

AC 2010-516: “ADVANCE-ENG GIRLS TO WOMEN: AN INNOVATIVE ENGINEERING FACULTY-STUDENT MENTORING SUMMIT FOR UNDERREPRESENTED MINORITY (URM) GIRLS AND THEIR MOTHERS”

Tuere Bowles, North Carolina State University

An Assistant Professor in the department of Leadership, Policy and Adult and Higher Education at NCSU. Professor Bowles has the following degrees: Ph.D., Adult Education, University of Georgia, M.Div., Christian Education, The Interdenominational Theological Center – Morehouse School of Religion and B.A., English, Spelman College. Bowles' research centers on social justice and equity issues in adult and higher education. Critical, feminist and ecological frameworks underpin her interdisciplinary endeavors while employing mixed-methods. A recurring theme in her scholarship explores gender and diversity for girls and women in environmental sciences and engineering with an emphasis on their learning, socialization and career development. She has served as an evaluator and senior researcher on the ADVANCE-ENG Girls to Women: An Innovative Engineering Faculty-Student Mentoring Summit for Underrepresented Minority (URM) Girls and Their Mothers and managed a cadre of other environmental training programs.

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Dr. Christine Grant is a Full Professor of Chemical and Biomolecular (CBE) engineering at North Carolina State University (NCSU). She obtained a Bachelors degree in Chemical Engineering from Brown University in 1984; her graduate degrees (M.S. and Ph.D.) were both obtained from Georgia Institute of Technology in 1986 and 1989. She joined the NCSU faculty in 1989 after completing her doctorate and has moved through the ranks of Assistant and Associate to Full Professor – one of only 4 African-American women in the U.S. at that rank. Her research focuses on surface and interfacial phenomena in the areas of green chemical engineering and polymers. She has served her profession as a leader in the American Institute of Chemical Engineers (AIChE) as a member of both the Board of Directors and the Chemical Technology Operating Council. She is the recipient of the NSF Presidential Mentoring Award and the Diversity Award from the Council for Chemical Research (CCR). Grant serves as an Associate Dean of Faculty Development and Special Initiatives at NCSU.

Pamela Martin, North Carolina State University

Dr. Pamela Martin (Co-PI) is an experienced assessment specialist focusing on psychology in the public interest. Her research emphasizes ecological theory, the person-environment fit between social institutions such as churches and behavioral outcomes, social support networks within African American faith communities, faith-based HIV/AIDS prevention, and academic achievement. After earning her PhD in Ecological/Community Psychology and Urban Studies at Michigan State University, she was a National Science Foundation Minority Postdoctoral Fellow at the Programs for Research on Black Americans (PRBA) in the Research Center for Group Dynamics at the Institute for Social Research at the University of Michigan.

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“ADVANCE-ENG Girls to Women: An Innovative Engineering Faculty-Student Mentoring Summit for Underrepresented Minority (URM) Girls and their Mothers”

Abstract

As a culturally relevant educational intervention, the ADVANCE-ENG Girls to Women Summit included over 70 underrepresented minority (URM) girls and their mothers (or other adult caregivers) to attend a day of engineering career exploration while interacting with over 60 URM women engineering professors from around the United States. The day was informative, empowering and encouraging, providing an opportunity for middle school girls to meet real women of color who are engineering professors, real women who at one time were girls making a critical move towards an engineering career. The prevailing Summit goal was to attract girls at a critical stage in the K-12 pipeline to engineering careers. The two-day event enabled the girls to take the time to envision themselves in the future, just like the faculty present, and for daughters and mothers/caregivers to connect or re-connect, forging an alliance to sustain the mothers/caregivers through the challenges they will face as their daughters become future women in engineering. A combination of faculty motivational speeches, a three-session rotation through hands-on activities (e.g., making lip gloss) and interactive career sessions culminated in a gala dinner for the girls, faculty/student/community volunteers, and special guests. The girls had continuous interaction with URM women engineering college students as role models throughout the event.

Introduction

Women are disproportionately represented in engineering professions. Previous research has documented that there is a leaky pipeline in all stages of women’s career trajectory in engineering. As early as at six-years of age gender stereotyping occurs in the treatment of children, which shapes their perceptions of STEM related opportunities.^{1, 2} It is in middle school, however, that girls begin to show lower levels of confidence and interest in engineering related fields than those of boys.^{1, 3, 4} Additionally, it has been found that girls do not participate in as many science and engineering relevant activities as boys outside of school; hence, extracurricular activities have been suggested as a method of intervention to remedy this lack of experience.

A report by The Level Playing Field Institute (LPFI) entitled, *Increasing the Representation of Women and People of Color in Science, Technology, Engineering, and Math (STEM): Scan and Synopsis of Approaches and Opportunities*³ made three points relevant to the initiative described in this paper: (1) The underrepresentation of women and people of color in STEM fields means that few role models are available, and women and people of color are rarely portrayed as participating in STEM careers. Researchers have also identified a fundamental conflict between social definitions of women and of engineering; (2) Intervention supported by existing research: There is a need to support the people of color and women that are currently in positions to be role models; and (3) A lack of role models and mentors in academic environments has an adverse effect on women and people of color in STEM fields. While there are several venues that

encourage the pursuit of a career in engineering for young female students; there is not, to the authors' knowledge, a venue that connects a group of underrepresented minority (URM) women faculty with a group of peer mothers and their daughters to talk about excellence in science, math and engineering. The inclusion of both undergraduate and graduate students will result in a program that has representation from all points in the engineering pipeline. For women of color, there are some unique aspects of both the mother-daughter relationship, and the “instant sisterhood” that many women feel that is not a function of their career-path or social standing. We utilized both of these points to foster an exciting, community building, intergenerational intervention that uses the special “sister-connection” to communicate with the mothers of potential leaders in engineering.

Purpose

The ADVANCE-ENG Girls to Women Summit represented a unique opportunity for women at all levels of the K-12 middle school to faculty pipeline to interact in a proverbial “mentoring village” – promoting careers in engineering. The purpose of this research study was to assess and evaluate an engineering summit for middle school girls and their mothers/caregivers. Overarching research questions included: What are the learning experiences of middle school girls in an engineering careers summit? What are the learning experiences of parents in an engineering careers summit? What impact has the summit made for adolescent girls, their mothers, and other stakeholders?

Method

This study is part of a larger study, which consists of both quantitative and qualitative components. For this report, however, we share only the quantitative component.

Participants

A total of 131 mothers/caregivers and female adolescent dyads applied to participate in the ADVANCE-ENG Girls to Women intervention. From the applicant pool, 70 mothers/caregivers and female adolescent dyads were invited to participate in the invention. Table 1 and 2 illustrates the demographic characteristics of the mother/caregiver and child dyads.

Table 1: Child Demographics

	N	%
Grade		
6	26	37.1
7	26	37.1
8	18	25.7
Ethnicity/Race		
African American/Black	51	72.9
Native American	2	2.9

Multiracial/Biracial	4	5.7
Hispanic	4	5.7
Asian	2	2.9
Caucasian/White	1	1.4
Other	6	8.5

Table 2: Mother/Caregiver Demographics

	N	%
Education		
PhD	1	1.4%
Masters	8	11.4%
Bachelors	27	38.6%
some college	17	24.3%
HS Grad or less	17	24.3%
Income		
100,000 or over	1	1.4%
75,000 - 99,999	0	0.0%
55,000 - 74,999	5	7.1%
45,000 - 54,999	7	10.0%
44,999 and under	57	81.4%

Procedures

A recruiting campaign involving NCSU College of Engineering, civic groups, community organizations, churches and the public school system focused on identifying Hispanic/Latina, African-American, and Native American girls. The recruitment efforts specifically placed emphasis on potential first generation college students and their mothers/caregivers. While the recruitment efforts were geared towards mother-daughter relationships, additional students were encouraged to participate with other significant adults over 21 years of age. These individuals included aunts, grandmothers, older female siblings, and non-relatives (e.g., teachers, counselors, and church member).

The recruitment efforts included various stages. First, a letter and informational packet were disseminated by electronic and traditional mail to a variety of community and educational organizations. These materials underscored the need of an educational program to expose young females of color to STEM related fields and to provide information to mothers/caregivers about academic preparedness to encourage careers in STEM fields, especially engineering. Second, follow-up phone calls were conducted targeting guidance counselors, clergy, and representatives from community-based organizations. Third, the research team presented at local STEM academic programs.

During the course of the intervention, adults and children participated in several events; some were whole group while others specialized for their respective age groups. Upon arrival at the intervention, participants went through the informed consent process described above. Participants were recruited for adult/child joint video interviews during the registration process as well. At the end of the registration process, supervising adults separated from their children, and all participants completed their first Draw an Engineer Test (DAET). This second phase lasted approximately one hour for both groups.

After completion of their respective DAET activities, the groups were reunited for a half hour lunch. Following lunch, a 1 hour and 15 minute welcome and keynote was held. During this first keynote session, Dr. Grant (principal investigator, Biochemical Engineering at North Carolina State University) and Dr. McCauley-Bell (Industrial Engineering and Management Systems, University of Central Florida) gave motivational speeches in addition to background information on the representation of women and under-represented minorities in engineering.

At this point, adults and children were again separated into their respective age groups for three back-to-back activity or information sessions. In between each session was a 10-minute break for refreshments or relocation. Children were further broken up into three groups, and attended each session in various orders. The Environmental presentation introduced children to the field of nuclear engineering and included a Geiger counter activity. The children's NANO-technology presentation provided an introduction to chemical engineering and included an activity that let participants make lip gloss. The Biotechnology presentation introduced the biological sciences and included an experiential activity.

While the girls were split into groups for these three sessions, all adults attended their three sessions as a single group. The first 50-minute session discussed the math and science courses students should cover in order to be considered for an engineering program. Adults were also given information on extracurricular programs and activities that would provide extra experience and knowledge about engineering and the sciences. The second 50-minute session covered strategies on how best to be active in their child's school life. This information included how to interact with school staff. Adults were also given information on financial aid, scholarships, and what qualities or skills colleges look for when admitting students. The third 50-minute session included a variety of information. Engineering students and parents shared personal information from their experiences in their programs. At this point, adults were also allowed extra informal time to ask questions to the speakers from any of the day's sessions. During this time, adults that required hotel accommodations for the event went through their respective check-in procedures.

An extended break was held after the end of the third 50-minute session to allow these adults to finish checking in at their hotels without missing intervention material.

Following the third 50-minute session and hotel check-in, girls and adults remained together for the remainder of the intervention. In the “Resource Room” (so named for the wealth of personal and more formal resources it contained on engineering) participants had access to pamphlets pertaining to the departments of the faculty volunteers, as well as larger displays about North Carolina State and Duke Universities' engineering departments. All participants were encouraged to interact with the intervention staff and volunteers. Children were given autograph books, booklets that contained space for autographs in addition to biographies and photographs of the faculty volunteers. In addition to the information these booklets contained, they were used as conversation starters to increase the amount of interaction between children and faculty. After one hour in the Resource Room, participants transitioned to a dinner provided by investigators.

During the two hour dinner session a variety of activities occurred. A motivational speech concerning the need for personal achievement as well as assisting others in their own personal achievement was delivered by Dr. Crumpton-Young (Industrial Engineering and Management Systems, University of Central Florida). A simulated doctoral graduation was held during the dinner, where children collected participation certificates as their mothers announced their names through a microphone. All participants received gifts during the dinner. Girls received special purses while mothers/supervising adults received artwork, personalized gifts and thank you cards from their daughters. The girls chose gifts for adults at an earlier time. At this point, children read two poems aloud to boost their motivation towards obtaining engineering degrees and to thank the faculty volunteers: one original poem commissioned from Mrs. Frances B. Grant, and “We Speak Your Names” by Pearl Cleage. Children received copies of two additional books during the dinner as well: *Winners Don't Quit...Today They Call Me Doctor*⁵ and *Turning Your Life Around (You've Got the Power!)*.⁶ Participants were allowed to collect signatures in these books in addition to the autograph books previously mentioned. The dinner timeslot was ended with a dessert social to allow additional informal interaction between all participants and staff. After the conclusion of the dessert social participants were released for the evening.

The following morning a continental breakfast was made available to participants. During this time participants completed the intervention Exit Survey and their second DAET activity. Attendees were also invited to participate in videotaped focus groups before leaving the intervention.

Instrumentation

Several dependent measures were utilized to assess the effectiveness of the intervention program. The research team developed an Exit Survey that asked participants to indicate their satisfaction with numerous aspects of intervention including location, registration process, materials provided, speakers/presenters, conference facilities, food, and hotel accommodations. A four point Likert scale ranging from very dissatisfied to very satisfied was utilized. Additionally, level of agreement with several statements, including appropriateness of intervention, the degree of organization of intervention, and the helpfulness of intervention staff was measured on a four point scale ranging from strongly disagree to strongly agree. Willingness to attend future

sessions and likelihood to recommend intervention to others were both measured on a three point scale whose response options consisted of “no”, “don't know”, and “yes”. Lastly, open-ended responses were used to gather information concerning likes, dislikes, recommendations for improvement, how individuals learned about intervention, and why individuals decided to attend intervention.

Results

The quantitative focus of this paper was the intervention Exit Survey. For the data analyzed, nonparametric tests were employed during data analysis due to issues with normality. Satisfaction with the speakers at the intervention was significantly affected by a daughter's grade level, as determined by a Kruskal-Wallis test ($H(2)=7.207, p <.05$). Mann-Whitney tests using a .0167 level of significance found eighth graders had significantly higher satisfaction ratings than seventh graders ($U=246.5, r=0.41$).

Level of agreement concerning the intervention's level of organization were significantly different between the grade level of the daughters in attendance, as evidenced by a Kruskal-Wallis test ($H(2)=9.23, p<.05$). Mann-Whitney tests using a .0167 level of significance determined that seventh graders rated the event as significantly more organized than eighth graders ($U=113.5, r=-0.42$), and that seventh graders rated the event as significantly more organized than the ratings of sixth graders ($U=101, r=-0.45$).

Table 3
Number of responses and means for significant satisfaction and level of agreement findings

Satisfaction Element/Grade Level	n	%	mean	sd
Satisfaction with Speakers				
7 th grade	22	100	3.7	.48
8 th grade	17	100	4.0	0.0
Level of organization				
6 th grade	16	100	3.4	.51
7 th grade	22	100	3.9	.35
8 th grade	17	100	3.5	.51

Note: % indicates percent of students in a grade level responding to each element out of total number of students in grade that completed the Exit Survey

Table 4
Summary of Kruskal-Wallis and Mann-Whitney tests on child satisfaction and level of agreement

Satisfaction Element/Grade Comparison	Test Statistic	df	p	r
Satisfaction with speakers	7.207	2	.027	

7 th vs. 8 th grade	246.5		.011	0.041
Level of organization	9.23	2	.01	
6 th vs. 7 th grade	101		.006	-0.45
7 th vs. 8 th grade	113.5		.009	-0.42

Note: Mann-Whitney follow up tests conducted at alpha <.0167

Discussion and Conclusion

All Exit Survey satisfaction and level of agreement questions were subjected to statistical analysis to look for differences between adults and children, as well as differences between children based on grade level. The only significant differences detected were that eighth graders were more satisfied with the speakers at the intervention than seventh graders, and that seventh graders rated the intervention as more organized than either sixth or eighth graders. This suggests that the speakers or topics presented at the intervention may have been relevant or interesting to eighth graders but not as interesting or relevant to seventh graders. Future interventions may benefit from attempting to specialize presentation topics or activities based on the grade level of a participant. With regard to the level of organization of the intervention, one possible explanation for the differences between age group ratings is that seventh graders may have differing or more relaxed expectations for what an event should provide them. When examined together, the significant differences found suggest that seventh graders may have been more interested in the content presented to them at the intervention than the level of order or smooth transition between activities at the event.

Overall, the satisfaction and level of agreement scores were very high for both adults and children. As no significant differences were found between children or adults (including tests to compare children in terms of grade level) except for those listed above, and the average response these questions was above three out of a possible score of four, the data analyzed suggest a high level of satisfaction with the intervention and that participants found the sessions and staff appropriate.

Chi-square tests were conducted on two of the open-ended questions on the Exit Survey. Question 2 concerning how individuals heard about the intervention was analyzed for differences between children based on grade level and for differences between children and adults. Responses were coded as “school or work” when a participant indicated they found out about the intervention from a school employee, an extracurricular activity, or a co-worker, and “social” if a participant indicated they found out about the intervention from a non-academic or job setting such as from a church member, family member, or friend. The lack of significant differences found by these comparisons suggests that both avenues of advertisement for the intervention were equally effective for reaching all participants, and that no changes are needed in the location of advertisements to reach the maximum number of prospective participants for future interventions. Question 3 concerning why individuals chose to attend the intervention was analyzed for differences between children based on grade level and for differences between children and adults. Responses were coded as “engineering” responses when participants indicated that engineering was relevant to why they attended. For example, participants may have indicated interest in learning about careers or meeting professional engineers. Responses

were coded as “social/personal” when engineering was not indicated as a reason for attending, for example mentioning that the event was free or only indicating that the event sounded interesting without mentioning any engineering aspect. The lack of significant findings between participants suggests that both categories of reasons to attend were equally important in a participant's final decision to come to the intervention. This also suggests that advertisements for future interventions attempting to reach the same population should be equally effective whether they emphasize the engineering aspects of the event or the social/personal aspects of the intervention.

Question 17 concerning whether participants would recommend the intervention to others could not be subjected to statistical analysis due to a 100% response rate for “yes”. When examined in conjunction with the rest of the statistical findings, the responses to question 17 suggest a high level of satisfaction with the event.

Finally, question 1 concerning if this was a participant's first intervention targeting underrepresented minorities and mother figures could not be analyzed statistically due to a 100% response rate of “yes”. This finding suggests that the results from this dataset will only generalize to the targeted population for their first experience in such an intervention. Further studies with follow-up interventions should be conducted to examine the influence of repeated exposure to such events.

There were limitations to this study. For example, not every participant answered every question. And, all participants did not return for the second day's events.

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ADVANCE-ENG Girls to Women Engineering Summit

Conference Agenda

Track 1 Girls' Separate Events

Track 2 Mother/Advocates' Separate Events

DAY ONE

10:30 am - 11:00 am	Registration Mother/Advocate-Daughter Video Interviews		
11:00 am - 12:00 pm	Registration (cont'd)		
	Draw An Engineer Task	Visioning Activity for Mothers/Advocates	
12:00 pm - 12:30 pm	Boxed Lunch		
12:30 pm - 1:45 pm	Opening Ceremonies Welcome: Summit Convener (NCSU) Introduction of Dr. Pamela McCauley Bell by Miss Taylor Shaw Miss Teen Essence of Orange County, NC Keynote Address: Dr. Pamela McCauley-Bell Associate Professor of Industrial Engineering (UCF) & President/CEO, Tech-Solutions Net, Inc. "DREAM-ENG BIG: You're Just Like Me!" Mother/Advocate-Daughter Group Picture		
1:45 pm - 2:00 pm	Mini-Break and Transition to Sessions		
2:00 pm - 2:50 p.m.	Sessions for Girls and Mothers/Advocates		
	<u>Biotechnology Group</u> Engineering ≠ Nerdy Women Speaker: Adande Williams Consultant at Wyeth Laboratories; CHE Alumnae	<u>NANO-technology Group</u> What is Engineering? Hands On Demonstration A Speaker: Dr. Laura Bottomley Director of Women in Engineering and Outreach (NCSU)	<u>Environmental Group</u> Scholarships, Awards, and Grades Hands On Demonstration B Speaker: Lisa Marshall Director of Outreach Programs; New Student Academic Advisor (NCSU)
	<u>Mothers/Advocates</u> Pre-College Curriculum: Ensuring Your Daughter is on the Math and Science Track Pre-College Engineering Opportunities in the Local Area Speakers: Dwight Hawkins: Assistant Coordinator of NC-MSEN Pre College Program and Dr. Joyce Hilliard-Clark: The Science House-PAMS Imhotep Academy		
2:50 pm - 3:00 pm	Refreshment Break		
3:00 pm - 3:50 pm	Sessions for Girls and Mothers/Advocates		

	<u>Biotechnology Group</u> Royal B Scholarships, Awards, & Grades Hands On Demonstration B Speaker: Lisa Marshall Director of Outreach Programs; New Student Academic Advisor	<u>NANO-technology Group</u> Imperial 6 Engineering ≠ Nerdy Women Speaker: Adande Williams Consultant at Wyeth Laboratories; CHE Alumnae	<u>Environmental Group</u> Royal A What is Engineering? Hands On Demonstration A Speaker: Dr. Laura Bottomley Director of Women in Engineering and Outreach
	<u>Mothers/Advocates</u> Negotiating Teachers and Guidance Counselors: How to Stay Involved in Your Daughter's Education Speaker: Dr. Monica T. Leach, Assistant Dean for Academic Affairs/Associate Professor of Social Work Admissions: What Will Colleges Look for in a Prospective Student? Speaker: Maritza Velasquez , Assistant Director of Admissions (NCSU) What Resources are Available for my Daughter to Attend College? Speaker: Theresa Cry Assistant Director, Scholarships and Financial Aid (NCSU)		
4:00 pm - 4:50 pm	Sessions for Girls and Mothers/Advocates		
	<u>Biotechnology Group</u> What is Engineering? Hands On Demonstration A Speaker: Dr. Laura Bottomley Director of Women in Engineering and Outreach (NCSU)	<u>NANO-technology Group</u> Scholarships, Awards, & Grades Hands On Demonstration B Speaker: Lisa Marshall Director of Outreach Programs; New Student Academic Advisor (NCSU)	<u>Environmental Group</u> Engineering ≠ Nerdy Women Speaker: Adande Williams Consultant at Wyeth Laboratories; CHE Alumnae
	<u>Mothers/Advocates</u> <ul style="list-style-type: none"> Talking from the Heart: My Experiences as an Engineering Student/Parent Extended Informal Chats with Admissions, Financial Aid, & Other Officials for Day Pass Attendees Mothers/Advocates begin to check into hotel, reunite with girls at end of break-out session 		
5:00 pm - 6:00 pm	Break for Daughters and Mothers/Advocates		
6:00 pm - 7:00 pm	<u>Resource Room</u> <u>Meet Women Engineering Professors, Engineers, and Students- Pick up Engineering College Information</u>		

7:00 pm - 9:00 pm	<p align="center">ADVANCE-ENG Girls to Women and Peer Mentoring Summit Joint Gala Dinner</p> <p align="center">Mistress of Ceremonies: Lisa Marshall: Director of Outreach Programs; New Student Academic Advisor (NCSU)</p> <p align="center">Keynote Speaker: Lesia Crumpton Young Industrial Engineering Professor - University of Central Florida Former Department Head of Industrial Engineering (UCF)/President & CEO: Crumpton & Associates, Crumpton Publishing Group/ Author of the "You've Got the Power" Workbook Series</p> <p align="center">Meet Faculty Women/ Gifts and other Surprises!!/ Book Signings/ Book Exchange for Mothers/Advocates/ Dessert Bar & Late Evening Mixer</p>
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DAY TWO

7:30 am - 9:00 am	<p align="center">Daughter and Mother/Advocate Continental Breakfast Mother/Advocate-Daughter Video Interviews; Summit Survey</p>
9:00 am - 10:00 am	<p align="center">Optional: Post Summit Focus Groups</p>