
AC 2011-1954: PREPARING COUNSELORS TO ADVOCATE STEM CAREERS: A PROFESSIONAL DEVELOPMENT MODEL FOR K-12 COUNSELORS

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Preparing Counselors to Advocate STEM Careers: A Professional Development model for K-12 Counselors

U.S. Department of Labor workforce projections for 2018 highlight that nine of the 10 fastest-growing occupations requiring at least a bachelor's degree will necessitate significant scientific or mathematical training[1]. The United States' science, technology, engineering, and math (STEM) workforce is aging while jobs requiring specialized training are growing at five times the rate of other occupations[1, 2]. STEM workers, who use science and math to solve problems, are needed to replace the many highly skilled workers who will retire over the next decade. A heterogeneous and culturally diverse workforce creates competitive advantage through greater creativity and innovation, and increased quality of team problem solving based on multiple perspectives[3-5]. Therefore, in order to sustain US capacity and increase global competitiveness for technological innovations, it is essential for people from a diverse representation of cultures, ages, and gender to enter STEM occupations.

Since 2000, women have earned approximately half of all science and engineering bachelor's degrees[6]. However, further examination reveals that there is a significant gender gap in the number of women earning engineering degrees. Remaining nearly stagnant over the last fifteen years, women today represent only 18.6% of bachelor's degrees awarded in engineering, and a diminutive 11% of the engineering workforce[6]. In order to effectively compete in the global marketplace, it is imperative that we advance the full and equitable participation of all Americans in science, engineering, and technology fields. The diverse viewpoints, approaches, and skills of women will benefit these high-tech industries, and in turn, positively affect our economy[3].

Aggressive and focused intervention efforts targeting women is recommended to address the gender gap in engineering[3]. While girls take more science and math classes and make better grades than boys, they are not readily choosing engineering as a college major and career path. Areas where consistent gender differences have emerged are children's and adolescents' interest in math and science, their beliefs about their abilities in math and science, and their perceptions of the importance of math and science for their futures[7]. Acknowledging and addressing these areas can increase girls' awareness, interest, and confidence to pursue a career in engineering. Through an integrated approach to learning, engineering education has the potential to not only be a catalyst for improving K-12 STEM education[8], but to enable girls in their development towards a career choice in engineering. This increased investment in STEM education will boost U.S. global competitiveness by increasing productivity[3].

The 2010-11 U.S. Bureau of Labor Statistics Report describes educational counselors as responsible for, among many things, operating career information centers and career education programs in order to promote the career development of children and youth[9]. The American School Counselor Association's National Standards (standard A in the area of career development) explicitly states: "Students will acquire the skills to investigate the world of work in relation to knowledge of self and to make *informed* career decisions[9]."

Education research shows that K-12 educators and students generally have a poor understanding of what engineers look like and do[10, 11]. Not only are there numerous misconceptions of engineering as a discipline, but educators tend to be very anxious to the

barriers they identify between themselves and engineering. With no background to know how to converse with students about who designs technology and how they do it, educators can feel very strong barriers that limit their contribution to the development of future technical talent[12].

Workshop Model on Engineering for K-12 Counselors & Educators

This paper presents a model for a professional development (PD) workshop for K-12 counselors on careers in STEM related fields. The purpose of this counselor PD is to inform counselors about specifically engineering careers and how they can help prepare students for such occupations. Additionally, an overview of major issues involved with gender stereotypes, bias, and disparities in STEM are introduced along with tools and resources to address such concerns in the K-12 environment. Interactive activities seek to reduce counselors' anxiety and build their self-efficacy with respect to STEM. The model is developed from a series of six counselor professional development workshops (PK-12) presented in urban and suburban areas in 2010 and 2011 in the southern region. This work was sponsored by and developed in conjunction with The Women of TI Fund High Tech High Heels program.

The purpose of developing this model was to enable the wide distribution of these messages. Since it is impractical for Engineering Education Consultants, or the like, to be able to reach the masses, this model seeks to enable any facilitator to create a professional development presentation targeted to their specific audience. The model consists of 6 modules outlined to provide a clear and relevant message about engineering, designed for counselors to become active advocates of careers in engineering. All related files and presentation slides are available free for download on the web [13]. Please refer to this companion site for a complete list of tools and resources.

Module 0 – Overview

The overview of the workshop modules enables facilitators to read up on the literature and prepare themselves for the messages they will deliver to their K-12 counselor audience. A synthesis of relevant literature [14] is the primary suggested reading. Other encouraged readings include [15-20].

Module 1 - Introduce Engineering

This workshop kick-off module suggests fun activities and examples for introducing engineering to workshop participants in order to capture their attention and engage them for the presentation. These activities seek to show how important engineering is to the fabric of our society and for our health, happiness and safety.

Module 2 - Why Engineering?

Why do we care about engineering? What is the point of this message? Gender disparity issues in STEM areas are introduced, along with much of the literature already reviewed in this paper. This module introduces some of the statistics that the facilitator may choose to use to frame their presentation, and provide the motivation for counselors to become advocates of engineering to their students.

Module 3 - What is Engineering?

After introducing engineering and discussing why engineering is important, it is imperative to portray an accurate and positive image of engineering for participants. Educational research shows that K–12 teachers and students generally have a poor understanding of what engineering is and what engineers do [10, 11]. Thus, if educators have a better understanding of engineering, they should be able to encourage students to take higher level math and science courses in middle school, enabling them to pursue engineering education in the future. This is especially important for girls and underrepresented minorities, who have not historically been attracted to technical careers in large numbers. There are three primary messages of engineering that appeal to students[17].

1. Engineers make a world of difference and help shape the future
2. Engineering is essential to our health, happiness & safety
3. Engineers are creative & collaborative problem-solvers

The second message is most appealing to females. If workshop participants take anything home, these should be the key enduring understandings, and it's especially important for participants to know which message is most appealing to females. There is an activity, with included worksheet, that helps the facilitator drive home this message.

Module 4 - Talk about Engineering

Students need to know and understand careers in STEM, specifically engineering. Since it is unlikely that students will find the correct messages in their environment or in the media, the responsibility falls on parents and educators. This module introduces strategies for talking to students about engineering. Activities are suggested for allowing workshop participants to practice, and prepare an implementation plan.

Module 5 – Bias

In a study engaging in the debate of biological versus environmental factors instigating the underrepresentation of women in STEM, it was found that men have higher mean TIMSS scores in all of the countries examined, but the size of these differences between men and women varies considerably, evincing the importance of environmental factors, whether parental, sociocultural, or educational[21, 22]. Strong implicit biases associated with gender and science influence early socialization and perpetuate gender stereotypes. These attitudes and messages skew girls' academic pathways early, placing them on a trajectory which may limit future career options due to insufficient course foundations.

A recent comprehensive review of the research on sex differences in math showed evidence that children conceptualize mathematics and science as a “masculine” activities[23, 24]. This is not hard to imagine when 70% of more than half a million Implicit Association Tests completed by citizens of 34 countries revealed implicit stereotypes associating science with males more than with females[25]. In a study by Sadker and Sadker examining stereotyped perceptions, the most strongly endorsed gender-biased statement (for boys, girls, mothers, fathers, coaches, and teachers) was, "Men are naturally better at

mathematics than women." In contrast, the most strongly endorsed non-biased statement was, "It is just as appropriate for women to study mathematics as for men"[26]. Herein lies the social conflict: "women and men should have equal opportunities for success in math, even though men have more natural talent than women" [27] (p. 289). Implicit stereotypes and sex differences in science participation and performance are mutually reinforcing[25].

Unsupportive, biased classroom environments and outdated pedagogy inhibit women's participation in STEM subjects[28]. Leedy found that even girls who are particularly motivated and talented in mathematics are not immune to the ill effects of gender bias, as they too experienced decreased confidence in math[27]. Schools disrupt female math trajectories by institutionalizing gendered expectations that work to discourage girls' pursuit of math-related skills[26]. Consequently, popular literature that emphasizes gender differences may in fact reinforce stereotypes that girls lack mathematical and scientific aptitude[29]. Environmental factors are at work, and gender equity in education is important not only for girls' math achievement but also for girls' self-confidence and valuing of mathematics[30, 31].

The referenced slides introduce some historical (and comical) forms of bias, and ways to discuss with the participants. The facilitator should make care to frame the importance of addressing gender bias to reduce influence on children's career options. Gender bias is a deeply rooted issue that will continue to permeate our society until we train up our children to not perpetuate stereotypes.

Future Work

This model is being used by the Women of TI Fund High Tech High Heels program in the Greater Dallas area schools. Volunteer engineers will use this model to craft presentations and workshops to educate K-12 counselors about engineering. This model has been posted online, with the intention that others will be able to craft appropriate workshops, disseminating this message to K-12 counselors all over the nation. The author is currently developing an assessment tool for counselors, but is not yet validated and ready for publication.

Conclusion

In order to meet the forecasted demands[32] for U.S. Labor in technical areas that require scientific and mathematical training, it is imperative that educators and students begin to understand STEM professions and the role of engineers. For students to make *informed* career decisions, it is essential for counselors to provide accurate STEM career information and be equipped to provide guidance on how students can prepare for such careers. This professional development workshop model provides a means for any facilitator to create a presentation specifically for their chosen audience, thus enabling counselors and educators to better advocate engineering professions.

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