% (n=1)
Pacific Islander	1	-	2% (n=1)
Other/Undisclosed	15	-	26% (n=15)

Among all youth, 60% were in the younger, 8 – 11 age range. Since focus groups were held at after-school programs for Latina youth, a large percentage (60%) of the total youth identified as Hispanic.

Table 2. Adult participant demographics

	OMSI adults (n=24)
Gender	
Male	17% (n=4)
Female	54% (n=13)
Unrecorded	29% (n=7)
Age of girl	
9 – 11	67% (n=16)*
12 – 14	33% (n=8)*
Race	
Caucasian	58% (n=14)
Multi-Racial	13% (n=3)

Asian/SE Asian	8% (n=2)
Hispanic	4% (n=1)
Other/Undisclosed	17% (n=4)

*Indicates age of the youth about which the parent/guardian was interviewed

Most adult participants were Caucasian (58%) and the majority of participants were parents/guardians of girls in the younger, 8 – 11 age range (67%). Although the gender of some adults (29%) was not recorded, most adult respondents were female (54%).

Findings: Youth Participants

An overview of the front-end evaluation study findings is provided in this section of the report. Findings for youth participants are presented first, followed by findings for adult participants. The findings are followed by a brief discussion and list of recommendations.

Single responses to open-ended questions often yielded multiple codes. As such, several tables indicate the distribution of codes rather than of respondents.

What are current perceptions of engineering?

- What are engineers perceived to do as part of their jobs?
- Do girls perceive engineering as something that they want to do? That they could do? Why/why not?

What are engineers perceived to do as part of their jobs?

Girls were asked to respond to the open-ended question, “What do you think engineers do as part of their jobs?” Responses were coded for commonly-occurring categories. Four distinct categories emerged from the data: hands-on/physical processes, imaginative/mental processes, physical objects, and personal characteristics of engineers.

Table 3. Youth participant descriptions of what “engineers do as part of their jobs”

Response category	OMSI youth (n=45)	Focus group youth (n=40)	Total youth (n=85)
Hands-on, physical processes	36% (n=16)	38% (n=15)	36% (n=31)
Imaginative/mental processes	31% (n=14)	28% (n=11)	29% (n=25)
Physical objects	22% (n=10)	23% (n=9)	22% (n=19)
Personal characteristics	11% (n=5)	13% (n=5)	12% (n=10)

Youth responses most often associated what engineers do as part of their jobs with hands-on, physical processes through responses such as “build things,” “machine work,” “fix cars,” and “put materials together.” The second most often-used code, imaginative/mental processes, was evident in responses such as “invents,” “computer programs that test things,” and “think.”

In addition to specific actions, such as “make” or “build,” responses also included references to some physical objects, including computers, planes, trains, bicycles, electronics, metals, roads, robots, and roofs.

Focus group youth were more likely than OMSI youth to describe the work of an engineer in terms of repairing or fixing objects, usually cars, as well as in terms of “helping.” It is also important to note that a few youth in focus groups did not initially understand what the word “engineer” meant until another person (peer or facilitator) provided the Spanish translation of the term (the translation provided was “ingeniero”).

Some responses referred to perceived characteristics of an engineer as a type of person. When discussing characteristics of engineers, responses from youth were generally positive.

“[Engineers] build things that can help us in the future.” –Youth at OMSI

“[Engineers] can help if your car breaks down.” –Youth in focus group

“Never gives up.” –Youth in focus group

“Creates structures or things that are made to help society.” –Youth at OMSI

The variety of responses indicate that many youth perceive engineering as a diverse set of activities and tasks that range from planning and designing to building and constructing objects and technologies. While materials and physical objects are prominent in such descriptions, skilled mental processes are also associated with the work of an engineer.

Do girls perceive engineering as something that they would like to do? That they could do? Why/why not?

After asking participants to describe what engineers do as part of their jobs, participants then were asked if engineering was something that they would like to do, or if engineering was something that they could do if they tried. (The interviewer/facilitator did not provide any separate or additional definition of the term “engineering” other than that already provided by the participant.) A total of 56 youth were asked to respond to these questions.

Focus group facilitators asked youth to raise their hands in response to the two questions of 1) whether engineering was something they would like to do, or 2) would not like to do, followed

by the separate two questions of 1) whether engineering was something that they could do, or 2) could not do if they tried.

Table 4. Focus group youth responses to whether engineering is something they would like to do/could do if they tried

	Focus group youth (n=32)
Would like to do	41% (n=13)
Would not like to do	38% (n=12)
No response	22% (n=7)
Could do	38% (n=12)
Could not do	6% (n=2)
No response	57% (n=18)

Among focus group youth who provided a response (n=25) to the question of whether engineering was something that they would like to do, just over half of the youth replied yes (n=13). A large number (57%, n=18) of youth in the focus groups chose not to raise their hands in response to the second question of whether engineering was something that they could do if they tried. Only two youth in the focus groups (6%) raised their hands to indicate that they did not believe that engineering was something they could do if they tried. It is unclear whether the girls who chose not to raise their hands did so because they were uncertain about their answers, or if they were embarrassed to assert belief or distrust in their personal capabilities in front of their peers. If the latter is the case, then it is notable that girls felt more comfortable sharing their likes than they did sharing opinions about their own capabilities.

OMSI youth were also asked whether engineering was something that they would like to do or could do if they tried, and their answers were recorded as responses to a single question.

Table 5. OMSI youth responses to whether engineering is something they would like to do/could do if they tried

	OMSI youth (n=24)
Would like to do or could do	83% (n=20)
Would not like to do or could not do	8% (n=2)
Unsure/maybe	8% (n=2)

Far more OMSI youth (83%) than focus group participants (41%, 38%) agreed that engineering was something that they would like to do or could do if they tried. One girl who was unsure specified that her answer would depend on the specific type of engineering activity under consideration. This indicates that her uncertainty stemmed from her knowledge that engineering involves a number of activities, rather than uncertainty about the definition of engineering itself. The second girl who was unsure indicated that she was more uncertain about the definition of engineering than about her own preferences or capabilities.

Among youth in focus groups and at OMSI who said “no” to either question, reasons included undifferentiated lack of interest, stronger interest in something else, or that engineering was “too hard” or “too much work.”

“[I’m] bad at fixing stuff.” –Youth in focus group

“[It’s] hard to put all the pieces together.” – Youth in focus group

“[It’s] boring. [I] like to make things, not fix things.” –Youth at OMSI

Those who said “yes” mentioned creativity, determination, and skills in math and science as reasons why they could be engineers, and a general interest in and enjoyment of hands-on, physical processes as the primary reason why engineering is something that they would like to do.

“[I’m] good at science and experimenting.” –Youth at OMSI

“[I] like to test stuff.” – Youth in focus group

“[I] like designing, building, creating. Dad says I’m very imaginative.” – Youth at OMSI

Among the 56 youth who were asked whether engineering was something that they would like to do or could do if they tried, one girl responded that her male sibling would be more capable as an engineer.

“More [my] brother. [My] brother is better at engineering.” – Youth at OMSI

Overall, OMSI youth generally indicated interest and/or belief in their capabilities regarding engineering, while youth in the focus group exhibited more ambivalence about their relationship to engineering—or about communicating their opinions regarding their relationship to engineering.

What do girls find personally relevant about engineering?

- What types of engineering-related activities sound most appealing to girls?
- What reasons for becoming an engineer are perceived to be appealing to girls?

What types of engineering-related activities sound most appealing to girls?

Youth participants ranked words for eleven types of activities (plan, lead, draw, test, play, build, write, investigate, create, design, make) in order of interest to them. For the purpose of analysis, this data was then translated to a 1 – 5 scale. This was the first question posed to both

interview and focus group participants, before they may have been aware that some of the words were associated with engineering-related activities. Therefore, these findings reflect types of activities the girls prefer generally, rather than types of specifically engineering-related activities preferred by girls. All 57 youth took part in this activity.

The words “create,” “draw,” “design,” and “make” were ranked highest. The lowest-ranked words were “test,” “write,” and “lead.” (The word “test” could have potentially been interpreted in the context of “taking a test in school” which may have impacted its low ranking.)

Table 6. Activity words ranked by youth in order of interest (5= most interesting, 1=least interesting)

	OMSI youth	Focus group youth	Total youth	<i>Standard Deviation</i>
Create	4.14	4.03	4.07	.07
Draw	4.13	3.97	4.04	.11
Design	3.83	3.83	3.83	.00
Make	4.00	3.67	3.81	.23
Play	3.54	3.97	3.79	.30
Build	3.80	3.28	3.51	.37
Plan	2.57	3.87	3.30	.92
Investigate	3.50	2.80	3.10	.50
Lead	2.57	3.31	3.01	.52
Write	2.78	2.91	2.85	.09
Test	2.70	2.59	2.64	.07

Among OMSI youth, the top three words were “create,” “draw,” and “make.” Among focus group youth, the top three words were “create,” “draw,” and “play” (the words “draw” and “play” were tied for second place).

Overall, there was the least amount of agreement between OMSI youth and focus group youth on the likeability of activities related to the words “plan,” “lead,” and “investigate.” The word “plan” was ranked much higher by the focus groups (3.87) than by OMSI youth (2.57). Focus group youth also liked the word “lead” much more (3.31) than did OMSI youth (2.57). Alternately, OMSI youth showed more interest in the word “investigate” (3.5) than did youth in the focus groups (2.8).

Respondents were asked follow-up questions about why they chose their most- and least-favorite activity-related words. These responses were coded for common themes. When asked why they chose specific activities as their favorites, responses most often involved hands-on or physical processes, particularly related to arts-related activities and physical object creation. Preferences for the top-ranked word, “create,” were often described in terms of making things, arts and crafts, and/or working with your hands. Other top-ranked words were also described in terms of hands-on activities and/or artistic creation:

“[You can] use anything to draw: colored pencils, glitter....”—Youth at OMSI, in

reference to the word “draw”

“[I’m a] hands-on person.” –Youth in focus group, in reference to the word “build”

“[I] like to make things, art things.” –Youth at OMSI, in reference to the word “make”

Lower-ranked activity words were often described as too difficult and brought up negative feelings or experiences.

“The work is left up to you. If you don’t know, it’s up to you. [You’re] responsible for messing up.” – Youth at OMSI, in reference to the word “lead”

“[It’s] hard when you don’t understand.” -Youth in focus group, in reference to the word “build”

“[It] feels like everyone is counting on you, [you don’t] want to disappoint [them].” – Youth at OMSI, in reference to the word “plan”

Overall, girls showed preferences for activities that involved creating, drawing, designing, and making objects, particularly if they involved artistic elements.

What reasons for becoming an engineer are perceived to be appealing to girls?

Girls were asked what they would say if they were trying to encourage one of their friends to become an engineer. If asked, interviewers clarified that encouragement would only be given in a context where the friend had already shown interest in engineering in the past. Responses were coded and analyzed to identify specific themes that emerged from the data.

A total of seven categories of codes were found in the response data. Each of these categories represents a different kind of argument used to convince a friend to become an engineer: altruism—that the job would enable the friend to help others; novelty/newness—that engineering lets you do or make things that are new; fun/experiential—that engineering activities offer positive experiences; diversity of activities—that engineering offers a wide variety of possibilities and things to do; physically create objects—that engineers get to make things; gender-specific relevance—that engineering is not just for boys; and job prospects—that engineering is a high-demand or high-paying career.

Table 7. Arguments youth participants would use to convince a friend to become an engineer

Response category	OMSI youth (n=36)	Focus group youth (n=15)	Total youth (n=51)
Altruism	22% (n=8)	27% (n=4)	24% (n=12)
Novelty/newness	19% (n=7)	27% (n=4)	22% (n=11)
Fun/experiential	17% (n=6)	20% (n=3)	18% (n=9)
Diversity of activities	14% (n=5)	6% (n=1)	12% (n=6)

Physically create objects	11% (n=4)	13% (n=2)	12% (n=6)
Gender-specific relevance	11% (n=4)	-	8% (n=4)
Job prospects	5% (n=2)	6% (n=1)	6% (n=3)

Reasons related to altruism were the most common, followed by the chance to invent or do things that are new. Responses that described fun experiences afforded by an engineering career were also common.

“They could help the world.” –Youth at OMSI

“[You] have to engineer things to make our world better.” –Youth at OMSI

“[You] could get famous by inventing something.” –Youth in focus group

“It’s fun—you can make many things that are fun.” –Youth in focus group

Explicit mentions of engineering as a sought-after career or lucrative job were only identified three times, which shows that the money, status, or security related to an engineering career was not perceived as the most compelling reasons for its pursuit. Rather, the most compelling reason to pursue engineering was related to its role in helping other people.

What influences girls’ self-perceptions regarding engineering?

- What are the perceived reasons why a lot of girls today aren’t interested in engineering?
- What are primary sources of information about engineering?

What are the perceived reasons why a lot of girls today aren’t interested in engineering?

Near the end of the interview/focus group, participants were asked, “A lot of girls today aren’t interested in engineering. Why do you think that is the case?” Responses were analyzed for common themes and coded into eight distinct categories: general interest/dislike—that girls don’t like engineering and/or prefer other activities; lack work ethic—that girls aren’t able or willing to work hard enough to become an engineer; lack opportunity—that girls aren’t given the chance to learn about engineering or become engineers; lack ability/skill—that girls don’t have the knowledge, ability, or skills that are needed to become an engineer; working conditions—that engineers work in dangerous or dirty situations that are unappealing to girls; engineer stereotypes—that engineers as people have unappealing characteristics; lack exposure—that girls aren’t taught or exposed to engineering; and lack role models—that girls don’t see other women engineers as teachers, mentors, or role models to help them become engineers.

Table 8. Reasons why girls today aren't interested in engineering, according to youth respondents

Response category	OMSI youth (n=36)	Focus group youth (n=29)	Total youth (n=65)
General interest/dislike	33% (n=12)	24% (n=7)	29% (n=19)
Lack work ethic	14% (n=5)	24% (n=7)	18% (n=12)
Lack opportunity	17% (n=6)	10% (n=3)	14% (n=9)
Lack ability/skill	8% (n=3)	21% (n=6)	14% (n=9)
Working conditions	11% (n=4)	7% (n=2)	9% (n=6)
Engineer stereotypes	6% (n=2)	7% (n=2)	6% (n=4)
Lack exposure	6% (n=2)	7% (n=2)	6% (n=4)
Lack role models	6% (n=2)	-	3% (n=2)

The most common (29%) type of responses involved general dislike of engineering or girls' stronger interest in something else.

"Engineering is boring." – Youth at OMSI

"Some people do it but my friend does acting and I like writing and we like those."
– Youth at OMSI

"Girls have different dreams like designing and fashion." – Youth in focus group

Perceptions of engineering as difficult and requiring hard work—too hard or too difficult for girls—were prevalent in responses regarding beliefs in girls' work ethic.

"[Engineering] uses a lot of math and physics and is a lot of work." – Youth at OMSI

"Girls give up easier." – Youth in focus group

"Girls are kind of lazy, vain, and superficial." – Youth at OMSI

"Girls don't have [the] courage." – Youth in focus group

Several barriers to girls' entry into engineering fields were mentioned in responses related to lack of opportunity, lack of exposure, and lack of female role models.

"[People] say they can't do it, so [girls] give up hopes to do it." – Youth in focus group

"Most people think girls should not be engineers. Girls haven't been given the option."

–Youth at OMSI

“[I don’t] know any girls into engineering.” –Youth at OMSI

“Nobody talks about what engineers do.” –Youth at OMSI

Traditional beliefs about gender differences were evident in responses related to girls’ lack of ability or skills in engineering.

“Boys are better at math and science, girls are better at arts.” –Youth in focus group

“Girls are all about fashion. [They] don’t think they have a brain.” –Youth at OMSI

Perceptions about engineering work as dirty, physically taxing, or dangerous were also mentioned.

“Girls don’t want to get dirty.” – Youth in focus group

“It’s scary because you have to work with dangerous things.” – Youth at OMSI

“Working with machines, long hours, and carrying things.” –Youth in focus group

“It’s a man’s job because they are stronger and tougher.” –Youth in focus group

Nearly all girls’ responses referred in some way to personal beliefs or cultural stereotypes about gender differences. However, it was difficult to determine the extent to which responses reflected personal beliefs or simply reflected awareness of cultural stereotypes. Even so, the content of these responses sheds light on the fact that engineering is perceived as a highly masculine field, and that traditional gender roles are still seen as playing a role in girls’ decisions whether or not to pursue engineering interests and careers.

What are primary sources of information about engineering?

Participants were asked where they had learned about their responses to a previously-asked question, “What do you think engineers do as part of their jobs?” This follow-up question usually took the form of, “Where do you think you learned about that?” or “Where did you learn about what engineers do?”

Responses were analyzed and coded into categories for family members, school, media, non-school programs, and friends. A total of five categories were identified among the responses. More detailed responses, and therefore more codes, were identified from youth at OMSI (n=35) than from youth in the focus groups (n=17), such that OMSI youth make up 67% of the total codes analyzed for this question.

Table 9. Sources of knowledge about what “engineers do as part of their jobs” among youth participants

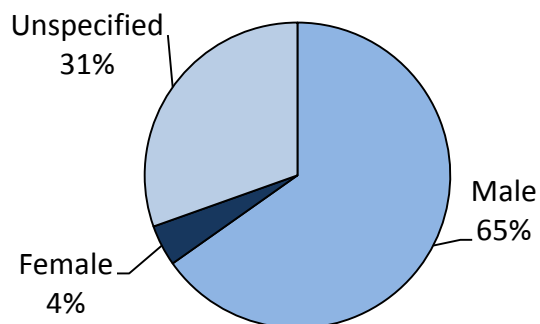
	OMSI youth (n=35)	Focus group youth (n=17)	Total youth (n=52)
Family members	40% (n=14)	47% (n=8)	43% (n=22)
Media	23% (n=8)	29% (n=5)	25% (n=13)
School	29% (n=10)	12% (n=2)	23% (n=12)
Programs unrelated to school	6% (n=2)	12% (n=2)	7% (n=4)
Friends	3% (n=1)	-	2% (n=1)

Most (43%) youth participants reported learning about engineering from a family member, followed by media and school. OMSI youth indicated that school was their primary source of information about engineering more often (29%, n=10) than did girls in the focus groups (12%, n=2).

Out of all sources of knowledge mentioned by OMSI youth, 17% (n=6) of OMSI youth reported that they primarily learned about engineering from a family member who was an engineer. No girls from the focus groups mentioned personally knowing an engineer who was a source of information to them.

Although respondents were not specifically asked the gender of family members that they mentioned as sources of knowledge, of responses where the gender was apparent, most family sources information about engineering were male. Youth at OMSI did not indicate that any of such family members were female, and only one youth in a focus group mentioned that she primarily learned about engineering from a female family member.

Chart 1. Gender of family members identified by youth as primary sources of information about engineering



Overall, responses indicate that family members are primary influences and sources of information about engineering to youth participants. Additionally, nearly all family sources

were identified as males. This indicates that not only do respondents identify engineering as a masculine field; information and knowledge about engineering is primarily communicated through men.

What aspects of altruism are important to girls?

- Are girls more attracted to altruism that impacts the environment, animals, friends/family, or strangers?

OMSI and focus group youth were shown examples of six engineering-related projects (see Appendix D) and asked to choose the two that they found most interesting/attractive and the two they found least interesting/attractive. Projects involved some form of altruism of benefit to others, as well as a form of technology (such as microchips or water filters) and an engineering-related activity (such as inventing or developing).

Table 10. Youth respondents' top two most interesting/attractive engineering-related projects

	OMSI youth (n=45)	Focus group youth (n=68)	Combined youth (n=113)
I make water filters for people in countries that don't have fresh, clean water	29% (n=13)	25% (n=17)	27% (n=30)
I developed a microchip that works with smartphones so people's pets never get lost	22% (n=10)	16% (n=11)	19% (n=21)
I invented a wheelchair that can climb stairs to help people get around easier	22% (n=10)	16% (n=11)	19% (n=21)
I build schools that are safer for people during earthquakes	11% (n=5)	22% (n=15)	18% (n=20)
I created an app that tells my friends when their favorite store is having a sale	9% (n=4)	13% (n=9)	12% (n=13)
I designed a solar-powered house for my family	7% (n=3)	7% (n=5)	7% (n=8)

The most popular choice (27%) was "I make water filters for people in countries that don't have fresh, clean water." This option was selected most often by both OMSI and focus group youth.

After choosing their favorite and least favorite activities, respondents were asked to explain what aspects about each project they found most/least appealing. These reasons were

analyzed for content and coded into four categories: altruism, activity type, technology, and personal experience/relevance.

Table 11. Reasons why youth respondents selected specific engineering-related activities as attractive/interesting

Response category	OMSI youth (n=45)	Focus group youth (n=18)	Total (n=63)
Altruism	64% (n=29)	83% (n=15)	70% (n=44)
Activity type	11% (n=5)	11% (n=2)	11% (n=7)
Technology	16% (n=7)	-	11% (n=7)
Personal relevance/experience	9% (n=4)	6% (n=1)	8% (n=5)

Of the various elements of each activity (altruism, technology, engineering-related activity), girls found the altruistic aspects to be the most compelling. For 70% of all youth, the altruistic activity was what most attracted them to choose a specific kind of activity. Altruism was mentioned more often than the specific technology (e.g., microchip, smartphone app) or activity types (e.g., create, design, or build). However, youth at OMSI more often identified the technology as an attractive element (16%, n=7) than did focus group youth (n=0).

All responses that highlighted altruism were analyzed separately to identify which targets of altruism were most attractive to youth. Among respondents who were attracted to altruism, they were most attracted to activities that benefited strangers in need and friends/family. Altruism was the reason behind many girls' first choice of the option, "mak[ing] water filters for people in countries that don't have fresh, clean water."

"People depend on water to live." – Youth at OMSI

"They have to walk all this way for water and they get sick." – Youth at OMSI

Altruism was a determining factor in girls' choices of other activities as well, such as the activity involving the wheelchair.

"[My] aunt is in a wheelchair. [I] want to help her." – Youth at OMSI

"[You] don't want [them] to feel like an outsider going up the ramp. [They] want to feel like any other kid." – Youth in focus group

When asked about the reasons for disinterest in lower-ranked projects, respondents cited lack of personal experience or relevance, as well as disinterest in the specific activity or technology mentioned.

"[I] don't really see that many houses with solar power." – Youth in focus group

“Creating apps is not interesting.” – Youth at OMSI

While a pilot study conducted for this project indicated that girls were highly interested in shopping, a proposed project in this study involving a smartphone “app that tells my friends when their favorite store is having a sale” was the second least appealing of the six project options.

“[I] don’t care about sales.” –Youth at OMSI

While a number of factors may have influenced girls’ decisions to choose one specific activity over another, altruism emerged as a compelling factor to most girls.

When and how do girls “share” as part of their own formal or informal learning experiences?

- What methods of sharing are used most often by girls in this age group, and what technologies do they involve? With whom do girls share the most?
- Under what circumstances are girls less likely to share, and why?

What methods of sharing are used most often by girls in this age group, and what technologies do they involve? With whom do girls share the most?

In an open-ended question, youth participants were asked how they communicate with other people about their life, how they keep in touch, and what technologies they use. If participants did not mention social media as part of their initial response to the question, interviewers and focus group facilitators followed up with a question about their use of social media.

Table 12. Methods of sharing mentioned by youth participants

	OMSI youth (n=69)	Focus group youth (n=47)	Total youth (n=116)
Text message	20% (n=14)	11% (n=5)	16% (n=19)
Face to face	16% (n=11)	13% (n=6)	15% (n=17)
Phone	20% (n=14)	6% (n=3)	15% (n=17)
Facebook	7% (n=5)	23% (n=11)	14% (n=16)
Skype	12% (n=8)	6% (n=3)	9% (n=11)
E-mail	9% (n=6)	2% (n=1)	6% (n=7)
Instagram	4% (n=3)	6% (n=3)	5% (n=6)
Snapchat	1% (n=1)	9% (n=4)	4% (n=5)
Letters	6% (n=4)	-	3% (n=4)
Twitter	-	4% (n=2)	2% (n=2)
Other	4% (n=3)	19% (n=9)	10% (n=12)

Text message, face-to-face conversation, telephone, and Facebook were the most mentioned methods of sharing information among youth participants. However, OMSI youth were more likely to mention using text messaging and phones than focus group youth. Also, focus group youth mentioned using Facebook more often than OMSI youth. Parents and friends were the people with whom girls shared the most.

OMSI youth were asked what forms of communication they rarely or never used. Out of 22 respondents, 13 (60%) stated that they rarely or never use any “social media.” (This finding was also reflected in responses from both OMSI adults and OMSI youth: over half (51%) of total OMSI respondents said that they (or their daughter/dependent) rarely or never used any social media. Also, over half of OMSI visitors (51%) reported rarely or never using e-mail. More detail about this data is discussed in the adult findings section of this report.)

Data were also analyzed according to the age of the respondent, with responses from younger girls ages 8 – 11 separated from responses from older girls ages 12 – 14.

Table 13. Methods of sharing mentioned by youth participants by age (8 – 11 and 12 – 14)

	Youth ages 8 – 11 (n=69)	Youth ages 12 – 14 (n=47)	Total youth (n=116)
Text message	14% (n=10)	19% (n=9)	16% (n=19)
Face to face	14% (n=10)	15% (n=7)	15% (n=17)
Phone	19% (n=13)	9% (n=4)	15% (n=17)
Facebook	10% (n=7)	19% (n=9)	14% (n=16)
Skype	10% (n=7)	9% (n=4)	9% (n=11)
E-mail	9% (n=6)	2% (n=1)	6% (n=7)
Instagram	3% (n=2)	9% (n=4)	5% (n=6)
Snapchat	3% (n=2)	6% (n=3)	4% (n=5)
Letters	4% (n=3)	2% (n=1)	3% (n=4)
Twitter	1% (n=1)	2% (n=1)	2% (n=2)
Other	12% (n=8)	9% (n=4)	10% (n=12)

Some methods of sharing mentioned by participants have minimum age requirements (for example, Facebook requires that a person be at least 13 years of age to register for an account on their site). In addition, some parents impose more restrictions regarding use of communication technologies when girls are younger (see findings for adult participants). These factors may influence the slight increase in mentions of text messaging, Facebook, Instagram, and Snapchat among the older group of girls.

Overall, girls report that they still rely on traditional methods of communication such as face-to-face conversation and telephone more than technologies like Skype or Snapchat.

Under what circumstances are girls less likely to share, and why?

Most girls (67%) said that they would share with others about something they learned in school but had trouble understanding, or about which they received a bad grade. However, some girls would limit that sharing to one or both parents or a teacher in an effort to get help or

encouragement. A few girls at OMSI provided reasons why they would not share in this context, which included fear of teasing and “distrust” that someone would “tell on” them.

“[I don’t] want to be made fun of.” –Youth at OMSI

“I would ask [friends] what it means if I don’t understand.” –Youth at OMSI

Most girls (64%) also said that they would share if they were working on a project but weren’t finished with it yet. Again, a few girls at OMSI provided reasons as to why they would not share an unfinished project, including worry about failing to meet raised expectations and worry about “getting [the] idea stolen.”

“[I] would rather focus and complete [the] project.” –Youth at OMSI

“[It would be] embarrassing if [it’s] not finished.” –Youth at OMSI

Despite some worries about sharing incomplete work or sharing about challenging learning experiences, most girls still agreed that they would share with others in such circumstances. This suggests that girls may be willing to share their work in trial-and-error processes that are common to engineering activities, even if such sharing involved communicating failed solutions or incomplete projects.

Findings: Adult Participants

Findings for the 25 adult participants interviewed at OMSI are included below. While youth were asked questions about their own preferences and ideas, adults were asked about their perception of their daughter’s preferences and ideas. As such, not all questions posed to youth participants were posed to adult participants.

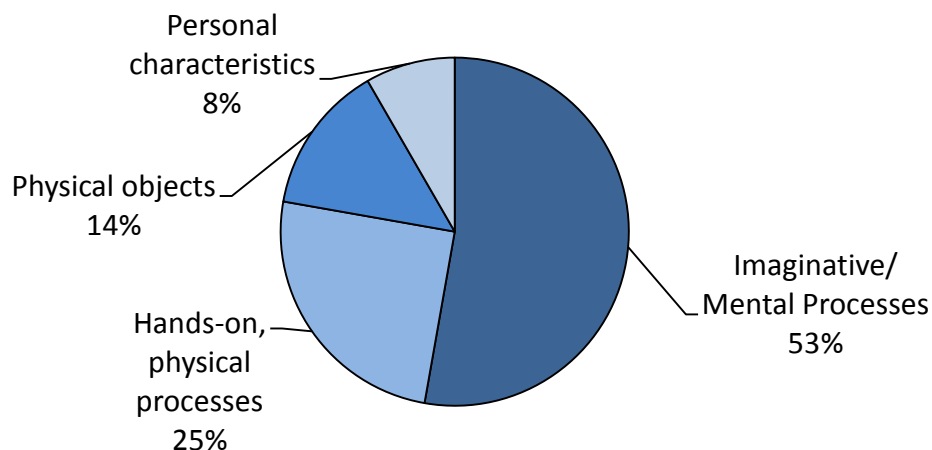
Single responses to open-ended questions often yielded multiple codes. As such, several tables indicate the distribution of codes rather than of respondents. Codes in adult responses mirror those used to analyze youth responses.

What are current perceptions of engineering?

- What are engineers perceived to do as part of their jobs?

Adult participants were asked to respond to the open-ended question, “What do you think engineers do as part of their jobs?” Responses were compiled and coded for common themes.

Chart 2. Adult participant descriptions of what “engineers do as part of their jobs”



Adults’ responses most often involved imaginative or mental processes (“planning and development,” “math and formulas”), followed by hands-on, physical processes (“making sure reactors and generators work,” “the way something is built”). Adults also referenced some physical objects, such as blueprints or computers.

A few adults described perceived characteristics of an engineer as a type of person. Overall, these characterizations were not positive.

“Those people who play those video games now are very employable but have limited social skills.” – Adult at OMSI

“[Engineers] are bossy, annoying and never wrong...always looking for improvement on existing process, possibly to things that don’t need it.” – Adult at OMSI

Overall, adults seemed to have a good grasp on the variety of kinds of engineers and engineering activities, with an emphasis on the imaginative and mental processes involved in such work.

What do girls find personally relevant?

- What types of engineering-related activities sound most appealing to girls?
- What reasons for becoming an engineer are perceived to be appealing to girls?

What types of engineering-related activities sound most appealing to girls?

Adult participants ranked words for eleven types of activities (plan, lead, draw, test, play, build, write, investigate, create, design, make) in order of perceived interest to their daughter, which was then translated to a scale of 1 – 5 for analysis. These results are listed below, along with the data from youth for comparison.

Table 14. Activity words ranked in order of interest (5= most interesting, 1=least interesting) to girls

	OMSI adults perceptions of girls interest	<i>Combined youth interest</i>
Play	4.20	3.79
Draw	4.11	4.04
Create	4.00	4.07
Design	3.88	3.83
Make	3.65	3.81
Build	3.43	3.51
Investigate	2.96	3.10
Plan	2.71	3.30
Lead	2.65	3.01
Write	2.52	2.85
Test	2.14	2.64

Adults ranked “play” higher than youth did, while youth ranked the words “plan,” “lead,” and “test” higher than adults.

A few respondents’ language indicated a shift beyond their daughter’s general like or interest in an activity and towards self-identification in terms of that activity. However, far more responses were voiced in terms of preferences for actions (such as “she likes to write”) than in terms of identities (such as “she is a writer”).

“She needs to be pushed. Not a natural investigator.” –Adult at OMSI

“She’s an artist, really working on her art. It’s part of her identity now.” – Adult at OMSI

Assuming that parents’ views of their daughters’ preferences and interests plays a role in the experiences and opportunities that parents make available to their daughters, it is likely that parents would be more inclined to offer their daughters activities related to playing, drawing, and creating. In addition, it is interesting to note ways in which daughters’ preferences are described in terms of natural inclinations or inborn characteristics. This may play an even stronger role in determining the type of experiences and opportunities parents provide for their daughters.

What reasons for becoming an engineer are perceived to be appealing to girls?

Adults were asked what they would say if they were trying to encourage their daughter to become an engineer, assuming that she had shown prior interest. Responses were separated into 7 commonly occurring categories.

Table 15. Arguments adults and youth would use to convince daughter/friend to become an engineer

Response category	OMSI adults (n=27)	Combined youth (n=51)
Diversity of activities	30% (n=8)	12% (n=6)
Gender-specific relevance	26% (n=7)	8% (n=4)
Job prospects	22% (n=6)	6% (n=3)
Altruism	11% (n=3)	24% (n=12)
Novelty/newness	7% (n=2)	22% (n=11)
Physically create objects	3% (n=1)	12% (n=6)
Fun/experiential	-	18% (n=9)

Adults most often discussed the variety of types of activities related to engineering.

“Explain all the options available in engineering.” –Adult at OMSI

“Encourage her to find what sparks her interest and look at possibilities more broadly at what problems she could solve.” –Adult at OMSI

“[They] don’t have to build industrial things, but can build beautiful things to help people and solve problems.” –Adult at OMSI

Some adults addressed the need for gender-specific strategies:

“Girls think they like science when they are given things to relate to.” – Adult at OMSI

“[Highlight the] more social side of things, not analytical or industrial, to appeal to girls.” – Adult at OMSI

The fact that adults mentioned the diversity of activities, gender, and job prospects more often than youth shows a potential disjunction between ways in which engineering is being “sold” to girls and what girls themselves find appealing about engineering.

What influences girls’ self-perceptions regarding engineering?

- What are the perceived reasons why a lot of girls today aren’t interested in engineering?

Adults were asked, “A lot of girls today aren’t interested in engineering. Why do you think that is the case?” Responses were coded and sorted according to response category type.

Table 16. Reasons why girls today aren’t interested in engineering, according to adults and youth

Response category	OMSI adults (n=30)	<i>Combined youth</i> (n=65)
Lack exposure	20% (n=6)	6% (n=4)
Lack opportunity	20% (n=6)	14% (n=9)
General interest/dislike	13% (n=4)	29% (n=19)
Lack ability/skill	13% (n=4)	14% (n=9)
Engineer stereotypes	13% (n=4)	6% (n=4)
Lack role models	13% (n=4)	3% (n=2)
Working conditions	7% (n=2)	9% (n=6)
Lack work ethic	-	18% (n=12)

The most common responses among adults discussed lack of exposure (20%, n=6) and lack of opportunity (20%, n=6). General interest/dislike, lack of ability/skill, engineer stereotypes, and lack of role models were described as factors as well.

“Girls are not exposed to it. [It’s a] male-dominated field so boys are more exposed.” – Adult at OMSI

“Intimidating because of the amount of men in the field. Women are in more altruistic fields.” –Adult at OMSI

“Girls tend to be more design-oriented while boys are more math-oriented which is better for engineering.” – Adult at OMSI

“It doesn’t sound sexy enough. Girls want to be involved in [activities] less statistical or analytical and more altruistic.”—Adult at OMSI

“[Engineer] guys are geeky so girls don’t want to go into it.” – Adult at OMSI

All responses indicated awareness of cultural stereotypes about women being unfit for or uninterested in engineering, and most saw gender differences as the root of this stereotype. However, it was often unclear whether respondents were articulating cultural beliefs/stereotypes or their own beliefs regarding gender differences.

When and how do girls “share” as part of their own formal or informal learning experiences?

- What do parents think about their daughters’ use of technology to share?

OMSI participants—both adults and youth—were asked what forms of communication they (or their daughter/dependent) rarely or never used. Over half (51%) of OMSI respondents said that they (or their daughter/dependent) rarely or never used any “social media.” Also, over half of OMSI visitors (51%) reported rarely or never using e-mail.

Most parents expressed relative comfort with their daughter’s methods of sharing, primarily because many currently monitor and/or limit girls’ use of communicative technologies. Parents often expressed trepidation over perceived dangers involved in such technologies, especially social media. Concerns included privacy, safety, “predators,” inappropriate content, and bullying.

“[I’m] comfortable right now, [but] concerned about dumbing down if she has contact with social media. [The] Internet should be used for academic purposes.” –Adult at OMSI

“Social media is not social!” –Adult at OMSI

“[It] might be necessary to use social media soon but [I’m] not happy about it. Many very damaging things have happened to [my] son in middle school around social media.” –Adult at OMSI

Of all the types of technology mentioned, adults seemed most comfortable with their daughters’ use of academic websites while under parental supervision. In addition, parents seemed most comfortable with communication between girls and other family members.

Discussion

Current perceptions of engineering

Overall, most respondents exhibited an understanding of engineering as a variety of types of activities and sub-fields. Most youth articulated engineering in terms of hands-on, physical processes, while most adults described imaginative, mental processes. Since most OMSI visitors are likely to have existing interest in and knowledge about STEM fields, it is perhaps not surprising that many OMSI respondents were quite informed about specific activities related to engineering. Youth in the focus group also described a wide variety of activities when discussing engineering, although generally respondents offered slightly different and less detailed descriptions of engineering than did OMSI visitors. This discrepancy may be related to differences in linguistic denotations of the term “engineer” in English and “ingeniero” in Spanish, or it may reflect the general level of understanding about engineering typical of an audience who does not regularly visit OMSI. The fact that many OMSI visitors noted that someone in their family was an engineer likely contributed to their depth of understanding as well, as such intimate access to a practitioner in the field is not common among the general public.

Most respondents did not exhibit strong emotions while discussing engineering, although a few adults described personal characteristics of engineers in negative terms. The majority of youth indicated interest and/or belief in their capabilities regarding engineering, although this response was much stronger among OMSI youth. The low response rate among youth in the focus group related to a question about one’s ability to participate in engineering is notable, as it signals uncertainty about personal efficacy in engineering-related activities, or discomfort with sharing information about one’s sense of efficacy. Given the peer pressure at work among this age group, it may not be surprising that girls were not eager to share feelings about efficacy for fear of being seen as overly prideful or overly self-deprecating. However, if this low response masked an overwhelming lack of self-efficacy towards engineering among girls in the group, then this finding is notable in signaling the extent to which girls may have internalized cultural beliefs about women’s unsuitability for engineering careers.

Engineering and its relevance to girls

Overall, girl respondents reported enjoying activities that involved creating, drawing, designing, and making objects, particularly if they contained artistic elements. Similarly, adults perceived their daughters as being interested in playing, drawing, and creating. In addition, girls preferred activities that they perceived being “good at” and disliked activities perceived to be difficult. These types of activities were preferred both in general and specifically related to engineering.

When asked what activities they enjoyed, and later asked what types of things an engineer does, many of the same words were used by the girls, which may indicate at least a general overlap between girls’ “likes” and girls’ understanding of engineering. Girls easily identified

altruistic activities related to engineering, and such altruistic activities and issues appealed to most girls. Girls also valued having a variety of kinds of experiences available to them, and this valuing of variety was also associated with engineering.

Adult respondents also valued the variety of opportunities afforded by an interest in engineering. Adults were also more aware of the need for positive female engineering role models and the need for girl-specific approaches to teaching engineering topics than were youth. The benefits of engineering as a career path were more relevant to adults than for youth respondents. In addition, more adults than youth articulated girls' "likes" in terms of an identity rather than just an activity ("I am an artist" vs. "I enjoy making art"). These differences may illustrate larger ways in which engineering has different relevance to youth than to adults. In addition, these findings may suggest ways in which parental perception of their daughters' "likes"—in particular, framing such "likes" in terms of an identity—may impact not only daughters' self-perceptions and sense of efficacy, but also the types of activities and opportunities that parent offers to their daughter. However, most adults showed a willingness to support their daughters' interests, no matter what direction those interests took.

Sources of influence on girls regarding engineering

Engineering was generally understood to be a masculine field among respondents. Youth and adult respondents nearly all exhibited awareness of cultural stereotypes that promote beliefs in gender differences—differences that represent women as unfit for or unable to succeed in engineering fields. Such beliefs included perceptions of engineering as physically or intellectually difficult, taxing, or strenuous, combined with beliefs that girls/women were unwilling or unable to meet these challenges.

While it is difficult to determine the extent to which participants articulated cultural stereotypes with which they may disagree, or if respondents expressed beliefs that they personally hold, the widespread awareness of stereotypes about women and engineering remains notable. Even if girls and their parents do not personally agree that women aren't skilled in math and therefore can't be engineers, for example, or that engineering requires physical strength that women don't have, the awareness that these stereotypes exist may still impact the way in which girls think about their relationship to engineering activities and engineering as a field.

In addition, many parents described lack of opportunity, access, and role models as barriers to engineering pursuits among girls. A cycle of exclusion emerges from these responses: engineering is perceived as a masculine field, which leads girls to not see themselves as potential engineers, which leads girls to not pursue engineering fields, which perpetuates the predominance of men in engineering.

The general association of engineering with men was mirrored by the fact that most youth describe learning about engineering from a male family member. This indicates that

respondents not only identify engineering writ large as a masculine field; even in daily life, girls are most likely to learn about engineering from men.

Altruism and its importance to girls

Altruism emerged as an important value and an attractive element of activities for youth respondents. Altruistic aspects of specifically engineering-related activities and projects were also seen as personally relevant and attractive by most youth. While a variety of factors may influence girls' attraction to one engineering-related project over another, the type of activity (i.e., building, designing) and the technology involved (i.e., microchips, water filters) were seen as secondary to the possibility that someone might benefit from the results.

Although these findings suggest that girls are most attracted to altruism that benefits strangers in need and animals, the ways in which girls described these preferences hints at a deeper connection to girls' personal relationships and prior experiences. That is, girls may have preferences for altruistic actions related to issues with which they are most familiar. If girls can relate a specific project to an issue with which they are familiar, this familiarity may impact the perceived attractiveness of an altruistic project. For example, girls showed a preference for an engineering-related project that provided clean water to people in need. When presented to girls, the image that accompanied this activity depicted a smiling child who was male and Black, with the subtext that this child may live in a country in Africa or the Middle East. It is possible that respondents are highly familiar with the "starving African child" trope common in American culture, and that this familiarity is what attracted girls to this project, rather than the overall category of "a stranger in need." Similarly, when asked about their interest in a project that enables a person in a wheelchair to climb stairs, some girls mentioned its applicability to friends or family members who use wheelchairs, while other girls imagined themselves in a wheelchair and related to the project through their existing desire to "fit in" and "feel like any other kid." As such, altruistic projects that draw upon existing knowledge and familiar issues may be highly attractive to girls, regardless of the specific human or animal target of such actions.

Methods of sharing information among girls

The ways in which girls share information about their lives and learning experiences varied widely, with text message, face-to-face conversation, telephone, and Facebook all well-represented in responses. Overall, adult and youth responses indicate that individual parents and children negotiate the details of such communication, and that parental limits on girls' use of communication technologies are common. In addition, youth did not indicate frequent use of social media platforms other than Facebook. Use of more traditional methods of communication—via telephone or in person—appeared much more frequently among girls' responses.

Most girls described a willingness to share learning experiences where they did not have mastery over the material, although such sharing was likely limited to a few trusted people (teachers, friends, or family). Similarly, most girls showed comfort with sharing experiences

with a project that was unfinished. Overall, these responses indicate that girls may be amenable to iterative processes common to engineering activities, where products may never be “final” and failures are embraced as further opportunities to experiment. However, youth responses suggest that a safe, trusted social environment is required in order for them to feel comfortable with sharing less-than-perfect experiences or outcomes.

Recommendations

Programming and Exhibit Development

The project should continue to plan to develop programming and exhibits that:

- highlight ways in which engineering is altruistic, personally relevant, and social.
- highlight examples of girls and women with both interest and skills in engineering.
- increase girls’ self-efficacy and confidence related to STEM skills.

The project should consider developing programming and exhibits that:

- involve hands-on processes, artistic object-creation, and relate to the words “design,” “build,” and “create.”
- include altruistic activities or storylines that benefit animals, strangers in need, or are otherwise familiar and/or relevant to girls.
- include messages aimed at boys and men that highlight the benefits of increasing girls’ participation in engineering, as well as practical ways in which boys and men might make engineering-related spaces and programs more comfortable and inclusive for girls and women.

The project should also reconsider the original “share” aspect of the project as necessarily involving social media. The use of social media as a form of technological communication in DOW may not provide sufficient reach to girls in this age range, as many do not use social media, particularly younger girls and OMSI visitors.

Clarifications and Additional Research

The project would benefit from further clarification regarding:

- the meaning of girls’ “engineering identities” and its function in the project, including indicators for how shifts in such identities might be measured.
- the meaning of the term “engineering” and the parameters that will be used in defining engineering-related activities and projects. This may have implications for programming and exhibit content.
- the extent to which girls will be invited to redefine their current “likes” and “interests” as “engineering activities” but fundamentally keep them the same (“you’re already an engineer!”), or whether girls will be invited to change their existing “likes” and

“interests” (“you can become an engineer!”). This may have implications for project strategies, programming and exhibit content.

The project could also benefit from further research into:

- the exact nature of gender stereotypes surrounding engineering. It remains unclear whether belief in and valuing of specific gender differences is the source of such stereotypes (i.e., girls are more nurturing than boys, and nurturing is a good/bad thing), or if the applicability of such gendered traits to engineering fields is the issue (i.e., nurturing skills are irrelevant to engineering). This may have implications for project strategies.
- how girls are more likely to explain the disjunction between themselves and engineering in terms of a characteristic of themselves (i.e., “I don’t like engineering”), rather than a characteristic of engineering (i.e., “Engineering isn’t likeable”). This distinction may relate to the mid-term knowledge and skills impacts outlined in the project logic model, as well as project strategies.
- closely examine the differences in denotations of the word “engineer” in Spanish and English, as linguistic and cultural differences in definitions and context of “engineering” may impact programming and exhibits targeted to a Latina audience.
- the culturally-informed strategies that are needed to achieve project deliverables of culturally-relevant educational programming and exhibit design. To avoid artificially collapsing multiple and intersectional identities under an umbrella category of “youth of color,” specific racial/ethnic audiences should be clearly articulated, and project language should reflect such decisions about intended audience.

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Appendices

Appendix A: Focus Group Facilitator Guide

Appendix B: Interview Guide for Girls

Appendix C: Interview Guide for Adults

Appendix D: Picture Cards Activity

Appendix E: Web Activity

Appendix A: Focus Group Facilitator Guide

Focus Group Facilitator Guide

Items in italics should be spoken to the focus group. Each section/activity includes anticipated duration in minutes, followed by how far along in the group you should be when you finish that section. For example, “10 minutes, :35” means that section of the group should take 10 minutes, and you should be 35 minutes into the focus group when you finish that section.

Facilitator and note-taker introductions

1. Introduce self and describe what you do at OMSI in simple terms.
2. Introduce note-taker and let them describe what they do in simple terms.

Project description and focus group purpose

1. *How many of you have been to OMSI (Oregon Museum of Science and Industry) in Portland before? Please raise your hand.*
2. *Some of us at OMSI are going to be setting up some special programs with girls from [name redacted] and some other groups around Portland, and we want to know more about you and your friends so our programs can be more interesting and fun. What we talk about today will really help us as we decide what kinds of activities and programs to make.*
3. *We’re going to be here for about **45 minutes**. I’d like for us to agree to some ground rules before we begin. This will make sure that our conversation is helpful and fun.*

Ground rules

1. *Our note-taker will be writing down what you say, so it’s important that only **one person speaks at a time**.*
2. *It’s also important that **everyone gets a chance to speak**. If you know that you like to talk a lot, be willing to step back and let others speak. And if you know that you sometimes don’t speak up when you could, try to be sure that you’re letting your voice be heard too.*
3. *There are no right or wrong answers. Everyone has different opinions and experiences. Just because we disagree doesn’t mean that one of us is wrong. So remember to **be respectful** and listen to each other.*
4. *We’re keeping notes, but we’re keeping your names **confidential**. No one other than us will know who you are, so you don’t have to worry about someone else finding out about what you say in here.*

Do you have any questions about these rules, or anything else you’d like to add?

Introductions/Icebreaker: Value Line Activity (5 minutes, :05)

Prop: Place “YES” sign and “NO” sign on the wall or floor to create an imaginary straight line long enough for all girls to line up with lots of room to spare.

1. *Everybody stand up!*
2. *Imagine there’s a straight line across the floor. One end is “YES” and the other end is “NO.” I’m going to make some statements and I want you to find a place on the line according to whether you think “yes” or “no.” For example, if I said “Green is a pretty color,” if you LOVE green, you would be all the way at one end by the “YES” sign; if you HATE green, you would be at the other end by the “NO” sign; and if you don’t really care about green, you would stand in the middle.*
3. Read one of the following statements and give the girls time to line up.
 - a) *“Pizza is my favorite food.”*
 - b) *“I want to make a lot of money when I grow up.”*
 - c) *“I love taking things apart to see how they work.”*
 - d) *“I can be good at anything if I try hard enough.”*
4. Once everyone is in place, ask at least two girls at different places on the line to **state their name and grade**, and then say one sentence explaining their location on the value line.
5. Repeat with a new statement listed above or until each girl has a chance to state her name and grade.
6. Ask everyone to take a seat.

1. Web Activity (7 minutes, :12)

Props: Paper webs (1 per person), activity word stacks (11 words per stack, 1 stack per person)

1. Pass out one paper web and one stack of activity words to each girl.

I want us to talk about different kinds of activities that people might do for fun or for part of their job. For example, some people like to plan things, and other people really like to draw. I’m interested to know which ones you might be interested in doing, and what things don’t sound interesting at all.

Each one of these papers has the name of an activity on it. I want you to read them and think about how appealing or interesting they sound to you. Then place them on the web in front of you with the ones you like most near the center, and the ones you like least near the outside. We’ll talk about your answers and then I will collect them from you.

Words:

<i>Plan</i>	<i>Write</i>
<i>Lead</i>	<i>Investigate</i>
<i>Draw</i>	<i>Create</i>
<i>Test</i>	<i>Design</i>
<i>Play</i>	<i>Make</i>
<i>Build</i>	

2. Give the girls time to complete the activity.
3. Ask 1-2 girls to explain which words they liked (top 1-2) and which ones they didn't like (bottom 1-2). Ask them to talk about why. Examples:
 - What words are near the center of your web?*
 - Why did you choose this word?*
 - What about it makes you say that?*
 - What words are near the outside?*
 - What was unappealing about that word?*
4. Collect the webs from the girls, keeping the activity words intact.

2. Engineering Brainstorm (10 minutes, :22)

Props: Flip chart, marker

1. Write the word "Work as an Engineer" at the top of the flip chart. Facilitate a brainstorming session and write the girls' ideas on the flip chart. Choose a few words from the flip chart for follow-up questions.
 - Now I want us to do another activity, but this time think about a specific job—engineering.*
 - What do you think engineers do as part of their jobs?*
 - Is this something that you would like to do? Why or why not?*
 - Is this something that you think you could do if you tried? Why or why not?*
2. Ask the girls how they know which words to choose, where they learned about what an engineer does. Examples:
 - Where do you think you learned this about engineering?*
 - Can you think of a place or person who may have taught you this?*
 - Can you think of a TV show, book, movie, or some other place you may have learned this about engineering?*

3. Picture Cards (10 minutes, :32)

Props: 6 large picture cards; note-cards and pen/pencil for girls (1 per girl)

1. *Let's talk some more about different kinds of activities. I have six examples here on these picture cards, and I'll read through these with you. For example, this card says [...]. I want you to think about whether these are things that you might want to do—things that sound fun or interesting.*
2. *You each have a note card in front of you. I want you to pick one or two that you like best and write them at the top of your card. Then pick one or two that you like least and write them at the very bottom of your card. Try to write down the letter associated with the picture card or at least a word about the picture so we know which one you mean.*
3. One at a time, show and say the words on each card. Include the card letter (A, B, C...) and repeat the card twice. You will go through the list at least two times. If possible, find a place to set the cards down where they will be visible to the girls during the exercise (such as the flip chart/easel).
 - A. *I make water filters for people in other countries who don't have fresh, clean water.*
 - B. *I designed a solar powered house for my family.*
 - C. *I created an app that tells my friends when their favorite store is having a sale.*
 - D. *I developed a microchip that works with smartphones so people's pets never get lost.*
 - E. *I build schools that are safer for people during earthquakes.*
 - F. *I invented a wheelchair that can climb stairs to help people get around easier.*
4. Ask the girls to talk through their answers with the goal **of identifying which elements are attractive**—specifically **who is being helped** or the **general topic of the activity**.

Example:

I see that you picked "make schools safer during earthquakes." What about that answer did you like? Is it that you want to help your classmates? Or are you interested in earthquakes?
5. Collect the note cards from each girl.

4. Girls in Engineering Discussion (5 minutes, :37)

1. *All of the activities we have been talking about are things that engineers do. A lot of girls today aren't interested in engineering. Why do you think that is the case?*
2. *If you were trying to convince a friend to become an engineer, what would you say?*

5. Sharing (8 minutes, :45)

1. *Now I want to know a bit about how you communicate with other people about your life. How do you keep in touch with other people?*

Give the girls time to talk/give examples on their own.

If it hasn't been mentioned yet, ask about technology and social media:

Do you ever use social media, like Facebook or Twitter?

2. *Which things do you do a lot? Which things do you rarely or never do?*

3. *Let's say that you learn something new and interesting at school*

Who would you share it with? How would you share it?

What if it's something that you had trouble understanding, or if you got a bad grade for that lesson?

Would you share if you were working on a big project but weren't finished with it yet?

Closing

Thank each girl for their time and honesty. Remember to give each girl their free OMSI passes before they leave.

Appendix B: Interview Guide for Girls

Interview Guide for Girls

Thanks for agreeing to talk to us! My name is _____ and this is my colleague, _____. I'd like to ask you a few questions, and _____ is going to take notes so we can remember what you say. If you have any questions or aren't sure about something, you can ask us, and you don't have to answer any question that you don't want to. There are no right or wrong answers; we just want to learn a little more about you. OK?

What is your age?

Do you know your race or ethnicity?

3. Web Activity

Props: Web Paper, activity word stacks

1. Pass out one web paper and one stack of activity words.

I want us to talk about different kinds of activities that people might do for fun or for part of their job. For example, some people like to plan things, and other people really like to draw. I'm interested to know which ones you might be interested in doing, and what things don't sound interesting at all.

Each one of these papers has the name of an activity on it. I want you to read them and think about how appealing or interesting they sound to you. Then place them on the web in front of you with the ones you like most near the center, and the ones you like least near the outside. We'll talk about your answers and then I will collect them from you.

Words:

<i>Plan</i>	<i>Write</i>
<i>Lead</i>	<i>Investigate</i>
<i>Draw</i>	<i>Create</i>
<i>Test</i>	<i>Design</i>
<i>Play</i>	<i>Make</i>
<i>Build</i>	

2. Give the girl time to complete the activity.
3. Ask the girl to explain which words she liked and didn't like (top and bottom 1-2).

What words are near the center of your web?
Why did you choose this word?
What about it makes you say that?
What words are near the outside?
What was unappealing about that word?

4. Collect the web from the girl, keeping the activity words intact until the note-taker has recorded the associated color from the web.

4. Engineering Brainstorm

Now I want us to do another activity, but this time think about a specific job—engineering.

What do you think engineers do as part of their jobs?

Is this something that you would like to do? Why or why not?

Is this something that you think you could do if you tried? Why or why not?

Ask the girl where they learned about what an engineer does.

Where do you think you learned this about engineering?

Can you think of a place or person who may have taught you this?

Can you think of a TV show, book, movie, or some other place you may have learned this about engineering?

5. Picture Cards

Props: Large picture cards with figures and statements

1. *Let's talk some more about different kinds of activities. I have six examples here on these picture cards, and I'll read through these with you. For example, this card says [...]. I want you to think about whether these are things that you might want to do, things that sound fun or interesting.*
2. *After we go through them, I'd like you to pick 1-2 that are most and 1-2 that are least interesting to you. Take your time.*
3. One at a time, show and say the words on each card. Then give the cards to the girl and wait for her to put them in her preferred order.

Cards:

- A. *I make water filters for people in other countries who don't have fresh, clean water.*
- B. *I designed a solar powered house for my family.*
- C. *I created an app that tells my friends when their favorite store is having a sale.*
- D. *I developed a microchip that works with smartphones so people's pets never get lost.*
- E. *I build schools that are safer for people during earthquakes.*
- F. *I invented a wheelchair that can climb stairs to help people get around easier.*

4. Ask the girl to talk through her answers with the goal **of identifying which elements are attractive**—specifically **who is being helped** or the **general topic of the activity**. Pose specific follow-up questions such as the example below:

I see that you picked "make schools safer during earthquakes." What about that answer did you like? Is it that you want to help your classmates? Or are you interested in earthquakes?

5. Collect the Picture Cards, keeping them in order if the order wasn't yet recorded by the note-taker.

6. Girls in Engineering Discussion

1. *Actually, all of the activities we have been talking about are things that engineers do. A lot of girls today aren't interested in engineering. Why do you think that is the case?*
2. *If you were trying to convince a friend to become an engineer, what would you say?*

7. Sharing

1. *Now I want to know a bit about how you communicate with other people about your life. How do you keep in touch with other people? What technologies do you use?*
2. If she does not provide option, you can mention some of the ones below:
 - A. Talk on a phone (cell or land line)
 - B. Text message
 - C. E-mail
 - D. Facebook
 - E. Twitter
 - F. Instagram
 - G. Instant Message
 - H. Skype
3. *Which things do you do a lot? Which things do you rarely or never do? What are other ways you keep in touch or share your life with others?*
4. *Let's say that you learn something new and interesting at school*
Is that something you would share?
What if it's something that you had trouble understanding, or if you got a bad grade for that lesson?
Would you share if you were working on a big project but weren't finished with it yet?

Closing

Thank her for her help, and remind her that her answers will help us as we make a new exhibit.

Appendix C: Interview Guide for Adults

Interview Guide for Adults

Thanks for agreeing to talk to us! My name is _____ and this is my colleague, _____. I'd like to ask you a few questions, and _____ is going to take notes so we can remember what you say. If you have any questions or aren't sure about something, you can ask us, and you don't have to answer any question that you don't want to. There are no right or wrong answers. Some of the questions will ask your opinion, and some we'll ask what you think your daughter's opinion might be. Your best guess is fine.

What is your daughter's age?

What is your race or ethnicity (optional)?

8. Web Activity

Props: Web Paper, activity word stacks

1. Pass out one web paper and one stack of activity words.

I want us to talk about different kinds of activities that people might do for fun or for part of their job. For example, some people like to plan things, and other people really like to draw. I'm interested to know which ones your daughter might be interested in doing, and what things don't sound like they would interest her at all. Your best guess is fine.

Each one of these papers has the name of an activity on it. I want you to read them and think about how appealing or interesting they might be to your daughter. Then place them on the web in front of you with the ones she would like most near the center, and the ones she would like least near the outside. We'll talk about your answers and then I will collect them from you.

Words:

<i>Plan</i>	<i>Write</i>
<i>Lead</i>	<i>Investigate</i>
<i>Draw</i>	<i>Create</i>
<i>Test</i>	<i>Design</i>
<i>Play</i>	<i>Make</i>
<i>Build</i>	

2. Give the adult time to complete the activity.

3. Ask the adult to explain which words they liked and which ones they didn't like (top/bottom 1-2).

What words are near the center of your web?

Why did you choose this word?

What about it makes you say that?

What words are near the outside?

What was unappealing about that word?

4. Collect the web, keeping the activity words intact until the note-taker has recorded the associated color from the web.

9. Engineering Brainstorm

Now I want us to do another activity, but this time think about a specific job—engineering.

What do you think engineers do as part of their jobs?

Is this something that your daughter would like to do? Why or why not?

Is this something that you think she could do if she tried? Why or why not?

Ask the adult where they learned about what an engineer does.

Where do you think you learned this about engineering?

Can you think of a place or person who may have taught you this?

Can you think of a TV show, book, movie, or some other place you may have learned this about engineering?

10. Picture Cards

Props: Large picture cards with figures and statements

1. Let's talk some more about different kinds of activities. I have six examples here on these picture cards, and I'll read through these with you. For example, this card says [...]. I want you to think about whether these are things that your daughter might want to do, things that sound fun or interesting for her.

2. After we go through them, I'd like you to pick 1-2 that would be most and least interesting to her. Take your time. Your best guess is fine.

3. One at a time, show and say the words on each card. Then give the cards to the adult and wait for them to put in their preferred order.

Cards:

A. I make water filters for people in other countries who don't have fresh, clean water.

B. I designed a solar powered house for my family.

C. I created an app that tells my friends when their favorite store is having a sale.

D. I developed a microchip that works with smartphones so people's pets never get lost.

- E. I build schools that are safer for people during earthquakes.*
- F. I invented a wheelchair that can climb stairs to help people get around easier.*

4. Ask the adult to talk through their answers with the goal **of identifying which elements are attractive**—specifically **who is being helped** or the **general topic of the activity**. Pose specific follow-up questions such as the example below:

I see that you picked “make schools safer during earthquakes.” What about that answer did you think your daughter would like? Is it that she would want to help her classmates? Or is she is interested in earthquakes?

5. Collect the Picture Cards, keeping them in order if the order wasn’t yet recorded by the note-taker.

11. Girls in Engineering Discussion

- 1. So, all of the activities we have been talking about are things that engineers do. A lot of girls today aren’t interested in engineering. Why do you think that is the case?*
- 2. If you were trying to convince your daughter to become an engineer, what would you say?*

12. Sharing

- 1. Now I want to know a bit about how your daughter communicates with other people about her life. How does she keep in touch with other people? What technologies does she use?*
2. If they don’t mention any specific, you may suggest some of these:
 - A. Talk on a phone (cell or land line)
 - B. Text message
 - C. E-mail
 - D. Facebook
 - E. Twitter
 - F. Instagram
 - G. Instant Message
 - H. Skype
- 3. Which things does she do a lot? Which things does she rarely or never do? What are other ways she keeps in touch or shares her life with others?*
- 4. What do you think about the different ways she shares with others, especially the different technologies?*

Closing

Thank the adult, and remind them that their answers will help us as we make a new exhibit.

A: I make water filters for people in countries that don't have fresh, clean water



B: I designed a solar-powered house for my family



Included here was an aerial-view photograph of five pairs of hands holding smartphones.

C: I created
an app that
tells my
friends when their favorite
store is having a sale



D: I developed a
microchip that
works with
smartphones so people's
pets never get lost

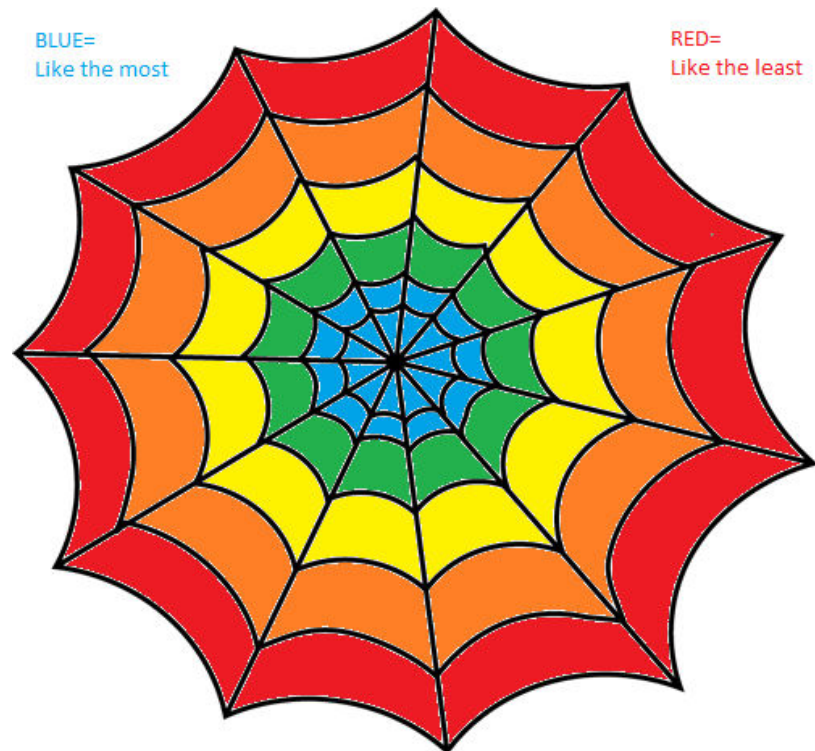
E: I build schools that
are safer for
people during
earthquakes



F: I invented a wheelchair
that can climb
stairs to help
people get
around easier



Appendix E: Web Activity



PLAN

LEAD

DRAW

TEST

PLAY

BUILD

WRITE

INVESTIGATE

CREATE

DESIGN

MAKE