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Equipping an Army of Ambassadors: A Workshop Model for a STEM Career Speaker's Bureau

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Equipping an Army of Ambassadors:
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Immersed in a society that is dominated and driven by work, and vulnerable to social influences of prestige and gender bias, children as young as five years of age begin to postulate what career they will one day have[1]. Young people tend to choose professions that are familiar[2], whether traditions in their family, or professions that have been exposed to them through education and experience.

Most careers in STEM aren't quite as tangible and recognizable as say a teacher, fireman, or professional sports player[3, 4], and young women are susceptible to stereotype threat that would discourage them from participating in STEM or choosing STEM careers[5]. Girls are attentive to the behaviors that women in their culture engage in and thus feel efficacious in and model those behaviors[6]. Girls' attitudes regarding scientists and engineers have been influenced by the lack of female representation in the media, and with this absence of role models, many girls tend to view science and technology an unsuitable career choice and personally irrelevant to their lives.

One way to alleviate these concerns is to expose students to role models, specifically females to dispel stereotype threat for young women, in math and science [6-10], or in general – STEM Professionals. With a national imperative to increase the number of students, particularly those of underrepresented groups, entering into STEM disciplines, concerted efforts to expose all students to STEM careers using terminology that is interesting and appealing can reverse misperceptions and threats[7].

In 2012, the High-Tech High Heels (HTHH) Fund founded a Speakers Bureau with a mission to inspire and encourage middle school and high school students, especially the underrepresented, to pursue careers in STEM fields. Volunteers are requested by local schools or organizations to speak to students, to serve as mentors, to assist teachers, and to meet the needs of the community as STEM ambassadors. HTHH believes it paramount to commission an army of ambassadors trained to be the best and most diverse representation of STEM professionals to students. In August of 2012, the inaugural training workshops were conducted as an effort to "Equip an Army" of volunteers to go forth and: 1) Share with students why they love working in STEM careers, 2) Explain to students the impact they can have on the world by working in STEM, and 3) Show students the diversity of real-life women and men in STEM. Using guided, inquiry based instruction and learning, participants/volunteers reflected on their personal stories, and developed strategies for how to talk to students about STEM careers using correct and positive messaging[11].

Two workshops were conducted, and evaluations and reflections from the first, informed the second. Each workshop was approximately two hours in length. This paper describes the workshops conducted, lessons learned, and feedback from both veteran and new Ambassadors. Results from this paper serve as a model for other STEM Speaker's Bureaus on how to train ambassadors.

Best Practices Research

Borrowing from healthcare industry, the best practices model used by Mold and Gregory [12, refer to Table 2 in cited document] has served as a guideline for establishing the best practices for a STEM Career Speaker's Bureau. Their model includes five steps, and Table 1 adapts those steps with the procedure for this model.

Table 1 Best Practices Research Model [Adapted from 12]

Development of Conceptual Model: Literature review and creation of a conceptual model of the components for the Ambassador training. (See sections: Theoretical Framework & Conceptual Model)
Definition of Best Method: Determine desired qualities and results for the Ambassador training, and then the ideal pedagogy [13] (See section: Instructional Design)
Identification/evaluation of potential methods for each component: Two parallel trainings, where the reflection and evaluation of the first informed the second. (See sections: Method & Discussion)
Combining best components: The summary of best components from the two parallel workshops. (See section: Discussion)
Test combined methods: Future work will validate the combined best components. (See section: Conclusions & Future Work)

Theoretical Framework

The theoretical framework for the speaker's bureau training is based on three sources of literature. The first is the report American Association of University Women 2010 report "Why So Few? Women in Science, Technology, Engineering, and Mathematics." The research summarized in this report such as that of implicit bias, stereotype threat, growth-fixed mindset, and ultimately the report's recommendations for increasing the participation of women in STEM[5] are the foundation of the training. The second key source is "Changing the Conversation: Messages for Improving Public Understanding of Engineering," by the Committee on Public Understanding of Engineering Messages, commissioned by the National Academy of Engineering[11]. The final source is a study by Duffy & Sedlacek[14] analyzing the work values[15] associated with student career choices. This particular study, in tandem with the Changing the Conversation Messages, serve as a framework for how to talk about STEM careers in a way that appeals to student interests and values.

Why So Few? The AAUW Why So Few? report makes several recommendations for cultivating girls' achievement and interest in science and engineering. The first recommendation (see Table 2) describes the importance of exposing students to role models, and dispelling stereotypes.

Table 2 AAUW Why So Few, Recommendation 1[5]

Spread the word about girls' and women's achievements in math and science.
The stereotype that men are better than women in STEM areas can affect girls' performance, how they judge their performance, and their aspirations. Help eliminate the stereotype by ◆ exposing girls and boys to female role models in STEM careers, ◆ talking about the greater numbers of girls and women who are achieving at higher levels in STEM subjects and fields than ever before, and ◆ pointing out the lack of gender difference in performance in nearly every STEM subject. The more people hear this kind of information, the harder it becomes for them to believe that boys and men are better in these areas.

Stereotypes such as "boys are better at math and science than girls," or that "engineering is for (white) men," are perpetuated through implicit biases[16], the media, and the actual lack of representation in fields such as engineering and computer science. Research has shown that stereotype threat, the threat of being viewed through the lens of a negative stereotype or the fear of doing something that would confirm that stereotype, is one reason why underrepresented groups do not choose math and science based careers. Long term or repeated threat can erode ambitions in the area of interest through a process called "disidentification," a defense to avoid the risk of being judged by a stereotype[5]. The good news is that role models can help alleviate this process, and aide students in identifying with careers in STEM. Exposing underrepresented groups to successful role models that fit their demographic can help counter negative stereotypes because they see that people like them can be successful and stereotype threat can be managed and overcome[5].

Another stereotype grounded in a misconception is that math is an innate ability. The work of Carol Dweck, highlighted in the Why So Few Report[5], "provides evidence that a "growth mindset" (viewing intelligence as a changeable, malleable attribute that can be developed through effort) as opposed to a "fixed mindset" (viewing intelligence as an inborn, uncontrollable trait) is likely to lead to greater persistence in the face of adversity and ultimately success in any realm[17-20]." Promoting a growth mindset can help students be less affected by stereotype threat in science and math.

Just as the AAUW recommendation encouraged, the High Tech High Heels Speaker's Bureau aims to "spread the word about girls' and women's achievements in math and science" by having diverse role models dispel stereotypes and promote growth mindsets for students.

Changing the Conversation. Educators, students and the general public have a poor understanding of what engineers actually do on a day-to-day basis, and there is a strong sense that engineering is not "for everyone," and perhaps especially not for girls. Past and many current messages of engineering frame engineering as requiring extraordinary skills in mathematics and science, and that without an aptitude and strong interest in these subjects, one is unlikely to succeed in engineering. In order to sustain U.S. capacity for technological innovation,

and to attract young people to careers in engineering, the National Academy of Engineering commissioned a study (released in 2008) to identify and test positive messages of engineering to improve the public's understanding[11]. The study found that the "branding" of engineers must be modified to appeal to different audiences, especially teenage girls. By changing the conversation from an emphasis on math and science, to the value engineering, and STEM in general, has on our society, we can attract more students to these disciplines. Therefore, the study recommends that the tested messages are used to guide conversations about engineering in order to effectively increase girls' awareness of opportunities in engineering and in turn, spark their interest in engineering careers. The messages selected and emphasized in this work are (Refer to Table 3): 1) Engineers make a world of difference and help shape our future; 2) Engineering is essential to our health, happiness, and safety; and 3) Engineers are creative problem-solvers. While these messages are the results of the study specifically for engineering, one can easily correlate these to describe STEM professionals and STEM careers.

Table 3 Changing the Conversation Messages

Engineers make a world of difference and help shape the future.	Engineering is essential to our health, happiness, and safety.	Engineers are creative problem-solvers.
From new farming equipment and safer drinking water to electric cars and faster microchips, engineers use their knowledge to improve people's lives in meaningful ways.	*From the grandest skyscrapers to microscopic medical devices, it is impossible to imagine life without engineering.*	*They have a vision for how something should work and are dedicated to making it better, faster, or more efficient.*

Work Values Framework. The Duffy and Sedlacek study[14] is based on Ros' definitions of the four key work values: *intrinsic values* typically refer to the importance placed on autonomy and interest, *social values* refer to an importance placed on working with people and making contributions to society, *extrinsic values* refer to an importance placed on making money and having job security, and finally *prestige values* refer to an importance placed on having a prestigious and respected occupation[15]. The survey instrument for the study was constructed from these four general facets, and a sample of 31,731 students were surveyed from 1995 to 2004.

The results revealed that men placed a greater emphasis on making money, women placed a greater emphasis on working with people and contributing to society. White students placed a greater emphasis on having independence and intrinsic interest in the field, and African Americans and Asian Americans espoused higher extrinsic work values. Other demographics aren't highlighted because there was no statistically significant difference in the values they favored. Additional analyses revealed significant cohort differences, as over the 10-year period students reported a 10% increase in the selection of intrinsic values, a 5% decrease in selection of extrinsic values, and a 5% decrease in selection of prestige values. This suggests that students

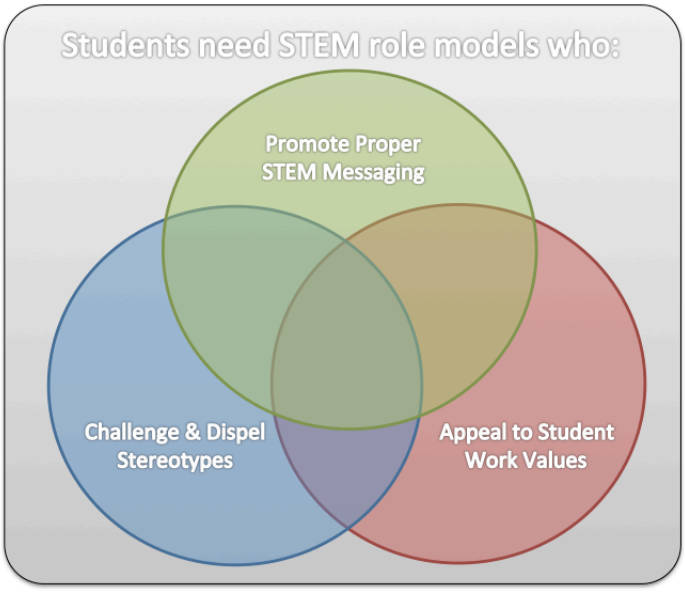
may be placing more emphasis on intrinsic interest and autonomy in their career choice and less emphasis on making money and finding prestigious careers.

Every person is likely to have motivations and values from each of the work value quadrants, and priorities are likely to change over time. Therefore the point is to recognize that there are different ways of talking about careers in STEM in order to attract and appeal to students. For example, one would not always want talk about engineering as being such a high paying job. While it certainly is, and that is attractive to many students, that is not all that engineering, or other STEM careers offer. STEM Careers are interesting, and many roles can allow for independence. STEM Careers are highly collaborative and make significant contributions to society. STEM Careers are high-paying and are in high demand, and STEM Careers are prestigious & respected occupations.

Conceptual Model

The three key components for STEM role models are: 1) promote proper STEM messaging, 2) challenge and dispel stereotypes, and 3) appeal to student work values. This underlying framework has grounded five years of similar work with K-12 counselors[21]. Based on the literature, the proposed conceptual model is displayed as a three element Venn Diagram, see Figure 1. A STEM Ambassador, or role model, should aim to achieve all three components in their interactions with students.

Figure 1 Conceptual Model for STEM Ambassador Training



Instructional Design

The framework used to develop the instructional design of the Ambassador training is based on the Wiggins & McTighe process known as *Backwards Design*[13], as shown in Figure 2. First identify desired results, then determine acceptable evidence, and finally plan learning experiences and instruction. This process is an alignment of content, assessment, and pedagogy.

Figure 2 Wiggins & McTighe Stages of Backwards Design

Content. There were four key objectives for the Ambassador training, and these translated into four "big ideas," both outlined in Table 4. These big ideas are what guided the assessment and pedagogy strategies.

Table 4 Ambassador Training Objectives & Big Ideas

Objective	Big Idea for Training
To inspire Ambassadors who will see their value to students, and who will become active volunteers.	Students most often don't know about careers in STEM, and as a volunteer speaker, I have the opportunity to be a role model.
To frame STEM careers in a context that is appealing to all students, including the Changing the Conversation Messages, and Work Values Framework.	We can attract students to STEM careers by using positive messaging.
To expand the Ambassador's perspective of opportunities and options in STEM careers.	Education in STEM provides lots of career options and opportunities.
To dispel stereotypes about math and science achievement.	Success in mathematics and science is not based on innate ability.

Assessment. Formative assessments were designed to be the primary source of evaluation. Used throughout the workshops, the facilitator designed the workshop to adjust teaching based on participant response, discussions, engagement, and activities. One of the pedagogical activities is concept mapping, and will be discussed at greater length in a subsequent section. Concept mapping is not only a learning tool but also an evaluation tool[22].

Pedagogy. The time period allotted for the workshops was short, after all these are busy professionals who are volunteering their time. The objective of the workshop was to provide *meaningful learning* experiences instead of a slide deck full of ideas for *rote learning* with no

participant engagement[23-25]. Three pedagogical strategies were incorporated in this workshop design: guided-inquiry, concept mapping and reflective storytelling.

Guided-inquiry based learning. Guided inquiry based learning, or sometimes referred to as scaffolded inquiry, is a powerful and effective model of learning[26]. In inquiry learning, the teacher facilitates learning by posing questions, and students learn content by collaboratively engaging in authentic investigations and constructing arguments. This is founded in constructivist theories of learning that stress that learners be engaged in constructing their own knowledge.

Concept Mapping. Concept maps are graphical tools for organizing and representing knowledge. This pedagogical tool is established on the discovery learning process as that of a toddler, where an individual discerns patterns or regularities in events or objects, and associates with words and symbols. Concept maps are a visual diagram where typically relationships between concepts are indicated by a connecting line linking two concepts[22]. This activity capitalizes on iconic learning, the mental storage of images of that which we encounter, experience, or create.

Concept mapping, when paired with guided inquiry, is an instructional strategy that emphasizes relating new knowledge to the learner's existing knowledge. This pairing fosters meaningful learning. Novak sums up, "We believe one of the reasons concept mapping is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold to help to organize knowledge and to structure it, even though the structure must be built up piece by piece with small units of interacting concept and propositional frameworks[22]."

Reflective Storytelling. One of the objectives of the Changing the Conversation messaging project is to essentially re-brand engineering to the public, particularly students[11]. From a business perspective, a brand is the perceived added value that a company or product represents, making customers loyal in preferences both to the company and to its products. A strong brand is a combination of facts and emotions[27], and this amalgamation is what we aim for STEM Ambassadors to portray to students. Facts and emotions, when weaved together become a story, and with the proper messaging, storytelling can improve the potential loyalty and preference for STEM careers among students as volunteer speakers. Besides the external benefits for STEM careers, reflective storytelling is also an effective pedagogical tool.

Adult learning theory suggests that professionals learn through interactions- formal and informal conversations- with other professionals[28]. Reflective storytelling creates a space for thoughtful deliberation that leads to professional growth[29]. Brill explains, "The use of storytelling requires a trust that professionals, working in teams, can and will grab hold of opportunities to tease out a deeper understanding of the ways in which their words and actions may have been received and perceived[29]." The use of reflective storytelling, paired with guided inquiry, not only helps the Ambassadors connect their stories with the messages, but also allows them the opportunity to practice verbally making these connections through the act of telling their story.

Research Question and Goal

The research question guiding this study is:

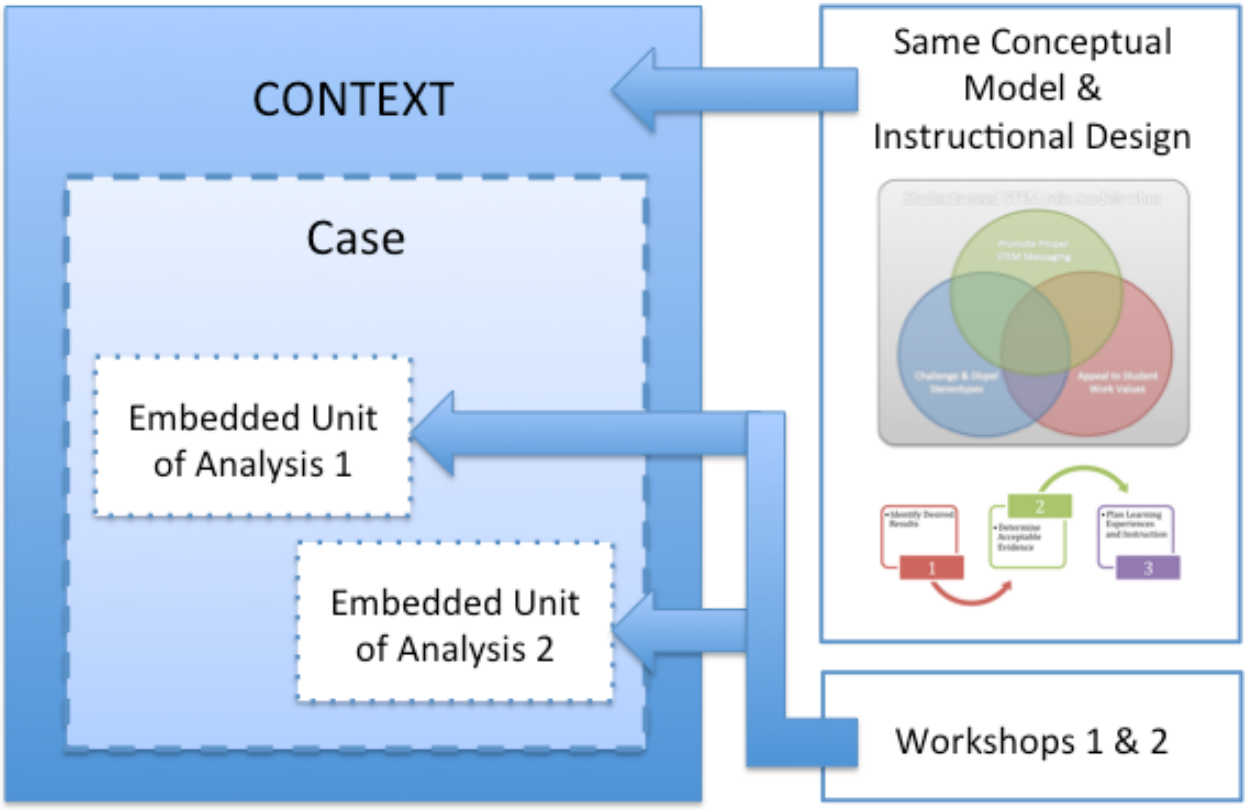
What best practices can be drawn from the High Tech High Heels STEM Speaker's Bureau training workshops?

The ultimate goal of this research is to propose a workshop model for training STEM Ambassadors, and to outline a research agenda for a STEM Ambassador network.

Method

The methodological design for this study is a single embedded case study (see Figure 3). A single case can represent a significant contribution to knowledge and theory building[30], and this work proposes a model for STEM Ambassador training. This is a single case, because of the singular context, one proposed conceptual model and instructional design. Embedded, because there are two parallel units of analysis, two workshops identical in context, but slightly different in execution.

Figure 3 Single Embedded Case Study Design - Adapted from Yin [30, Figure 2.4, p46]



Study Context. The sponsoring organization, High Tech High Heels (HTHH), offered two parallel workshops for the volunteer Ambassadors in the summer of 2012. The purpose of two offerings was simply for scheduling options for the busy professionals. Coincidentally, there were fourteen participants for each offering. Some of the volunteers have previously been active in a similar Speaker's Bureau, though many had not yet volunteered to go speak to students.

The majority of the volunteers who participated in the workshops were donors to the HTHH Fund, were recruited through corporate community engagement strategies, or were invited through local professional networks. While all volunteers who attended were female, they did

represent strong diversity in age, ethnicity, and STEM careers. This paper does not address the recruitment process.

None of the volunteers had ever attended any sort of training such as this workshop. Participants sat at tables in small groups of three to five.

Data Collection & Analysis. The data for this analysis includes the facilitator's lesson plans, presentation slides, notes, and reflections. Reflections include conversations (in person and via email) with the commissioning representatives in review, and feedback from Ambassadors during the workshops. In addition, ten evaluations were gathered through an online application, post sessions. Since two workshops were conducted, evaluations and reflections from the first were able to inform the second.

Yin's [30] definition of case study research establishes it as an "all encompassing" method, which converges the logic of design, data collection techniques, and specific approaches to data analysis. Thus, the case study is not limited to being a data collection tactic alone or even a design feature alone [30, 31]. A case study is an in-depth exploration of a contemporary phenomenon, in this study – an embedded case of parallel STEM Ambassador training workshops.

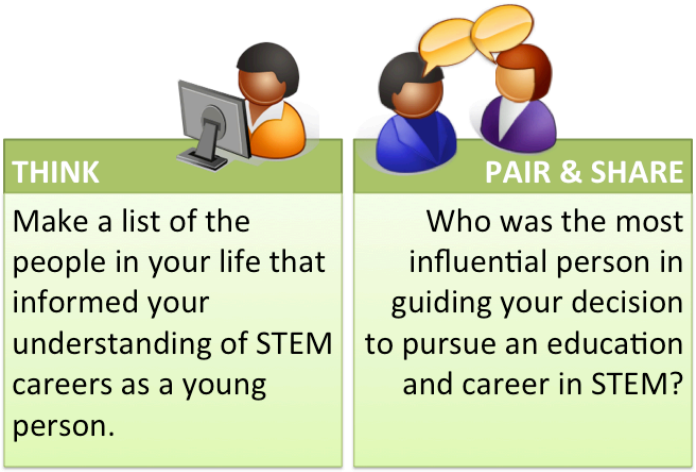
Discussion

This section will review and summarize the best components from the two parallel workshops.

Pre-Training Homework. All participants were asked to do two things prior to the workshop. First, they were provided with a four page summary of the topic we would discuss. This can be accessed at: http://engineeringfocus.org/docs/Engineering_Focus_Vol1_Issue1.pdf. Second, they were asked to write ~100-200 word answers to the following two questions, while remembering to keep the language at an 8th grade level. They were provided with an example, and the questions were: 1) What do you love about being a STEM professional? 2) What impact does your work have on the world today? Twenty percent of the participants sent in their stories, and a couple were submitted after the workshop. The objective of this was begin the reflective storytelling process, and prime the volunteers for the workshop.

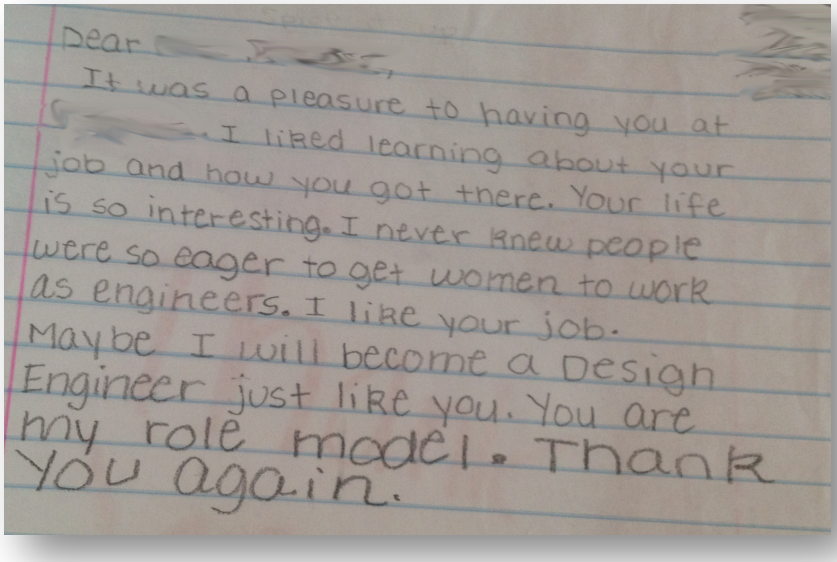
Big Idea 1: ***Students most often don't know about careers in STEM, and as a volunteer speaker, I have the opportunity to be a role model***. The objective of this section of the workshop was to inspire Ambassadors to see their value to students, and to motivate them to become active volunteers. The primary activity was a Think-Pair-Share activity with the following prompts (Figure 4): THINK - Make a list of the people in your life that informed your understanding of STEM careers as a young person, PAIR & SHARE - Who was the most influential person in guiding your decision to pursue an education and career in STEM? Some of the follow up questions, guided inquiry for large group discussion, were: Do you think that your list is common among others like you? What about others different than you? What factors influence someone's list? In what school or neighborhood would a student's list likely be longer? Shorter? Who are you influencing today? Why do you want to be a volunteer in the speaker's bureau? The connections we were aiming to make is that students need STEM role models, and the stories people shared helped demonstrate the variety of types of influences, where some had no influences at all.

Figure 4 Big Idea 1 - Think/Pair/Share



One of the differences between the workshops was an extra emphasis on motivation. The facilitator, who had previously been active in a local STEM Speaker's Bureau, was able to locate some thank you notes received from students she had spoken with in year's past. Two were integrated into the workshop. The first, Figure 5, was read aloud in the second workshop, and was positively received. A discussion ensued by the participants that validated they understood their role in talking to students about STEM careers.

Figure 5 Student thank you note, "You are my role model."


Dear [redacted],
It was a pleasure to having you at [redacted]. I liked learning about your job and how you got there. Your life is so interesting. I never knew people were so eager to get women to work as engineers. I like your job. Maybe I will become a Design Engineer just like you. You are my role model. Thank you again.

Big Idea 2: ***We can attract students to STEM careers by using positive messaging***. The objective of the second section of the workshop was to frame STEM careers in a context that is appealing to all students, including the Changing the Conversation Messages, and Work Values Framework. The primary activity for this section was related to their pre-workshop homework, but they were asked to answer both questions (Figure 6) by writing a single idea on a post it note. In the end, each Ambassador would have a pile of post-its.

Figure 6 Concept Mapping Preparatory Exercise

In workshop 1, all participants were then invited to a large table and were asked to work together to group all of their post it ideas and thoughts into some organized system (concept mapping) that displays the groups' experiences most accurately. Guiding questions directed the participants to establish both the changing the conversation messages, and the four work values. With fourteen people, this didn't work well. There were too many post-its, many people were afraid to speak up, there were too many opinions, and they weren't able to come up with a concept map, even with significant effort by the facilitator to pose guiding questions. In the second workshop, the activity remained the same, but participants were asked to work in their small groups. This was tremendously more successful! Each small group had already developed a rapport that enabled better discussion and negotiation of ideas. During this exercise, the facilitator helped each group by asking guiding questions leading to the key messages and values. Figure 7 shows the concept maps by the three small groups. In workshop 2, after the groups presented their concept maps, they were asked in a large group discussion to find similarities among the ideas shared. The participants were able to determine through this exercise the positive messaging for STEM, and the different work values for which STEM careers can be appealing.

Some of the follow up questions, guided inquiry for large group discussion, were: Do you think this is an accurate picture of STEM careers? How do you think this aligns with student's perceptions? What do you think is most attractive to students? How would you lead with these messages in talking with students?

Figure 7 Workshop 2 Concept Maps

Big Idea 3: ***Education in STEM provides lots of career options and opportunities.*** The objective of this section was to expand the Ambassador's perspective of opportunities and options in STEM careers. The primary activity was reflective storytelling. Participants were asked to draw a diagram or picture of their career path, and then share it with their small group. For a large group discussion, participants were challenged to summarize the breadth of opportunities and pathways for STEM careers. Many participants commented that they were unaware of all of the different options for STEM, and feedback from the first workshop indicated that they would like to learn about more STEM careers. Thus for the second workshop, the facilitator kept a list on a flipboard in front of the room, and the large group brainstormed other ideas.

In addition, for the second workshop, another activity was added that aimed to introduce an online tool where they could further explore career opportunities in STEM. Working in pairs, participants visited http://www.sciencebuddies.org/science-fair-projects/science_careers.shtml and were challenged to explore 2-3 careers that sparked their interest. Then there was a large group discussion on these careers. The final question for this section was: How would you share with students about what you have observed in these exercises?

Big Idea 4: ***Success in mathematics and science is not based on innate ability.*** The objective of this section was to dispel stereotypes about math and science achievement. Though brief, this was the weakest portion of the workshop that needs further refinement. Almost through with the workshop, this exercise invited the participants to get out of their seats to stretch a bit. The facilitator designated three areas of the room as A, B, or C, and posed statements shown in Table 5.

Table 5 Math Ability / Growth Mindset Exercise

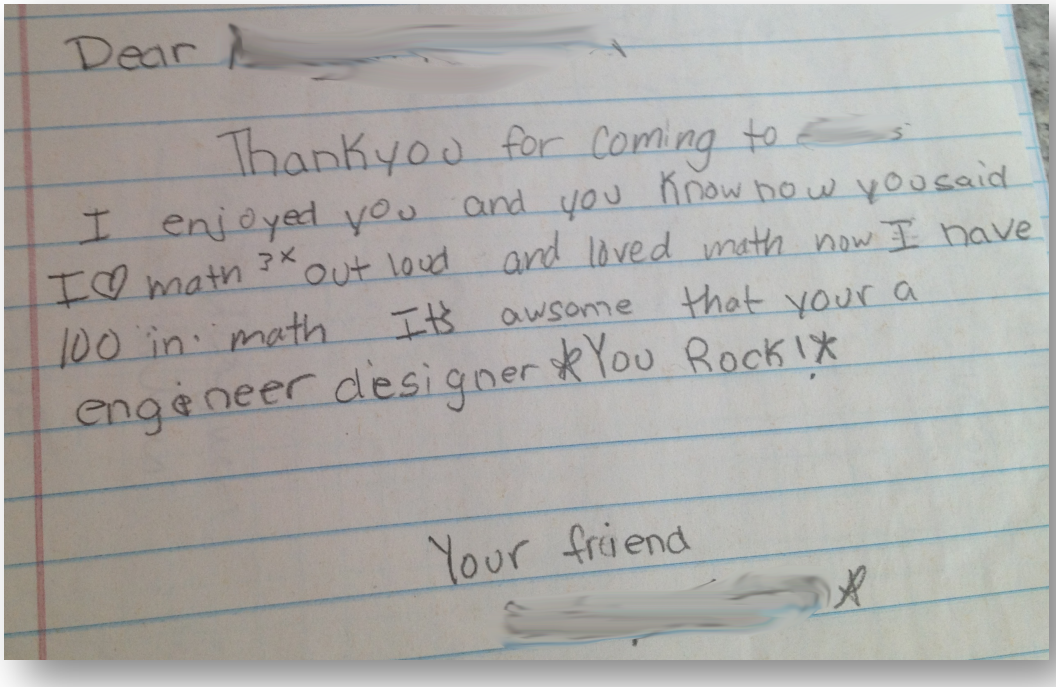
	A	B	C
Workshop 1	I think I am naturally gifted at math.	I worked/studied hard to excel at math.	I think that I am "not a math person."
Workshop 2	My math ability is something very basic about who I am, and I can't change that very much.	No matter what my current state of math ability might be, I can improve it quite a bit.	I can learn new math concepts, but I am not a math person, and my ability won't change.

For workshop 1, there was an even distinction between groups A & B, and no one openly identified group C. The facilitator had prepared for these questions: A) Why do you think you are good at math? B) So you worked hard at math, what does that mean to you? C) Why do you think you aren't a math person? While no one volunteered for group C, everyone knew someone who does identify with this group, so we were able to still discuss. The objective was to dispel the stereotype that math is for some people and not for others, as an indirect approach to discussing the growth mindset.

For workshop 2, feedback from one of the HTHH directors suggested being more direct in discussing the growth mindset, and altering the prompts. Unfortunately the group prompts for Workshop 2 (Table 5) were too complex and caused more confusion. While the facilitator did introduce the growth mindset theory, the stereotypes were lost in this activity.

One addition to the second workshop was sharing another personal thank you note from a student about math (Figure 8). In 2008, the facilitator told a group of 3rd graders a personal story about math. She said, "Math is sometimes really hard, and sometimes I don't like math! When I was in school, and working really hard problems, I used to tell myself 'I love math!' Whether I believed it or not, that helped me keep trying." She then had the large audience of students chant three times, "I love math!" While this story and note helped to wrap up the objective, the message wasn't as clear as it could have been with a combination of the Workshop 1 prompts, brief description of growth mindset, and the note from the student.

Figure 8 Math Mindset - Thank You Note



Wrap up. The final 15 minutes of the workshop was spent sharing online resources available to the speakers, and then an open discussion where the more seasoned speakers could share stories and experiences. This reflective storytelling portion was well received and praised in both workshops.

Conclusions

The High Tech High Heels STEM Speaker's Bureau Ambassador training described in this paper can be a model for similar trainings for STEM role models to students. The best practices process[12] of developing a conceptual model, defining best method, evaluation of components, and combination of best methods enables one best practices model of STEM Ambassador training. The three key components of the conceptual model for STEM role models are: 1) promote proper STEM messaging, 2) challenge and dispel stereotypes, and 3) appeal to student work values. The integration of a variety of pedagogical strategies such as guided-inquiry, concept mapping and reflective storytelling, are one example of a best method. Through two parallel workshops, the reflections and evaluations from the first were able to inform the second. This allowed the facilitation team to evaluate the components and offer a combination of best methods in this paper.

Future Work

There is significant work to be done to further understand the roles, training, and influence of STEM Ambassadors. Future work will further research and validate these best practices, and improve the model for training STEM Ambassadors. In addition, more specific formative, interim, and summative assessments will improve the workshop model, and our understanding of the effectiveness of the training.

Some questions for future research:

- How can we motivate and recruit STEM Ambassadors?
- What tools do Ambassadors use, or need, to be the most effective?
- What sort of network is needed to support the requesting and assignment of Ambassadors?
- How can we monitor and improve the image and messaging of STEM careers by Ambassadors?
- How can we capitalize on the personal stories of STEM Ambassadors to inspire students via social media and the web?
- Are Ambassadors better equipped to speak about their STEM professions in the schools after a workshop?
- How effective are STEM Ambassadors in improving student awareness of and interest in STEM careers?

References

1. Gottfredson, L., *Circumscription and compromise: A developmental theory of occupational aspirations.* Journal of Counseling Psychology, 1981. **28**(6): p. 545-579.
2. Parker, W. and J. Jarolimek, *Social studies in elementary education*. 1997: Prentice-Hall, Inc., Simon and Schuster/A Viacom Company, Upper Saddle River, New Jersey 07458.
3. Cunningham, C., C. Lachapelle, and A. Lindgren-Streicher, *Assessing elementary school students' conceptions of engineering and technology.* American Society of Engineering Education, Portland, OR, 2005.
4. Knight, M. and C. Cunningham. *Draw an engineer test (DAET): Development of a tool to investigate students' ideas about engineers and engineering*. in *American Society for Engineering Education*. 2004. Salt Lake City, UT.
5. Hill, C., C. Corbett, and A. St Rose, *Why So Few? Women in Science, Technology, Engineering, and Mathematics*. American Association of University Women, 2010: p. 134.
6. Else-Quest, N.M., J.S. Hyde, and M.C. Linn, *Cross-national patterns of gender differences in mathematics: A meta-analysis.* Psychological Bulletin, 2010. **136**(1): p. 103-127.
7. Huber, R. and G. Burton, *What do students think scientists look like?* School Science and Mathematics, 1995. **95**(7): p. 371-376.
8. Fancsali, C. *What We Know About Girls, STEM and Afterschool Programs*. 2002 12 November 2010]; Available from: http://www.jhuapl.edu/mesa/resources/docs/whatweknow.pdf.
9. McIntyre, R.B., et al., *A social impact trend in the effects of role models on alleviating women's mathematics stereotype threat.* Current Research in Social Psychology, 2005. **10**(9): p. 116-36.
10. McIntyre, R.B., R.M. Paulson, and C.G. Lord, *Alleviating women's mathematics stereotype threat through salience of group achievements.* Journal of Experimental Social Psychology of Education, 2003. **39**(1): p. 83-90.
11. Committee on Public Understanding of Engineering Messages, *Changing the Conversation: Improving Public Understanding of Engineering*. 2008, Washington D.C.: National Academy Press.
12. Mold, J.W. and M.E. Gregory, *Best Practices Research.* Practice Management, 2003. **35**(2): p. 131-4.
13. Wiggins, G. and J. McTighe, *Understanding by design*. 2 ed. 2005, Alexandria, VA: Association for Supervision & Curriculum Development.
14. Duffy, R. and W. Sedlacek, *What is most important to students' long-term career choices: analyzing 10-year trends and group differences.* Journal of Career Development, 2009. **34**(2): p. 149-163.
15. Ros, M., S. Schwartz, and S. Surkiss, *Basic individual values, work values, and the meaning of work.* Applied psychology, 1999. **48**(1): p. 49-71.

16. Nosek, B., et al., *National differences in gender–science stereotypes predict national sex differences in science and math achievement.* Proceedings of the National Academy of Sciences, 2009. **106**(26): p. 10593.
17. Dweck, C. and E.L. Leggett, *A social-cognitive approach to motivation and personality.* Psychological Review, 1988. **95**(2): p. 256-73.
18. Dweck, C., *Is math a gift? Beliefs that put females at risk*, in *Why aren't more women in science? Top researchers debate the evidence*, S.J. Ceci and W.M. Williams, Editors. 2006, American Psychological Association: Washington, DC. p. 47-55.
19. Dweck, C., *Mindsets and math/science achievement*. 2008, New York: Carnegie Corporation of New York, Institute for Advanced Study, Commission on Mathematics and Science Education.
20. Blackwell, L.S., K.H. Trzesniewski, and C.S. Dweck, *Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention.* . Child Development, 2007. **78**(1): p. 246-63.
21. Pollock, M. *Attracting Future Engineers: Best Practices from K-12 Counselor Professional Development, 2008-2012*. in *proceedings for WEPAN's 24th National Conference.* 2013. Atlanta, GA.
22. Novak, J.D. and A.J. Cañas, in *The Theory Underlying Concept Maps and How to Construct and Use Them*2008, Technical Report IHMC CmapTools 2006-01 Rev 01-2008.
23. Ausubel, D.P., *The psychology of meaningful verbal learning*. 1963, New York: Grune and Stratton.
24. Ausubel, D.P., *Educational psychology: A cognitive view*. 1968, New York: Holt, Rinehart and Winston.
25. Ausubel, D.P., J.D. Novak, and H. Hanesian, *Educational psychology: A cognitive view (2nd Ed.)*. 2nd ed. 1978, New York: Holt, Rinehart and Winston.
26. Hmelo-Silver, C.E., R.G. Duncan, and A.C. Clark, *Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006).* Educational Psychologist, 2007. **42**(2): p. 99-107.
27. Fog, K., et al., *Storytelling: Branding in Practice*. 2nd ed. 2010, Berlin Heidelberg: Springer-Verlag.
28. Bransford, J.D., A.L. Brown, and R.R. Cocking, *How People Learn: Brain, Mind, Experience, and School*. 2000: Report of the Na-tional Research Council by National Acad-emy Press.
29. Brill, F., *REFLECTIVE: storytelling as professional development.* Leadership, 2010. **40**(2): p. 18-21.
30. Yin, R.E., *Case Study Research: Design and Methods (4th Edition)*. 2009, Thousand Oaks, CA: Sage.
31. Stoeker, R., *Evaluating and rethinking the case study.* The Sociological Review, 1991. **39**: p. 88-112.