

Attracting Future Engineers: Best Practices from K-12 Counselor Professional Development, 2008-2012

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Description

K-12 counselors are an untapped resource for increasing student awareness and interest in STEM careers. From 2008-2012, nineteen workshops for counselors aimed to address this need. An analysis of workshop materials, facilitator notes, and evaluations provides a framework for best practices for both content and delivery, informing future initiatives.

Introduction

K-12 counselors have a responsibility to introduce students to all types of careers, and should be prepared to help students plan for these types of careers (American School Counselor Association, 2004). Unfortunately, the general population has a poor understanding of what engineering is and what engineers do (Cunningham, 2009; Cunningham, Lachapelle, & Lindgren-Streicher, 2005), and most counselors are not prepared to talk about or encourage students to pursue a career in engineering. Thus it is imperative to improve counselor understanding of engineering careers, so that they can increase student awareness of the options and opportunities available. This is of national importance so that we can meet the tremendous demand for engineers, and specifically encourage more female students and students of color, groups traditionally underrepresented in the field (National Science Foundation, 2012), to pursue engineering.

Since 2008, High Tech High Heels, a donor advised fund whose primary programs are now directed and managed by the National Alliance for Partnerships in Equity (NAPE), has been working with K-12 counselors in Texas. The overarching goal of this work is to increase counselor understanding of careers in STEM (with a heavy bias towards engineering), using language that is positive and attractive to ALL students. Through the course of nineteen professional development workshops for counselors, the design and facilitation team has experimented with varying objectives, formats, and workshop styles. The conceptual framework for the counselor workshops has been primarily based on the *Changing the Conversation* messages (Committee on Public Understanding of Engineering Messages, 2008), and the *Why So Few?* Report (Hill, Corbett, & St Rose, 2010). A review and analysis of all workshop materials, facilitator notes, and available participant evaluations provides a framework for best practices for both content and delivery. The results aim to inform future counselor professional development curriculum (Ross, 2011), and assessment methodologies (Ross, 2012) that expand counselor's understanding of their role in encouraging females to pursue engineering/STEM. With recent NSF funding, NAPE plans to develop a robust counselor curriculum for secondary educators and community college counselors from these best practices and scale it across the U.S.

Research Question and Goal

The research question guiding this study is:

What best practices can be drawn from the K-12 Counselor Professional Development STEM Career workshops?

The ultimate goal of this research is to review current models for training K-12 counselors on STEM careers, and to outline a research agenda for a K-12 counselors and their advocacy of STEM Careers.

Best Practices Research

Best practices research refers to a systematic process used to identify, describe, combine, and disseminate effective and efficient strategies. In this paper, the strategies are presented as a best practices framework developed and refined from over 5 years and 19 counselor workshops on STEM careers. Borrowing from healthcare industry, the best practices model used by Mold and Gregory (Mold & Gregory, 2003, p. 133, Table 2) has served as a guideline. It involves five steps: development of a conceptual (or theoretical) model for the content of the workshop, definition of the best method of how to structure and facilitate the workshop, identification and evaluation of potentially effective methods for each component, combination of most-effective methods, and testing of combined methods. Table 1 below is an adaptation of their model, identifying the procedure for determining the best practices from K-12 Counselor workshops on STEM Careers.

Table 1 Best practices model (Adapted from Mold & Gregory, 2003)

<i>Development of Conceptual Model: Literature review and creation of a conceptual model of the components for the K-12 Counselor workshops on STEM Careers.</i>
<i>Definition of Best Method: Determine desired qualities and results for the Counselor training, and then the ideal pedagogy (Wiggins & McTighe, 2005)</i>
<i>Identification/evaluation of potential methods for each component</i>
<i>Combining best components</i>
<i>Test combined methods</i>

The following section describes the method of analysis for this paper. Subsequent sections define the conceptual model and best method, while the author evaluates these from practice within those sections. These two sections are both analysis and discussion in the format of the best practices framework. After this, a concluding summary of a combination of best components and best practices prefaces the final section proposing a research agenda for future work with K-12 counselors.

Method

The methodological framework for this paper is a multiple-case study analysis. Case study research is not limited to being a data collection tactic alone or even a design feature alone (Stoeker, 1991; Yin, 2009), as it demonstrates an “all encompassing” method, which converges the logic of design, data collection techniques, and specific approaches to data analysis. Multiple, or sometimes referred to as collective, case study research, endeavors to address an issue (research question) while adding to the literature base that helps better conceptualize a theory

(Hancock & Algozzine, 2006; Stake, 1995), or in this case a best practices framework. Collective case study analysis will enable greater transferability, where rather the researcher aims to produce generalizability in the context of the study, with the responsibility on the reader to determine transferability to other contexts (Lincoln & Guba, 1985).

Study Context

Since 2008, 19 counselor workshops on STEM careers have been conducted, and approximately 852 K-12 counselors (or in some cases educators) have participated. Sixteen of the workshops were conducted in Texas, one in British Columbia, and two in Oklahoma. See Figure 1. In 2008, there were three workshops in the same school district with ~150 counselors. In 2009, there were no workshops, though three workshops reached almost 200 in 2010. In 2011, four workshops instructed ~85 counselors, and our busiest year was 2012 with nine workshops, and over 400 in attendance. Workshop lengths ranged from 50 to 180 minutes (mean: 117 minutes, median: 90 minutes, mode: 120 minutes). All workshops were designed and facilitated by the same instructor; a former female engineer turned engineering educator, researcher, and consultant.

The overarching objective of all of the workshops has remained approximately the same, with specific learning objectives varying slightly. Essentially, no two workshops were the same, as the facilitator modified each workshop to meet the specific needs of the school and participants. Over the course of the past five years, the workshops evolved. This evolution was from reflection in and on practice (Schön, 1993), or lessons learned, and as the developer became more familiar with the supporting literature and adult learning pedagogies, the content and concepts were integrated.

Because the audience and presentation varied for each presentation of the workshop, each was considered it's own case within a unique context.

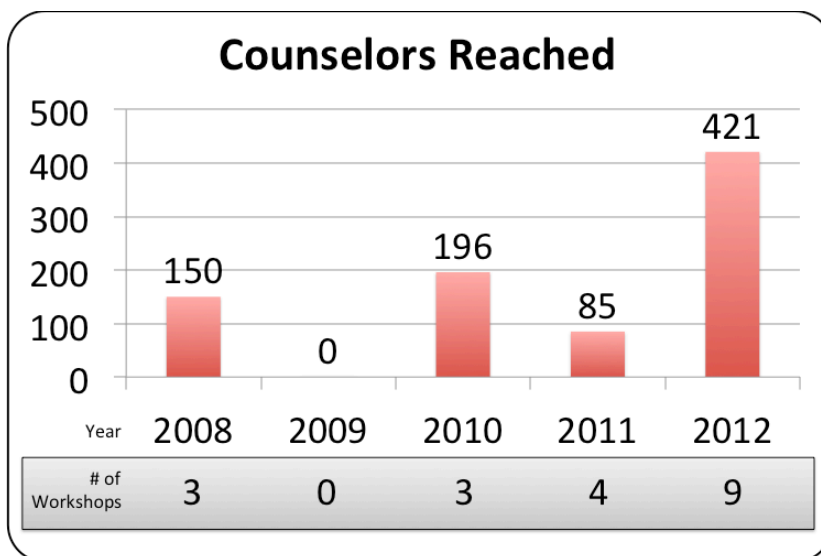


Figure 1 Counselors reached since 2008

Data Sources

The data used for this multiple case study analysis consists of three sources: 1) the workshop summaries which included the facilitator's reflection on the workshop and analysis of evaluations; 2) the slides, speaker notes, handouts, and other workshop materials created and provided to participants; 3) additional reflections and assertions from the facilitator which may include verbal feedback from the hiring client (NAPE).

Multiple case study is both the design and analysis methodology for this paper, with the goal of identifying best practices from 19 K-12 Counselor Professional Development STEM Career workshops offered from 2008-2012. The next sections follow the procedure of Mold and Gregory's (Mold & Gregory, 2003) best practices framework, as both a method of articulating the conceptual model and best method, and as an evaluation of the components of each.

Development of Conceptual Model

In order to define the optimal conceptual model for this best practices framework, two existing models developed in tandem to this counselor work will be reviewed, and one ultimately, through analysis of available data from the case studies, recommended and established for the best practices framework.

First model: In 2011, a STEM Career workshop model for K-12 counselors was proposed by Ross and included five modules (Ross, 2011). This was the original framework used for the development of the workshops, primarily from the work in year 2010. These modules included: 1) introduce engineering, 2) why engineering?, 3) what is engineering?, 4) talking about engineering, and 5) bias.¹ Over the course of the last two years, the framework has essentially stayed the same, however the emphasis and method of delivery has been adapted to integrate lessons learned.

Second model: In 2013, Pollock (Pollock, 2013) proposes a culminating conceptual model for STEM Career Ambassadors, or role models, in a three circle Venn diagram: Students need STEM Career role models who 1) promote proper STEM messaging, 2) challenge and dispel stereotypes, 3) appeal to student work values. This conceptual model can be easily tailored to counselors, where the application and responsibilities are different from a STEM career role model.

Thus, drawing from both Ross & Pollock (Pollock, 2013; Ross, 2011), the theoretical framework for the counselor workshops on STEM careers 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 (Hill et al., 2010) are the

¹ Formerly, large portions of the STEM career workshops focused on bias and stereotypes against women in STEM disciplines. After much trial and error, this portion was determined to be counter-productive and could easily de-rail a workshop. These messages are now integrated throughout the workshop, and the ideas are weaved into the previous two key concepts. Research from the Why So Few? Report is the guideline for these messages.

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 (Committee on Public Understanding of Engineering Messages, 2008). The final source is a study by Duffy & Sedlacek (2009) analyzing the work values (Ros, Schwartz, & Surkiss, 1999) 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.

In summary, facilitator reflection, participant evaluations, and client feedback suggest that the latest threefold conceptual model (Pollock, 2013) is the most effective model for instruction on STEM Careers for counselors. The most important concepts are the Changing the Conversation messages (Committee on Public Understanding of Engineering Messages, 2008). These messages in and of themselves dispel myths and stereotypes about engineering, and by association STEM careers. Feedback from activities surrounding these concepts is almost always positive, and suggests truly eye opening learning for counselors. The second most positively received concept is the work values framework. This provides an applicable lens for how to talk to students, and is accepted as an almost tangible take-away tool for implementation into the counselor’s job. Through the instruction of this framework, more myths and stereotypes about STEM careers are dispelled. These two concepts help answer the big questions from counselors: What is engineering? What are the opportunities for students in STEM careers?

Definition of Best Method

The best method defined in this section is how to structure and facilitate the counselor workshops on STEM careers. This is the second piece of the Mold and Gregory (Mold & Gregory, 2003, p. 133, Table 2) best practices model. The best method is informed by and established from the 19 cases, or each of the counselor workshops taught from 2008-2012. Analysis of the data reveals four key components: instructional design, pedagogy, panel of professionals, and take-away tools.

Instructional Design

The inaugural year, the workshop was designed based on what a practicing engineer thought counselors needed to know about engineering. While the workshop was highly rated, it was not pedagogically sound. Since 2010, the framework used to develop the instructional design of the workshops has been based on the Wiggins & McTighe process known as *Backwards Design* (Wiggins & McTighe, 2005). The process requires that you first identify the desired results, then determine acceptable evidence, and finally plan learning experiences and instruction. This process is an alignment of content, assessment, and pedagogy, and has been the cornerstone of all workshops post 2008.

Pedagogy

In the beginning, the designer and facilitator was less skilled at teaching, less familiar with the material, and the presentations included dozens of slides, with too many objectives and activities. Rarely was all of the information adequately covered and likely not absorbed by the participants. The most recent presentations have dwindled down to a handful of slides, one objective, and more pedagogically sound activities that better assess participant learning. Instruction has progressed from “a sage on the stage, to a guide on the side.” While efforts since 2008 have sought to incorporate cooperative learning, current efforts utilize guided inquiry (Hmelo-Silver,

Duncan, & Clark, 2007) to better scaffold more strategic cooperative learning activities. For example, instead of simply giving the changing the conversation messages and work values framework to the participants, as was done in the past, activities are designed to challenge participants to create this knowledge from their own experience. Again, the level of scaffolding, through guided inquiry, varies depending on the audience. While this has not been tested among the counselor workshops, it is reasonably assumed that this form of instruction enables learners to better retain new information based on adult learning theory(Bransford, Brown, & Cocking, 2000).

Panel of STEM Professionals

Since the very beginning, in 2008, the single most popular portion of any workshop is when a panel of engineers or STEM professionals is presented to the audience. However, in the more brief workshops (<60 minutes), it is unlikely that a panel will be offered. A panel usually includes 2-4 STEM professionals from diverse backgrounds, recruited locally, and will have hopefully been trained on proper messaging(Pollock, 2013). Most often, a set of questions is posed to the panel such as: What do you love about being a STEM professional? What impact does your work have on the world today? Describe a typical day in your work life? Describe how a teacher or counselor influenced your decision to choose a STEM career? Then the panel is open for the audience to ask questions. Adult learning theory suggests that professionals learn through interactions- formal and informal conversations- with other professionals(Bransford et al., 2000). The meaningful storytelling that takes place during this portion of the workshop have always been well praised. In addition, it ties to the importance of STEM career role models for young women(Hill et al., 2010), and is perceived to decrease the anxiety of counselors who may feel pressure to remember all that they have learned. By inviting a STEM Ambassador to their school, they are able to help their students identify with career opportunities.

Take-away tools

One of the most frequent comments in the first four years, was a request for “take-away tools” that can be directly implemented into their schools. As a designer and facilitator, this constant feedback was very frustrating, particularly when workshop activities were designed to be replicated with students, resources were provided on an easily accessible webpage, and handouts provided. Since this was a common theme, it may suggest the counselors’ lack of confidence in talking about engineering, and hence they request more resources to scaffold their efforts. In 2012, more focus was placed on emphasizing the application of the tools provided in the workshops for use with students, or in their roles as counselors. New activities were developed, and with the reinforcement in the workshops, the evaluation commentary requesting more “take-away tools” has significantly subsided. NAPE, in 2013, is developing a toolkit for counselors with explicit lesson plans for the counselors to implement with students, or parents, etc.

Conclusions

In summary, there are five key best practices for K-12 Counselor workshops on STEM Careers (See Figure 2). The first is, workshops should be conducted in a collaborative learning environment using guided inquiry. Second, messaging using the Changing the Conversation and work values framework(Committee on Public Understanding of Engineering Messages, 2008; Ros et al., 1999). This helps dispel myths and stereotypes about STEM careers, and provides the language for counselors to talk about these careers with their students. Third, opportunities and pathways to STEM Careers: broaden the perspective of counselors to see the vast opportunities in STEM disciplines. Fourth, a panel of STEM Career Ambassadors helps counselors to learn

more about STEM careers, and connect with a real STEM professional (and potential role model for their students!). Fifth, and finally, provide tangible tools and applications that are immediate “take-aways” for participants. With these five components, STEM Career training for K-12 counselors will be more likely to increase student awareness and interest in STEM careers.

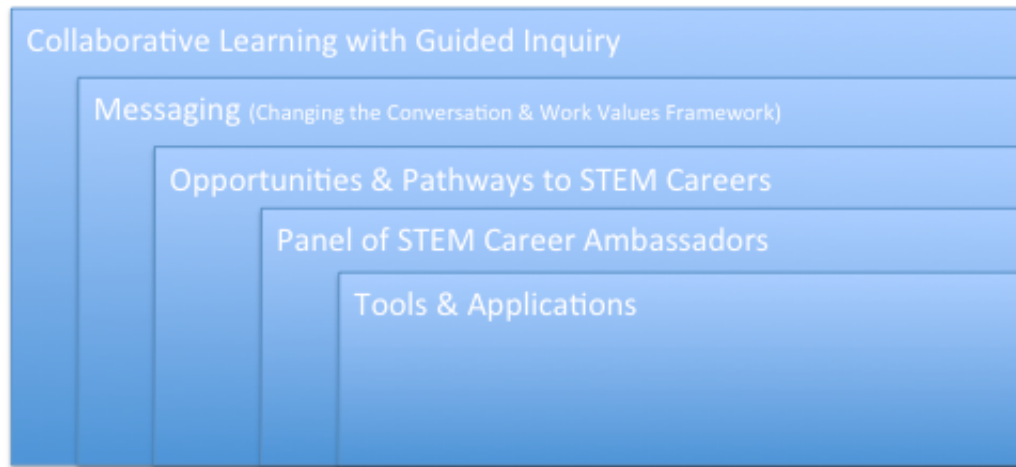


Figure 2 Best practices for counselor STEM career workshops

Future Work

It is important for us to not only understand the role of counselors, but to have a better grasp of their knowledge, attitudes, and behaviors regarding gender and STEM, and how this may potentially influence how they counsel and engage with students. While some initial assessment efforts have begun to examine counselor’s knowledge, attitudes, and behavior related to gender and STEM, this work is still incomplete (Ross, 2012). In order to outline a research agenda for K-12 counselors and their advocacy of STEM Careers, here are some guiding questions:

- What are K-12 counselors’ perceptions of STEM careers and opportunities?
- Who do K-12 counselors advise to be suited for STEM careers, and why?
- What are the roadblocks for K-12 counselors in advising students towards STEM careers?
- What do K-12 counselors need to be better advocates for STEM careers?
- How do counselors use the knowledge learned and tools provided in STEM career workshops?

In review, the ultimate goal of this research was to review current models for training K-12 counselors on STEM careers, and to outline a research agenda for a K-12 counselors and their advocacy of STEM Careers. Acknowledging that K-12 counselors are an untapped resource for increasing student awareness and interest in STEM careers, 19 workshops conducted between 2008-2012 were analyzed to create a best practices model of content and delivery for future counselor training on STEM careers.

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