

Drawing Girls into Engineering, 30 at a Time

For several years, we have been observing that fewer girls than boys participate in our various high school outreach programs and wondered if high school was in fact too late to draw more girls into courses that would lead them to an engineering career. In 2014, with funding from the National Science Foundation, the Peggy and Jack Baskin Foundation, and General Electric, an outreach summer program, called UC Berkeley: Girls in Engineering (GiE), was launched for girls in middle school. The goals were simple: to bring together middle school girls from the local community of Berkeley, California, especially those in underserved areas, to engage in hands-on learning in engineering and to broaden their interest in engineering through engaging projects; exposure to college and career pathways; and opportunities to meet engineering students, faculty, and researchers.

In June and July 2014, 60 girls from local middle schools in Berkeley, Oakland, and San Ramon were invited, over two weeks, to the University of Cali-

fornia (UC), Berkeley, campus to learn about a range of topics in engineering. The girls participated in modules with many hands-on activities in biomechanics, robotics, programming, materials, and big data. They also had modules on learning style, presentations, and elevator pitches. At the end of the program, the girls presented their team projects. They had field trips to Pixar and the Lawrence Hall of Science (LHS). All of the teachers, students, staff, and the engineers at LHS and Pixar that stood up in front of the girls were women.

The program was free, and food and transportation were provided to all students. The girls who participated in the program are also now participating in a longitudinal study run by LHS to track the choices that they make in high school math and science courses.

You can see a short video of the program at <http://engineering.berkeley.edu/2014/08/berkeley-engineering-launches-girls-engineering-summer-camp>. We achieved both of our goals in 2014 and are implementing the program for 2015. The ultimate goal, of course, is to achieve gender equity in science, technology, engineering, and mathematics (STEM) fields.

PROGRAM LOGISTICS STRUCTURE

The pilot GiE program was offered during the last week of June and the second week of July 2014. The program was offered free of charge, and application materials available in both Spanish and English to maximize the participant pool from a broad socioeconomic background. Complimentary bus service was offered to and from campus at two locations, one in Oakland and one in Berkeley, or the students could be shuttled to campus by parents or guardians. Breakfast, lunch, and snacks were provided.

Once on campus, the girls were placed in carefully designed teams of five for the week. Selection was by age (in any team, the maximum allowable age difference among the girls was 15 months) and school attended (no more than two participants from the same school on a team). This was done to ensure an age-optimized learning environment and to encourage cross-school relationships. To showcase the campus and higher education, in addition to workshops and labs, the girls were able to visit different iconic locations to get a feel for college life and the energy that

*Digital Object Identifier 10.1109/MCS.2015.2449680
Date of publication: 16 September 2015*



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Dr. Grace O'Connell shares her expertise on designing solutions for broken bones and treating infirm or aging bodies with middle-school girls during the Introduction to Mechanical Engineering module.



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Participants enjoy learning about how engineering benefits medicine during a module about studying and creating laboratory-grown tissues to improve treatment for many conditions and diseases.

exists on campus. Lunch breaks were held at different places each day to incorporate a mini tour into the schedule. The girls were able to chat with new friends and GiE mentors while eating at the McLaughlin Hall Esplanade, the LHS, the UC Berkeley Faculty Club, and in front of the Campanile, where the Cal band played. To encourage college applications and show that higher education is within reach, a recruiter from Engineering Student Services

gave an informative presentation during lunch on Thursday, “How to Prepare for and Apply to College.”

PROGRAM CURRICULUM STRUCTURE

UC Berkeley’s GiE program is designed to expand participants’ views of who engineers are, to show how engineers help the world, and to demonstrate how participants might pursue a career in engineering. This program is distinctive for its multidimensional approach to inspiring girls to pursue careers in STEM fields—combining leadership and team skills alongside technical skills learned through hands-on design experiences. All workshops, lab activities, and tours, including a tour of Pixar, were conducted by female role models who are practicing engineers or by Berkeley Engineering faculty or students.

As outlined below, our framework consists of three main themes: Engineering Leadership: Communication and Team Skills, Design Innovation: Hands-On Learning, and Tours and Lab Experiences: Learning in Context.

Engineering Leadership: Communication and Team Skills

To excel in engineering, excellent communication skills are needed in tandem with technical skills. The first part of each day is dedicated to learning about leadership and team communication. In these modules, students learn more about who they are



The girls make origami robotic bugs.

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as individuals, how to maximize their particular learning style, and strategies for working effectively in groups with diverse modes of learning. Building on what they learn in the beginning of the program, they are taught skills to communicate effectively in a group setting. Their experience culminates in an audience-focused team presentation.

Design Innovation: Hands-On Learning

Experiential education and team projects are at the heart of Berkeley Engineering. Working in groups on design projects teaches students to communicate effectively, to work together to solve problems, and to successfully negotiate differences. Each project in the design innovation portion of the schedule combines several analytical skills to successfully create a working prototype. This method reinforces the group communication lessons from earlier in the day, while allowing the girls to explore the similarities and



EECS Ph.D. student Dorsa Sadigh talks to the girls about robotics.

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differences between disciplines by providing an overview of different types of engineering paths of study.

Tours and Lab Experiences: Learning in Context

The tours and lab experiences are the capstone of our sequenced modules for each day, culminating with the graduation ceremony at the end of the week.

This portion of the schedule allows us to tie all of the morning lessons together.

In addition to the daily curriculum, a project-design component is woven throughout the week. The participants work each morning in small groups to use their developing engineering knowledge and critical-thinking skills to solve a real-world problem of their choosing. During the last day of the program, they present posters outlining their solutions using elevator-pitch skills learned earlier in the week to an audience consisting of their families and Berkeley faculty and staff.

PRELIMINARY RESULTS OF PROGRAM EFFICACY

According to our preliminary feedback, the UC Berkeley: GiE program made a significant impact in the participants’ lives. See “Survey Data” for the raw data from the surveys given at the end of week to parents/guardians and participants. Of particular note is the girls’ change in interest in engineering before and after the program for the participants. Before the camp, they rated their interest in knowing about engineering as an average of 3.4 on a five-point scale with 1 being “no interest” and 5 being “high interest.” After the program, the girls reported an average of 4.4 interest level in pursuing a career in engineering on the same five-point scale.

Participants have been kept informed of other STEM learning opportunities throughout the year, such as programming at the LHS and outreach presented by

Survey Data



UC Berkeley: *Girls in Engineering* Participant Feedback Responses: June 23-27, 2014

Question#	Question	Mean
1	On a scale from 1 to 10, how would you rate your experience at Girls in Engineering overall?	8.71
2	Would you recommend Girls in Engineering to your friends? 28 yes, 1 no, 4 blank	
3	How would you categorize your own level of interest <i>before</i> camp? (Scale of 1 to 5)	3.39
3a	1. Not really interested in engineering	
3b	2. Interested in engineering	
3c	3. Interested in engineering, but didn't know anything about it	
3d	4. Knew a little about engineering and wanted to learn more	
3e	5. Interested in going into science/technology/engineering as a career	
4	How has your week in the program affected your likelihood of doing the following (Scale of 1 to 5)	
4a	Taking more science and math classes in school	4.25
4b	Majoring in engineering in college	4.21
4c	Learning more about engineering (books, websites, etc.)	4.25
4d	Considering a career in engineering	4.42
4e	Looking for ways to learn about science/technology/engineering (camps, internships, etc.)	4.28
5	Please indicate the extent to which you agree or disagree with the following statements (Scale of 1 to 5)	
5a	I learned a lot in Girls in Engineering	4.42
5b	I have talked to my friends and/or family about engineering	4.33
5c	I want to learn more about engineering	4.21
5d	I want to have a job that involves science/technology/engineering	4.15
5e	I am more interested in science/technology because of Girls in Engineering	4.12
6	On a scale from 1 to 10, please indicate the extent to which each aspect of this camp was a positive part of your experience	
6a	Lectures/lessons	6.77
6b	Hands-on activities	9.08
6c	Tours and Field Trips	9.21
6d	Team Project	7.98
7	On a scale of 1 to 10, how much did you enjoy the Communication & Team Skills classes?	
7a	What is Engineering? (Monday)	6.82
7b	What is your Learning Style (Tuesday)	7.62
7c	Effective Group Communication (Wednesday)	7.89
7d	Presentation Skills (Thursday)	8.11
8	On a scale of 1 to 10, how much did you enjoy the following hands on activities?	
8a	Engineering in Medicine (Monday)	7.48
8b	Coding from Scratch (Tuesday)	7.55
8c	Optics: Hooked on photonics - Jello Experiment (Wednesday)	7.58
8d	Nano 101: Exploring the Nano World (Thursday)	8.48
8e	Big Data - It's a big deal! (Friday)	8.17
9	On a scale of 1 to 10, how much did you enjoy the following experiences?	
9a	Robotics Workshop: Origami Bugs (Monday)	9.24
9b	Lawrence Hall of Science: Digital Pinatas (Tuesday)	7.77
9c	Pixar: Merging Art and Science (Wednesday)	9.47
9d	Materials Science Lab: The Science of Food and Annealing Steel (Thursday)	9.13

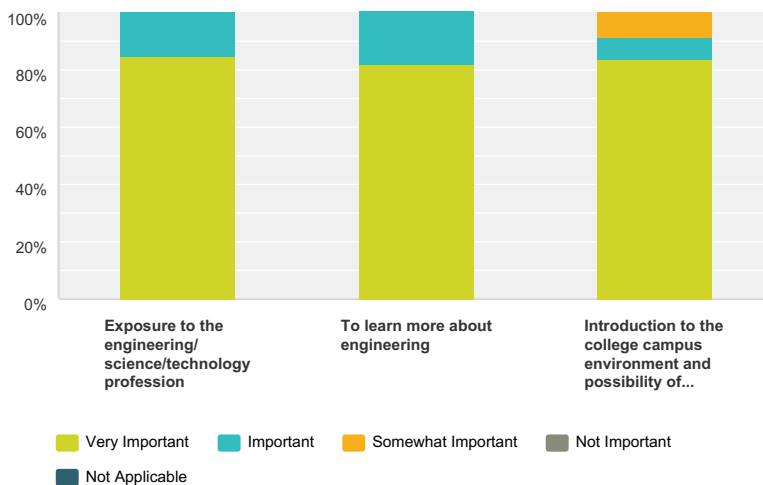
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Survey Data (continued)

2014 Girls in Engineering Parent Survey

Q1 What were your objectives for sending your child(ren) to the Girls in Engineering summer program? Please rate their importance:

Answered: 13 Skipped: 0



	Very Important	Important	Somewhat Important	Not Important	Not Applicable	Total
Exposure to the engineering/ science/technology profession	84.62% 11	15.38% 2	0.00% 0	0.00% 0	0.00% 0	13
To learn more about engineering	81.82% 9	18.18% 2	0.00% 0	0.00% 0	0.00% 0	11
Introduction to the college campus environment and possibility of becoming an engineering student	83.33% 10	8.33% 1	8.33% 1	0.00% 0	0.00% 0	12

#	Other (please specify)	Date
1	This program was outstanding!!! My child loved every minute of it - the robotics lab, Pixar, the materials lab with nano fabrics, building the origami bug robot and the lectures on learning style. She now wants to be an engineer. I hope there will be a continuing program in the future to keep up her interest. Thanks so much to all of you for offering this program!	8/13/2014 2:03 PM
2	Let her see how UC Berkeley is in the hope she'll apply when old enough.	8/12/2014 2:05 PM

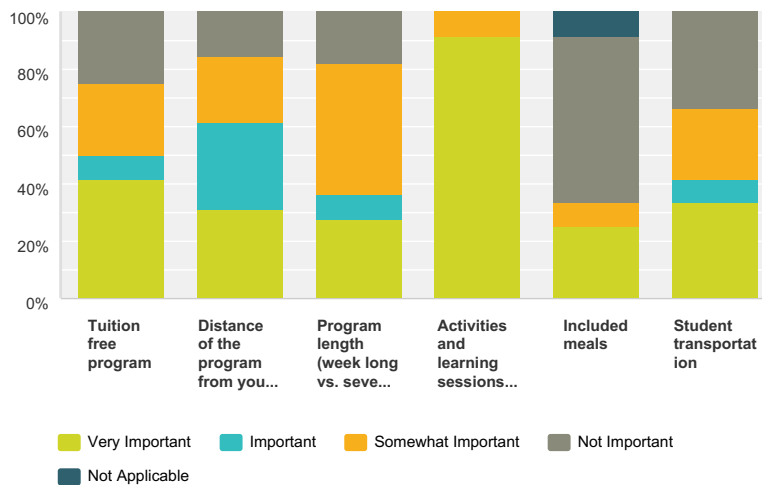
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Survey Data (continued)

2014 Girls in Engineering Survey

Q2 When choosing the Girls in Engineering program over other summer camps, please rate the importance of the following aspects.

Answered: 13 Skipped: 0



	Very Important	Important	Somewhat Important	Not Important	Not Applicable	Total
Tuition free program	41.67% 5	8.33% 1	25.00% 3	25.00% 3	0.00% 0	12
Distance of the program from your home	30.77% 4	30.77% 4	23.08% 3	15.38% 2	0.00% 0	13
Program length (week long vs. several weeks)	27.27% 3	9.09% 1	45.45% 5	18.18% 2	0.00% 0	11
Activities and learning sessions offered	91.67% 11	0.00% 0	8.33% 1	0.00% 0	0.00% 0	12
Included meals	25.00% 3	0.00% 0	8.33% 1	58.33% 7	8.33% 1	12
Student transportation	33.33% 4	8.33% 1	25.00% 3	33.33% 4	0.00% 0	12

#	Comments	Date
1	This was her favorite camp ever!	8/13/2014 2:03 PM
2	Even without the free transportation and meals we'd find a way to make it work. More important was the fact is was all- girls, which is quite safe and inspiring! I went to an all- girls high school and it's a chance to be the the leaders, the center of attention and speak in a less self- conscious setting you can't have with boys in the room.	8/12/2014 2:05 PM

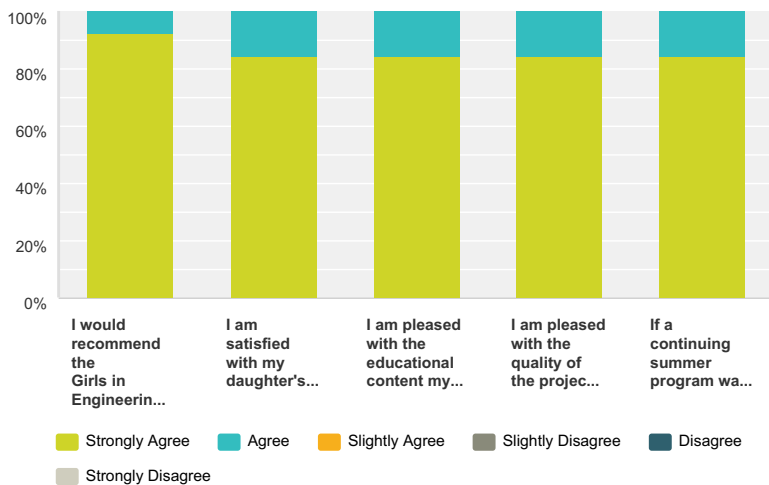
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Survey Data *(continued)*

2014 Girls in Engineering Survey

Q3 Please rate your level of agreement with the following statements based on your experience with staff and faculty:

Answered: 13 Skipped: 0



	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree	Total
I would recommend the Girls in Engineering program to a friend	92.31% 12	7.69% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	13
I am satisfied with my daughter's experience during the program	84.62% 11	15.38% 2	0.00% 0	0.00% 0	0.00% 0	0.00% 0	13
I am pleased with the educational content my child experienced	84.62% 11	15.38% 2	0.00% 0	0.00% 0	0.00% 0	0.00% 0	13
I am pleased with the quality of the projects my child worked on	84.62% 11	15.38% 2	0.00% 0	0.00% 0	0.00% 0	0.00% 0	13
If a continuing summer program was offered next year would you enroll your child(ren)	84.62% 11	15.38% 2	0.00% 0	0.00% 0	0.00% 0	0.00% 0	13

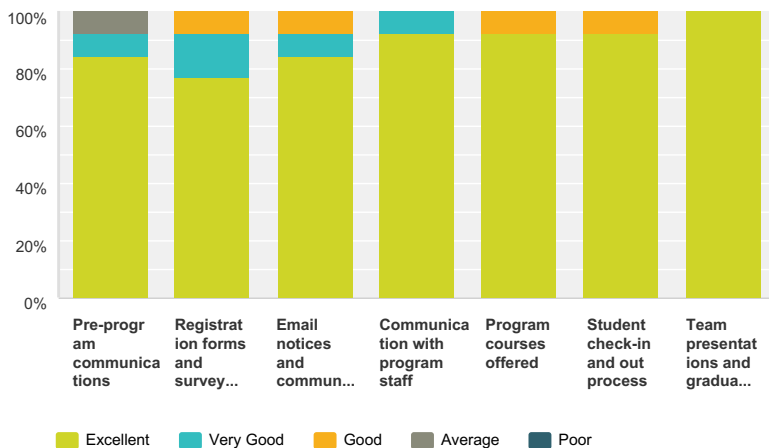
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Survey Data (continued)

2014 Girls in Engineering Survey

Q4 Based upon your experience with the Girls in Engineering summer program, please rate the following

Answered: 13 Skipped: 0



	Excellent	Very Good	Good	Average	Poor	Total
Pre-program communications	84.62% 11	7.69% 1	0.00% 0	7.69% 1	0.00% 0	13
Registration forms and survey instructions were easy to understand	76.92% 10	15.38% 2	7.69% 1	0.00% 0	0.00% 0	13
Email notices and communications during the program	84.62% 11	7.69% 1	7.69% 1	0.00% 0	0.00% 0	13
Communication with program staff	92.31% 12	7.69% 1	0.00% 0	0.00% 0	0.00% 0	13
Program courses offered	92.31% 12	0.00% 0	7.69% 1	0.00% 0	0.00% 0	13
Student check-in and out process	92.31% 12	0.00% 0	7.69% 1	0.00% 0	0.00% 0	13
Team presentations and graduation	100.00% 12	0.00% 0	0.00% 0	0.00% 0	0.00% 0	12

#	Comments	Date
1	Registration packets arrived late and was nearly unable to complete due to vacation plans the week before camp. Also, in order to compete with other summer camps and programs, information needs to get out much sooner. We were just fortunate that I was not working this year and my daughter didn't have a prior camp commitment. Typically, camps are set up in February.	8/14/2014 10:01 PM
2	Very professionally done!	8/13/2014 2:03 PM
3	Cool!	8/12/2014 2:05 PM
4	The caliber of those involved from administration to teaching staff was off the charts impressive. Every person involved was just amazing!	8/12/2014 11:18 AM

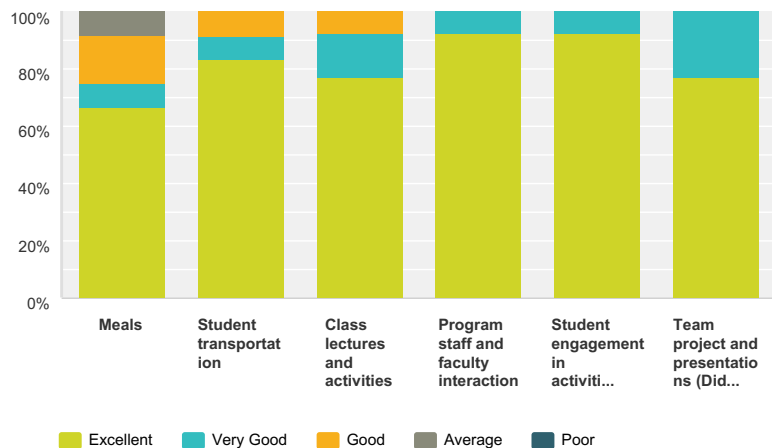
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Survey Data *(continued)*

2014 Girls in Engineering Survey

Q5 Based upon your child's experience during the Girls in Engineering program, please rate the following:

Answered: 13 Skipped: 0



	Excellent	Very Good	Good	Average	Poor	Total
Meals	66.67% 8	8.33% 1	16.67% 2	8.33% 1	0.00% 0	12
Student transportation	83.33% 10	8.33% 1	8.33% 1	0.00% 0	0.00% 0	12
Class lectures and activities	76.92% 10	15.38% 2	7.69% 1	0.00% 0	0.00% 0	13
Program staff and faculty interaction	92.31% 12	7.69% 1	0.00% 0	0.00% 0	0.00% 0	13
Student engagement in activities and lectures	92.31% 12	7.69% 1	0.00% 0	0.00% 0	0.00% 0	13
Team project and presentations (Did your child find the project enjoyable?)	76.92% 10	23.08% 3	0.00% 0	0.00% 0	0.00% 0	13

#	Comments	Date
1	Hope to send my youngest daughter next year! She used to take apart toys when she was 4.	8/12/2014 2:05 PM
2	test test	8/11/2014 9:22 AM

(continued)

Survey Data (continued)

2014 Girls in Engineering Survey

Q6 Please provide us with any additional comments or feedback about the program.

Answered: 8 Skipped: 5

#	Responses	Date
1	This was a great program and we hope it continues. It was great for our daughter to be exposed to the various engineering and sciences at a young age.	8/14/2014 10:03 PM
2	My daughter enjoyed the program more than she expected. I hope her sister gets to follow in her footsteps in a few years!	8/14/2014 9:49 AM
3	This program was outstanding!!! My child loved every minute of it - the robotics lab, Pixar, the materials lab with nano fabrics, building the origami bug robot and the lectures on learning style. She now wants to be an engineer. I hope there will be ongoing opportunities in the future to keep up her interest. I was so impressed that college professors could relate so well to middle school aged children and design a program that was so appealing and educational for them. Thanks so much to all of you for offering this program! I very much hope you will offer ongoing programs that the girls can return to and learn even more about the interesting opportunities to work in engineering.	8/13/2014 2:03 PM
4	If there is another Girls in Engineering camp, Joi Owens wants to participate again!	8/12/2014 8:20 PM
5	I've never seen an engineering or science camp just for girls. Bravo! Love the way they were taught analysis of problems and to solve their own problems, a skill which is applicable to almost anything in life! I don't like helplessness. As a mother of two girls I keep hearing myself saying "figure it out, see what works."	8/12/2014 2:11 PM
6	This was one of the most amazing opportunities my daughter has had. Please, please, please continue and let other girls be privileged enough to have such an amazing, unique experience.	8/12/2014 11:19 AM
7	Really wonderful inaugural program. It was such an honor to be included in this program. I hope it continues next year.	8/12/2014 10:34 AM
8	testing	8/11/2014 9:22 AM

the Society of Women Engineers geared specifically to middle school girls. Positive comments have been received from parents/guardians regarding this follow up.

CURRENT PLANS

The UC Berkeley: GiE program will continue and has garnered significant interest from other potential sponsors and partners. Of note is a new partnership with Twitter. For the summer of 2015, the two cohorts will do day-long field trips to Twitter headquarters for our Introduction to Computer Science day to learn how to do simplified computer code as well as to meet and visit with successful women engineers in industry. We also have new generous financial support from the SanDisk Foundation to supplement the budget, enabling us to further grow the programming as we

move ahead. Looking forward to the summer of 2016 and beyond, we would like to extend the reach of the program to include participants from other locations around the San Francisco Bay area.

ACKNOWLEDGMENTS

We would like to thank those organizations who provided support: Berkeley's College of Engineering, the National Science Foundation through the CPS projects ActionWebs and FORCES, the Baskin Foundation, SanDisk, General Electric, Pixar, and Twitter. Special thanks go to the women engineers at GE, Pixar, and Twitter who are volunteering their time to work with the girls.

The team is also indebted to the many people who helped make this program a success: in the Berkeley College of Engineering, Jayne Anderson (director of Events and Pro-

grams), Jasmine Payne (executive director of Development), Melissa Nidever (assistant dean, College Relations), Jaclyn Lau (events assistant), and Gian Bruno (Engineering Achievement adviser); all of our faculty, staff, and graduate students who volunteered their enthusiasm, time, and energy to design and teach compelling modules; Sherry Hsi, research director at LHS; our new Program Director Lizzie Hager-Barnard; our fantastic program assistants Beth, Imara, Dylan, and Shari; and finally Shankar Sastry, who as dean of Engineering at Berkeley had the vision to push for this program to help place more girls in the pipeline to become the engineers of tomorrow.

Annie Averitt and Claire Tomlin

