SHARING SOLUTIONS 2016

BUILDING A BETTER PIPELINE

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THE AGNES IRWIN SCHOOL'S CENTER FOR THE ADVANCEMENT OF GIRLS & THE FRANKLIN INSTITUTE

"STEM IS A SUPERPOWER AND 'CAN'T' ITS KRYPTONITE."

DR. AINISSA RAMIREZ

BUILDING A BETTER PIPELINE

SHARING SOLUTIONS 2016

"Sharing Solutions 2016: Building a Better Pipeline" brought together nearly one hundred dedicated representatives from higher-education, K-12 schools, industry, and the nonprofit sector to think collaboratively about changing the culture of STEM classrooms and careers. The conference was created through a unique collaboration between The Agnes Irwin School's Center for the Advancement of Girls and The Franklin Institute intended to curate and engage thoughtful and transformative discussion around STEM education for all girls. The outcome of this partnership was a national discussion with key stakeholders, and, in April 2016, the Sharing Solutions conference held in Philadelphia to capture this discussion and plan for a direction forward. This white paper summarizes the proceedings of the conference, reviews and contextualizes the relevant academic research, and uses conference evaluation data to outline the "next steps" that we will take.

Participants mingle before the start of the conference.

Dr. Wendy Hill, Head of School, welcomes participants to the conference.

INSTITUTIONAL CULTURE

This paper, like the conference, focuses explicitly on changing the institutional school culture surrounding the participation of girls in Science, Technology, Engineering and Math (STEM). At a conference in March of 2015, The Agnes Irwin School brought together a diverse audience to share best-practices for increasing the participation and persistence of girls and women in STEM fields. Evaluations after the conference revealed that participants were most interested in learning more about how to change the culture of institutions in such a way that girls are more likely to participate and persist in STEM fields long-term. In this report, as a focus of discussion for the 2016 conference, the culture of schools is given special attention due to the crucial space it occupies at the beginning of the pipeline.

Institutional or organizational cultures, can be imagined and defined in many different, and sometimes contradictory ways (Smart, Kuh & Tierney, 1998; Martin, 1992; Schein, 2004). In her seminal work Martin (1992) explains that organizational cultures have been defined as both a source of unity and one of conflict, both fragmented and consistent, and as both boundless and clearly demarcated. Despite the conflicted nature of the term, Smart, Kuh & Tierney, 1998 lend a useful definition: an institutional culture concerns "the patterns of interpretations people form about the manifestations of their institutions' values, formal rules and procedures, informal codes of behavior, rituals, tasks, jargon, and so on" (p. 258) wherein an institution can be any type of informal or formal organization. Thus, every business,

Dr. Ainissa Ramirez, keynote speaker (l) and Mariandl Hufford, Assistant Head of School and Director of the Center for the Advancement of Girls.

Participants register for the conference.

every school, every sports team and every scout troop has an institutional culture that dictates what behaviors and attitudes are acceptable.

The culture of an individual institution can help explain either the success or failure of that organization in the face of a challenge. The cultural norms of an institution can result in a business that is either highly efficient or populated by who "continue to behave in obviously ineffective ways, often threatening the very survival of the organization" (Schein, 2004 p. 9-10). It is only through a deep understanding of a culture of an institution that meaningful, lasting change is possible.

THE CULTURE OF SCHOOLING

One place where institutional culture greatly impacts the participation and persistence of its constituents is school and academia. In the influential 1994 article published in the American Educational Research Association Journal, David Tyack and William Tobin explain that "The basic 'grammar' of schooling, like the shape of classrooms, has remained remarkably stable over decades" (p. 454). In other words, schools as institutions are surprisingly resistant to change. While the article details the ways that schools return again and again to the same academic programs and physical structures, this concept can also easily be applied to the static nature of the culture of schooling (Finnan & Levin, 2000; Joseph, Mikel & Windschitl, 2011). School culture, according to Finnan & Levin (2000) "describes both the sameness and uniqueness of each school" (p. 87). This broad term, they explain, is incredibly hard to define because culture exists in every movement, decision and interaction within a given context. When you can't see something, it is incredibly difficult to change it. This is perhaps most true regarding girls in STEM, and throughout the schooling experience.

The culture of schooling can best be understood as an 'agreement' among students, staff, faculty, parents, and the broader community about what makes up a school, what the school does and how it does it (Finnan & Levin, 2000). School cultures, notably, exist at many levels. While each school has a unique shared culture, schools in the same district, independent schools and suburban schools and four-year colleges each share a broader institutional culture. In the United States there is also a 'culture of schooling' that governs how we collectively imagine the school or university and it's unique job. This particular image can impact everything, including the way kindergarteners line up for

The Franklin Institute in Philadelphia.

lunch, who will participate in an advanced Chemistry class during high school, and which professors will get tenure. Even the notion of elementary, middle and high school is part of this broad institutional culture (Eisner, 1985).

To change a school's culture requires that the school community "must recognize, challenge, and then profoundly change commonly held assumptions, values, norms and practices" (Joseph, Mikel & Windschitl, 2011 p. 55). This agreement and these values are often completely implicit, therefore identifying and raising awareness about various elements of the culture of schooling has proven incredibly difficult, especially those things that are ingrained in our national image of schooling. Although recognizing and reforming the culture of schooling is incredibly challenging, many would argue that educational reforms that specifically and successfully address the institutional culture are more likely to create lasting change (Sarason, 1996; Fullan 1993; Eisner, 1985).

WHY GIRLS IN STEM?

Over the past few years a plethora of research has surfaced to document the stability of the underrepresentation of women in STEM fields (Hill, Corbett & St. Rose, 2010; Corbett & Hill, 2015. According to data reviewed for the 2015 AAUW report, *Solving the Equation*, women only represented 12% of the engineering profession in 2013 and just over 25% of jobs in computing and math fields (Corbett & Hill, 2015). Furthermore, it has become quite clear that girls' interest in pursuing STEM careers declines steadily throughout their school and career experience (Sadler, Sonnert, Hazari & Tai, 2012; Dasgupta & Stout, 2014; Perez-Felker, McDonald & Schneider, 2014). It is this steady decline that requires educators, industry leaders and researchers to investigate the causes and solutions to such a pressing problem.

Randie Benedict, Director of Enrollment Management.

THE IMPACT OF INSTITUTIONS

The factors influencing the STEM participation gap cover a range of possibilities including irrelevant curricula and ineffective teacher pedagogy within schools, the dearth of strong female role models and mentors outside of schools and sexist climate in STEM industries. Blickenstaff (2005) explained that "no one in a position of power along the pipeline has consciously decided to filter women out of the STEM stream, but the cumulative effect of many separate but related factors results in the sex imbalance in STEM that is observed today" (p. 369). At the 2015 Sharing Solutions conference, participants agreed that what unites all of these challenges together are institutional cultures that tend to devalue girls in STEM fields. Therefore, to increase the participation and persistence of girls and women in STEM fields, schools, community organizations and industries need to partner in order to actively change the cultural norms surrounding girls and women in STEM within their individual institutions and more broadly.

Institutionalized bias against women in STEM fields is one of the most pressing challenges that girls face along the pipeline. In a large-scale study of STEM-focused high schoolers, college students and doctoral candidates, Robnett (2016) found that 60% of the girls and young women surveyed experienced gender bias in the last calendar year. Most commonly, respondents explained that they often heard "negative comments about girls' and women's STEM abilities" and that they felt that they "had to work harder than male students to be taken seriously" (p. 71). Notably, the results of this study varied by school level and discipline with Math undergraduate students most likely to experience bias. More importantly, the girls and women in this study who reported experiences with bias were more likely to have a negative self-concept around STEM. Therefore, a woman who perceives gender bias in her STEM field is less likely to see herself as successful. Carli et al. (2016) explain that STEM-based biases are so ingrained that we have convinced ourselves that men are

Participants engage in design thinking process.

better suited for certain professions because of certain natural gender-specific behaviors. Their research reveals that both men and women see a high degree of overlap in stereotypes categorizing both males and scientists. For example both men and scientists were described as agentive and women were seen as passive when scientists were not. Notably, "Only women attending a single-sex college saw some similarity between the characteristics of women and scientists" (p. 8).

What makes these institutionalized beliefs so detrimental is how they impact students and job applicants in very direct ways. In a study where science faculty were asked to review employment applications Moss-Racusin and colleagues (2012) found that the professors consistently rated women lower and offered them lower starting salaries than their equally qualified male counterparts. They further explain that data suggest "that the female student was less likely to be hired than the male student because she was perceived as less competent." What is more, men are less likely to believe that these biases exist when presented with clear evidence on the topic (Handley, Brown, Moss-Racusin & Smith, 2015). In a qualitative study of sixty scientists who are women of color, Williams (2014) outlines four basic types of gender bias in STEM fields documented in academic research:

- the need to work twice as hard to prove themselves,
- the "tightrope" that women walk to be seen as both 'feminine' and 'competent' at the same time,
- assumptions made about 'typical mothers' and,
- the assumption that there is only room for a few women 'at the top' (191-193).

All of the women in the study—both women of color and white women—reported experiencing at least one of these biases during their careers. Notably, while most women are confronted with these biases in the workplace, women of color experience these biases in addition to racial biases, which leads to a double bind for women of color, who are the least likely to pursue science careers (Jarrett & Tchen, 2014). This research indicates that these institutional biases both alienate women from STEM fields *and* make it harder for women to obtain positions in STEM fields because those who are in positions of power are less likely to hire and promote women (Reuben, Sapienza & Zingales, 2014). Notably, because of the strong institutional biases concerning women—especially women of color—in STEM, women who have played important roles in these fields are often overlooked. The 2017 film "Hidden Figures" tells the story of three such women: female, African American mathematicians working for NASA in the 1960s. While popular media has begun to pay more attention to the historical role of women in STEM fields, they continue to feel alienated in the classroom and beyond.

Larry Dubinski, President of The Franklin Institute welcomes participants.

SCHOOL CULTURE AND GIRLS IN STEM

Because school culture is a multifaceted and amorphous concept, it is difficult to pinpoint how, specifically, the culture of an educational institution can lead to such a gender disparity in STEM fields. In the case of schools, the pervasive nature of a masculine STEM culture has been documented for decades. According to Kelly (1985) science textbooks in the early 1980s were up to ten times more likely to refer to or show pictures of boys and men doing science. She further writes, "girls and women are seldom included in science textbooks; when they do appear they do so in sex stereotyped roles which serve to emphasize their marginal position in science" (136). Sex-stereotyped images in textbooks, researchers argue, can send messages to female students that they do not belong in the world of science. A build-up of these messages from a multitude of sources can cause girls to disengage from the science classroom. What is more, research indicates that institutionalized gender-based science stereotypes at the national level are directly correlated with math and science achievement (Nosek et al., 2009). In the study, which used data from citizens in more than thirty-four countries, the researchers found larger gender-based achievement gaps in countries with stronger biases towards men in STEM.

Textbooks that portray male students as scientists are simply one element of the culture of schooling that can perpetuate gender norms. Advisors who counsel girls into less advanced math classes, teachers who call on male students more often than female students in the science classroom, and curricular decisions that favor the learning styles of boys are all ways that a masculine STEM culture can alienate girls throughout their school careers (Halpern et al., 2007; Shapiro & Williams, 2011). In a recent opinion piece in the *New York Times*, Hope Jahren (2016) explains that "every school year, science, technology, engineering and math programs—known as the STEM fields—shed women the way the trees on campus lose their leaves in the fall." This opinion piece specifically attributed the blatant sexual harassment she and her female colleagues experience in STEM fields on the culture of college and university STEM departments. Unlike the subtle messages that textbooks send, Jahren indicates that she knows women who leave because male colleagues and superiors sexually harass them (Mervis, 2016; Witz, 2015).

What undergirds the construction of textbooks, interactions between students and teachers, and individual decisions about what courses to take is the pervasive belief that women are somehow of inferior ability when it comes to the STEM fields (Brickhouse, Lowery & Schultz, 2000; Blickenstaff, 2005; Scantlebury, 2011). At a 2005 conference on Diversifying the Science and Engineering Workforce, Harvard President Lawrence Summers explained that, in his opinion, "there are issues of intrinsic aptitude" in Science and Engineering that have kept women out of those professions. He went on to explain his belief that discrimination and socialization only play a minor role in this phenomenon. Summers, notably, was unable to provide any research to support his theory and, instead, demonstrated exactly how these stereotypes are perpetuated by high-ranking officials at major universities.

The startling reality of the statement made by Summers is that, although there are no definitive differences between the intrinsic aptitudes of boys and girls for STEM subjects, women will continue to underperform in math, science, engineering and computing until schools can overcome the belief that they cannot. Any number of new partnerships and pedagogical techniques will produce little change if schools do not build cultural ecosystems wherein girls are seen on the same level as their male counterparts.

CHANGING INSTITUTIONAL CULTURES

There are many different ways to achieve change within an organization and these methods vary with the level or type of change sought. Alvesson and Sveningsson (2015) cite four 'metaphors' for different degrees of organizational change: "Fix and maintain, build and develop, move and relocate, and liberate and recreate" (p. 17). It is this final type of change, liberate and recreate, that applies most directly to changing institutional cultural norms. The authors explain that this type of transformational change "occurs through experiment, radical and innovative thinking, creativity and fantasy, commonly among the employees" (p. 18). The authors further explain that it is possible to achieve this type of change, with one caveat. Change, they explain, is not 'neat,' because "people tend to interpret and make sense of change efforts in quite diverse ways (sometimes this is explained as forms of resistance)" (p. 33). Therefore, change needs to focus on and incorporate the ways in which each individual relates to the intended change and, understandably, needs to include people from all levels of an organization from start to finish.

To address institutionalized biases and behaviors that directly relate to gender inequity, Ely and Meyerson (2000) propose four different approaches: fix the women, value the feminine, create equal opportunities, and assess and revise work culture (pp. 106-107). Again, it is the last frame, "assess and revise work culture" that provides both the most challenge and the deepest and most meaningful change. The authors argue that the best type of change in this case is incremental and inherently local. In an extensive review of research, Bielby (2000) explains that institutionalized biases are generally masked behind job titles and promotion tracks. He states that any "visible trace of bias lies in patterns of segregation within and across organization," so change first requires a careful examination of the policies and practices for hiring, pay, promotions and mentorship (p. 123). Ely and Meyerson (2000) further explain that "members inside the organization must help identify and decipher the organization's cultural codes" (pp. 133-134). To change gender norms within an organization, members of the organization must be involved in the investigation. The authors suggest that organizations might follow a process of critique, narrative revision and experimentation as they work to investigate and bring about incremental change in gender bias. In other words, members or organizations must identify negative social processes, imagine a different reality and make small changes to the policies and interactions that result from the cultural biases. If organizations engage in this cycle continually, eventually large-scale cultural change is possible.

Dr. Ainissa Ramirez speaks to participants.

CHANGING SCHOOL CULTURES

The challenge of changing the culture of schooling is a different, yet related, process to general cultural change in organizations. While changing the overall culture of schooling is exceedingly difficult, changing the culture of an individual school is more manageable. Manageable, however, does not imply easy. Finnan and Levin (2000), explain that even within an individual institution "real, sustained change... does not occur unless basic beliefs and assumptions also change" (p. 90). The authors outline five areas of basic beliefs that form the foundation of each school's culture:

- What schools expect students to be able to do
- What children expect from their schooling
- Expectations the school holds for adults (parents, teachers, administrators)
- Beliefs and assumptions about acceptable educational practices (within teachers, administrators and parents, among others)
- The extent to which the community desires change

In order for the culture of an individual school to fundamentally change, therefore, the school would need to address each of these crucial areas. Joseph, Mikel and Windschitl (2011) make a similar argument. They explain that "reculturing demands more than just partial modifications. Changing school cultures, adopting incremental standards or trying new instructional methods cannot by themselves alter the core assumptions about learning and teaching or beliefs about the aims of schooling" (p. 55). To go beyond simply restructuring, the authors argue that schools need to engage in a thoughtful and systematic change process. Furthermore, to create lasting cultural change, schools need to be prepared to address two major hurdles: teacher buy-in and scaling up (Hargreaves & Goodson, 2006; Desimone, 2013). Without fully addressing these two hurdles, deep change in the aforementioned areas is unlikely.

In a study of three different reform efforts in twenty two different schools, Datnow (2000) found that, as educators are generally the ones who carry out reforms 'on the ground,' their buy-in is necessary to successfully implement any educational change. Furthermore, the reform programs in this study were much less likely to continue if teachers didn't see the need for a particular reform or if they didn't feel included in the change process. Datnow's study offers several lessons for institutions attempting to create educational change. Among these lessons, she urges schools to "genuinely increase the level of teacher involvement in reform adoption" (p. 369). In other words, teachers should be engaged in determining both what the problems are and what the potential solutions are, well before implementation would begin. Additionally, she encourages schools to extend their reform timelines. Successful change requires input from multiple actors and is more sustainable when schools take the time to carefully make decisions about the reform process. She explains that "building additional time for reform adoption into the process will contribute to an increased possibility for support for reform among teachers" (p. 368).

When fundamental educational change is successful within individual schools or departments, the next challenge is to ensure those changes spread to other departments or other schools (Hargreaves & Goodson, 2006). In education reform literature the process of spreading change is often referred to as 'scaling up.' Hargreaves and Goodson explain that "educators appear to know how to create islands of change but not know how to construct archipelagoes or build entire continents" (p. 4). To effectively create deep cultural change in a school, reform needs to extend beyond these islands of change. This is especially true of changing the cultural assumptions and practices surrounding girls in STEM education. While islands of change may plug the pipeline in a few places in piecemeal ways, change taken to scale can effectively build a better pipeline. It is against this backdrop that The Agnes Irwin School's Center for the Advancement of Girls, in partnership with The Franklin Institute, held the second Sharing Solutions in STEM conference, with the goal of beginning to build a new pipeline. Appendix A contains the conference program.

KEYNOTE ADDRESS: DR. AINISSA RAMIREZ

After conference participants were welcomed by representatives from the Agnes Irwin School and The Franklin institute, Dr. Ramirez began her talk by stating, "I am a material scientist and most people don't know what that is, including my mother." As she explained what her job entails, she posed three crucial questions to the audience that she used to structure the rest of her talk: What is STEM? Can girls do STEM? And, how do we change the world?

WHAT IS STEM?

When we use the term 'STEM,' according to Ramirez, we are following the natural order of the world. STEM, she explained, is Science, Technology, Engineering, and Math blended into one holistic field, "as nature has put them together." One of the biggest challenges that the field faces, she continued, is the fact that each of these pieces have been operating in silos for as long as we can remember. The goal of this blended field, she stressed, is to generate creative solutions to the problems we face. These solutions are more creative and more robust when approached through this holistic lens. Ramirez gave a number of examples of problems that require these creative solutions, highlighting the citizen science effort that spread awareness about the water crisis in Flint, Michigan in 2016. After outlining her definition of a cohesive 'STEM,' education Ramirez explained that, while developing STEM practitioners is crucial, everyone needs to have a STEM background so that they can make thoughtful decisions in their work and in their lives.

CAN GIRLS DO STEM?

After defining STEM, Ramirez addressed and disputed the prevailing cultural belief that girls can't do STEM. To rebut this belief she explored the many ways that women have been involved in various STEM fields throughout history. She asked the audience to guess the percentage of women in STEM classes in the 1890s. After clarifying that she meant co-educational institutions (Agnes Irwin and other girls' schools, of course, had STEM classes with 100% girls), she revealed that women comprised 57% of STEM

DR. AINISSA RAMIREZ

Keynote Speaker

Dr. Ainissa Ramirez is a self-declared science evangelist who is passionate about getting the general public excited about science. She co-authored *Newton's Football: The Science Behind America's Game* (Random House) and authored *Save Our Science: How to Inspire a New Generation of Scientists* (TED Books). Before taking on the call to improve the public's understanding of science, she was an associate professor of Mechanical Engineering and Materials Science at Yale University. *Technology Review*, the magazine of the Massachusetts Institute of Technology (MIT), named her one of the world's 100 Top Young Innovators for her contributions to transforming technology. She has been profiled by *Time, The New York Times, Fortune, Inside Edition, CBS News, Fox News, CNN, ESPN and NPR*, as well as *Scientific American* and *Discover Magazine*. Dr. Ramirez received her training in materials science and engineering from Brown University (Sc.B.) and Stanford University (Ph.D.). Prior to being on the faculty at Yale, she was a research scientist at Bell Laboratories, Lucent Technologies, in Murray Hill, NJ, where she did award-winning research. She has authored more than 50 technical papers, holds six patents and has presented her work worldwide.

Dr. Ainissa Ramirez, keynote speaker.

classes in this era. Despite this statistic, she explained, we have no institutional memory of women in these fields, so it is up to teachers, researchers and industry leaders to create that memory. To help the participants in this crusade, she gave several specific illustrative examples like NASA scientist Mary Sherman Morgan who developed rocket fuel and Polymer scientist Stephanie Kwolek who invented Kevlar. What is more, she did not just present isolated cases of STEM superstars, she talked about the many women who did better than men in NASA trials for astronauts, and the countless women who used to operate computers. According to Ramirez, as the home economics movement grew, women dropped out STEM fields. She stressed, however, that women were not leaving these fields because of ability, but because of societal constraints and expectations. Girls today, she said, need to know that they are not the first to do STEM because, women "used to rock STEM."

HOW DO WE CHANGE THE WORLD?

In closing her talk, Ramirez addressed how we take on the institutionally ingrained practices and beliefs that keep girls out of STEM fields in the 21st century. Girls, Ramirez posited, need four crucial skills to be successful in an age where information is so readily accessible: curiosity, creativity, the ability to work through problems, and an appreciation of failure. STEM, crucially, provides a 'gymnasium' for learning each of these important skills. Furthermore, she stressed that girls and young women must develop these skills, because diverse teams of people that include women, can offer the most robust solutions to the most pressing problems. In other words, "we cannot solve problems with the same thinking that we used when we created them." Girls of all ages, according to Ramirez, need to learn to remain curious and how to teach themselves, they need to learn how to attack problems and, critically, they need to learn to treat failure as data. To explain her final point, she described Thomas Edison's invention of the incandescent bulb. Edison and his partner, African American Scientist Lewis Latimer, tried 10,000 different materials before they found success. Edison, she deduced, was successful because he didn't look at those experiments that didn't work as failure, he simply felt that he learned 9,999 ways that it didn't work. Girls and women need to be able to see their failure as data in order to be successful in any field, and STEM is where they can learn those skills.

In order for girls to both become truly interested in and to stay invested in STEM, Ramirez explained a simple progression that these girls must follow: Find your question, understand that STEM is a superpower and 'can't' is kryptonite, and 'own it!'

1. **Find Your Question:** A unique problem that a student is really passionate will keep her interested and help her persist in the face of adversity.
2. **Understand that STEM is a superpower and 'can't' is kryptonite:** In explaining this particular skill Ramirez cited a study (Correll, 2004) that suggests how powerful influence can be on behavior. She explained that the brain is a "wonderful computer," and if you say 'can't' it will listen. Therefore, girls need to learn that they can do anything they can imagine.
3. **Own it!:** In illuminating this final point, Ramirez stressed that girls need to take ownership of their own interests and persevere, to be excited when they are at "the edge" of their knowledge. What is more, she explained, the adults around them need to model this behavior. Girls need to see their teachers and mentors learn new things and keep trying. They need to learn that just because you are not an expert when you start something, you could become an expert by the time that you finish.

In closing her keynote address, Ramirez explained that the difference between fear and fun "is in the breathing." If girls can understand both the history of women in STEM and how desperately the world needs them, then they can have the power to think outside the box. With this inspiration, they can go on to create the innovative solutions that we need to the world's most pressing problems.

TED-STYLE TALKS: RECULTURING STEM FIELDS

After the keynote address, conference participants had the opportunity to select one of two sets of themed "TED-Style" talks based on their area of interest. Each theme had two different talks aimed at addressing a different arena. The first theme, featuring Elizabeth McCormack and Claudia Anderson, focused on proven solutions deployed in higher education and the workplace to increase and retain the number of women in STEM fields. The second theme, featuring Chanel Summers and Frederic Bertley, focused on methods to engage K-12 girls in STEM both in and out of school. These talks were intended to give the audience case studies of successful programming that has led to increased participation and persistence of girls and women in STEM fields.

ELIZABETH McCORMACK, BRYN MAWR COLLEGE

In her TED-style talk, Elizabeth McCormack, the associate provost of Bryn Mawr College and Professor of Physics, described the methods that her women's college has used to broaden the participation of women in math and science. She opened her talk by addressing a "false duality" that often inhibits culture change: do we change the individuals or do we change the system? To achieve culture change, she explained, we must both bring society forward for students of the future and also provide "today's" students with the tools to pursue their passions now.

To accomplish both of these things; McCormack outlined six research-based strategies Bryn Mawr has employed to positively impact the experiences of women and underrepresented groups in science: Engaging Pedagogies, Inclusive Learning Environments (both social and physical), Support for Academic Success, Early Exposure to Research, Whole-Person Mentoring, and Community Building. In explaining each of these strategies, McCormack offered a range of examples at Bryn Mawr such as student cohorts to support academic success and build community such as the "STEM Posse" program and faculty education programs focused on growth mindset,

DR. ELIZABETH MCCORMACK

TED-Style Talk Speaker

Dr. Elizabeth McCormack received her bachelor's degree in astronomy and physics from Wellesley College and her Ph.D. in Physics from Yale University. She was an Alexander Hollaender Distinguished Postdoctoral Fellow and a staff physicist at Argonne National Laboratory before joining the faculty at Bryn Mawr College in 1995. Her research interests include fundamental aspects of molecular excited-state structure and dynamics using a variety of laser spectroscopy techniques. She has published over 30 peer-reviewed journal articles and is a Fellow of the American Physical Society. She was a National Science Foundation CAREER Award recipient and a Fulbright Senior Research Scholar and Visiting Professor at the University of Paris XI. At Bryn Mawr College, she has served as chair of the faculty, director of the Center for Science in Society, dean of graduate studies, director of the college's STEM Posse Program and is currently serving as associate provost. She received the college's McPherson Prize for Faculty in 2007. She has served as a curriculum consultant for Effat College in Saudi Arabia and was a Fellow of the American Council on Education at Lesley University. She is a member of the Joint Task Force on Undergraduate Physics Programs of the American Physical Society and the American Institute of Physics. She serves on the Board of Directors of the Research Corporation for Science Advancement, the Board of Advisors to Project Kaleidoscope at the Association of American Colleges and Universities, and is a consultant to the Scientific Equipment Program at the Sherman Fairchild Foundation.

stereotype threat, and imposter syndrome. A very powerful element of her talk, however, was not the specific programs but how she described the institutional process of learning along the way. All of these programs have experienced "lumps and bumps," but they have continued to learn from mistakes and successes to help girls learn to navigate and change STEM culture from the inside, rather than simply adapt to it.

CLAUDIA ANDERSON

TED-Style Talk Speaker

Claudia Anderson, Vice President of Customer Experience at TE Connectivity, currently leads the Extraordinary Customer Experience (ECE) efforts for TE Connectivity, a global technology leader. In this role, she works to accelerate systemic process improvements that will enable TE to consistently exceed customer expectations. In addition to her ECE responsibilities, Ms. Anderson also leads the TE Global Quality Council and coordinates quality improvement initiatives for the corporation. Prior to her current role, she led the operations organization for TE's automotive business in the Americas, which included approximately 7,000 employees located in the United States, Mexico and Brazil. Ms. Anderson also serves as board chair of *FIRST* North Carolina Robotics, a not-for-profit organization devoted to helping young people discover and develop a passion for science, engineering, technology and math. The owner of several U.S. patents for product design, Ms. Anderson holds a Bachelor of Science in Mechanical Engineering from Purdue University, a Master of Science in Mechanical Engineering from the University of Michigan and a Master of Science in Engineering Management from the University of Detroit Mercy.

CLAUDIA ANDERSON, TE CONNECTIVITY

Claudia Anderson, the Vice President of Customer Experience at TE Connectivity, used herself as a case study during her talk to explore both why women are so important in STEM fields and also the environment and skills to help women succeed in these fields. Anderson began by explaining that she had a STEM role model, her father, who exposed her to his work as a biomedical engineer and encouraged her to use LEGO® bricks and other building toys from a very young age. Anderson went on to explain that both her problem-solving skills and her commitment to lifelong learning have been the two major contributors to her success as a mechanical engineer. Women, she asserted, are excellent problem solvers because they generally want to find ways to help everyone around them. Engineers, for the most part, are responsible for making other people more successful. To be able to solve problems effectively, girls and women need to understand that it is a process that almost always involves failure. Women, Anderson explains, "hate to fail." But, she continued, women make or influence most of the huge purchasing decisions in this country—so women should be involved in designing, among other things, houses, cars and appliances. To get there, they need to learn to value the struggle of problem solving. Anderson closed her discussion by giving her wish for her daughter, a biomedical engineering major in college. She explained, the world really needs young women to go after STEM careers, but these young women need to understand that "it's OK to not know everything."

Elizabeth McCormack, TED-style speaker.

Chanel Summers, TED-style speaker, takes the stage.

CHANEL SUMMERS
TED-Style Talk Speaker

Chanel Summers is the co-founder of Syndicate 17, an audio production, technology and design consulting company where she also serves as an audio designer and composer. Ms. Summers began her career as a pioneering designer and producer of video games, developing innovative products ranging from high-performance 3-D vehicle simulations to action/arcade platform games and hardware peripherals while working at early industry-leading companies such as Mindscape, Velocity and Mattel Media. Recruited to Microsoft in the late 1990s, Ms. Summers was responsible for the release of the company's first multiplayer Internet game, Fighter Ace, a precursor to the rise of online gaming. She lectures and teaches the art of video game audio at the University of Southern California, where she launched the Experimental Audio Design Lab (EADL). Ms. Summers has been a highly regarded game producer and designer, Microsoft's first audio technical evangelist and a member of the original Xbox team, helping to design the audio system for the groundbreaking console and to create the first-ever support team for content creators.

CHANEL SUMMERS, SYNDICATE 17

Chanel Summers, an audio technologist and artist-in-residence at the Forest Ridge School of the Sacred Heart just outside of Seattle, addressed the topic of "new visions for immersive education" in her K-12 focused TED-style talk. She explained that traditional approaches to teaching and learning are not working—she stressed that we must teach girls differently to prepare them for the future. Summers described in detail the processes and approaches that she uses with students in at Forest Ridge to stress analytical skills, creativity, ingenuity, and outside the box thinking. One of the models that she uses is referred to as 'World Building,' a process that originated in fantasy and science fiction writing. This process, quite literally, requires students to work collaboratively to build new worlds and to imagine inhabiting them. Along the way they develop critical thinking skills and creativity as they imagine the people, the architecture and the context of these worlds. As she explained it, educators need to think about teaching and assessing students in entirely new ways. In World Building, educators act as facilitators and "get out of the way" as the students go through the process as they develop these crucial skills. While World Building is not necessarily Project-Based-Learning, it has similar aspects including ideation, prototyping, iteration, and collaboration. World Building is interdisciplinary as teachers provide the students with a prompt (the origin story) to allow them to build the world in all aspects (education, architecture, people, life in this new area, science, technology, etc.). From Summers' experience, the students she's worked with have quickly bought into the simulation and they love it because they are not bound and constrained by a teacher's conception of the problem. This activity gives them freedom to explore topics in a way that makes sense to them. Often students who struggle with a particular content area find that World Building affords them with a way to make the content make more sense. In addition, highly motivated students can learn advanced topics in math, science and engineering in these workshops resulting in a lifelong passion and possible career path. In summary, World Building provides a diverse set of learning opportunities for students to move beyond the traditional classroom to explore the limitless possibilities of the world and beyond.

Dr. Frederic Bertley, Senior Vice President, The Franklin Institute.

DR. FREDERIC BERTLEY

TED-Style Talk Speaker

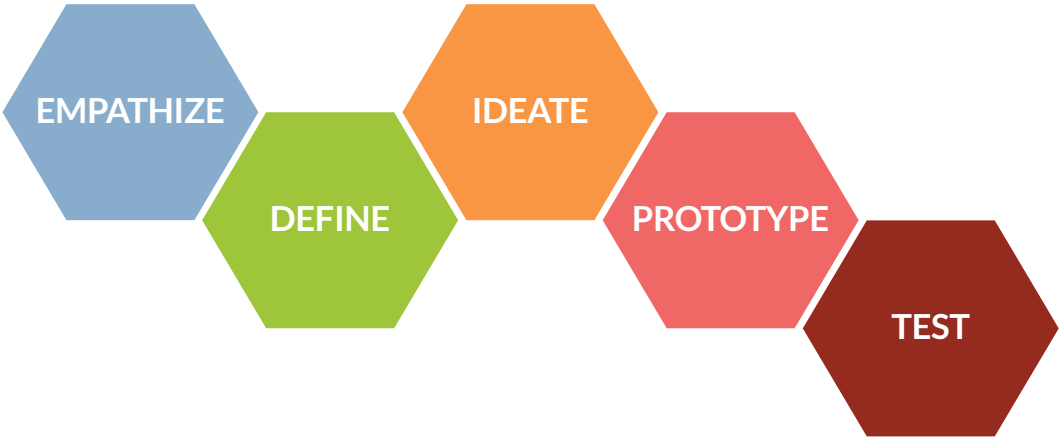
Dr. Frederic Bertley directs both science and educational programs for The Franklin Institute, including overseeing TFI's partnership with its magnet high school, Science Leadership Academy. Additionally, he directs the prestigious Franklin Awards Program, the long-running Journal of The Franklin Institute and the institute's international efforts, including shepherding a USAID-supported effort to build five STEM high schools in Egypt. Dr. Bertley holds a B.Sc. in Mathematics and Physiology and a Ph.D. in Immunology from McGill University. Prior to The Franklin Institute, he joined a Harvard Medical School HIV vaccine research group, and managed multinational teams in Haiti and Sudan. Dr. Bertley has received numerous honors, including the Harvard Medical School Dean's Service Award, The President's Award (QBMA) and Philadelphia Business Journal "40 Under 40." He has been an invited speaker at numerous venues, including the White House, the U.S. Department of the Interior and the United Nations.

FREDERIC BERTLEY, THE FRANKLIN INSTITUTE

Frederic Bertley, Senior Vice President for Science and Education at The Franklin Institute, opened his talk by reiterating the message that we live in a world that revolves around STEM. STEM, he continued, can solve some of the world's greatest problems. Scientists, for example, borrowed genes from a Canadian Arctic white fish to grow tomatoes resistant to cold that could survive cold nights and frost snaps. These tomatoes, known as genetically modified organisms (GMOs), can provide safety and security to farmers. He explained that, although STEM is at the heart of everything, many Americans have a significant level of science illiteracy. In explaining this further, he cited a common misconception that humans coexisted with dinosaurs, a lack of climate change understanding and confusion about the common uses for antibiotics. He stressed that those who are involved in educating children, adolescents and adults (in and outside of schools) need to challenge these learners to really understand the world in which they live.

According to Bertley, for students to be successful in STEM, especially underserved communities and girls, they need both the support of their families and programs specifically designed to let them experience science first hand. Teachers and schools do their best to provide STEM education, however often these teachers do not have the resources or training to give their students the experiences that would make STEM come alive. To elucidate this point, he outlined several programs that The Franklin Institute offers that do just this, such as: Community Night at The Franklin Institute with hands-on activities once each month; the Philadelphia Science Festival, a nine-day celebration of science with over ninety events in the greater Philadelphia region for people of all ages; NSF-funded programs like LEAP into Science, a national science literacy program from elementary students, and STEM3D–an Out of School Time (OST) STEM infusion program; and finally its long-term youth programs called Partnerships for Achieving Careers in Technology and Science (PACTS) and STEM Scholars for middle and high school students. Programs like these will help everyone participate actively in STEM fields, get exposed to science in "real life" and many allow participants to gain the necessary skills that they need to consider STEM careers and make an impact on the world in which they live.

DESIGN THINKING WORKSHOP



"Design is the art and science of cutting cubes out of fog."

LARRY KEELEY

After hearing inspirational TED-style talks, conference participants reconvened as a large group to begin engaging in a design-thinking workshop for the remainder of the day. Design thinking, broadly conceived, is "a methodology that imbues the full spectrum of innovation activities with a human-centered design ethos" (Brown, 2008). The workshop, led by consultants Carla Silver and Natalie Nixon, opened with the big question of the day: How might we inspire more girls and young women to pursue careers and leadership roles in STEM related fields? The facilitators explained that their goal was to give participants the tools that designers use to solve an ambiguous challenge like this one. Designers, they underscored, solve problems that meet human needs. According to the presenters, the elements that undergird collaborative design thinking are *empathy*, *lateral thinking* and *story*, all of which have a focus on human needs and a bias towards action. In addition to exploring what design thinking is, the facilitators also outlined the process that most designers engage in as they try to solve the problems handed to them: empathize with the end user, define the problem, ideate and explore a wide range of solutions, create a physical prototype of your solution, and test a product to refine your idea.

Design Thinking in action.

EMPATHIZE

Empathy, the facilitators explained, is the ability to step outside of yourself and see the world as others do. They stressed to the participants that the assumptions they have and the problems they face are not the same problems faced by the end users. Designers are designing for others, so they need to understand their users quite deeply. In order to help participants empathize with the end users, the facilitators began with an activity using rapid ethnography. Participants were placed into small groups and assigned roles of interviewer, interviewee and one or two observers. They were asked to listen and observe (not interpret) as the interviewee talked about the origins of their personal attitudes towards STEM. As the groups rotated through roles, they shared moments like, "when I was two years old, I found my grandfather's watch and I opened it to see how it worked," and "I got my first B ever in Physics…" that would help them understand how different people have come to understand their own role in STEM. As they debriefed afterwards, the group discussed how important it was to truly listen as you learn about the different experiences, because these experiences could be useful data in designing solutions to the very problems that they faced.

Agnes Irwin students shared multiple perspectives on STEM experiences.

After learning about each other's experiences, participants were given the opportunity to listen to the STEM stories of four Agnes Irwin students. This panel was intended to give conference participants more data to inform their task of increasing the participation and persistence of girls in STEM. The students, seniors Sophie Fisher and Anisha Mittal and sophomores Brynne Pergolini and Alex Blomstrom, were interviewed about their experiences with and their attitudes towards STEM by Taunya English, a reporter for Philadelphia's NPR affiliate, WHYY. English began by asking each girl to talk about her relationship with STEM and as the girls began to talk, they revealed how complex girls' attitudes towards STEM are today. While Fisher and Mittal are passionate about STEM, co-founding the STEM club at Agnes Irwin and with decided career aspirations in computer science and biomedical engineering, Pergolini and Blomstrom expressed more hesitance about their interests and career pathways. Blomstrom, for example, explained that, while she does well in her Math and Science classes, she sees herself more as an 'English person,' who doesn't plan on pursuing a STEM field in college. As English probed further, she uncovered that each girl had a unique pathway to their interest in STEM. Mittal noted a guidance counselor who encouraged her to take a computer science class and Pergolini explained that her father, an engineer, once asked her for help on a project. Fisher, who wants to study biomedical engineering in college, commented that, while

CARLA SILVER

Design Thinking Workshop Facilitator

Carla Silver is the executive director and co-founder of Leadership + Design. She is an experienced independent school educator, school administrator and experience designer. Ms. Silver partners with schools on strategic design and enhancing the work of leadership teams and boards, and she designs experiential learning opportunities for leaders in schools at all points in their careers. She also leads workshops for faculty, administrative teams and boards on design thinking, collaboration and group life, and leadership development. She has presented regularly at the NAIS annual conference as well as other regional and local seminars, workshops and conferences. Ms. Silver currently serves on the boards of Breakthrough Silicon Valley and the San Francisco School. She holds a B.A. in English from Emory University and a M.A. in Nonprofit Management and Leadership from the University of San Diego. As a lifelong learner, she has recently pursued her interests in design thinking, creativity, improvisation and education innovation.

she never really had a mentor, she may have become more interested in STEM at an earlier age if she had one.

Some of the most useful data came out of one question English asked, "what about your bedroom in Elementary and Middle School could have signaled that you had an interest in STEM?" In response to this question, both Blomstrom and Pergolini were quick to describe their childhood fascination with building toys, like LEGO®, K'Nex® and GeoTrax®. Notably, both girls explained that they played with these toys with their brothers, but they both seemed to think that they would have had these toys anyway. They both also stressed that they liked the more realistic looking toys, like Lincoln Logs, and were not really engaged by the pink LEGO® sets intended for girls. Fisher, on the other hand, described a different type of young girl. She explained that when she was young she was very artistically inclined, and spent hours copying princesses and making detailed drawings. It was no surprise, then, that Fisher explained that she sees a lot of benefit in STEAM, where the arts become an essential component to learning all STEM subjects.

English closed the panel by asking the girls what can be done to get girls interested in STEM subjects from a young age. One of the students explained that more hands on activities and real-world experiences in the classroom is a great first step. A second student added that girls should be encouraged to ask questions and to question the world around them. Video and computer games, one suggested, are excellent tools to teach girls these skills. In all, the panelists explained, girls should be treated as individuals and encouraged to try as many new things as possible as they go against the mainstream and chart their own courses.

DR. NATALIE W. NIXON

Design Thinking Workshop Facilitator

Dr. Natalie W. Nixon is a hybrid thinker whose consulting and research interests are at the intersections of creativity and strategy, and business and design. She is an associate professor and the director of the Strategic Design MBA program at Philadelphia University, where she holds the G. Allen Mebane IV '52 Chair for Design Thinkers. In her consultancy, Figure 8 Thinking LLC, she taps into her background in anthropology and fashion when working on projects that call for a strategic design process. She is the editor of *Strategic Design Thinking: Innovation in Products, Services, Experiences and Beyond* and is a regular contributor to INC.com online magazine on creativity and design thinking. Her public speaking invitations have included TEDx Philadelphia, TEDx George School, Copenhagen Institute for Interactive Design, European Innovation Academy (Nice, France), SEB Bank (Tallinn, Estonia) and the Mayo Clinic's Transform Conference. Ms. Nixon earned her B.A. from Vassar College with a double major in anthropology and Africana studies; an M.S. in Global Textile Marketing from Philadelphia University and a Ph.D. in Design Management from the University of Westminster, London.

DEFINE

After listening to the panel, participants were put in working groups of three-to-four to begin to make meaning out of what they had just heard. This process of synthesizing is referred to as "definition" in design thinking, and is intended to help the designer adopt the perspective of the end user. They were instructed to use chart paper and sticky notes to, first, identify the things that they had observed auditorily and visually from both of the 'empathy' exercises. During this process, participants were supposed to only note things that they had directly observed, free of inference or interpretation. When asked to write what they had heard, participants recounted specific pedagogies that had come up in the morning, such as small group instruction, hands on activities and connections to the real world. Additionally, they recorded some interesting observations, such as the inability of the panelists to identify role models and the fact that, when asked, none of the girls on the panel were able to narrow their interest down to only one STEM field. Participants also recalled specific language that they had heard, such as one from the keynote "The only difference between a scientist and a kindergartner is their height" and one of the panelists talking about how she had put herself "in a box" to study biology and become a doctor. When asked to identify what they had seen, participants noted how confident and comfortable the keynote and TED-talk speakers were with their choices and how the girls on the panel seemed to look at each other, as if for confirmation, before they answered any question.

After seven minutes, participants were finally encouraged to begin interpreting what they had seen and heard. They examined the lists that they had generated during the observation phase, and wrote things like, "girls do like STEM," "Teachers=Coaches," and "we beat the creativity out of kids." Examining all of the comments made by participants, there were several big themes on which they focused their interpretations. First, schools and organizations need to increase and diversify the STEM opportunities that they give girls, such as more 'interesting' classes like Astronomy. Second, while STEM interest can start early, there is no ideal background or skill set for a 'STEM Person.' These two themes, in fact, are interrelated. As one participant wrote, "the pipeline needs to take differences in opportunities and pathways into account," signaling that, perhaps, the best pipeline would be many pipelines because STEM is so many different things. In addition to these big themes, participants noticed how important encouragement was for people to persist in STEM. Additionally, participants noted that teacher risk-taking could help girls both to treat failures as data and also to build self-efficacy. Girls, participants believed, need to have a strong growth mindset, and risk taking and encouragement will help them develop this mindset.

Participants connected easily in the welcoming setting of The Franklin Institute.

IDEATE

After participants spent time interpreting all of the data they had gathered during the empathy exercises, they moved into the 'ideate' phase, where they began identifying as many possible solutions as possible to the problem of participation and persistence of girls and women in STEM. To help with this phase of the design thinking process, the facilitators handed each group one of four different persona's to imagine as their potential end user. The facilitators explained that, in the design process, you can't design one thing for everyone, you have to design for one specific person. Having a persona in mind stops a designer from drifting into her own biases and assumptions about a given problem. Participants were handed one of the personas below and asked to imagine, what might we do to bring out the inner scientist in your end user?

PERSONAS

LISA

Lisa is a seven-year-old who loves being outside and playing in the dirt. She's always the first one on the jungle gym. Lisa is super inquisitive and loved her class trip to the Franklin Institute. Her mom is a doctor and her dad is an accountant.

AMANDA

Amanda is a thirteen-year-old and she is very excited about science. She really loves her 8th grade science teacher. She has heard from her older brother, Leo, that there are not many girls in his physics class. She is hoping that won't be the case when she gets to high school!

JUSTINE

Justine is sixteen years old and not crazy about math. She has become more interested in arts and design in the last three years and she is thinking about applying to a liberal arts college, or perhaps, one with a strong design program.

CLARA

Clara is twenty-four years old. As a recent college graduate, she is now realizing that her lack of a science background may put her at a disadvantage for a position she wants to interview for at a tech startup. A lot of her friends seem to be doing cool things in the world of technology, fashion, health care, transportation, etc. She wants to be part of that!

After reviewing the personas, everyone participated in a short divergent thinking exercise where they had to list all of the different uses for a paperclip. The goal of this exercise was to help participants to begin thinking "outside of the box." After this brief exercise, participants were given a specific goal: develop a product, a service, a process or an experience to ignite this persona's interest in STEM. Each group began by "quiet storming" where they silently wrote ideas on post-it notes and attached them to chart paper. Participants were encouraged to build off of each other's ideas as they developed as many possible products, services, processes and experiences as they could. After the quiet, participants placed their ideas on "the idea horizon," a picture on chart paper of the ground, a series of mountains and clouds in the sky. Items placed on the ground were more realistic, items in the sky, more abstract or more difficult to achieve.

The horizon lines that participants generated clearly demonstrated the range of ideas that the design thinking process had generated. Nearest to the ground, those items that were most realistic, participants placed ideas for visits to The Franklin Institute, online coding classes, guest speakers in schools and more recess. Not only were the more feasible ideas clearly less costly, they also seemed to require less administrative buy-in and, therefore, only represented surface level changes that would have little impact on the overall culture. About halfway up the mountains on the Horizon Lines participants placed ideas that were both more logistically complicated, such as an interdisciplinary course in design and math, and those that would require more community buy-in, such as a school-university partnership. Notably, those items that require more community buy-in, appear to be highly focused on changing the culture of an individual institution, such as a teacher workshop on implicit bias. Lastly, those items that participants placed in the clouds fell into two distinct categories: those logistically or financially complex, and those that would redefine the entire system of STEM education. Notably, those solutions in the former category, such as an interview with Steve Jobs (who is dead) or a fossil dig in Montana, would likely have little impact on the culture of STEM within individual institutions and society. However, the potential solutions that would redefine the entire system, and would require a good deal of work and community buy-in, such as redefining the curriculum collaboratively with students, or the "clownfishification" of the STEM world, were those items that appear to have the most promise regarding change in the culture of STEM.

"Clownfishification" of the STEM World

'Clownfishification' is based on the idea that clownfish can alternate sexes between male and female during their lives. This term was coined by attendees to represent a STEM world with no bias.

As the participants began discussing which idea they would focus on for the rest of the workshop, the facilitators introduced the idea of critique, with the goal of helping the participants separate themselves from the design. To do this, each group was handed a sticky note with a letter on it that represented a prompt. The facilitators explained that groups would have to use these prompts to improve and refine their idea for the day:

- If the letter G was on the sticky note, they had to 'gameify' their product, service, process or experience.
- If the letter C was on the sticky note, they had to include a campaign (political, social media).
- If the letter B was on the sticky note, they had to add biomimicry (attributes from nature).
- If the letter S was on the sticky note, they had to add in the attributes of a superhero.

After receiving their challenge, participants continued to refine their ideas as they prepared for the prototyping process. Some groups chose the idea that seemed most difficult, thinking that this idea would change the norm or the 'mental model' or STEM. Some chose the idea that seemed most feasible, and others selected the idea that simply seemed the most beneficial.

Facilitators Natalie Nixon (l) and Carla Silver (r) guide participants through the design thinking protocol.

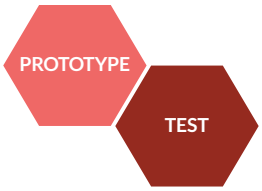
Taunya English facilitates the student panel.

TAUNYA ENGLISH

Girls and Young Women Panel Facilitator
Wrap-up Session Facilitator

As a part of the National Public Radio network, Taunya English is WHYY's senior health writer and tracks government policies and community efforts to overhaul the places where people live, work and play. She is a contributor to "The Pulse," WHYY's weekly radio show on health, science and innovation news. Ms. English created the series "Designs on Health" with support from the Dennis A. Hunt Fund for Health Journalism — a look at the ways zoning and neighborhood influence well-being. She is a member of Health Care in the States, a journalism collaborative between National Public Radio and Kaiser Health News, which works to expand reporting on the implementation of the Affordable Care Act. She produced the radio series "In the Gap," 12 installments of news and conversation exploring the divide that separates African Americans from better health. Her radio work airs during "Morning Edition," "All Things Considered" and "NewsWorks Tonight." Her television stories appear on Delaware's newsmagazine, "First." Before joining WHYY, Ms. English led statehouse news coverage for Public Radio Capitol News in Harrisburg, PA. For three years, she worked as a freelance health reporter for Baltimore's National Public Radio affiliate, WYPR. She began her journalism career as a newspaper reporter in Northern California, then moved on to become a science writer in Washington, D.C. She holds a master's degree from Northwestern University's Medill School of Journalism.

PROTOTYPE AND TEST



To design their own prototypes, participants were handed a concept map template to fill out. The facilitators explained that the goal was for participants to continue to ideate and build on these solutions as they completed the concept map. They also explained that, while designers often focus on feasibility, viability and desirability, the focus for this phase should be desirability. Participants set to work completing the concept map, giving their product, process, experience or service a name, drawing their persona engaging with their solution and listing the key features and benefits.

After about twenty minutes, participants were given the chance to "pitch" their ideas, in order to test them with a broad audience. After all of the pitches were complete, Taunya English selected two to investigate further as models. Drawing on the 'critique' experience of art and design programs at the college level, she asked questions and the audience asked questions to help the presenters refine their ideas for broader audiences. The first prototype selected was *Ninja Blocks*, a set of lifesize legos that children like Lisa could use to design their own jungle gym. English first posed the idea that Lego might want to partner with them on the project, then she asked about their process. The interdisciplinary and multi-grade level group of teachers explained that they started sketching and got into the seven year old mindset, which helped them to imagine that anything was possible. The other prototype discussed in more detail was *Meals to Morph*, a mentorship program for Clara that utilized biomimicry modeled on the morphing of a butterfly. English commented that the service was immediately understandable and resembled a professional dating website.

After the pitches were presented and the two case studies were examined, Mariandl Hufford and Frederic Bertley concluded the conference by thanking all of the participants for their hard work, and invited everyone to complete a 'call to action.' They explained that the next conference would focus on celebrating the very actions inspired by this conference. As they documented their future action steps, participants wrote a variety of things that they plan to implement, ranging from presenting a faculty meeting to interviewing students to design a new experience for them. Most meaningfully, many participants noted how beneficial learning the design thinking process was, and articulated a plan to implement the process with students or teachers.

CONCLUSION AND NEXT STEPS

Overall, *Sharing Solutions 2016: Building a Better Pipeline* was a tremendous success. Participants interested in transforming the institutional culture which surrounds STEM were able to come together both to better understand the STEM culture and to develop concrete action steps for their own institutions. Appendix B summarizes the feedback that participants provided on the "call to action" and exit surveys that they completed. In both of these formats, participants outlined how beneficial they found both the morning's speakers and also the afternoon design-thinking workshop. In the morning, the diverse group of participants gained knowledge that upended STEM-related stereotypes. Participants explained how eager they were to share their new knowledge with their own communities. For example, one participant expressed a desire to share Ramirez's phrases, "Failure is Data," and "Can't isn't part of your vocabulary," with other teachers and with her own students. While participants seemed excited about the prototypes that they developed, they were overall more focused on the design-thinking process itself, explaining that they would use it both with faculty in professional development and also in the classroom the following year.

Constructive feedback from the conference evaluation also inspired the direction of next year's meeting, which will highlight sharing and partnerships. Several participants explained that they wished that they had more time for networking and sharing. As such, we have created a LinkedIn group to continue the conversation and will plan a longer, two-day conference, next year. To ensure continuity of this conference, the Agnes Irwin Center for the Advancement of Girls and The Franklin Institute have committed to building a conference model that builds and continues from previous years into future conferences. To ensure the development of conferenced-based communities of practice, and to further emphasize the "sharing" aspect of the conference, we also plan to dedicate a significant portion of next year's conference to "reporting out" and hearing the progress made of this year's conference attendees as they implement their learned outcomes, born out of conference participation, and the power of community engagement in achieving lasting change.



Participants are actively engaged in the design thinking challenge.

THE PITCHES

DESIGN THINKING WORKSHOP

What follows are the ideas generated by participants in the design thinking workshop.

LISA

Science Timewarp

In this game, Lisa becomes a time traveler that goes through stories and learns lessons to alter the fate of women in STEM. This paper and interactive online subscription service would allow Lisa and her parents to become science historians as they complete challenges.

GUESS (Global User Extreme Scavenger Scout)

In this app that teaches problem solving, girls will travel all over the world to do experiments that are based both in the local community and globally. Through the app, girls create a community and gather together to perform experiments. When they finish they get a facetime call from a celebrity!

iTree

The iTree is an interactive jungle gym community designed to "grow your STEM." The tree, which collects water, is both a classroom and a jungle gym where the water goes to a community garden. Students and teachers check-in using a QR code and teachers can monitor and guide students while they play.

Ninja Blocks

Taglined, "welcome to the jungle," Ninja Blocks allow young students to design their own jungle gym using lifesize legos. The customizable kit helps students learn flexibility, creativity and teamwork.

AMANDA

See yourself in STEM App / The Fearless Mirror

The goal of this app is to help Amanda to understand the heritage of women in STEM and to connect with her peers. Using the app, Amanda can share her own scientific triumphs and celebrate the triumphs of her peers. This will help girls learn to celebrate their successes and see themselves as scientists.

@ohheyscientists

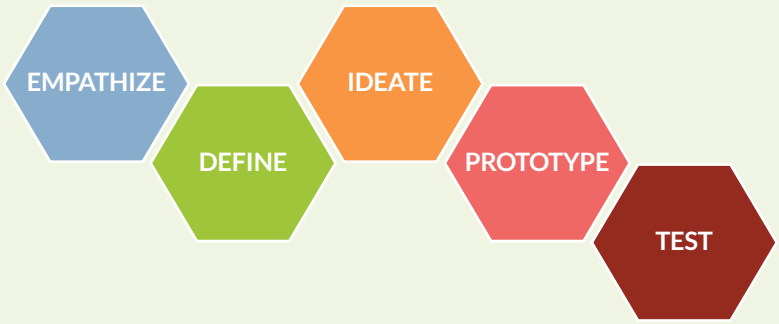
Taglined, "you have a question, scientists have answers" would be a twitter and instagram account that would allow students to send scientists their pressing questions and network/interact with those scientists as they dig into their big questions.

Changing NEMO (Changing Norms in Education through Mentoring Opportunities)

This program is based on the idea that clownfish change their sex through their lifetime, and girls should learn that they can be scientists too! This would include an empowering curriculum with hands on and experiential activities. Students in classrooms would form, "clownfish societies" and build community as they learn science.

Science Storytelling, "Be the Hero of your own story"

Science Storytelling is a new class for incoming 9th graders that would be co-taught by an English and Science teacher that investigates the science behind storybook fiction. The final project would be a mini-citizen science project of their choice where they would meet with professionals and scientists to guide them.



JUSTINE

#FindTheTeamInSTEAM

In this program, Justine would create and develop a website to show the knowledge that she has gained while tutoring a small group of girls in the community. The goal is to inspire her and the next generation while helping to build community. Ending with a field trip to the Franklin Institute, the website would model the tutoring process for others.

Fibonacci Fashionista

The goal behind this program is to use clothing design to get Justine interested in math. In the program, Justine would use CAD for fashion design and she would learn 3D printing. One of the main components is a jewelry design using the fibonacci sequence. Not only would the winner get a trip to France, but Beyonce would wear the jewelry.

Tech Art, Girls Inspired by STEAM

This math-based art competition, co-sponsored by the Philadelphia Museum of Art, is for an authentic audience, is interdisciplinary and contains a real-world application. The winner of the competition would have their math-inspired art showcased at the museum.

Design Camouflage

Design Camouflage is a way to get STEM to Justine even though she doesn't want it. This innovative curriculum adapts to student interests and minimizes the marginalization that they feel in traditional classes.

Play by Design

In Play by Design, Justine would be partnered with a math student to create a game. She would create the art and the anatomy of the game components and a programmer would make that anatomy move. Not only would this help get Justine and those like her interested in programming, but it would help to build collaborative thinking skills.

CLARA

Tech Trek, Creating a Technology Pathway

This mobile app was designed based around the idea that Clara probably has a better understanding of STEM subjects than she thinks. The app, which operates like a scavenger hunt and helps her figure out key tech concepts, helps her understand her own place in the technology world through everyday activities like baking with her friends. The app would connect to instagram, so it would be social and community building.

Meals to Morph

Meals to morph is modeled on the idea of a butterfly going through different stages of her life. This is a mentorship program with online coursework and she would interview other people in these fields over lunch. Clara, or someone like her, would have different lunches with professionals as she discovers her newest passion.

SCOUT (Seeking Careers for women like you in STEM)

The SCOUT company provides career counseling and placement in tech internships, coding academies and connects them to mentors. Eventually, SCOUT participants would become a mentor to pay it forward.

Career Coaster

The career coaster is a mobile gaming app where you can go on quests, such as building a team and gaining a mentor. The badges that you gain can transfer to your linkedin profile and live check-ins to get points and earn badges.

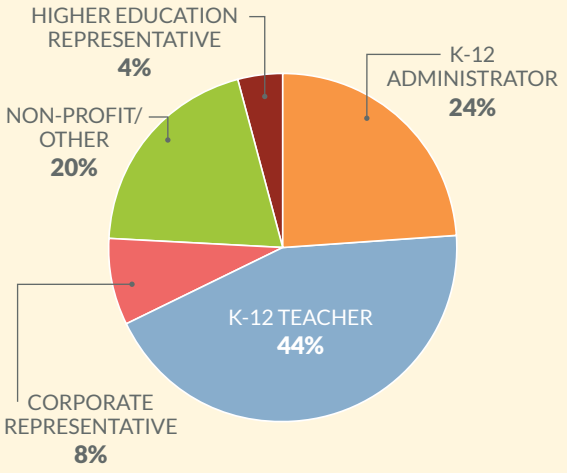
APPENDIX: CONFERENCE EVALUATION

At the conclusion of the design thinking workshop, participants completed an evaluation and a "call to action," where they specifically wrote what they planned to do as a result of the conference. The purpose of the evaluation was to examine the three main goals of the conference:

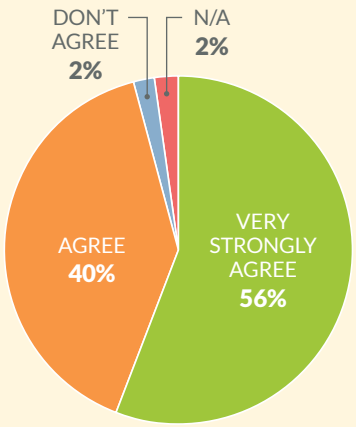
1. Develop concrete methods for improving the culture so that more girls and women participate and persist in STEM careers.
2. Inspire attendees to implement those concrete ideas that they develop.
3. Build a network of likeminded individuals who connect and continue to collaborate across industries and institutions.

Of the fifty participants who completed the evaluation, the vast majority were either teachers or administrators in K-12 schools. Fully 44% of the respondents identified as K-12 Teachers. In addition to K-12 teachers and administrators, the conference also had representatives from higher education, the corporate world and the nonprofit sector.

PARTICIPANTS



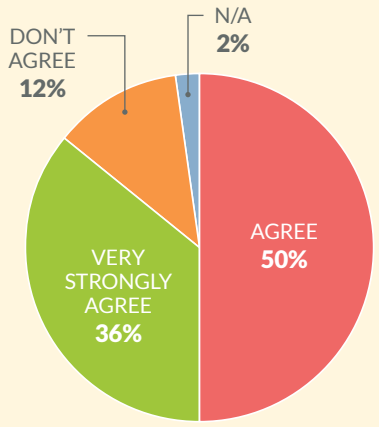
I FEEL INSPIRED TO DO SOMETHING NEW IN MY ORGANIZATION



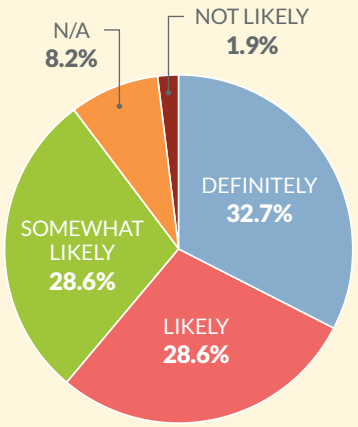
In general, survey respondents left the conference feeling very positive, with 96% of the fifty respondents indicating an inspiration to do something new in their own organizations. When pressed for a concrete action step 86% of respondents agreed or strongly agreed with the statement, "I have at least one concrete action step…" Even more specifically, when participants were asked if they would begin implementing that action step this year, 51% indicated that they were Definitely Likely or Likely. Among participants, the twelve administrators in K-12 schools were the most likely to have concrete action steps, yet the ten respondents from the nonprofit sector were more likely to anticipate implementing those action steps this year.

Conference attendees were asked to describe their specific action step in more detail on both the evaluation and on the "Call to Action." Responses revealed two main themes: sharing the information gained during the keynote and TED-style talks, and implementing design thinking strategies. Participants were clearly energized by the overall design thinking process, commenting that they plan to, use "design thinking to empower students and teachers to change what learning looks like in the classroom." One participant explained that the most beneficial aspect of the conference was learning "the various tools such as "brain and quiet" storming, creating ideas and being innovative." Participants also really resonated with the ideas of the speakers from the morning, particularly the words of keynote speaker Anissa Ramirez. Not only did participants indicate that they would look to her as a speaker for future events like this, they particularly liked some of the examples that she cited, such as the percentage of women in STEM classes in 1890 and the idea of failure as data.

I HAVE AT LEAST ONE CONCRETE ACTION STEP THAT I WANT TO IMPLEMENT



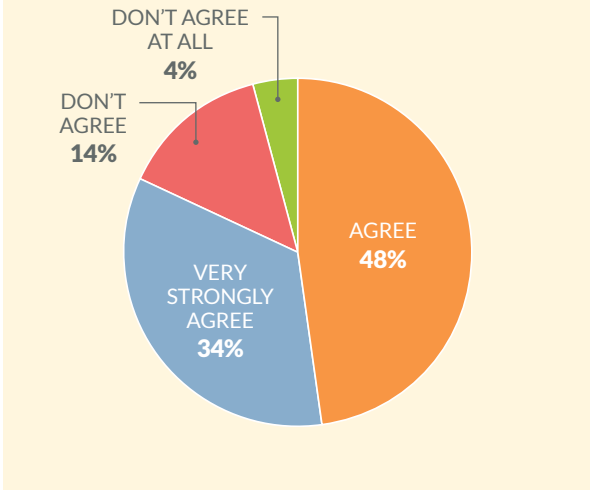
HOW LIKELY IS IT THAT YOU WILL BEGIN TO IMPLEMENT THIS STEP THIS YEAR?



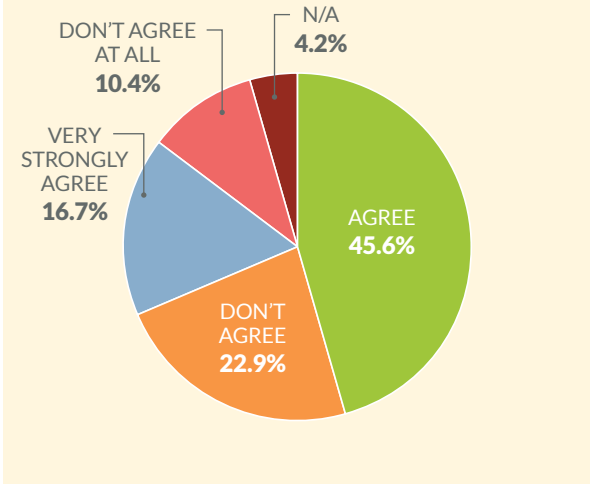
In addition to the energy that participants felt about design thinking and the opening speakers, a few noted that they want to continue developing their prototypes, such as "design camouflage" and others anticipated major changes in their curriculum. Notably, there were a few participants who left the conference without a concrete action step. One wrote, "While this was an informative and fun conference, I found it much more difficult to imagine a concrete action step for the future this time." Another participant was clearly processing their next action step, but had a positive attitude that one would come up, "I am still thinking about this, but I would like to collaborate with my students and coworkers to generate ideas."

The design thinking challenge led to creative problem solving.

I MADE AT LEAST ONE NEW CONNECTION



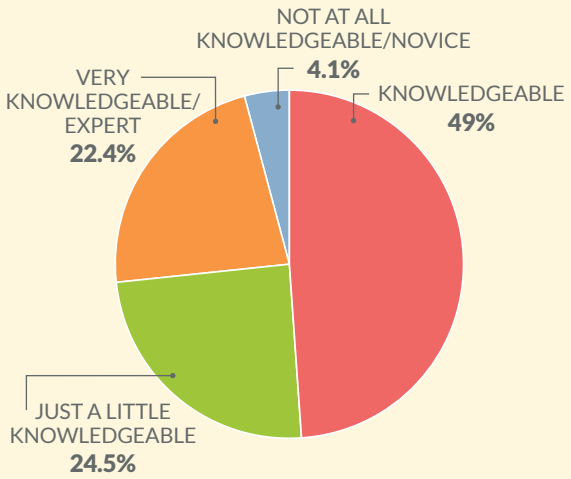
I FEEL THAT I HAVE BUILT A NETWORK OF LIKEMINDED INDIVIDUALS



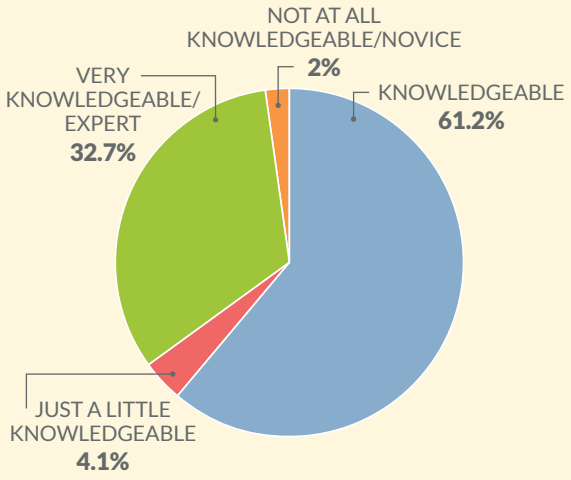
In addition to identifying concrete actions and goals, the conference evaluation also asked participants whether they formed meaningful connections and created a network as a result of the conference. While most participants agreed that they did make new connections and build new networks, several commented that the working lunch and the static groups made it harder to network than at the previous conference.

Lastly, respondents were asked to rate how knowledgeable they felt about changing the culture surrounding girls and women in STEM before and after the conference. Responses indicated that, while like last year we began with a very knowledgeable group, there was some growth in overall understanding about these issues. While only 22.4% of respondents felt that they were at the "expert level" before the conference, 32.7% felt that they were at expert level after the conference and while almost 25% of participants felt that they were "just a little knowledgeable" before the conference, only 4.1% felt this way at the conclusion of the conference.

LEVEL OF UNDERSTANDING **BEFORE** THE CONFERENCE



LEVEL OF UNDERSTANDING **AFTER** THE CONFERENCE



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