SHARING SOLUTIONS 2015

ADVANCING GIRLS IN STEM

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THE AGNES IRWIN SCHOOL & THE CENTER FOR THE ADVANCEMENT OF GIRLS

FINDING SOLUTIONS TO MANY OF THE BIG PROBLEMS OF THIS CENTURY,

including climate change, universal access to water, disease, and renewable energy, will require the skills of engineers and computer scientists. When women are not well represented in these fields, everyone misses out on the novel solutions that diverse participation brings.

CORBETT & HILL, 2010

INTRODUCTION

The challenge of preparing children for the world of tomorrow is not an endeavor that schools, colleges, and other youth serving organizations embark upon lightly. These institutions are tasked with understanding the knowledge, skills, and dispositions that will help their students both to lead rewarding lives in the future and to make meaningful contributions to society. Schools and other institutions, therefore, must prepare girls with a broad range of skills that will afford them opportunities regardless of what the job market will look like when a five-year old turns twenty-two. Unfortunately, at various places along the educational pipeline, girls are missing out on opportunities that would lead them to embark on careers in science, technology, engineering and mathematics (STEM). As a result, the insights and innovations of nearly half of the population are lost. From 2000-2010 STEM jobs grew at a rate three times greater than non-STEM jobs (Langdon, McKittrick, Beede, Khan & Doms, 2011). Projections indicate that between 2010 and 2018 nearly 800,000 jobs will be created in the United States that require STEM graduate degrees, but the country will have only produced 550,000 STEM graduates (Carnevale, Smith & Melton, 2011). Furthermore, on average, STEM degree holders make 26% higher wages than non-STEM workers (Langdon et al. 2011). This translates to an extra $14,000 at minimum per year at every educational level or an extra $300,000 over a lifetime (Carnevale, et al. 2011). Despite the positive outlook for STEM jobs, there is an immense disparity in how men and women experience these benefits. This disparity, in turn, decreases the talent pool and minimizes the scope and perspective of what STEM innovators are able to accomplish. The goal of the conference described herein was to address this disparity and examine it from multiple angles. This White Paper summarizes the discussions from the conference to build upon the momentum that was generated that day.

Women are both underrepresented and underpaid in STEM fields. According to data from the National Science Foundation (2010), women occupied only 28% of all jobs in Science and Engineering fields in 2010. This number, however, includes psychology and other social science fields that tend to attract women (and that tend to garner less pay). According to the more detailed data, in 2010 23% of computer scientists and only 13% of all engineers were women. According to more recent data from the 2015 AAUW report, *Solving the Equation*, in 2013 women were still only 12% of the engineering force and 26% of "computer and mathematical professions" (Corbett & Hill). Even when women do enter STEM fields, they tend to be paid less than men. Corbett & Hill (2015) indicate that salaries for men and women in engineering and computing are more equitable than those in other professions. In engineering and computing women make 90 cents for every dollar a man makes as compared with 78 cents to the dollar average across all fields. However, according to an earlier report, the wage gap between men and women starts out small but becomes larger in STEM than in other occupations. The salaries for men and women in entry-level STEM positions only differ by about 5%, but by ages 45-49 "men earn almost 60% more than their female counterparts in STEM" (Carnevale, et al. 2011). Notably, the same report points out that there is a pay gap in the general workforce where men still earn 50% more than women in non-STEM fields by ages 45-49 (Carnevale, et al. 2011). While some of the pay gap is explained by occupational decisions, women tend not to favor Engineering or Mathematical Science professions, which have higher wages, a study by Blau and Kahn (2007) indicates that only 27% of the pay gap is related to women's decision to pursue STEM jobs that tend to pay lower wages.

The gaps in women's presence and pay in STEM fields has an impact of society at large. In a 2013 Google + hangout, President Barack Obama stated, "One of the things that I really strongly believe in is that we need to have more girls interested in math, science, and engineering. We've got half the population that is way underrepresented in those fields and that means that we've got a whole bunch of talent…not being encouraged the way they need to." Those in STEM fields are tasked with solving some of the world's most

pressing problems and without women those solutions will likely only target half of the population (Hill, Corbett & St. Rose, 2010).

The disparity between men and women entering STEM fields begins long before young men and women select their first career. Research has shown that the STEM "pipeline" for women is leaking—and women disengage from STEM fields at various points in their educational careers from elementary school through the end of college (Sadker & Sadker, 1994; Dasgupta & Stout, 2014; Perez-Felker, McDonald & Schneider, 2014). Research posits that, while girls outperform boys in math and science in Middle School and girls and boys take math and science courses in the same numbers in Middle and High School, girls begin to lose confidence in their abilities and disengage from STEM subjects in the 6th-8th grades (Reid & Skryabina, 2003; Catsambis, 2005; Pajares, 2005; Burke & Mattis, 2007). During high school, girls' interest continues to decrease (Sadler, Sonnert, Hazari & Tai, 2012). In one study Sadler and colleagues found that boy's interest in STEM careers remained relatively static with 39.5% indicating interest at the beginning of high school and 39.7% indicating interest at the end of high school. Girl's interest, on the other hand, began lower with just 15.7% of 9th grade girls indicating an interest in pursuing STEM careers in adulthood. This declined significantly to only 12.7% of girls specifying a desire to pursue STEM careers at the end of high school. So, while the gender gap is not evident in Middle and High School in terms of grades and the curriculum taken, girls have already begun to lose confidence in their abilities and subsequently exclude themselves from STEM fields before they begin college.

In college, the leaky STEM pipeline becomes much more visible as it begins to impact participation. While less than 40% of the college students who begin as STEM majors actually graduate with a STEM degree, women start out underrepresented in STEM majors (Olson & Riordan, 2012). Of those who enrolled in postsecondary institutions in the 2004-2005 school year 20.6% of all male students enrolled in STEM majors while only 6.3% of female students enrolled in STEM fields. Olson and Riordan (2012) further explain that at graduation, 12.1% of male students attain a STEM degree whereas 5.1% of female students attain a STEM degree. While women seem more likely to stay in the STEM field (indicated by the smaller decline), this figure does not account for the type of degree. In that same study, the researchers found that women earn less than one-fifth of bachelor's degrees in high growth fields like computer science and engineering (Olson & Riordan, 2012). More recently, according to data from The National Science Foundation reported in the 2015 AAUW Report, although women made up 57% of all bachelor's degrees and 50% of all science degrees, they comprised only 19% of the Engineering degrees and 18% of Computer Science degrees in 2013 (Corbett & Hill, 2015). Furthermore, women who choose science majors disproportionately select life science degrees. For example, the share of life science degrees awarded to women has increased from 50 to 70 percent over the last 30 years whereas women earn only 30% of physical science degrees and less than 25% of engineering degrees (National Science Foundation, 2010). In 2014, while only 6% of women and 19% of men entered college intended to major in engineering, 16% of women and 11% of men planned on majoring in biological and life sciences (Corbett & Hill, 2015). It is clear that, despite sharp declines in gender segregation of occupations from 1940-1990 (Cotter, Hermsen & Vanneman, 2004), the participation gap in STEM careers starts well before women embark upon their careers.

To further understand both the problems leading to and the solutions for the "leaky" STEM pipeline, The Agnes Irwin School, through its Center for the Advancement of Girls, held a two-day conference. The conference, which represented a multitude of voices, including educators and administrators from both K-12 and higher education sectors, representatives from corporate and non-profit institutions, and researchers, allowed members of various communities to come together and share solutions.

SHARING SOLUTIONS 2015

ADVANCING GIRLS IN STEM

The overarching goal for *Sharing Solutions 2015* was to understand why so few girls and women enter STEM fields as well as why so many girls and women leave STEM fields *and* to share best practices for increasing the participation and persistence of these populations in STEM fields. With this overarching goal in mind, the planning committee developed three concrete objectives for the two-day conference:

- Build a shared understanding of the issues surrounding girls and women in STEM
- Share best practices and proven solutions
- Find actionable ways to increase participation and persistence of girls and women in STEM in the participants' own sector

Wendy L. Hill, Ph.D., Head of School, The Agnes Irwin School

THREE THEMES: LITERATURE BASE

To further focus the discussions during the two-day conference, the conference planners identified three main factors that strongly influence the participation and persistence of girls and women in STEM: Teacher Preparation and Curriculum, Mentoring, and Partnerships. Given that these three factors (or the absence thereof) can affect leaks along the pipeline, they each represent opportune areas for solutions.

TEACHER PREPARATION & CURRICULUM DESIGN

Together, teachers and the curriculum play a crucial role in the intellectual lives of their students. Throughout the course of the day, teachers not only help to develop critical thinking skills and knowledge in their students, but they also pass on attitudes, perceptions, and assumptions. Similarly, the curriculum provides students with the academic foundation that they need for their future careers in STEM and have the power to attract students into new and different fields. Research, notably, demonstrates that girls who engage in curricula that explicitly teach spatial skills early or begin with a focus on the application of a field are more likely to engage with STEM fields later in life (Holdren, Lander & Varmus, 2010; Hill, Corbett & St. Rose, 2010).

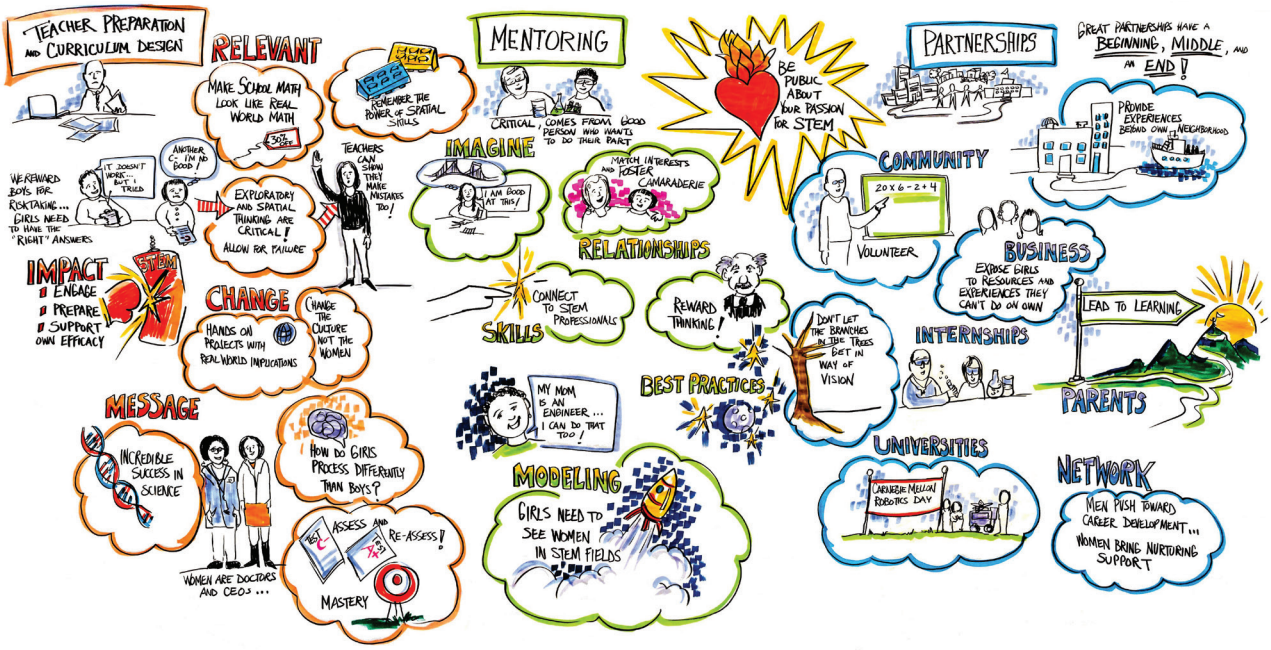
Panel 1: Teacher Preparation & Curriculum Design – Peg Cagle, David Pinder, and Mary Roth, Ph.D.

A report by the President's Council of Advisors in Science and Technology states, "The most important factor in ensuring excellence is great STEM teachers, with both deep content knowledge in STEM subjects and mastery of the pedagogical skills required to teach these subjects well" (Holdren et al., 2010, p. 12). More specifically, Hill et al. (2010) explain that teachers play the dual role of helping girls both develop a belief that they belong in STEM fields and build the cognitive skills in spatial reasoning that they need for success and persistence.

Because of their own experiences or anxieties, teachers can either perpetuate or reduce the impact of stereotype threat for girls interested in STEM (Halpern et al., 2008; Holdren et al., 2010; Gunderson et al. 2011; Shapiro & Williams, 2011). Put simply stereotype threat is a fear of conforming to negative stereotypes about your social group that can lead to a decrease in working memory load (Murphy, Steele & Gross, 2007). Because of their preparation or knowledge, teachers may or may not provide environments rich with opportunities to develop spatial skills, and may or may not make girls feel comfortable with STEM (Halpern et al., 2008; Holdren, et al., 2010). The roles of teacher education and curriculum development, therefore, are crucial in both preparing girls cognitively for STEM fields but also for attracting and retaining those girls.

MENTORING

Exposing girls at each stage of the pipeline to mentors and, in the early stages, to role models, is an essential component of increasing their participation and persistence in STEM fields. At early ages young girls need to see women in STEM fields in order to imagine themselves as physicists, computer programmers, mechanical engineers, and math teachers (Kerr & Robinson Kurpius, 2004; Halpern et. al, 2011; Sikora & Pokropek, 2011). Sikora and Pokropek (2011), for example, find that across the globe, boys are more likely to aspire to careers in engineering and computing. Based on



counts of engineering mothers, they posit that one major reason for differential career aspirations in these STEM fields is a lack of strong female role models who would "normalise" these STEM fields for girls and they explain that this may be the reason for unequal career aspirations.

Later in the pipeline, the focus shifts from role models to mentors, who mediate girls' interactions with STEM professions (Liston, Peterson & Ragan, 2008). Both mentors and role models reduce stereotype threat, create informal spaces for learning, and provide access to programs and careers previously unavailable to girls (Hill et al., 2010; Holdren et al. 2010; Gunderson et al., 2011; Weber, 2011; Mosatche et al., 2013).

Mentors are particularly important in increasing girls' self-efficacy, or helping them to gain confidence in their own abilities, because they provide the safe environment, vicarious experience, and positive feedback that build confidence in their abilities (Kerr & Robinson Kurpius, 2004). Unlike role models who mainly allow girls to imagine themselves in different ways, mentors foster relationships that give girls skills and access to programs and professions that they need (Halpern et al., 2011). Recently, numerous nonprofit groups like Million Women Mentors (MillionWomenMentors.org) and Black Girls Code (BlackGirlsCode.com) have been created to provide mentorship opportunities for girls and women in STEM. The effectiveness of these programs and how best to expand them, however is under-researched. Therefore, a stronger understanding about how to identify and prepare mentors and on how best to connect mentors with girls is needed.

FORGING PARTNERSHIPS

To effectively increase the participation and persistence of girls in STEM fields, it is essential that K-12 schools, colleges and universities, and businesses build strong and active partnerships with each other (Holdren, et al., 2010). More specifically, Liston, Peterson and Ragan (2008) explain that leveraging such partnerships is especially crucial to helping programs succeed because collaboration inherently multiplies resources and strong collaboration is mutually beneficial.

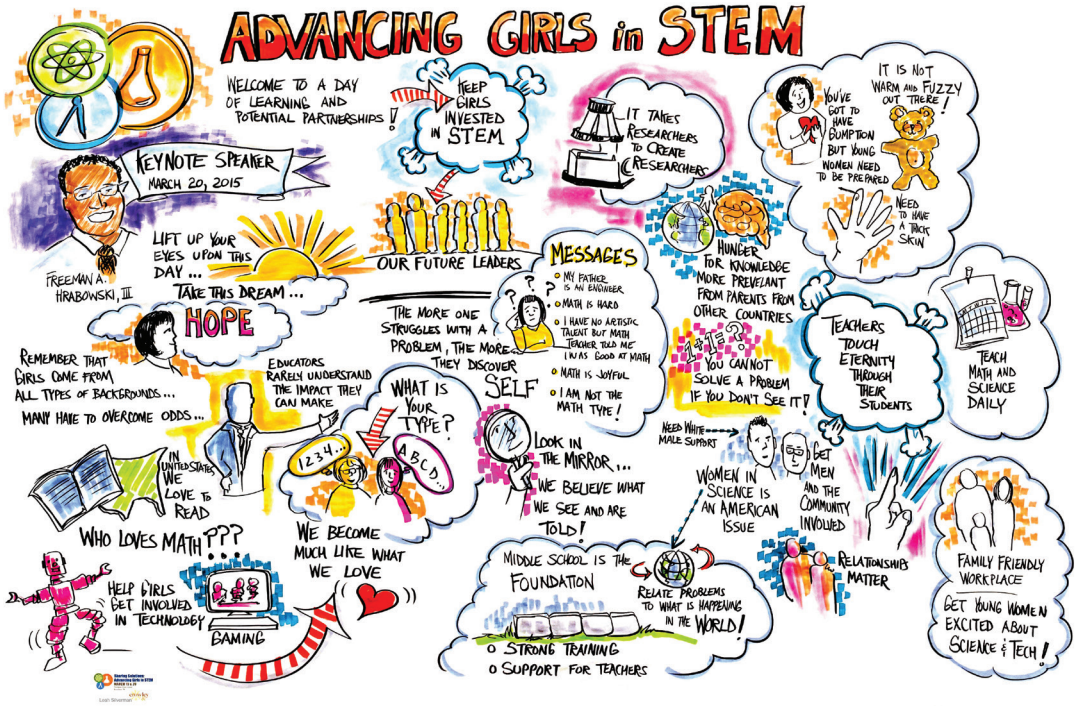
Partnership means access to mentors, equipment, additional personnel in the form of volunteers, and the sharing of ideas between individuals from different perspectives (Downs & DeSouza, 2006; Holdren, Lander & Varmus, 2010; Mosatche et al., 2013). In an analysis of effective STEM programs for girls, Mosatche, et al. (2013) explain that one of the main benefits of partnership is the ability to "provide girls with experiences beyond their own neighborhoods" (22). In this way, partnerships allow for the application of skills and knowledge in a new context that provides a more real-world experience. Additional research, however, is needed. After extolling the benefits of partnerships for increasing persistence and participation of girls in STEM, Brotman and Moore (2008) provide an important question for future research: how might more effective partnerships be created between schools, universities, and community organizations?

OVERVIEW OF THE CONFERENCE

Sharing Solutions: Advancing Girls in STEM brought together 120 invited educators from K-12 and higher education settings, policy makers, and senior-executive industry leaders. The conference began with keynotes from two major voices in STEM advocacy, followed by a day of small group discussions focused on the three main factors that contribute to the participation and persistence of girls and women in STEM fields. The full conference program is found in Appendix A of this report.

KEYNOTE ADDRESSES

The conference began with keynote addresses focused on the conference theme. The first keynote speaker, Jill Birdwhistell, Chief Ooperating Officer of AAUW, gave a preview of the new AAUW report entitled *Solving the Equation: The Variables for Women's Success in Engineering and Computing*. As she described during her keynote, this report is an update to the widely read report *Why So Few? Women in Science, Technology, Engineering, and Mathematics*. Reviewing findings from the new research report, Birdwhistell explained that the most recent data indicate that women are still more attracted to life and biomedical sciences and less interested in computer science, physics, and engineering. This starts early, she detailed, with girls taking 59% of Biology AP Exams and only 20% of Computer Science AP Exams. In her presentation, Birdwhistell focused on computer science, specifically, because that is the only field where women's participation has dropped in recent years: in 2013, women represented 26% of the computing workforce, which represented a decrease from 35% in 1990. In reviewing the recent AAUW study, Birdwhistell pointed out several key things that teachers can do to increase participation and persistence in STEM fields:



- Set clear performance standards
- Adopt a growth mindset: abilities are not fixed, but can grow and develop with hard work
- Embrace the struggle: find value in the process and not just the product
- Develop spatial skills

The second keynote address was delivered by Dr. Freeman Hrabrowski, President of University of Maryland, Baltimore County (UMBC). Hrabrowski has received national recognition for the documented successes he has had in *creating* strong STEM pipelines at UMBC for underserved groups through initiatives such as the Meyerhoff Scholars Program. Through a series of powerful stories, Hrabrowski challenged the audience to think differently about which students would become scientists. He also emphasized the role that teachers and counselors can play in plugging the leaky pipeline. Hrabrowski explained that, in order to increase the number of girls who aspire to become scientists and engineers we must, first, remember that they come from all types of environments and backgrounds and second, we must change the culture of educational institutions. According to Hrabrowski, our society is bifurcated into people who identify as "math and science" people and those who don't. Girls, he explained, need to be able to see themselves in STEM fields, which requires a cultural shift. Hrabrowski noted that educational institutions need to begin by naming and understanding the problems, explaining that the secret to changing culture is to "think differently about fundamental problems." Hrabrowski ended his keynote address with a story about the importance of relationships, concluding that "I now understand that teachers touch eternity through their students."

PANEL DISCUSSIONS

Following the second keynote address, conference participants each selected one of three panel discussions focusing on the three themes articulated previously: teacher preparation/curriculum, mentoring, and forging partnerships. Each panel consisted of three 'experts' selected to represent a broad knowledge base on the topic and a moderator (See Appendix A for details). After brief introductions, the moderator posed several questions to the panels followed by additional questions from the conference participants. Throughout the day participants were given the opportunity to grapple with what they heard, expand on their initial discussions, and share with each other what they gleaned in a variety of forums. In the following sections of the report, notably "Lunchtime Conversations" and "Action Planning," we detail the elements of the panel discussions that were most salient to participants as they discussed them throughout the day.

Keynote speaker Freeman Hrabrowski, Ph.D., President of University of Maryland, Baltimore County

LUNCHTIME CONVERSATIONS

To expand upon the work that began in the panel discussions, participants were sorted into groups at lunch so that, at every table, there were individuals who had attended each of the three panel presentations. Each table also had a facilitator/recorder and a series of discussion questions to probe what they learned, what surprised them, and what they would like to learn more about.

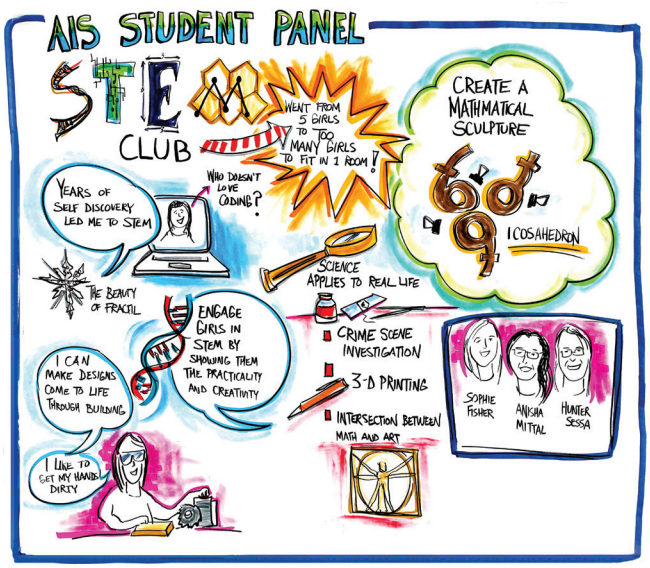
When asked what they learned, participants focused on four general areas: early learning opportunities, learning as a process, designing real partnerships, and the importance of mentors. First, participants explained that developing early learning opportunities means that K-8 teachers need more support in STEM, that math and science should not be departmentalized in elementary school, and that schools need strong maker spaces and design labs for our youngest students. Similarly, participants felt that students should be engaged in STEM both in and out of school at many points in their lives. Second, participants articulated a need to focus on learning as a process—relying heavily on language from literature on growth mindset, the idea that intelligence and

other abilities are not static and can be molded and changed through hard work and persistence (e.g. Dweck, 2006, 2010; Good, Rattan & Dweck, 2012). According to the facilitators, participants feel that girls need to learn to embrace the cognitive struggle and not to view their education as a finite process. To this end, students need to learn that struggling to succeed in a task is part of the growth process and not an indication that they should not engage in that task or field. Teachers, therefore, should praise these struggles in addition to commending the correct answer. Competitions, by this logic, should not be the only feature of strong STEM programs. Third, participants defined some key components to strong partnerships: trust, time, and teamwork. More specifically, participants suggested that partnerships ought to focus on collaboration rather than sponsorship. In other words, a true partnership is not purely financial. Simply providing funds for a new science lab, for example, does not represent a partnership. In a true partnership, each member is contributing in multiple, meaningful ways. Finally, participants explained that they learned that mentoring relationships can be lateral, rather than hierarchical. These relationships, they articulated, need to involve a good deal of trust and need to take culture and generation into account.

Mariandl Hufford, Assistant Head of School, The Agnes Irwin School, and Director of the Center for the Advancement of Girls

When asked what surprised them from the morning discussions, participants noted that there was a need for a culture shift to improve the number of girls and women in STEM in both K-12 and Higher Education institutions. For example, participants were surprised that telling girls that they are "good at math" does not promote a growth mindset, but a fixed mindset that perpetuates the STEM gap. Participants similarly were surprised that spatial reasoning is a teachable skill, which serves as evidence of the need to revisit their own fixed mindsets. Within the responses there was some question as whether girls in STEM need to be nurtured or instructed to have a "thick skin." This, again, speaks to culture. Participants asked the question: do we need to change girls so that they can survive or do we need to scaffold their experiences—or both? In addition to a gender-related culture shift, participants were also surprised about the confluence of race and gender in the leaky STEM pipeline. One person commented that in STEM, underrepresented races feel that they have to represent their race, but white women do not feel that the same pressure to represent all women.

When asked what they want to learn more about, people continued to probe the idea of culture change. They asked how to change girls' perspectives about their own abilities, how to grade when you want to praise the cognitive struggle, how to prepare teachers, how to get parents involved, and how to address covert discrimination. Participants, therefore, not only wanted to know how to shift the culture, but how to make sense of a culture shift in the face of already entrenched methods of teaching and grading. One question posed by a participant relates to this issue: How do you change the culture in STEM if the people in charge are white men? Those at another table asked: What defines STEM? What does it mean to be a STEM school? How is that measured? Who defines STEM? As participants went through their discussions, the facilitators' notes point further towards a need for culture change and a desire to know how that culture change could happen. Illustrative of the need for cultural change was the call to have students "embrace failure" and a need to better understand how to best accomplish this. Seeing a poor test grade or an experiment with no results as failure is one of the cultural touchstones that has limited the participation and persistence of women in STEM fields. While participants fully recognized this, they asked for guidance on how best to shift this mindset.



AGNES IRWIN SCHOOL STEM CLUB ACTIVITY

Following lunch the three co-heads of The Agnes Irwin STEM Club, all students in 11th grade, conducted a demonstration activity with the conference participants to model what the STEM Club does each week. In this activity, participants were given large cardboard pieces of an icosahedron and were challenged with assembling them correctly. The conference participants all engaged actively in the struggle. Some groups were able to assemble their pieces quite quickly and others had to tinker a bit longer before finishing their section. The Agnes Irwin STEM club is by far one of the most popular at the school, in part because of the hands-on activities that the club heads design to engage their fellow students in STEM fields.

SUCCESS STORIES

After the hands-on activity of the STEM club, conference participants heard short presentations from three young women working in various engineering fields. Each of the young women shared how she was first attracted to engineering and the various factors that helped her to become successful. While each woman described a unique path to her engineering career—one recounted a friend's car accident, another discussed a desire to marry science and art—all three highlighted mentors and teachers who helped them to get through tough spots in their careers and the importance of learning how to ask for help. One of the speakers, Kristin Ford-Ransom (a graduate of The Agnes Irwin School), really pushed the audience by saying that "you can be a catalyst or a black hole" and encouraged the participants to work to change potential energy into kinetic energy. In other words, she, and the other two speakers, all talked about how important it is to take what they were discussing at the conference and to take action with the girls with whom they work.

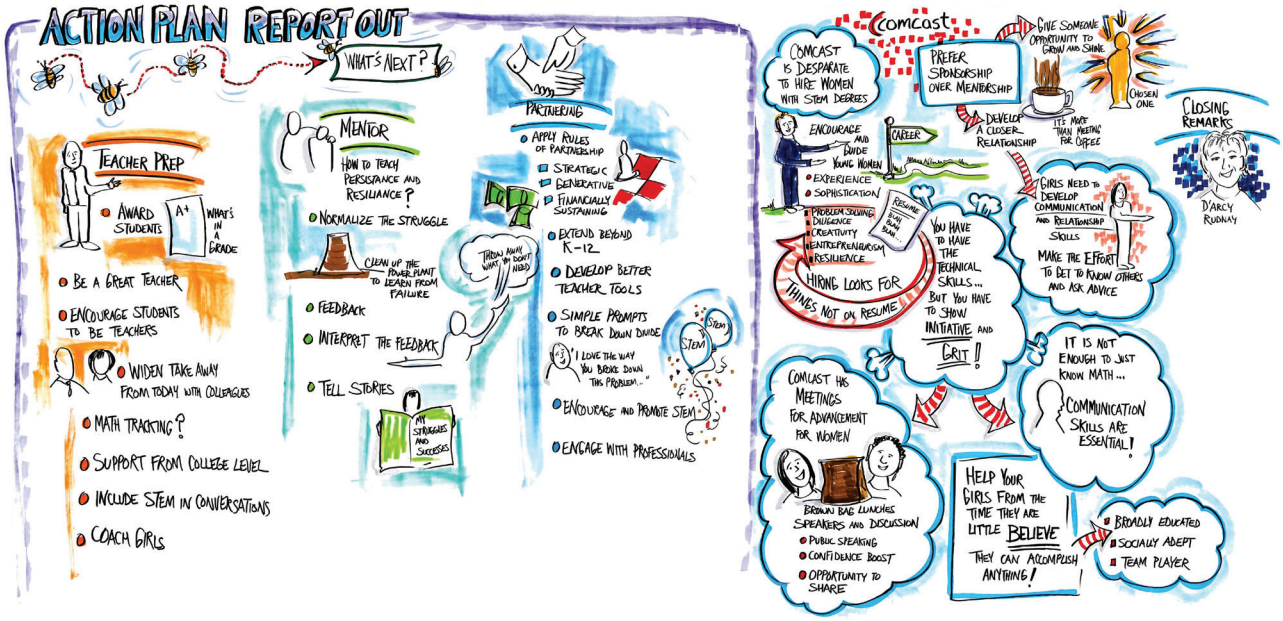
ACTION PLANNING

After hearing from women who have found success in their STEM fields, participants reconvened with their groups from the panel discussions to develop an action plan and to report out all that they had learned that day based on the three conference themes. Together with a facilitator, participants discussed common understandings of the relevant issues facing girls in STEM fields, identified what still needs exploration, and brainstormed recommendations for action.

AIS Student Panel

STEM Club demonstration activity

Kristen Ransom, AIS '09



The group focused on *Teacher Preparation and Curriculum* began with a set of questions that they were each going to continue to grapple with on an individual and institutional level:

- How do you reward students in the cognitive struggle in our graded culture?
- How do we educate pre-service teachers to be great teachers?
- What are the best ways to have honest conversations with your colleagues about the issues that you have found?
- Are there differences in the ways to engage and recruit women STEM teachers?
- Given our discussion, is math-tracking the best idea?
- Is there a difference in effective ways to engage STEM based on gender and race?

The *Teacher Preparation and Curriculum* group additionally identified several recommendations based on their conversation. Several of the recommendations, encouraging students to become teachers, the EDGE mentoring approach, coaching girls to ask questions about the kind of support women are given in the STEM fields at the colleges to which they are applying, looking for partnerships, and including gender and race into the curriculum were concrete actions that many institutions could begin doing fairly quickly. However, the participants explicitly pointed to the need to attract more education majors with interest and confidence in STEM subjects—a plan that clearly needs more support and planning if it is to be enacted.

The *Mentoring* group focused on two particular aspects of mentoring: how mentors can teach resilience and how mentors can help to develop networking skills. The mentoring group asked the question: "How do you teach persistence and resilience to yourself and those you mentor?" The group agreed that the best strategy a mentor can use is to normalize failure and struggle through sharing examples. The first goal of a mentoring relationship should be to help the mentee see a path not a destination, and the second, that along that path there will always be hurdles. Additionally, participants concurred that there needs to be greater focus on feedback in a mentoring relationship. Feedback should be given via a two-way communication pattern where mentees and mentors are given time and support to interpret the feedback—i.e. to "size it and put it in perspective." One of the main challenges that the mentoring group discussed was how to best recognize the efforts and time required by mentors. While the focus on two-way communication is not a definitive solution to this challenge, it does change the feeling of mentorship from a task to a relationship. In their action plan, the mentoring group also focused on networking and put forth the strategy of conducting informational interviews with mentees or students as a means to start developing networking skills and finding sponsorship. Additionally, the mentoring group suggested that mentors and schools both need to show girls the creative side of STEM through embracing STEAM (Science, Technology, Engineering, Art, and Mathematics).

The *Partnerships* group agreed that partnerships have a very important role to play when it comes to developing resilience and confidence and in creating better tools for teachers. The group was quick to note that partners should focus on building resilience—not on helping girls develop a "tough skin." They also articulated a need to figure out how to break down or deconstruct the divide for students who are good with math or language. To achieve these goals all partnerships (both new and already existing) should work to include the three rules of partnerships: 1) Be strategic to the mission, 2) Be replicable or generative, and 3) Be financially self-sustaining. Through this, the partnership group suggests developing asset maps to extend partnerships into the community. Partnerships, they concluded, should be evaluated regularly, with the ability to say no always as an option.

CLOSING KEYNOTE CONVERSATION: D'ARCY F. RUDNAY AND DR. WENDY HILL

The conference ended with a keynote conversation between D'Arcy F. Rudnay, the Executive Vice President at Comcast and Dr. Wendy Hill, Head of The Agnes Irwin School in which they reflected on several of the themes that had emerged over the course of the day. Hill began by asking Rudnay about what Comcast, the world's largest media corporation based on revenue (Institute of Media and Communications Policy, 2015), looks for in a new employee. Rudnay explained that, while Comcast rarely hires students who have just graduated from college, the company is desperately looking for women who have degrees in math and engineering who possess resilience, creativity, and entrepreneurism. In other words, Comcast seeks people who, first, look for problems to solve and second, solve those problems. Hill also asked her about mentorship and Rudnay explained that at Comcast, sponsorship is far more important because of the symbiotic relationship. A sponsor (to disambiguate the language from the partnership discussion wherein sponsors provide funds) is a "powerfully positioned champion" (Hewlett, 2013) who advocates for, guides and connects a protégé. Reflecting on formal mentorship programs, Rudnay explained that when you are assigned a mentee it can be hard to develop that personal relationship with the mentee because it can feel artificial. Sponsorship technically means that you work to develop a relationship with someone who works for you. This can happen more naturally, Rudnay proffered. In the math, science, technology fields, Rudnay recommends that young women need to be as aware of the importance of developing relationships and communication skills as they do of their STEM skills. Rudnay emphasized that employees need to make an effort to get to know the people on the team to create strong relationships. Being good at one's job and meeting deadlines is not enough. She further explained that it is important to collaborate and build bridges should an issue arise. In response to these comments Hill and Rudnay discussed the need for companies to help women develop those softer skills and whether formal mentoring programs need more structure to achieve this goal of becoming more 'sponsor-like'.

Keynote speaker Jill Birdwhistell, Chief Operating Officer, AAUW

FROM SHARING TO ACTION: NEXT STEPS

Overall, *Sharing Solutions 2015: Advancing Girls in STEM* was a great success. Participants interested in improving the participation and persistence of girls and women in STEM fields were able to come together to gain a deeper understanding of the issues, to share solutions and best practices, and to begin the process of taking action. One participant wrote, "This conference provided a wonderful opportunity to educate educators and organizations regarding the challenges and remarkable opportunities for girls in STEM. I am excited for the future." Appendix B contains a detailed evaluation of the conference using a pre-post survey design. By far one of the most salient themes of the conference evaluation was the benefit of collective problem solving with people from many different sectors. Teachers and administrators from K-12 and higher education institutions, non-profit and corporate representatives, and researchers were able to spend the day interacting with each other in meaningful ways to both share and build solutions to the complex problems involved in patching and rebuilding the leaky STEM pipeline. As detailed in the evaluation in Appendix B, several participants indicated that interacting with this diverse group allowed them to elevate their understanding of these issues. For example, one participant wrote: "I enjoyed and learned a lot from interacting with people who shared my concerns but represented different structural or institutional places." It was rewarding that even the most knowledgeable participants learned something from these different perspectives.

Panel 2: Mentoring – Frederic Bertley, Ph.D., Nicole LeVine, Rhonda Hughes, Ph.D., and Amy Fleisher, Ph.D.

When participants were asked what they would want to focus on in the future, there were two distinct themes: first, how to change the culture surrounding girls and women in STEM, and second, information about concrete educational strategies. Sparked, in part, by the words of Freeman Hrabrowski, participants became cognizant that to be truly successful the change needs to happen at an institutional level, thus requiring a culture change. However, participants were clearly unsure of how to go about developing that culture change, asking for examples of "successful models of changing cultures, (top down? bottom up?) what works?" Our next gathering, from this perspective, will take the shape of a workshop focused explicitly on changing cultures. This workshop, notably, will also satisfy those who were looking for more concrete educational strategies because it will allow teams to come together to develop action plans that work for their institutions.

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Panel 3: Partnerships – Loretta Sweet Jemmott, Ph.D., Natalye Paquin, and Larry Dubinski

APPENDIX A: CONFERENCE PROGRAM

KEYNOTE SPEAKERS

Jill R. Birdwhistell

Jill R. Birdwhistell, Ph.D., joined the American Association of University Women (AAUW) as chief operating officer in 2009. In addition to her role as chief of staff, Jill works closely with AAUW leaders on governance and other legal issues. She has a bachelor's degree from the University of Pennsylvania, a master's degree in education from the University of Virginia, and a doctorate in higher education administration and policy/law from the University of Kansas. In her early career, Jill was a high school teacher, a labor negotiator for 12 Alaskan fishing unions, a medical editor, and the director of two metropolitan alcoholism/drug education and rehabilitation programs. She served on the graduate faculties of the Schools of Education at the University of Kansas and the University of Virginia, and Tulane University's School of Public Health in Health Systems Management. Subsequently, she was senior vice president for America's Health TV Network and a senior national executive for the American Lung Association; National Mental Health Association; National Alliance for the Mentally Ill; American Medical Women's Association; Food Allergy & Anaphylaxis Network; and the Association of Women's Health, Obstetrics, and Neonatal Nursing. Jill is a member of the AAUW of Arlington (VA) and Capitol Hill (DC) branches. She and her husband, Fred Cory, are do-it-yourselfers and perpetually remodeling their Arlington home.

Freeman A. Hrabowski, III

Freeman A. Hrabowski, III, Ph.D. has served as President of UMBC (The University of Maryland, Baltimore County) since 1992. His research and publications focus on science and math education, with special emphasis on minority participation and performance. He chaired the National Academies' committee that produced the recent report, "Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads." He also was recently named by President Obama to chair the newly created President's Advisory Commission on Educational Excellence for African Americans. In 2008, he was named one of America's Best Leaders by U.S. News & World Report, which ranked UMBC the nation's No. 1 "Up and Coming" university for the past six years (2009-14). TIME magazine named him one of America's 10 Best College Presidents in 2009, and one of the "100 Most Influential People in the World" in 2012. In 2011, he received both the TIAA-CREF Theodore M. Hesburgh Award for Leadership Excellence and the Carnegie Corporation of New York's Academic Leadership Award, recognized by many as the nation's highest awards among higher education leaders. In 2012, he received the Heinz Award for his contributions to improving the "Human Condition" and was among the inaugural inductees into the *U.S. News & World Report* STEM Solutions Leadership Hall of Fame.

NCGS HEADS BREAKFAST AND MODERATED DISCUSSION

"Are All Girls' Schools STEM Schools?"

Nilanjana "Buju" Dasgupta

An established expert and researcher in her field, Dr. Nilanjana Dasgupta, Ph.D. focuses on the study of prejudice, stereotyping and the self-concept, with special emphasis on the ways in which societal expectations unconsciously or implicitly influence people's attitudes and behavior toward others in relation to race and ethnicity, gender, sexual orientation, age and nationality. As a Professor of Psychology at University of Massachusetts, Amherst, Dr. Dasgupta has presented research on how implicit bias affects girls and women in science and engineering to local groups of science faculty and graduate students, at an international conference of engineers, and at a meeting of the Association of Women in Science. She was Associate Editor of *Personality and Social Psychology Bulletin* and currently works on the consulting editorial board of several journals. Dr. Dasgupta graduated summa cum laude from Smith College and went on to complete her M.S., M.Phil. and Ph.D. in Social Psychology at Yale University. Her teaching interests remain in the fields of social psychology, social cognition, stereotyping and prejudice, and emotional responses.

Megan K. Murphy

Megan K. Murphy is the Executive Director of the National Coalition of Girls' Schools (NCGS). NCGS is the leading advocate for girls' education with a distinct commitment to the transformative power of all-girls' schools. Before joining NCGS, Ms. Murphy served as the Vice President of Development and Alumni Affairs at Semester at Sea. While there, Ms. Murphy was instrumental in establishing a comprehensive development program and implementing a strategic outreach plan to 55,000 alumni worldwide. Previously she served as the Director of Development at the all-girls' Marlborough School. She has also served as the Dean of Admissions and Enrollment Management at Allegheny College. Ms. Murphy earned a B.A. in International Studies and French from Allegheny College and an M.A. in Public Administration and International Affairs from the University of Pittsburgh. She served on the board of the Henry T. Nicholas Education Foundation, Inc. Recently, Ms. Murphy joined the Advisory Board of the Center for the Advancement of Girls at The Agnes Irwin School and the National Girls Collaborative Project Champions board.

Alana Yoel, AIS '07

Frederic Bertley, Ph.D., and Larry Subinski of The Franklin Institute

Kelly Peeler

SESSIONS / PANEL 1

Teacher Preparation & Curriculum Design

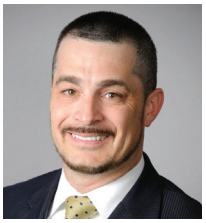
Moderator: Wendy L. Hill, Ph.D., Head of School, The Agnes Irwin School

This moderated panel discussion brings together STEM experts from both higher education and K-12 arenas who focus on the powerful impact teacher education, school leadership, and effective curriculum and pedagogy have on the persistence of girls in STEM fields. Research indicates that teachers, through their pedagogical practice, and their own attitudes, perceptions, and assumptions, play the single most important role in both preparing students cognitively for STEM careers and in encouraging girls to enter and persist in STEM fields. Similarly, curricula not only provide students with the academic foundation they need for future careers in STEM, but coursework also has the power to spark and retain students' interest in STEM subjects. Panelists will provide best practices for preparing and supporting STEM educators and designing curricula that engage STEM students at all educational levels.

Peg Cagle

Margaret "Peg" Cagle began her working life as a registered architect but after learning of the shortage of qualified STEM educators, decided she could make a greater difference teaching math in a large urban district. During 17 years with the Los Angeles Unified School District, Ms. Cagle taught every math course from 6th grade through Algebra II/ Trigonometry, earned National Board Certification and was recognized as LA County Teacher of the Year, Raytheon Math Hero, USA-Today's All-USA Teacher and recipient of the Presidential Award for Excellence in Mathematics Teaching. Beyond the classroom, Ms. Cagle serves as a board member of the National Council of Teachers of Mathematics, consultant for Bill Nye the Science Guy, staff of the Park City Mathematics Institute, and Albert Einstein Distinguished Educator Fellow on Capitol Hill. Ms. Cagle currently works in mathematics teacher education at Vanderbilt University.

David Pinder



David Pinder is an educational reformer whose career has been marked by success in empowering educators and students, developing high-performing professional learning communities, and implementing strategies that drive incredible student achievement gains. As principal of McKinley Technology High School from 2007-2013, Mr. Pinder led a team of educators that moved student achievement to significant growth. Mr. Pinder was awarded the 2012 DCPS Principal of the Year. On July 1, 2013, he began a new role as Executive Director of New Leaders, DC to attract, train and support the next great leaders in education. Today, Mr. Pinder has returned to DCPS as an Instructional Superintendent managing a cluster of high schools in the District of Columbia Public Schools.

Mary Roth

Mary Roth, Ph.D. is the Simon Cameron Long Professor of Civil and Environmental Engineering at Lafayette College in Easton, PA. She received her degrees in civil engineering from Lafayette College (B.S.), Cornell University (M.S.), and University of Maine (Ph.D.). She joined the faculty at Lafayette in 1991, and her research interests include risk assessment for earth retaining structures, site investigation methods in karst, and engineering pedagogy. She has authored or co-authored over 50 publications and has served as principal or co-principal investigator on seven grants from the National Science Foundation. At Lafayette College, Dr. Roth has served as Department Head of Civil and Environmental Engineering, Director of Engineering, and Associate Provost for Academic Operations in addition to multiple faculty committee assignments.

SESSIONS / PANEL 2
Mentoring

Moderator: Lynn Yeakel, Founder, Executive Director, Vision 2020 and Director, Drexel University College of Medicine's Institute for Women's Health and Leadership®
Exposing girls at each stage of the STEM pipeline to mentors and, in the early developmental stages, to role models has been demonstrated to be an essential component to increasing their participation and persistence in these fields. This panel brings together four expert STEM mentors to discuss mentorship of girls and women both in school and across the career path. Mentors and role models not only help girls and women imagine themselves in STEM careers, but also foster relationships that give them skills and access to programs and professions. Despite the firm belief among researchers that mentors and role models are crucial, best practices for mentorship are under-researched. This panel will highlight best practices for mentoring girls and women in STEM fields from the perspective of industry, higher education, public institutions and community organizations.

Frederic Bertley

Frederic Bertley, Ph.D. directs both science and educational programs for The Franklin Institute, including overseeing TFI's partnership with its magnet high school, Science Leadership Academy. Additionally, he directs the prestigious Franklin Awards Program, the long-running Journal of The Franklin Institute and the Institute's international efforts, including shepherding a USAID-supported effort to build five STEM platform high schools in Egypt. Prior to The Franklin Institute, he joined a Harvard Medical School HIV Vaccine Research Group, and managed multinational teams in Haiti and the Sudan. Dr. Bertley has received numerous honors, including the Harvard Medical School Dean's Service Award, Merck Scholarship, and The President's Award (QBMA). He is a Philadelphia Business Journal "40 Under 40" honoree and a Mid-Atlantic Emmy™ winner.

Amy Fleisher

Amy Fleischer, Ph.D. is a Professor of Mechanical Engineering at Villanova University, where she is also Associate Chair of Mechanical Engineering and Director of Graduate Studies. She heads the NovaTherm Research Laboratory, where her research interests include the broad topics of sustainable energy system design and thermal management of electronic systems. Dr. Fleischer is recognized as an expert in thermal-fluid system design and was elected by her peers as Chair of the ASME Technical Committee on Electronics Thermal Management (2009-2011). She has received numerous awards from her peers, including the 2010 ASME EPPD Woman Engineer of the Year award.

Rhonda Hughes

Rhonda Hughes received her B.S., M.S., and Ph.D. from the University of Illinois at Chicago. Since 1980, she has taught at Bryn Mawr College, serving as Chair of the Mathematics Department for six years. She retired in 2011 after 31 years. During that time, she served as President of the Association for Women in Mathematics, and received several awards for teaching and mentoring, including the 2004 AAAS Mentor Award for Lifetime Achievement. In 1998, she co-founded the EDGE Program (Enhancing Diversity in Graduate Education) with Sylvia Bozeman of Spelman College. The program addresses the attrition of women attending graduate school in the mathematical sciences. To date, over 200 women have participated in the EDGE Program, with 140 earning master's degrees and 56 earning the doctoral degrees.

Nicole LeVine

Nicole LeVine has more than 15 years of experience in the utility industry. She began her career in highway engineering consulting, and moved into the gas and electric utility industry in 2000 with PECO. She held various engineering roles and quickly moved into management. Beginning in 2003, Ms. LeVine has had management responsibility for Gas Regulatory Compliance, Overhead and Underground Electric Transmission, Energy Technicians, Electric Distribution System Operations, and the Electric and Gas Operations Control Center. She currently holds the position of Director, Gas Operations. She has a B.S. in Civil Engineering from the University of Delaware and is a three-time Ironman finisher.

SESSIONS / PANEL 3

Partnerships

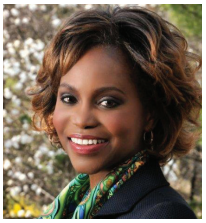
Moderator: Dale McCreedy, Ph.D., Director of Gender, Adult Learning and Community Engagement, The Franklin Institute

To effectively increase the participation and persistence of girls in STEM fields, it is essential that community organizations, K-12 schools, higher education institutions, and businesses build strong and active partnerships with each other. This moderated panel addresses how we might create more effective partnerships among these organizations. Successful partnerships have taken many forms: universities partnering with major corporations to create internship opportunities; schools collaborating with universities for access to professors or laboratories; or community organizations connecting with businesses and local schools to give girls new experiences with STEM. Partnership is essential because of the combined intellectual, human, and material resources it offers. However, questions about best practices still remain. This panel enhances this conversation by offering best practices for building and maintaining STEM partnerships that have been learned from partnerships between schools and universities, industry and community organizations, and public institutions and schools.

Larry Dubinski

Larry Dubinski is the President and CEO of The Franklin Institute. Prior to his current position, he served as Senior Vice President of External Affairs and General Counsel, as Executive Vice President, and later as COO. His career at the Institute began in 1997, as Director of Corporate and Government Relations, and later as Director of Development. He left the Institute in 2000 to join the law firm of Morgan, Lewis and Bockius LLP, and returned to the Institute in 2004. He currently serves on the Board of Trustees of the Greater Philadelphia Cultural Alliance and on the Parkway Council, and as the Development Committee Chairman for the Association of Science and Technology Centers.

Natalye Paquin



As CEO of the Girl Scouts of Eastern Pennsylvania (GSEP), the state's largest non-profit organization serving girls, Natalye Paquin is responsible for oversight of $40 million in assets, managing a $16 million annual operating budget, and leading a workforce of 450, including part-time and seasonal employees. Prior to joining the Girl Scouts as CEO in 2010, Ms. Paquin was the Executive Vice President and Chief Operating Officer of the Kimmel Center for the Performing Arts. A lawyer, Ms. Paquin began her career in private practice as a litigation attorney, and spent the next 15 years in executive and legal roles in the education arena with the U. S. Department of Education, the Chicago public schools and the School District of Philadelphia.

Loretta Sweet Jemmott

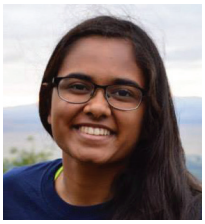
Loretta Sweet Jemmott, Ph.D. is one of the nation's foremost researchers in the field of HIV/AIDS prevention, having the most consistent track record of evidenced-based HIV risk-reduction interventions. As an expert in health promotion research, she has led the nation in understanding the psychological determinants for reducing risk-related behaviors. Her premier contribution is the development of knowledge on how best to facilitate and promote positive changes in health behaviors. Dr. Jemmott is an outstanding translational researcher who has had global impact. She has partnered with community-based organizations, including churches, clinics, barbershops and schools, and transformed her NIH-funded, evidenced-based research outcomes for use in real-world settings. Dr. Jemmott has received numerous prestigious awards for her significant contributions. Dr. Jemmott is the van Ameringen Professor in Psychiatric Mental Health Nursing at the University of Pennsylvania School of Nursing. She is also Director of the Center for Health Equity Research.

AIS STUDENT PANEL: STEM CLUB FOUNDERS

Sophie Fisher '16

Sophie Fisher is interested in computer science and mathematics, and enjoys applying her programming skills to projects in 3D printing, mathematical art, robotics, and web and game development. Sophie is a member of the Upper School Robotics team, in which she helps design a fully-functional robot. She is the co-founder of STEM Club, a mentor to the Lower School's STEM and Math Clubs, and a member of the school's select a cappella choral group. Sophie aspires to become a software engineer and pursue research in computer science.

Anisha Mittal '16



Anisha Mittal's interest in STEM arose from breaking complex issues into simple sets of challenges and seeking to apply this outlook to medicine. She is a co-founder of the STEM Club, a mentor to the Lower School STEM and Math Clubs, and an active member of the Upper School Robotics team, helping with the design and programming aspects of making a functional robot. Anisha currently conducts research in alternative energy and neurobiology at the University of Pennsylvania and wants to pursue research in biology, engineering and environmental toxicology.

Hunter Sessa '16

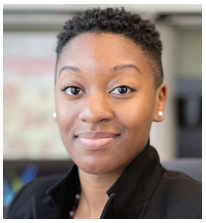
Hunter Sessa aspires to combine her passion for innovation and medicine and pursue a career in biomedical engineering. Knowing the importance of outreach, especially to girls who may be intimidated by STEM fields, Hunter enjoys spending time cultivating this enthusiasm in others. She mentors the Middle School Lego Robotics team, and the Lower School Math and STEM Clubs, and tutors students from Philadelphia; her proudest accomplishment is co-founding and leading the Upper School STEM Club. Hunter is an active member of the Upper School Robotics team and works each week on the design and construction of the team's robot.

CASE STUDIES: SUCCESS STORIES

Elaine Luczka

Elaine Luczka is a licensed Structural Engineer with AECOM in Philadelphia. She graduated from Drexel University in 2007 with a dual B.S. in Civil and Architectural Engineering and recently returned part time to pursue a Master of Science in Civil Engineering. Her volunteer experience reflects values of community involvement, STEM initiatives and mentorship, and includes work with Big Brothers Big Sisters, Habitat for Humanity, ASCE Concrete Canoe and Steel Bridge, and Women's LEAD. She serves on boards for her alma mater's College of Engineering Alumni Association and Arcadia Commons.

Kristen Ransom, AIS '09



Kristen Ransom graduated from Tufts University with a B.S. in Human Factors Engineering. Ms. Ransom is currently a systems engineer at the MITRE Corporation, where she uses her passion for human-centered design to create exciting technology for government agencies. She hopes to inspire women and girls to pursue careers in STEM and hopes to inspire a love of STEM fields. Ms. Ransom is also a proud member of the graduating class of 2009 from The Agnes Irwin School.

Alana Yoel, AIS '07

Alana Yoel graduated from Carnegie Mellon University in 2011 with a dual B.S. in Mechanical Engineering and Cognitive Science, with a concentration in Robotics. After graduation, Ms. Yoel moved to the Bay Area to co-found Agent of Presence, a fashion technology company. In 2012, the company released projects called Presence of Heart, a dress that lights up in response to the wearer's heartbeat, and Geometry Darling, an illuminated handbag. These projects resulted in international press coverage for Agent of Presence. Ms. Yoel is now a manufacturing engineer and lead machinist at Other Machine Company.

Q&A SESSION

Wendy L. Hill

Wendy L. Hill, Ph.D. assumed the position of 13th Head of The Agnes Irwin School in July 2014 after a highly successful career as Provost and Dean of Faculty at Lafayette College in Easton, PA. An expert in the field of behavioral neuroscience and animal behavior, Dr. Hill was a member of the faculty at Lafayette College for 25 years. She held the William C '67 and Pamela H. Rappolt Chair in Neuroscience, playing a leading role in the development of the college's interdisciplinary Bachelor of Science degree program in neuroscience and serving as its founding chair. Dr. Hill was honored with several awards from Lafayette in recognition of her superior teaching and scholarly activities, not the least of which was the naming of the college's neuroscience lab in her honor upon her departure. In addition, Dr. Hill was selected as the 1999 Pennsylvania Professor of the Year by the Carnegie Foundation for the Advancement of Teaching. Dr. Hill received her B.A. in psychology, with honors, from Douglass College at Rutgers University and her Ph.D. in psychology from the Animal Behavior Program at the University of Washington.

D'Arcy F. Rudnay

D'Arcy F. Rudnay serves as Executive Vice President and Chief Communications Officer for Comcast Corporation. In this role, Ms. Rudnay provides communications counsel to the Chairman and CEO and other members of the executive team and leads the management of the company's brand, reputation and strategic communications initiatives across the company. She most recently led the strategic communications activities around the announcement of the $45 billion Time Warner Cable acquisition as well as the $30 billion NBC Universal transaction in 2011. Ms. Rudnay has over 35 years of experience in strategic communications for public corporations, national family-owned businesses and large public relations agencies in a broad array of industries. In 2012, she led the rebranding of Comcast Corporation following the NBCUniversal acquisition with a particular emphasis on repositioning the company in the media and technology industries. Ms. Rudnay was inducted into the PR Week PR Hall of Fame in 2014 and has been named among the "Most Powerful Women in Cable" for the last five years. She earned a B.A. from Trinity College and an M.S. from the University of Pennsylvania.

Opening reception in the M. Penney Moss Library kicked of the two-day conference

Loretta Sweet Jemmott, Ph.D.

APPENDIX B: CONFERENCE EVALUATION

EVALUATION OF THE CONFERENCE

To fully evaluate the effectiveness of the conference participants completed a pre-conference evaluation before the conference began and a post-conference evaluation just before they departed the school. Of the approximately 120 attendees, 94 participants completed the pre-conference survey and 66 completed the post-conference survey. Due to an unexpected snowstorm during the full day of the conference, several conference participants left before completing the survey and only a few participants responded to the survey online. The surveys were designed to measure the effectiveness of the conference in fulfilling the stated goals of the conference:

- Building a shared understanding of the issues surrounding girls and women in STEM
- Sharing best practices and proven solutions
- Finding actionable ways to increase participation and persistence of girls and women in STEM in their own area

GOAL 1: BUILDING A SHARED UNDERSTANDING OF THE ISSUES SURROUNDING GIRLS AND WOMEN IN STEM

To evaluate this goal we first provided participants with a list of the issues that we believed have the power to impact the participation and persistence of girls and women in STEM fields. Notably, we left space for participants to add issues that we had neglected to include. We asked participants on the pre-survey both to rate their level of knowledge about those issues and to select the three most important issues. On the post-survey we asked participants to indicate the issues about which their understanding increased and to, again, select the three most important issues. Table 1 displays means and standard deviations for self-reported expertise level for the conference participants. For all issues, participants rated themselves as having a moderate-to-high level of knowledge on all of the issues selected. The takeaway is that, while we set out to build a shared understanding, we began with a group that felt fairly

TABLE 1: MEANS AND STANDARD DEVIATIONS FOR LEVEL OF EXPERTISE ON STEM ISSUES

Current level of understanding of each topic (5 = Expert, 1 = Intro)	*Mean*	*Std. Dev.*
The implications of the lack of strong female mentors and role models in STEM fields	3.64	0.72
The perception that girls do not belong in STEM fields	3.58	0.79
Fear of failure and/or perfectionism among girls and women	3.75	0.89
The lack of teacher preparation in the effective delivery of problem-based STEM curricula	3.17	0.92
The implication of low teacher confidence in STEM subjects	3.14	1.06
The need to connect STEM curricula to girls' strengths and interests	3.42	1.06
The impact of limited early exposure and socialization experiences with STEM	3.40	0.91
Perceived stereotypes among girls that STEM careers are "nerdy"	3.57	0.89
The need to share resources and create partnerships between educational institutions, corporations and other organizations.	3.43	0.96
Sexism in the workplace	3.80	0.95

Other: student grouping by gender (3), Similar expertise in underrepresented groups in STEM (no rating)

TABLE 2: PERCENTAGE OF PARTICIPANTS INDICATING INCREASED UNDERSTANDING

The implications of the lack of strong female mentors and role models in STEM fields	66.2 %
The perception that girls do not belong in STEM fields	33.8 %
Fear of failure and/or perfectionism among girls and women	53.8 %
The lack of teacher preparation in the effective delivery of problem-based STEM curricula	67.7 %
The implication of low teacher confidence in STEM subjects	63.8 %
The need to connect STEM curricula to girls' strengths and interests	47.7 %
The impact of limited early exposure and socialization experiences with STEM	58.5 %
Perceived stereotypes among girls that STEM careers are "nerdy"	30.8 %
The need to share resources and create partnerships between educational institutions, corporations and other organizations.	49.2 %
Sexism in the workplace	35.4 %

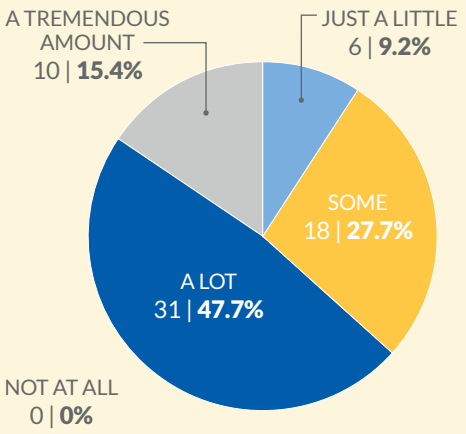
confident in how well they understood each of these issues. Two issues, notably, stood out because they were noticeably lower than others: the lack of teacher preparation in the effective delivery of problem-based STEM curricula and the implication of low teacher confidence in STEM subjects.

Table 2 represents the percentages of people who indicated that their understanding increased surrounding each of the issues that could impact the persistence and participation of girls and women in STEM fields. Despite moderate-to-high levels of knowledge of the participants reported in Table 1, Table 2 demonstrates that many participants reported increasing their understanding about these issues. Additionally, two of the issues with the highest rate of growth were, perhaps not surprisingly, two of the issues that participants felt weaker on during the pre-survey. Therefore, where people felt less confident, they were able to develop a greater understanding. The average participant increased his or her understanding on five of the issues listed, and all but two of the participants indicated increasing his or her knowledge on at least one of the issues listed. Of the two people who did not indicate increasing his or her understanding of any of the issues listed, one wrote a note in the comments section, "None of the above, but it was still a great opportunity to nuance this knowledge."

Some groups quickly worked through the icosahedron challenge

FIGURE 1: INCREASED UNDERSTANDING

How much do you feel the Conference **increased your understanding of the issues** related to the participation and persistence of girls and women in STEM?



Additionally, when asked whether or not the conference overall led to an increased understanding of the issues that impact the participation and persistence of girls and women in STEM 63.1% of respondents reported that the conference increased their understanding "A Lot" or "A Tremendous Amount." Figure 1 shows the breakdown of all responses to that broad question.

For the majority of participants, the conference led to an increase in understanding of the issues that impact the participation and persistence of girls and women in STEM. The goal, however, was to build a shared understanding. Table 3 demonstrates a slight change in priorities for the group after the conference ended. Initially, the hope was for responses to cluster more closely around one or two issues in the post-conference survey than in the pre-conference survey. The responses, while altered, are just as diffuse in the post-conference survey as they were in the pre-conference survey. Upon reflection, however, the goal of the conference was not to establish the 'group think' of identical priorities but to develop a shared understanding through learning from each other.

It is clear from Tables 1 and 2 and Figure 1 that participants increased their understanding of the issues that impact the participation and persistence of girls and women. What is more important, however, was that they learned from each other to create a shared understanding. In open response questions, one participant wrote about the knowledge that he or she gained "I feel I have better tools to become a more effective mentor for girls interested in STEM." Another participant, however, wrote about inquiring into "what fields graduates from our school" enter. Still another wrote, "As a student studying engineering and gender and women's studies and conducting STEM research in Philadelphia schools, I was blown away with some of what I learned in these panels — specifically that telling girls to study engineering because they are 'good at math and science' is actually a deterrent instead of encouraging." The purpose

TABLE 3: PRIORITIES BEFORE AND AFTER THE CONFERENCE

Rank of top priority	*Pre*	*Post*
The implications of the lack of strong female mentors and role models in STEM fields	19%	23%
The perception that girls do not belong in STEM fields	10%	5%
Fear of failure and/or perfectionism among girls and women	16%	17%
The lack of teacher preparation in the effective delivery of problem-based STEM curricula	6%	14%
The implication of low teacher confidence in STEM subjects	6%	5%
The need to connect STEM curricula to girls' strengths and interests	10%	12%
The impact of limited early exposure and socialization experiences with STEM	20%	14%
Perceived stereotypes among girls that STEM careers are "nerdy"	2%	2%
The need to share resources and create partnerships between educational institutions, corporations and other organizations.	5%	5%
Sexism in the workplace	6%	5%

TABLE 4: SHARING BEST PRACTICES

	Strongly Agree	*Agree*
I gained new ideas from the conference	64.6%	35.4%
I feel inspired to do something new in my organization	62.5%	37.5%

of the day was to bring diverse audiences together to create a greater understanding of these issues. While the priorities noted in Table 3 are still quite diffuse, they speak to a collective understanding of the number of factors that each play a role in the participation and persistence of girls in STEM. One participant wrote it best: during the day, everyone was able to "gain insights into the difficulties structurally and societally to teaching STEM."

GOAL 2: SHARING BEST PRACTICES AND PROVEN SOLUTIONS

In reviewing survey data related to this goal is it important to note that the purpose of the survey was not to determine whether a given practice is "best," but rather to focus on whether participants were able to learn from the experiences of others that had previously been successful. To evaluate whether participants learned from each other, they were asked to agree or disagree with two statements on the post-survey. Notably, on a 4-point scale from Strongly Agree (1) to Strongly Disagree (4), everyone either agreed or strongly agreed with each of the two statements and there were no significant differences between any of the populations surveyed. In other words, there were no significant differences between teachers and researchers or corporate representatives or K-12 administrators.

In addition to asking the participants directly about gaining new ideas, participants were asked to agree or disagree with a series of statements on both the pre- and post-survey to measure how hopeful they felt about the state of the STEM pipeline for girls. Table 5 summarizes the average scores from both the pre-survey and the post-survey. In the far right column, an arrow indicates the direction of change from the pre-conference survey to the post-conference survey. While only a few of those changes were significant, the data collectively represent participants who feel more hopeful about the future of girls and women in STEM. For example, the average ranking for the first statement, "I am generally encouraged about the future of women in

A participant reports on small-group discussion

TABLE 5: CHANGE IN RESPONSES RELATED TO "HOPEFULNESS"

Statement (Strongly Agree = 1, Strongly Disagree = 4)	*Pre*	*Post*	*Change*
I am generally encouraged about the future of women in STEM careers	1.93	1.71	↓*
The opportunities for women in STEM are no longer growing.	3.31	3.66	↑
There is little more we can do in my organization to support STEM.	3.61	3.69	↑
We have many new and doable ideas for supporting STEM in my organization	1.98	1.76	↓*
The main factors influencing STEM opportunities are outside my influence	3.07	3.41	↑**
I am generally discouraged about the future of women in STEM careers.	3.32	3.45	↑

*** indicates that (p <. 01), * indicates that (p < .10), there were no significant differences between demographic groups (K-12 teachers, K-12 administrators, higher education representatives, non-profit sector, corporate sector and researchers)*

STEM careers" shows a significant decrease. This means that participants were more likely to agree with it in the post-survey than on the pre-survey, thus feeling more encouraged after the conference. Similarly, the statement "The main factors influencing STEM opportunities are outside my influence" went up, indicating that people were more likely to disagree with the statement because they felt more in control and, thus, more hopeful. As participants shared best practices and proven solutions they became more hopeful about the role that they can play in the STEM pipeline.

In order to fully evaluate whether participants shared best practices and proven solutions, participants were asked to elaborate on their answers to several of the survey questions. In many instances, participants wrote about how the most meaningful aspect of the conference was that they were able to share best practices with those from *other sectors*, not simply with their peers. One Higher Education professor or administrator explained "I enjoyed and learned a lot from interacting with people who shared my concerns but represented different structural or institutional places." Similarly, a researcher wrote that "it was wonderful to be in a community of educators and industry members to think towards solving a complex problem." These comments exemplify that the benefit of this conference was sharing best practices across fields. Even more specifically, one K-12 teacher wrote that Amy Fleischer, an engineering professor from Villanova University, would be sending information about a program aimed to change cultural norms. Another K-12 teacher wrote that she or he gained "new ideas about how we talk about 'math' to girls." Similarly, a corporate representative wrote that "I feel that I have better tools to become a more effective mentor for girls interested in STEM." The participants at the conference clearly learned a great deal—and, more importantly, they learned from each other. Because of the diverse set of voices participating in the conference everyone was able to learn something.

GOAL 3: FINDING ACTIONABLE WAYS TO INCREASE PARTICIPATION AND PERSISTENCE OF GIRLS AND WOMEN IN STEM IN THEIR OWN AREA

The post-conference survey contained two specific questions aimed to assess this goal. Participants were asked to agree or disagree with the following statements: 1) I have at least one concrete action step that I plan to take when I return to my organization; and 2) I made at least one new connection with a person outside of my organization with whom plan to follow-up. Figures 2 and 3 provide summaries of the responses to these questions. What the figures do not show is that every person, with one exception, agreed or very strongly agreed with one of the two questions. The one exception wrote in response to the elaborated on her "Not Applicable" answers by stating, "Since I am retired you will notice that many of the items do not apply. I did, however, gain a lot of new information about STEM and the problems that still lie ahead." With this one exception the few that did not agree with the question in Figure 2 did agree with the question in Figure 3 and vice versa. Therefore, all of the respondents either walked away with an action step or a meaningful connection. Notably, there were no significant differences among groups in how they responded to either of the questions, therefore the conference was similarly beneficial for those from each sector.

Following these two questions participants were asked to elaborate on their answers with specific examples. Several participants gave several concrete examples such as "creating a STEM Club," creating a "dinner dish" program for girls to discuss the challenges, and restructuring the school's "Fab Lab." Other participants, however, gave responses that were less concrete such as integrating Carol Dweck's work on mindset, working to normalize failure, and focusing on mentorship. Still others seemed to have specific ideas in mind, but didn't specify them on the survey. For instance, one participant who took the survey online wrote "I came back with a brain on fire from all the great discussions. We've already taken much of it and held meetings with faculty, students, etc. in pursuit of several avenues for addressing these issues." In part, the lack of specifics was due to the timing of the post-conference survey. Most of those who completed the survey did so on paper as they left the conference. At that point, participants had just engaged in a full day of workshops and discussions and likely had not yet fully processed everything that they had learned. It was clear from their responses to the direct question that they had made connections and found action items, but what they actually planned to do was perhaps still a bit amorphous at the end of the conference.

FIGURE 2: ACTION STEPS

In relation to increasing the participation and persistence of girls and women in STEM fields, I have **at least one concrete action step that I plan to take** when I return to my organization.

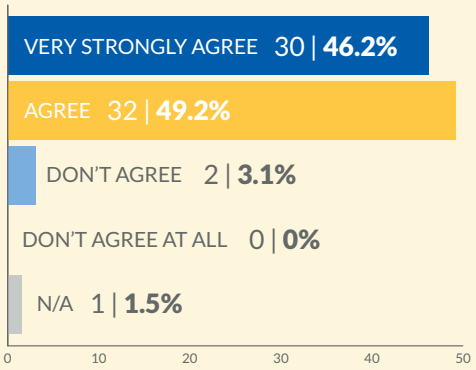
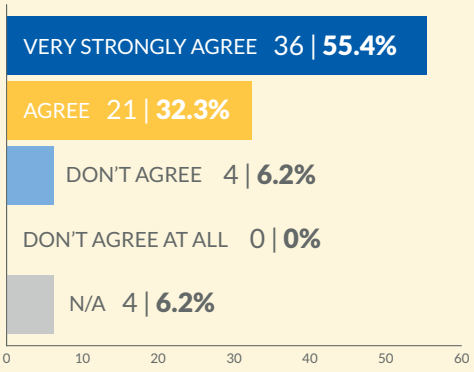


FIGURE 3: NEW CONNECTIONS

In relation to increasing the participation and persistence of girls and women in STEM fields, I made **at least one new connection** with a person outside of my organization on which I plan to follow-up with.



NEXT STEPS

At the conclusion of the survey participants were asked what they still wanted to learn more about. One of the most salient issues from these responses was a thirst for more knowledge about changing cultures. One participant wrote, "changing cultures, successful models of changing cultures, (top down? bottom up?) what works?" Similarly, a K-12 Teacher indicated that she or he wanted to know more about "educating the parents and community about STEM." Another teacher asked, "How do we impact the ideas of those stuck in the status quo?" Many participants learned that there was a great need for a shift in institutional cultures. The conference provided the space and energy to unpack this idea, but participants left wanting to continue this conversation to develop concrete action steps in this area.

In addition to focusing on culture change, participants also indicated wanting to know more about teacher preparation and teaching strategies. One corporate representative indicated that she or he would like to know more about the preparation of educators through partnership because "it would be nice to get more time on this topic even in the panel. A lot of time was put on identifying deficiencies but not much on addressing them." This participant, like several others, wants access to more concrete information. One college professor wrote that she or he would like to learn more about "specific STEM curriculum ideas geared towards women," and a K-12 teacher wanted to know whether "to track or not for Math classes."

Many participants learned that there was a great need for a shift in institutional cultures. The conference provided the space and energy to unpack this idea.

Lynn Yeakel, panel moderator

AIS students past and present: Kristen Ford Ransom '09, juniors Anisha Mittal, Hunter Sessa, and Sophie Fisher, and Alana Yoel '07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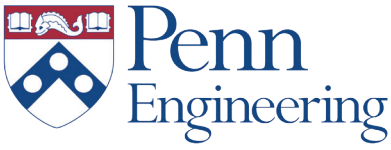
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