AC 2011-917: WE-IMPACT- WOMEN IN ENGINEERING - IMPROVING PROGRAM ASSESSMENT TOOLS FOR OUTREACH AND RETENTION PROGRAMS

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WE-IMPACT- Women in Engineering - Improving Program Assessment Tools for Outreach and Retention Programs

Abstract

The Women in Engineering organizations at the Rochester Institute of Technology include Women in Engineering at RIT (WE@RIT) and Women in Technology (WIT). WE@RIT and WIT have programming to retain and recruit women into their respective engineering based educational programs. The ability to track data to assess the outcomes of their efforts is a critical component in determining individual program and overall organizational success. WE@RIT and WIT are working cooperatively to improve and expand the assessment framework of their outreach and retention programs. This paper focuses on two outreach programs for middle school girls run by WE@RIT and WIT: Park & Ride, a two day program for girls in grades 6-8 and Girls Technology Day for girls from 4th-7th grades. This paper outlines the analysis and enhancement of existing assessment tools used by two outreach programs. The improvement strategy includes integrating a social science based perspective on creating survey questions from intended behaviors and associated outcomes as well as through using age-appropriate language. In addition, a revised stream-lined approach including summative assessment and both indirect and direct measures is presented as an alternative to an existing cumbersome structure based heavily on formative assessment and indirect measures. Full program descriptions, desired outcomes, and past assessment results are included as case studies.

Introduction

Problem Overview

Unless the U.S. can attract more students to science, engineering, and technical fields, there will be a shortage of qualified workers for our increasingly technology-oriented society. Women make up 46 % of the available workforce, but only 9 % of engineers are women.[1,2] Additionally, the next generation of scientists and engineers will have to be innovative to quickly adapt to emerging technologies. Participation in the development of innovative technologies requires diverse perspectives.[3] With the continued success of recruitment and retention programs offered at the Rochester Institute of Technology and universities throughout the country, a greater percentage of women will graduate with engineering degrees and more women will view engineering careers as appropriate and appealing.

In an attempt to increase the number of engineers, many universities offer programs to recruit and retain students in their engineering programs. These programs are often offered by Women in Engineering (WIE) program coordinators and / or engineering faculty. The ability to track data to access the outcomes of these programs is a critical component in determining the success of these programs However, meaningful assessment of these programs is often lacking.[4] Challenges to meaningful assessment include: lack of expertise in the design and analysis of high-quality tools by program facilitators, lack of time to develop these tools, and lack of funding to cover time needed to develop these tools and analyze data.[5,6] Rigorous assessment is often required by agencies funding these activities.[7]

The assessment strategy described in this paper is based on Bandura's Social Cognitive Theory.[8] This theory has been used to support the use of strategies that develop self-efficacy in engineering related tasks to increase the motivation of young women to pursue careers in the engineering field.[9, 10, 11] Self-efficacy is ones belief that they have the capability of learning or performing actions at designated levels. As defined by Bandura, self-efficacy is "beliefs in one's capabilities to organize and execute the course of action required to manage prospective situations."[8] Strategies for improving self-efficacy include hands-on experiences, social persuasion: giving verbal encouragement, imitation-the use of mentors and role models, a supportive environment that includes activities with low levels of stress, and mastery experiences.[12, 13]

Women in Engineering Programs

WE@RIT and WIT have programming to retain and recruit women into their respective engineering based programs.

WE@RIT is dedicated to expanding the representation of women engineers and women leaders within the engineering profession. Founded in 2003, WE@RIT strives towards achieving gender parity within the Kate Gleason College of Engineering and hosts a comprehensive series of pre-engineering outreach, recruitment, and community building programs in support of this vision. In the past year, WE@RIT has hosted over twenty programs and over 2000 students (K-16 and graduate) and K-12 educators participate annually. Pre-engineering outreach programs target females in grades 4-12 and include [program name] (one day program, grades 4-5); [program name] (two day program, grades 6-8); [program name] (one day program, grades 8-10); Everyday Engineering Summer Camp (multi-week day camp series, grades 5-12); [program name] (9-week online course, grades 10-12); SWE Sleepover and Shadow Program (two day program, grade 11, hosted by SWE Student Section); Student to Student Recruitment Program (women engineering students visit home or local school districts to discuss engineering as a career option); and, [program name] in-class educational kits developed and taught by RIT engineering students, grade 6). In addition, [Program name] offers several programs designed for prospective, incoming, and current women engineering students including WE Retreat (overnight event, accepted engineering students); [program name] (four day pre-orientation event, incoming female engineering students); [program name] (off-campus corporate shadowing experience); [program name] ("interview" clothing library); and [program name] (frequent one hour sessions focused on career preparation, work-life balance, academic success, graduate studies, communication skills, etc.)

Assessment of the WE@RIT programs in the past has largely focused on outreach and recruitment offerings with identified audiences including participants, parents, and program volunteers who are female engineering students. The process begins with defining the desired outcomes for each program and creating survey instruments based on the outcome set for each targeted audience. Measures have been consistently indirect and formative, guiding program refinement in the past. The instruments are electronically administered and data analysis is conducted. After reviewing assessment results, survey questions responses are compared to linked outcomes to ensure achievement of each outcome. For longitudinal data analysis for

multiple offerings of the same program, it is important that there are consistent program outcomes for each offering and consistent survey question and responses for each offering. For longitudinal data analysis for multiple offerings of the programs within the same type (i.e. outreach, recruitment, and community building) there is the need to do the analysis across multiple programs. WE@RIT is in the process of improving the assessment framework through the addition of summative assessment and indirect measures while expanding assessment to include a more useful participant tracking system.

The goals of the Women in Technology group at RIT are to promote communication and networking among students, staff and alumni; develop and execute programs to recruit girls and retain women in science and technology; provide mentoring for freshmen, shadowing with alumni for upperclassmen and licensure and exam preparation for graduates; and form partnerships with organizations (educational, professional, community and youth), businesses and corporations to assist in introducing women to the various opportunities in science and technology. In support of these goals, WIT has series of programming initiatives to meet these goals that include recruiting events, professional skills development workshops, academic support, industrial tours, networking events with engineering professionals, community building social activities, and outreach activities for 6^{th} -12^{th} grade students. This paper describes one outreach activity aimed at 4^{th}-7^{th} grade girls.

WIT is a relatively new program, founded in 2005. Until fall of 2009, the programming was developed and implemented solely by faculty. Although passionate about the program, the faculty did not have the time to fully develop an assessment strategy and framework for the program. Assessment strategies have been limited and not clearly linked to overall program goals. Examples of assessment used by WIT include tracking retention of the female students in the Engineering Technology program and academic performance. A climate survey was given in Spring of 2007 and 2010 based on a modified version of the Assessing Women in Engineering's Longitudinal Assessment of Engineering Self-Efficacy used by Purdue University's Engineering Technology program.[14]

For the Girls Technology Workshop, a short survey (included in the Appendix) was developed to measure the girls' attitudes towards science, understanding of engineering and interest in pursuing a career in this field. An effort was made to keep the survey short and easy to comprehend. Paper surveys have been used and compiled by a student worker. Hand entry of data can lead to challenges with analysis because of misspellings and other entry errors. No longitudinal data has been analyzed. Volunteers are also surveyed using a modified version of the AWE's "PDQ Leader Survey" from the Assessing Women in Engineering (AWE) project (http://www.engr.psu.edu/awe/.org).[15] This tool measures the volunteer's agreement with statements regarding connections made with other students and faculty, a fuller understanding of their major, and their viewing their participation as a positive experience. These factors have been reported to correlate to increased retention of engineering students. [16, 17]

In the fall of 2009, WIT hired a part-time program coordinator and in the summer of 2010 a faculty member was given release time to serve as the director of the program with the task of developing and growing the WIT program. A goal of the Women in Technology program for the 2010 academic year was to develop a comprehensive list of program desired outcomes for the programs that are linked to the overall goals of the WIT program. This task led to collaboration

with the other women in engineering program at the same institution, WE@RIT, who was also in the process of reviewing and improving their assessment framework.

Assessment Development

This section details steps taken to improve the overall assessment framework of the women in engineering programs and assessment tools. This step was done collaboratively with guidance from a professional evaluation consultant and an assessment expert at our institution. The new assessment strategy and assessment tools will be adopted and implemented by both programs.

Matching measures and specific items most appropriate for any given program requires specifying an evaluation logic model that is based on theory and/or knowledge of the behavior being addressed, i.e. pursuing education and careers in STEM. The WE@RIT has specified a basic logic model shown in Figure 1. This model assumes that young women who are introduced to science will have an interest in STEM and gain knowledge and competency about STEM and STEM career options will commit to STEM education and pursue STEM careers.

The behavioral logic model also specifies a number of variables that have been shown to influence each of the major areas of the model. Interest is influenced by the individual's perceptions of norms related to science. For young girls the most notable is the persistent gender bias that portrays science as a male interest.[18] Parental attitudes as well as parental behavior, e.g. parent engagement in science, are also powerful potential influences.[19] Science knowledge and competency are influenced by access to effective science education. However, science education results in competence only when the student has sufficient self-efficacy to engage in education with an expectation of success. Similarly, pursuit of science careers requires access to education as well as self-efficacy.

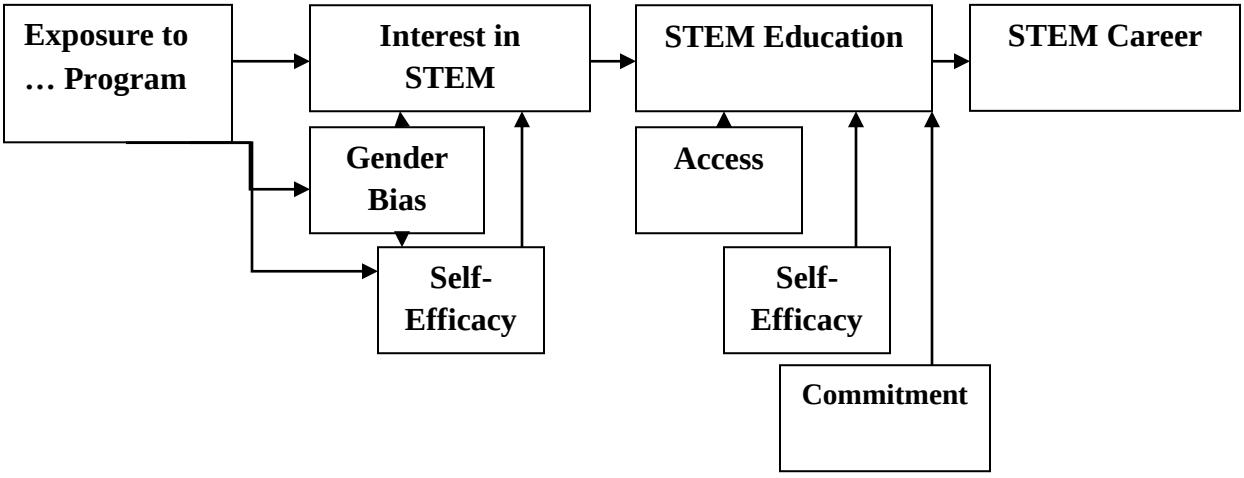

Figure 1: Basic Logic Model for Assessment Development

WE@RIT and WIT's programs are intended to influence young women's attitudes about science by providing access to educational opportunities that promote interest in science, a sense of self-efficacy related to success in science and knowledge of and experience with science. Measures

have been identified for various components of the logic model. Interest in science, attitudes related to interest, e.g. gender bias, and self-efficacy can be measured with surveys and one-on-one or focus group interviews.[20,21] Commitment to science education and/or careers can generally not be observed or measured within the time and resource restraints of the program. However, social scientist often use "behavioroid" measures, that is, a measure of commitment that more than an expressed attitude but not an immediately observed behavior.[22] Unlike attitudinal measures, e.g. checking yes to a survey item, "I would like to attend more science education", behavioroid measures entail a commitment to a behavior such as signing up for an actual future training.

The improvement strategy includes integrating a social science based perspective on creating survey questions from intended behaviors and associated outcomes as well as through using age-appropriate language. In addition, a revised stream-lined approach including summative assessment and both indirect and direct measures is presented as an alternative to an existing cumbersome structure based heavily on formative assessment and indirect measures. WE@RIT and WIT worked on this development collaboratively and in the future will both use the same assessment strategy and tools.

There were several motivators for this refinement activity including ensuring that outcomes had clear measures defined, enhancing the ease of data analysis, improving the readability of surveys, and shortening surveys for administrative ease. Refinement began with reviewing WE Build (outreach programs for grades 4-5) surveys and mapping every question on the survey to a learning outcome. For learning outcomes that did not have at least one question, new questions were created. WE Build surveys were compared to Park & Ride surveys because that program had the most established set of participant, parent, and volunteer surveys. Question responses included more multiple choice or Likert scales to improve readability and reduce completion time. All Likert scales were also revised to incorporate consistent scales and ordering. This improved both survey use and data analysis. Using these enhancement measures, all four WE Build surveys (participant pre- and post-, volunteer post and parent post) and Park & Ride surveys were updated and revised.

Revised surveys were shared with both a social scientist specializing in K-16 evaluation and a university assessment expert. The social scientist provided feedback on question wording and content. The assessment expert looked at the WE@RIT overall assessment structure and provided guidance on how to make the process more sustainable and practical. During the creation of program offerings formative assessment is helpful in program refinement in order to meet intended learning outcomes. However, due to the number of programs offered and the longevity of most of the programs, the WE@RIT organization was becoming overloaded with data which showed nearly constant input. The expert also pointed out that the number of goals, outcomes, and questions was burdensome. A stream-lining effort was recommended to decrease goal, outcome, and question count; incorporate summative assessment strategies; and add direct measures where practical.

During this overall assessment refinement process, the WE@RIT organizational mission was restated as *WE@RIT expands the representation of women engineers and women leaders within the engineering profession*. Organizational goals were reduced in number (from four to three) and are listed in Table 1. Table 1 also includes a mapping of goals to a significantly reduced set

of learning outcomes which are intended to be comprehensive for all target audiences (participants, parents, volunteers, etc.) across all offerings (outreach, recruitment, and community building). Information is provided in Table 1 regarding methods and measures. Figure 2 includes relevant information from Table 1 in regards to the Park & Ride outreach program with questions included.

Table 1: WE@RIT Goals Mapped to Outcomes, Method(s) and Measures

Goals and Outcomes	Methods	Measures
Goal 1: Explore the engineering experience		
Outcome 1: Enhance understanding of engineering profession	**Indirect -** Participant surveys	Pre/Post-survey (track responses from pre to post): Participants are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) Add additional descriptive text saying that there is no right or wrong answer; we just want their opinion of how they feel about engineering. • Engineers work on things that change the world. • Engineers are professional problem solvers. • Engineers make a big salary. • Engineers get to work with great people. • Engineering is a team effort. • Engineers have lots of career options and can work anywhere. • An engineering degree is good preparation for many different careers. Post-survey: • What types of engineers work with *add program specific context based on outreach program such as "robots and computers".* Provide several options including erroneous options to determine if participants can recall types of engineering that are relevant to the given context area (based on 5d). Consider open-ended responses for this question (per Rob Lillis feedback).
Outcome 2: Link math and science knowledge to engineering	**Direct -** Feedback from pre-engineering outreach program teaching team	• Complete rubric addressing student's ability to relate math and science knowledge to engineering related exercises. Rubric design to be informed through past survey question (6f).
Outcome 3: Develop skills essential for engineering	**Direct-** Feedback from pre-engineering outreach program teaching team	• Complete rubric(s) addressing the student's demonstrated skill development during the pre-engineering outreach program. Rubric(s) related to teamwork, communication, logical reasoning, problem solving, and/or design may be completed based on program age level and focus. Rubric design informed through past relevant survey questions.
Goal 2: Progress towards an engineering career		
Outcome 1: Understand pre-requisite knowledge necessary for	**Indirect**- Participant and parent surveys	Pre/Post-survey (track responses from pre to post): Participants are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • I think it is important to take math and science classes to prepare for a career in engineering (based on 4a).

admittance into engineering		• I understand what the math and science requirements are for admittance into RIT's engineering programs (new). • Do you plan on taking these courses in high school (based on 5c)? Parent Post-survey: Parents are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • I think it is important to take math and science classes to prepare for a career in engineering (based on 4a). • I understand what the math and science requirements are for admittance into RIT's engineering programs (new).
Outcome 2: Build interest in pursuing a degree and career in engineering	**Indirect**- Participant and parent surveys	Pre/Post-survey (track responses from pre to post): Participants are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • I am interested in studying engineering in college. • I like learning about engineering (16c, 16g, 8c). • I know about pre-engineering courses offered at my school (new). • If available, I will enroll in pre-engineering courses at my school (based on 5d). • I know about team-based design/build clubs in my school (new). • If available, I will join a team-based design/build club at my school (new). • In the future, I want to be an engineer (14g) Participant Pre-survey: • Do you know any engineers… • Have you attended other science, math, or engineering programs in the past? Note: This information helps better understand any intervening variables, per Rob Lillis feedback. Participant Post-survey: Participants are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • I will recommend that my friend(s) attend this program in the future (12a). • I will participate in another pre-engineering outreach program like this one in the future (based on 16e). • I plan on coming to summer camp (or the next outreach offering). If agree – check box to hold spot and receive more info via mail. Note: This "behavioroid" measures a commitment to action and not just an attitude, per Rob Lillis feedback.
	Direct - Demographics	Parent Post-survey: parents are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • I know about pre-engineering courses offered in our school district (new). • I know about team-based design/build clubs offered in our school district (new).

		• Participation counts for outreach programs • Gender diversity within incoming engineering class
Outcome 3: Achieve academic success in engineering	**Direct -** Engineering student data **Indirect -** Volunteer surveys (post)	• GPA for engineering students by gender, department, major, and year level. • Retention rates for engineering students by gender, department, major, and year level. Volunteer Post-survey: Volunteers are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • Participation in this program increased my confidence in my ability to solve problems. • Participation in this program strengthened my interest in pursuing a career in engineering.
Goal 3: Engage and excel within an engineering community		
Outcome 1: Connect with an engineering community	**Indirect -** Participant and volunteer surveys	Pre/Post-survey (track responses from pre to post): Students are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • I feel connected to the KGCOE community.
Outcome 2: Seek mentoring opportunities	**Indirect -** Participant and volunteer surveys	Pre/Post-survey (track responses from pre to post): Students are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • Serving as a role model is beneficial in developing self-confidence. • I see value in an experience that requires me to serve as a mentor. • When I serve as a mentor I learn things about myself. • I recognize that mentors can provide me with valuable advice and guidance. • Teaching others strengthens my understanding of the subject matter. Volunteer Post-survey: • What motivated you to volunteer for this event? (open-ended) Volunteers are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • I will recommend to a friend that she/he volunteer for this event in the future. • I will volunteer for other pre-engineering outreach programs in the future.
Outcome 3: Develop leadership abilities	**Indirect -** Volunteer surveys	Pre/Post-survey (track responses from pre to post): Volunteers are asked to answer the following using a 5-point likert scale (Strongly Agree to Strongly Disagree) • I am confident in my ability to lead others. • I look for opportunities to lead others during my college experience. • I am confident in my technical communication abilities. • My participation in this program gave me a positive experience that when shared will highlight my skills during a job interview. (only on post)
Outcome 4:	**Indirect**	Participant Post-survey:

Create awareness of advanced engineering education and research opportunities	Participant surveys	Participants are asked to answer the following yes/no and open-ended questions • Are you planning on pursuing an advanced degree? • If so, will you pursue the advanced degree in engineering? • Have you participated in an undergraduate research experience (paid or unpaid) at RIT? • If yes, please describe. • If no, are you interested in participating in an undergraduate research experience at RIT? • Do you know how to learn more about research opportunities at RIT?

Workshop Case Studies

This paper describes two outreach workshops as case studies. The Park & Ride workshop is run by WE@RIT and the Girls Technology Day is run by WIT. This description includes:

- An overview of the programs
- Typical program schedules
- Desired outcomes for participants and volunteers
- Participation history
- Past assessment results

Park & Ride

Park & Ride: Creative Robotic Design is pre-engineering outreach program designed for middle school girls who are at a critical age in deciding whether or not to choose an educational path that will enable them to pursue an engineering college degree. This two-day program provides girls with an opportunity to experiment with the physics of a roller coaster and learn fundamentals of teamwork before embarking on a lengthy design challenge involving the design, build, and programming of a Lego Mindstorms© NXT robots based on a prescribed set of customer requirements. Table 2 includes a detailed program schedule from the last offering of Park & Ride in January 2010. The participants of this program interact extensively with engineering undergraduate students, who serve as team mentors for each small group of girls during the program. The program also includes a parent informational session and invitation to watch the final design challenge. Park & Ride learning outcomes were created for the participants, parents, and volunteers as described in Table 3. Over eight offerings of this event have occurred since 2004 as described in Table 4, with overall participation of 295 middle school girls and 145 engineering students.

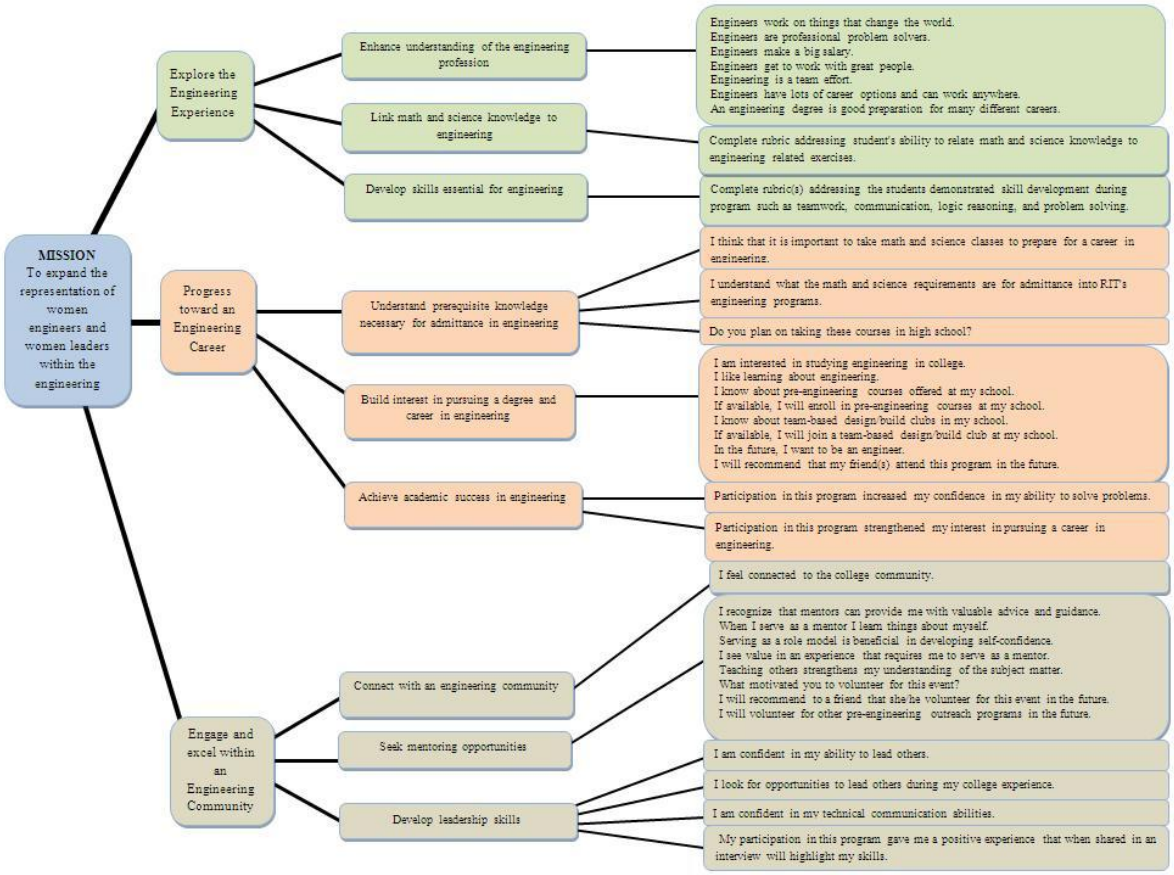

Figure 2: Park & Ride Revised Assessment Model

Table 2: 2010 Park & Ride Two Day Program Schedule

Day/Time	Programming
Saturday Morning	• Participant Pre-Survey • Icebreaker Questionnaire for participants to get to know each other • Introductions – Staff and Team Leaders • Program Overview • Physics of a Roller Coaster Intro • Introduce Engineering Design Process • Meet Team Leader and teammates (pre-selected in groups of 2-3participants determined by NXT skill level and age) • Physics of a Roller Coaster hands-on activity • Team Roller Coaster Construction w/challenges • Team demonstrations • Discuss Engineering Design Process and best practices for team work • Lego build session with partially built kits
Saturday Afternoon	• Lunch at Grace Watson Student Dining Hall • Robotics Lab Tour/demonstration • Learn NXT Software with Team Leader • Simple robotic challenges to navigate vehicle • Engineering Design Process with homework to "design" demonstration on Arena Schematic
Sunday Morning	• Overview of day • Teams collectively work to make one demonstration design • Design and Build utilizing Amusement Park Arena • Creative Demonstration design and build time
Sunday Afternoon	• Lunch w/ Team Leaders • Final design and build time for demonstration • Information session for parents • Creative demonstrations for families • Hand out Participant Folders

Table 3: Park & Ride Learning Outcomes for Participants, Parents, and Team Mentors

Audience	Learning Outcomes
Participants	• Build confidence in ability to solve problems. • Improve teamwork abilities. • Learn elements of the engineering design process. • Connect engineering with relevant societal impact. • Support understanding of math and science concepts using engineering as the context. • Enroll in curriculum necessary for admittance into engineering. • Promote participating in pre-engineering outreach experiences. • Become acquainted with a university setting. • Create experience that invokes participant interest in engineering. • Enhance understanding of engineering profession and discover career options within engineering. • Meet and work with female engineering role model. • Meet other females who are similar in age and who share similar interests. • Develop a future engineering student.
Parents	• Promote participating in pre-engineering outreach experiences. • Introduce parents to a university environment.

	• Develop interest in daughter becoming a future RIT student. • Enhance understanding of engineering profession and discover career options within engineering. • Learn curricular options available in high school within technology. • Understand importance and relevance of math and science classes.
Team Mentors (Engineering students)	• Build volunteer's confidence that they can persist in engineering. • Deepen understanding of engineering principles through teaching others. • Improve teamwork abilities. • Advance technical communication abilities. • Build confidence and leadership skills. • Improve ability to quickly solve problems as they may arise. • Participate in a positive, service-related experience. • Experience the value of being a role model to a younger student. • Promote participating in other pre-engineering outreach. • Build sense of community amongst RIT KGCOE students through volunteering.

Table 4: Park & Ride Past Participation History

Academic Year	# of Park & Ride Offerings	Participant Count	Volunteer Count
2003	1	12	7
2004	1	21	12
2005	1	36	18
2006	1	55	32
2007	2	83	29
2008	1	41	19
2009	1	47	28
Total	**8**	**295**	**145**

Past Assessment Results -*Park & Ride*

Formative assessment results from *Park & Ride* (n=41) held in January 2010 follow (see Appendix for extended list):

- Percentage of participants stating that engineers work mainly on machines and computers decreased from 41.5% to 35%.
- When asked "What is your first thought when faced with a new math, science, engineering, or computer problem?" those responding "Bring it on - I'm up for a challenge!" increased from 31.7% to 43.9%.
- 75% of participants agreed or strongly agreed that the program "Made me more confident in my ability to solve problems" and 70% thought that it "Increased my confidence in my ability to participate in engineering projects or activities."
- 67.5% of participants thought that participating in the program "Made me think more about what I will do after graduating from high school."
- 67.5% of participants reported the program "Increased my interest in studying engineering in college."

The program was perceived as high-quality with 87.5% of participants and 89.6% of their parents or guardians (n=29) recommending the program to a friend in the future. 86.2% of parents or guardians also reported that "My participant was excited to return on the second day."

All (100%) of the female engineering student volunteers (n=18) would recommend that a friend volunteer for this event in the future. The female engineering students who served as team mentors either agreed or strongly agreed to the following statements after participating in the event:

When asked "*my participation in this program*:"	Agree	Strongly Agree
Strengthened my understanding of engineering.	66.7%	5.6%
Led me to better understand my own career goals.	44.4%	11.1%
Strengthened my interest in engineering.	66.7%	27.8%
Made me more confident in my ability to solve problems.	72.2%	27.8%
Strengthened my technical communication ability	44.4%	55.6%
Increased my confidence in my ability to lead others.	33.3%	66.7%
Gave me a positive experience that will highlight my skills in an interview.	33.3%	61.1%
I met new friend(s) who are fellow engineering students.	22.2%	61.1%
I feel more connected to the KGCOE community.	61.1%	27.8%

When asked……	Agree	Strongly Agree
I would recommend that my friend(s) volunteer for this event in the future.	22.2%	77.8%
I am interested in volunteering for other pre-engineering outreach programs held through WE@RIT in the future.	22.2%	77.8%

In order to streamline the formative assessment structure which relied solely on indirect measures in the past for nearly all WE@RIT programs, efforts have been taken to reduce the number of program goals and outcomes and create an assessment strategy which is more manageable, sustainable, and effective. Progress made will be discussed in the Assessment Development sub-section.

Girls Technology Workshop

The Girls Technology Day is a day-long workshop offered to area Girl Scouts. The goal of the workshop is to increase the girls' interest in engineering. In support of this goal, hands-on experiments are carefully designed to: 1) show the girls that science can be both fun and creative 2) connect science and engineering to things in everyday life that they already know and care about 3) demonstrate that women can make a positive impact on the world with a career in engineering. WIT is currently surveying past participants to see if the increased positive perception is maintained over time.

Women in Technology has hosted a Girl Technology Workshop 2-3 times per year since the 2008 academic year. This workshop is led by female Engineering Technology students with support from female faculty members. The workshop introduces engineering concepts to 4^{th} -7^{th} grade girls through a series of interactive laboratory experiments. The day-long workshops were originally exclusively offered to area Girl Scouts. The benefits of working with this group

include girls could attend the event with friends and girls who are not already predisposed to finding science and engineering interesting may attend because their troop is attending. In 2011, the workshop is now offered to any girl in the 4^{th}-7^{th} grade on a trial basis. This was done to broaden the availability of the camp beyond girls involved in scouting.

The workshops take place on the college campus and make use of four different Engineering Technology laboratories. The girls spend one hour in each lab where they are presented with an overview of that particular engineering technology field and a brief description of the theory behind the experiment that they will be performing. Registration is limited to 48 girls. The group is broken down into four groups of twelve. It is important that the ratio of volunteers to girls is 1 to 2 or 1 to 3 so that the girls receive a great deal of individual attention and none are forced to spend much time waiting for somebody to help them. If the girls have to wait for help and become frustrated, they will form negative feelings about the activities.

The college students who volunteer their time for the program also benefit from their participation. The students gain the satisfaction of influencing the attitudes of the girls as well as developing a sense of community with their fellow students and faculty in their departments. The students improve their communication skills and increase their knowledge of their own majors, both of which contribute to self-confidence.

An example of one laboratory session is a workshop held in the Mechanical Engineering Technology's Plastics testing lab. A plastics experiment involves running a tensile test on plastic test bars. The girls are allowed to decorate the tensile bars before stretching them. The speed at which the bars are pulled apart is varied so the students can see that speed (strain rate) changes the behavior of the material. Plastics that are pulled slowly are more ductile but not as strong. Plastics pulled quickly behave in a brittle fashion but are stronger. The student volunteer explains how these mechanical properties of ability to stretch (ductility) and strength (ultimate tensile strength) play a role in product design. More details about the Girls Technology Day are presented in the paper "Increasing Girls' Interest in Engineering by Making it Fun".[23]

The assessment used for the Girls Technology Workshop is an opinion survey given before and after the one-day workshop. The survey consists of five simple questions that assess their (1) perception of the difficulty of science, (2) their interest in science (boring or fun), (3) their knowledge of what an engineer does, (4) their idea of which gender an engineer is and (5) whether their interest is in pursuing science or engineering as a career. The hypothesis being explored is if the participants are inspired by the activities during the program, they may be more likely to pursue a degree and a career in engineering or science.[24]

Table 5 includes a typical schedule for the Girls Technology Workshop.

Table 5: 2010 Girls Technology Workshop One Day Program Schedule

Day/Time	Programming
10:00 am	• Participant Pre-Survey • Introductions – Staff and Team Leaders • Program Overview
10:15-11:10	• Session 1: Students rotate through a series of four workshops • Example: Packaging Science workshop- making a box using a 2D automated cutting table

11:10-12:00	• Session 2 • Example: Civil Engineering Technology Workshop: cement and spaghetti bridges
12:00-12:30	• Lunch
12:30-1:20	• Session 3 • Example: Mechanical Engineering Technology Workshop: Plastics: slime and shrinkable plastics
1:20-2:10	• Session 4 • Example: Electrical Engineering Technology Workshop: Building a motor
2:15-3:00	• Post survey • Panel session • Closing

Table 6: Girls Technology Workshop Outcomes for Participants, and Team Mentors

Audience	**Outcomes**
Participants	• Create experiences that are engaging ('fun") • Create experiences that demonstrate science and engineering is not always difficult • Increase interest in science and engineering • Enhance understanding of engineering profession • Promote the understanding that anyone can be an engineer and the field is not limited to men • Determine impact of student interest and perceived ease of science on desire to pursue a career in science or engineering
Student Volunteers (Engineering Technology students)	• Deepen understanding of engineering principles through teaching others. • Participate in a positive, service-related experience. • Experience the value of being a role model to a younger student. • Promote participating in other pre-engineering outreach. • Build sense of community amongst RIT WIT students and faculty through volunteering.

Table 7: Girls Technology Workshop Past Participation History

Academic Year	**# of Girls Technology Workshop Offerings**	**Participant Count**	**Volunteer Count**
2007	1	31	18
2008	3	109	36
2009	3	119	41
2010	1	44	20
Total	**8**	**303**	**115**

Past Assessment Results-*Girls Technology Workshop*

Formative assessment results from Girls Technology Workshop (n=259) held through spring of 2009 follow. Note that full statistically analyzed results were presented at the American Society of Engineering Educators Annual Conference in 2010. [23]

- The percentage of participants indicating science was hard or very hard decreased from 46.8 % to 30 %
- Most participants perceived the difficulty of science as "neither hard nor easy" with a statistically significant increase in respondents answering easy as compared to the pre-survey
- Participants reporting that they "definitely knew" what an engineer does increased from17.2 % to 51.9% with a total of 92 % indicating they "think they knew" or "definitely knew"
- After the workshop, 77.4 % of the participants reported an interest in becoming a scientist or engineer (maybe or definitely yes) compared to 61.2 % before the workshop.
- A positive correlation (Pearson's correlation coefficient of 0.41) was found between the girls' opinion of science as being "fun" and their attraction to becoming a scientist or engineer

Key findings from the assessment of the college volunteers indicated:

Survey question	Agree	Neutral
I have made a connection with one or more females in my department	83%	17%
I have made a connection with one or more females in another Engineering Technology Department	65%	26%
I have made a connection with one or more female faculty members	67%	13%
I have a better understanding of my major	48%	48%
I plan to participate again	95%	5%
Participating was a positive experience for me	96%	4%

When asked to provide an (optional) comment on the benefits of participation, 96% of the respondents chose to provide feedback. Approximately one-half of the comments related to making an impact and the mentoring experience with the Girl Scouts:

- *I feel like we've made a difference in how the Girl Scouts we've worked with view engineering.*
- *Participating in the WIT Girl Scout events is a chance to help young girls realize the possibilities they have if they decide to pursue a future in the technological field.*
- *I just like volunteering and giving back - it makes me feel right at home.*

The other half of the comments related to the importance of these activities in community building. Sample comments include:

- *This has given me a chance to meet girls in different years than my own, something that I probably would not have been able to do otherwise*

- *It was nice to be in a relaxed setting with other females in my major. We bonded and made instant friendships. It helped me find friends in my major.*

Full results of assessment of participants and student volunteers for the Girls Technology Workshop can be found in the Appendix.

Conclusions

WE@RIT and WIT have presented a revised stream-lined approach to assessment of Women in Engineering (WIE) programs. This stream lined approach includes summative assessment and both indirect and direct measures. This approach is presented as an alternative to an existing cumbersome structure based heavily on formative assessment and indirect measures. This work can aid future developers of WIE programs as they seek to design effective assessment frameworks and strategies for their programs.

Acknowledgement

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APPENDIX

Full Park & Ride Assessment Results from 2010

Participants (n=41): instruments – pre and post event survey

When asked "*Read the following statements about what engineers might do and indicate your agreement or disagreement with each statement*:"	**Agree Pre-survey (%)**	**Agree Post-survey (%)**
Engineers……		
mainly work on machines and computers	41.5%	35%
mainly work with other people to solve problems	53.7%	47.5%
work on things that help the world	80.5%	82.5%
can choose to do many different kinds of jobs	68.3%	70%
mainly work on things that have nothing to do with me	9.8%	7.5%

	Bring it on - I'm up for a challenge!	**This is a little scary, but I think I can figure it out.**	**I'm not so sure about this - maybe I should get somebody else to do it...**	**I'll never figure this out!**
What is your first thought when faced with a new math, science, engineering, or computer problem?	31.7% Pre-survey 43.9% Post-survey	63.4% Pre-survey 51.2%Post-survey	4.9% Pre-survey 0% Post-survey	0% Pre-survey 0% Post-survey

When asked in the POST event survey "*my participation in this program*:"	**Agree**	**Strongly Agree**
Led me to a better understanding of my own career goals.	45%	12.5%
Increased my interest in studying engineering in college.	47.5%	20%
Made me think more about what I will do after graduating from high school.	40%	27.5%
Made me decide to work harder in school.	42.5%	20%
Made me decide to take different classes in school (including college) than I had planned to.	32.5%	17.5%
Made me more confident in my ability to solve problems.	55%	20%
Increased my confidence in my ability to participate in engineering projects or activities.	45%	25%

When asked in the POST event survey….	**Agree**	**Strongly Agree**
I would recommend that my friend(s) come to this event in the future.	45%	42.5%

Engineering Student (n=18): instrument – post event survey

Year Level:	**1**	**2**	**3**	**4**	**5**	**grad**
% (count)	44.4%(8)	22.2%(2)	11.1%(3)	5.6%(1)	0	16.7%(3)

When asked "*my participation in this program*:"	Agree	Strongly Agree
Strengthened my understanding of engineering.	66.7%	5.6%
Led me to better understand my own career goals.	44.4%	11.1%
Strengthened my interest in engineering.	66.7%	27.8%
Made me more confident in my ability to solve problems.	72.2%	27.8%
Strengthened my technical communication ability	44.4%	55.6%
Increased my confidence in my ability to lead others.	33.3%	66.7%
Gave me a positive experience that will highlight my skills in an interview.	33.3%	61.1%
I met new friend(s) who are fellow engineering students.	22.2%	61.1%
I feel more connected to the KGCOE community.	61.1%	27.8%

When asked……	Agree	Strongly Agree
I would recommend that my friend(s) volunteer for this event in the future.	22.2%	77.8%
I am interested in volunteering for other pre-engineering outreach programs held through WE@RIT in the future.	22.2%	77.8%

Participant Parent (n=29): instrument – post event survey

When asked……	Agree	Strongly Agree	Didn't Know or Answer
My participant was excited to return on the second day.	37.9%	48.3%	3.5%
My participant gained enthusiasm about engineering through participating in this program.	37.9%	31.0%	17%
I enjoyed the design demonstration.	24.1%	51.7%	20.7%
I would recommend that my friend(s) send their child to this event in the future.	31.0%	58.6%	3.5%
I am interested in sending my participant to pre-engineering outreach programs held through WE@RIT in the future.	31.0%	55.2%	10.4%

	Meets Expectations	Exceeds Expectations	Didn't Know or Answer
Please give your overall rating of the program.	41.4%	48.3%	6.9%

Girls Technology Workshop – Assessment Tools

Girls Technology Workshop: Pre-survey

I think science is…..

Very hard	Hard	Easy	Very easy

I think science is….

Always boring	Sometimes boring	Sometimes fun	Always fun

Most engineers and sceintists are….

Men	Women	I'm not sure	Anyone can be an engineer

I know what an engineer does…

I don't know	I am not sure	I think I know	I definitely know

I would like to become an engineer or scientist someday…

Definitely not	I don't know	Maybe	Definitely yes

I know someone who is an engineer. How do you know this person?

Girls Technology Day Post-Survey

Same as above except last question is removed.

Girls Technology Workshop Results

Participant <u>before</u> Program Responses

KEY:	I think science is:	I think science is:	I know what an Engineer does	Most Engineers and Scientists are:	I'd like to become a Scientist or Engineer	Someone I know is an Engineer or Scientist
1	very hard	Boring	I don't know	men	definitely not	no
2	sometimes hard	neither boring nor fun	I'm not sure	women	I don't know	not sure
3	neither hard nor easy	sometimes fun	I think I know	I'm not sure	Maybe	yes
4	easy	always fun	I definitely know	anybody can be an engineer or scientist	definitely yes	
1	1.31%	1.31%	9.15%	11.76%	12.42%	27.34%
2	47.06%	1.96%	15.03%	0.65%	27.45%	44.53%
3	39.87%	53.59%	59.48%	10.46%	50.98%	46.88%
4	11.76%	43.14%	16.34%	77.12%	9.15%	----

Participant <u>Before</u> Program Responses

I think science is:		*I think science is:*		*I know what an Engineer does*		*Most Engineers and Scientists are:*		*I'd like to become a Scientist or Engineer*		*Someone I know is an Engineer or Scientist*	
Mean	2.621	Mean	3.386	Mean	2.830	Mean	3.529	Mean	2.569	Mean	2.176
Standard Error	0.057	Standard Error	0.048	Standard Error	0.065	Standard Error	0.080	Standard Error	0.067	Standard Error	0.064
Standard Deviation	0.707	Standard Deviation	0.597	Standard Deviation	0.809	Standard Deviation	0.987	Standard Deviation	0.825	Standard Deviation	0.787
Sample Variance	0.500	Sample Variance	0.357	Sample Variance	0.655	Sample Variance	0.974	Sample Variance	0.681	Sample Variance	0.620
Kurtosis	-0.573	Kurtosis	1.617	Kurtosis	0.366	Kurtosis	2.340	Kurtosis	-0.392	Kurtosis	-1.177
Skewness	0.467	Skewness	-0.767	Skewness	-0.735	Skewness	-1.975	Skewness	-0.400	Skewness	-0.242

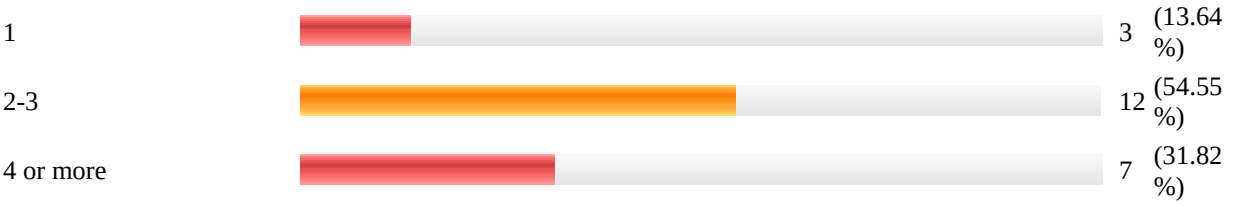
Participant <u>After</u> Program Responses

KEY:	I think science is:	I think science is:	I know what an Engineer does	Most Engineers and Scientists are:	I'd like to become a Scientist or Engineer
1	very hard	Boring	I don't know	men	definitely not
2	sometimes hard	neither boring nor fun	I'm not sure	women	I don't know
3	neither hard nor easy	sometimes fun	I think I know	I'm not sure	Maybe
4	easy	always fun	I definitely know	anybody can be an engineer or scientist	definitely yes
1	0.00%	0.63%	0.63%	5.63%	5.63%
2	31.88%	3.13%	5.63%	0.00%	17.50%
3	44.38%	32.50%	39.38%	2.50%	62.50%
4	23.75%	63.75%	54.38%	91.88%	14.38%
Change from Pre-Post					
1	-1.31	-0.68	-8.53	-6.14	-6.79
2	-15.18	1.16	-9.41	-0.65	-9.95
3	**4.51**	-21.09	-20.10	-7.96	**11.52**
4	**11.99**	**20.61**	**38.04**	**14.75**	**5.22**

Girls Technology Workshop- Volunteer Survey and Results

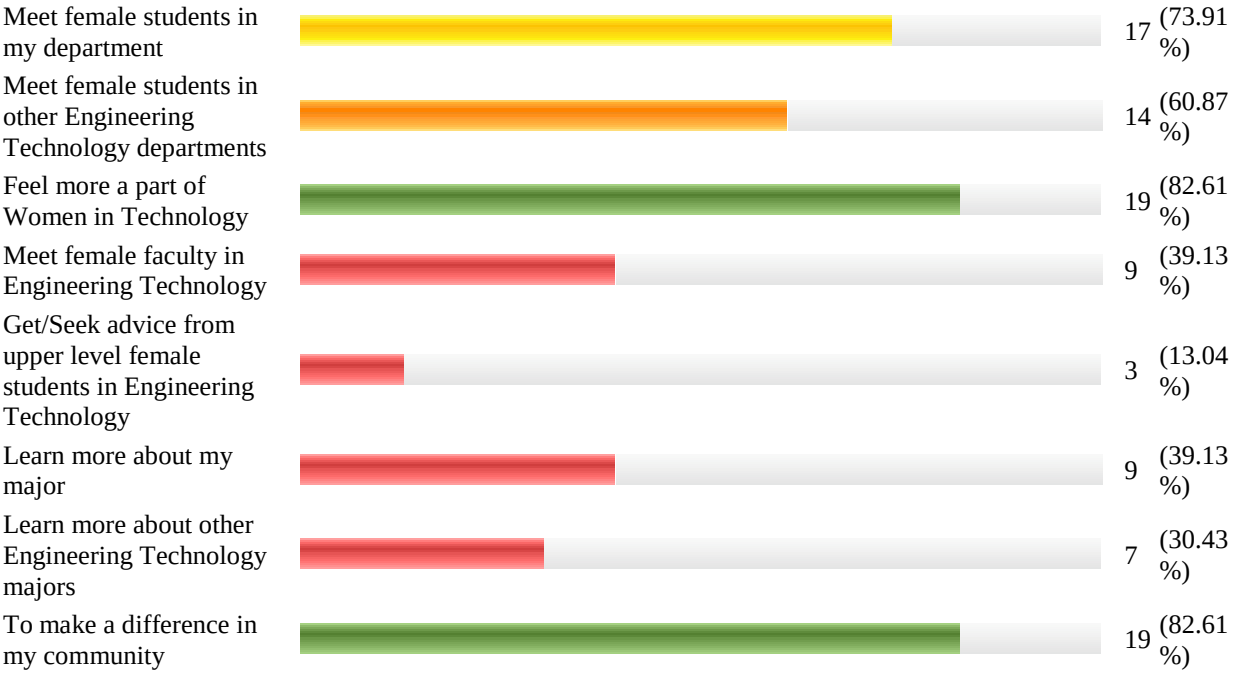
Volunteer Results: (n=23)

Question 1 How many Girl Technology Workshop days have you participated in?



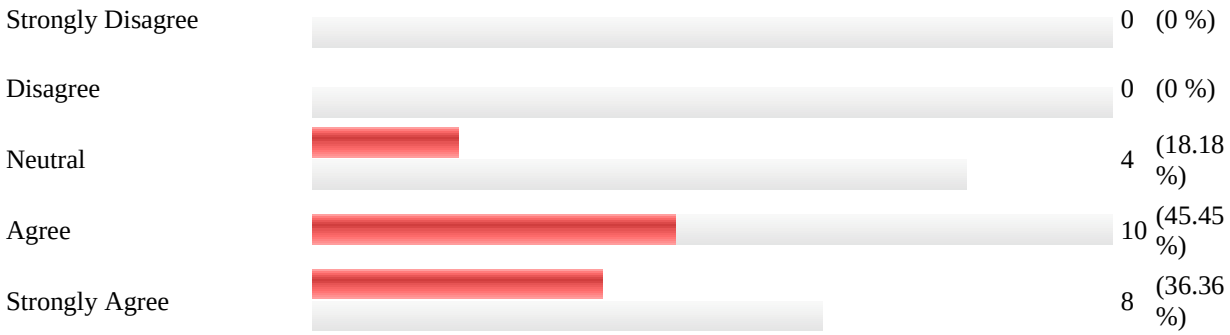
Number of Responses: 22

Question 2 What were your goals in participating in the Girl Technology Workshop? (check all that apply)

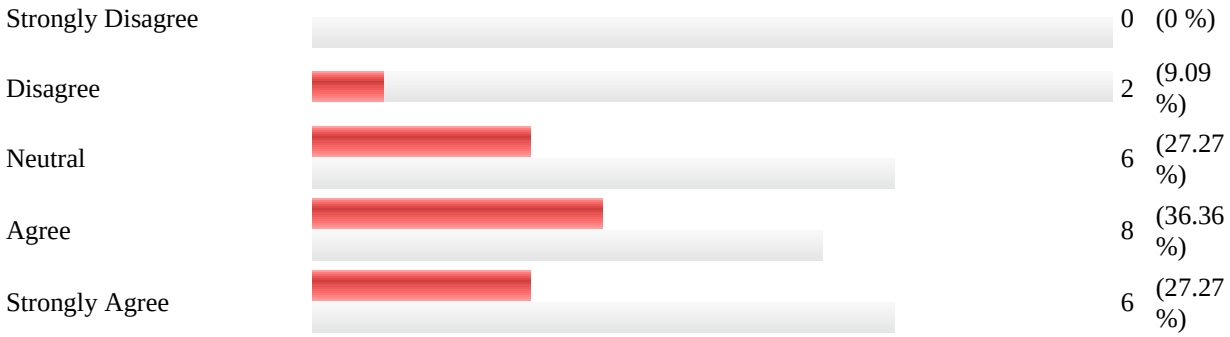


Question 3 For each of the questions below please indicate your level of agreement

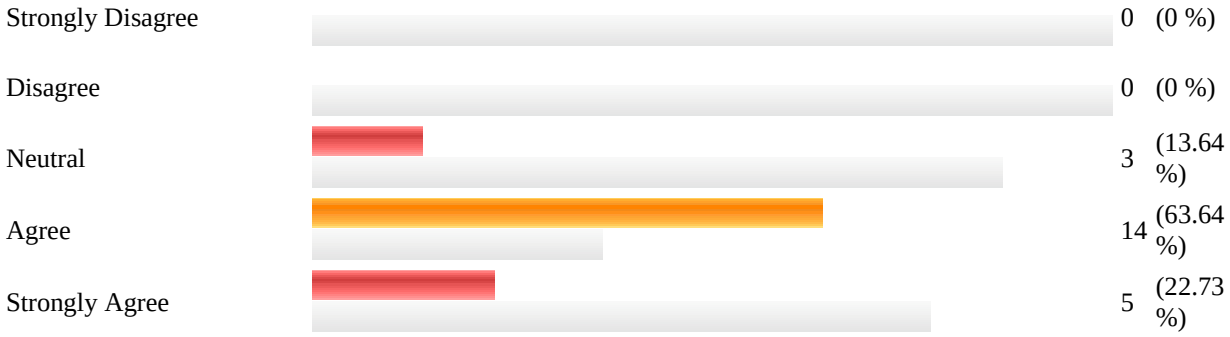
Through participation in the Girl Technology Workshop I have made a connection with one or more female students in my department



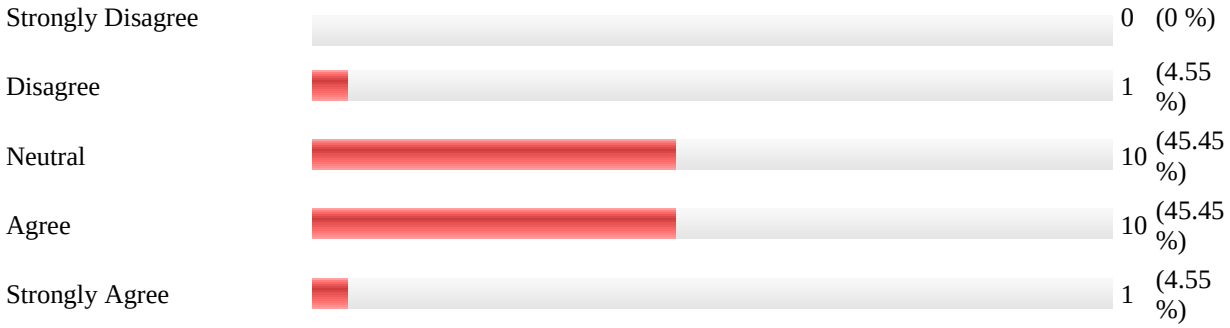
Through participation in the Girl Technology Workshop days I have made a connection with one or more female students in another Engineering Technology Department



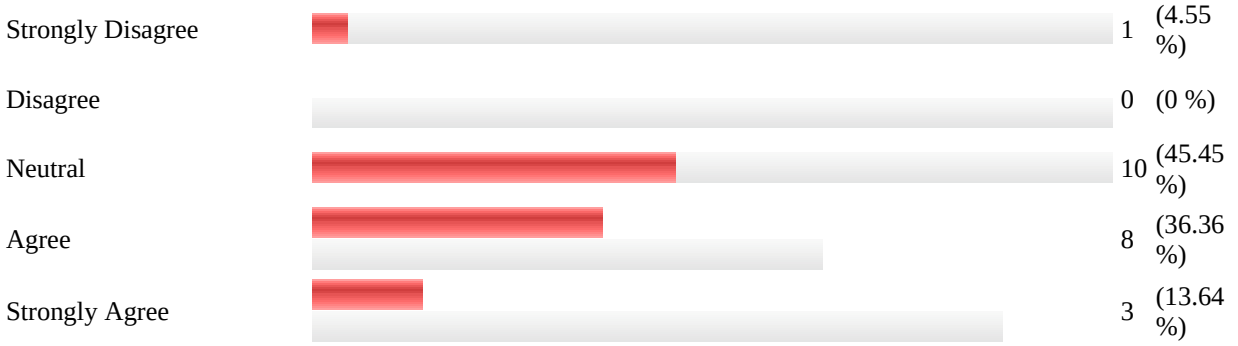
Through participation in the Girl Technology Workshop days I have made a connection with one or more female faculty members



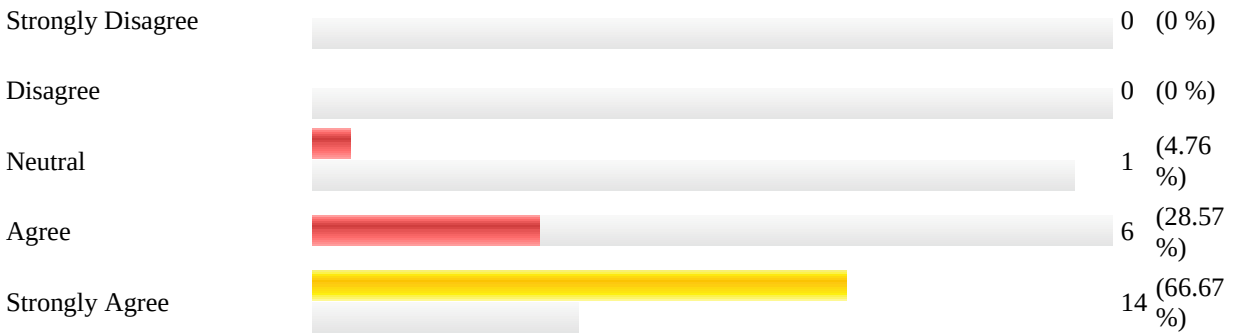
Through participation in the Girl Technology Workshop I have a better understanding of my major



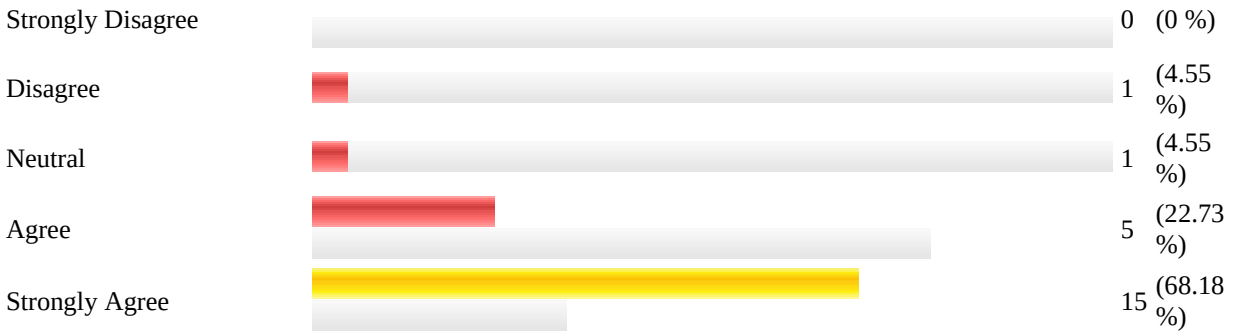
After participating in the Girl Technology Workshop I feel more confident speaking in front of a group



I plan to participate in the Girl Technology Workshop again



Participating in the Girl Technology Workshop was a positive experience for me



Question 4 Please comment on how participating in the Girl Technology Workshop has benefited you the most

- I love being able to encourage young girls to pursue a technical degree if that is what they desire. Even after so many years, technology fields are still believed to be a "Man's Field" and there is no reason for females to feel discouraged about pursuing what they'd like to do.
- This has given me a chance to meet girls in different years than my own, something that I probably would not have been able to do otherwise.
- It was great to give these girls an opportunity to check out majors in things that they have not considered. Most of the majors in the Engineering Tech program and not often publicized in schools, this gave these girls a chance to see what majors like packaging science are all about.
- It is fun and makes me feel more well rounded within my major.

- I got free cookies.
- I feel like we've made a difference in how the Girl Scouts we've worked with view engineering. I hope the girls feel that engineering is a less foreign and more realistic field than they did before participating in the Girl Scouts in Technology day.
- I think the biggest benefit was getting a chance to encourage younger females to enter the sciences. It was also good to learn to speak in front of a much younger group of people.
- It was great to see that young girls are interested in Engineering. I wanted to show them that it is not boring and can be a lot of fun.
- This program has been very beneficial. I'm able to work closely with other female engineering students and female faculty members. As a predominantly male field, it's nice meeting and getting to know other women in engineering. It's fun talking to older civil engineering students and getting their perspective on the major and hearing their opinions of classes and professors. By participating in the program, I'm given the chance to educate and interest young girls in the field on engineering. These girls need to grow up knowing that women, along with men, can become engineers too.
- It was neat to get the younger girls interested in an engineering major, and introduce them to things they may have never found out about.
- It's great to see these girls excited about engineering, and what they are learning.
- It's slowly helping me build leadership skills and allowing me to work with kids, which I love. The program is also allowing me to meet other girls in CAST.
- it was a good experience to meet other female students from the department
- I have volunteered to help with the girl scout days a few times. Every time is a little different and it lets me be more creative with applying my major to a different age group in order to get them involved. I like being creative with my major and getting others enthused as well.
- It has helped me get involved with the community as well as help with my public speaking. Also it has helped me with time management between events for the girl scouts and it has allowed me to creatively explore my own major to come up with different activities for the girl scouts. I can show them what conceptual components of my major are applied every day in real life applications.
- I just like volunteering and giving back. It just makes me feel right at home.
- I enjoy helping others in anyway I can. I feel that Girl Scouts in Technology day opens up a new avenue for me to help, in which otherwise I most likely would not have had the opportunity to do so.
- This event helped me to meet other female students, as well as I had a wonderful time with young girls
- It was nice to be in a relaxed setting with other females in my major. We bonded and made instant friendships. It helped me find friends in my major.
- I enjoy helping younger kids learn about technology, and, being a Girl Scout, love to expose girls to new, beneficial experiences.

Question 5: Please comment on the importance of the Girl Technology Workshop for the Girl Scouts and/or the volunteers

- It's important for girls to hear from a young adult who's more like a "Big sister" and less like a "mom" to tell them how important it is for women to study math, science, and technology. It also helps us, the volunteers, to realize that our success in technology means a lot to more than just ourselves. It means a lot to these girls as well who should be able to see the results of hard work.
- I think that it’s helpful for the girls to see that there is more than one girl in each of the different programs, and that we all have camaraderie with each other.

- It was great for me to get to have an influence on these girls and show them what my major is about. It was also good to get to talk and work with other people in my major I normally don't get the chance to work with due to being different years in school or having different classes.
- I feel that giving the girl scouts an enjoyable experience with different engineering makes it more likely they will consider a future in that field. For the Volunteers I think it makes us feel like there is more that we can do w/ our majors than simply work in that field. Woman like variety and usually to do something in the community and this gives us a way to do that.
- It introduced the girl scouts to engineering in a fun and informal way. For the volunteers it helps them give back to the community and feel a part of something other than just their classes. It is also a good networking opportunity for the different community.
- I think that having the Girl Scouts do hands-on engineering activities gives them a reason to feel like they could be engineers one day. For the volunteers, it's fun to show young girls what we do, and that they could one day be engineers as well.
- I think participating in events like this keeps college students connected to younger people they can help in the "pipeline" and community, which can be hard to do for college students.
- The girl scouts can see what engineering is like at a young age. It helps them to get with older girls who are already interested in the field.
- I think this program is very important. As a teen in high school, I never considered a field in engineering. Talking with teachers and my student adviser, a career in engineering was never mentioned or suggested. It wasn't until my dad's friend who worked at R.I.T told me about civil engineering that I became interested. This program helps bring awareness to young girls. I wish someone had introduced me to engineering long before my senior year of high school.
- I think it gives the girls a head start on learning about professions that aren't always talked about to girls.
- I believe that this program is important for the Girl Scouts because it shows them what women in technology do. It may help them decide when they are old enough to go to college that they would like to pursue a degree in engineering/technology.
- It's important for young girls to know that "women's work" can be anything. Girls shouldn't be afraid to pursue a career in engineering or science just because the fields are dominated by men. As for the volunteers/students, the program helps build leadership skills which are important in school, during co-ops, and in the working world.
- Being able to show the girls what "cool" things you can do with technology was really neat, seeing their enthusiasm was great. We need more enthusiastic girls in engineering.
- I've had a lot of girls be awed at the school and the different programs available. I think they get excited about college at a young age which is important in helping them want to continue their education. It also helps them be more open to a career in technology.
- It has helped me get involved with the community more and see where the younger generation of girls might not have an understanding of what engineering fields have to offer them.
- I think it's great that we do this. We bring in the girls at a young age and expose them to the STEM fields. We're preparing them for their future.
- I think it is important for the Girl Scouts to see young women striving to work and succeed in mainly male dominated fields. For us, as volunteers, it is important to lead as examples and show these girls that they can be successful in anything they choose to do.
- It is important for young girls, who probably might be engineers in the future.
- I believe that the Girl Scouts can learn a lot from these experiences. Even if they leave deciding that engineering is not something they are interested in, at least they can have some female role models to look up to and realize

that they can do anything they want to do. Also they can realize that what they are learning now is all leading up to a future, and we all support each other no matter what.

- This program gives the younger girls a hands on experience with some science and technology and it shows them that they are capable of doing anything. It's great exposure for them.