THE IMPACT OF PRE-VISIT CONNECTEDNESS TRAINING FOR STEM ROLE MODELS VISITING FORMAL STEM CLASSROOMS

by

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ABSTRACT

Science, technology, engineering and mathematics (STEM), is a popular topic in education and workforce development. Middle and high school Formal Educators often seek to increase their students' interest in STEM topics and potential STEM careers. Role models may be brought in for a visit to assist with this effort but are unlikely to have an impact if they cannot quickly form a personal connection with students during their time in the classroom.

While some STEM professionals may have experience and training regarding communication in their particular field, they often do not have any training to help them successfully relate to students. For this research project, an interactive one-hour online training module was designed for role models which focused on best practices for engaging and connecting with students. To measure the impact of the training, students were given pre- and post-visit surveys which gauged their attitude regarding three factors: *normality of STEM professionals* (i.e., STEM professionals are normal people with normal interests and habits), *leisure interest in STEM* and *career interest in STEM professions*. The STEM area the role model represented (i.e., technology for the computer programmer and engineering for the electrical engineer) was specifically targeted in the version of the attitude survey given. Change in attitude was calculated and analyzed for statistical significance. While there were no statistically significant increases in student attitude, one statistically significant decrease was measured, which indicates role models who do not connect with students may, unfortunately, negatively impact students' attitudes towards and interest in STEM.

Correlation between change in student attitudes and connection with the role model, C-score, was calculated for each role model, and slight to moderate positive values were found for almost all attitude factors. This implies that, in general, the more a role model is able to connect with a student, the greater the positive change in attitude towards STEM topics the student will experience.

Strong correlation, Pearson's $r=0.83$, between the role model's C-Score and their level of adherence to the required and strongly recommended elements from the online training indicates that training was well designed and addressed the most critical elements for connecting with students during a single, one- to two-hour classroom visit.

INTRODUCTION AND BACKGROUND

Almost all of my professional career has involved working in informal science education, primarily focused on youth. I have run camps and overnights in science museums, led after school science clubs, and coordinated special events around science, technology, engineering and mathematics (STEM) themes such as Earth Day, architectural design and girls in STEM. My specialty has become the intersection of informal education and industry, training STEM professionals to interact directly with youth and coordinating opportunities for those encounters to occur. When I began working on my Masters of Science in Science Education at Montana State University, I wanted to find ways to bring my areas of strength, with informal education and industry, together with the realm of formal classroom education. In the world of informal science education, one of the primary goals is to engage and inspire participants. This is achieved through a variety of conscious decisions on the part of the education staff including efforts to help participants find meaning and see the relevance of STEM in their own lives. In terms of sustaining interest in STEM, building a STEM identity has been identified as an important component (Schweingruber & Fenichel, 2010).

Formal classroom educators often share the goal of increasing their students' interest in STEM topics and broadening their knowledge of potential STEM careers. While educators often feel bogged down by the amount of standardized testing and content they are required to cover, many actively seek relatively quick opportunities to spark this type of curiosity. One way this often occurs is in the form of a guest speaker. In my positions running STEM camps, I too have brought in guests to interact with my

students, but with mixed results. I wondered whether formal educators were encountering similar challenges to mine. Prior to the start of my formal research, I surveyed 21 middle and high school educators to learn about their experiences with what I termed *STEM role models* using the Formal Educator Survey Regarding STEM Role Models (Appendix A). I provided the following definition for those surveyed:

> For the purpose of this study, a STEM role model is defined as a working professional or an expert (such as a graduate student or amateur astronomer) in a STEM field who interacts with students a limited number of times. This person may visit the classroom as a guest speaker or you may take students to a special event (such as a career introduction) where they are in a classroom-like setting with the role model. This interaction may or may not involve an interactive activity but, at a minimum, should involve the role model speaking to the students about their work. This differentiates a role model from a STEM mentor or someone embedded in a classroom over a longer time period where relationship building is emphasized.

Results indicated role models most often struggled to keep student interest with presentations that were age appropriate and not full of jargon. Nearly every educator indicated that the role models that were most successful were those who displayed excitement for what they were discussing. My findings helped me narrow down the areas where STEM role models needed the most assistance to connect with and engage students.

I designed a one-hour webinar to address those weaknesses, utilizing elements of research-based professional development training I had attended or led in the past. Armed with this tool, my research focus question became, *What impact does a visiting STEM professional's ability to connect with students have on student attitudes towards STEM topics and STEM professionals?* A secondary question examined was, What impact does pre-visit connectedness training, regarding best practices for engaging, inspiring and

communicating with youth, have on the ability of classroom STEM role models to connect with youth? Along with answering the focus questions from the perspective of the role model, students and Formal Educators, I also asked role models what portion of the training(s) was most and least beneficial to them.

CONCEPTUAL FRAMEWORK

Recruiting STEM role models to engage youth has become a popular movement in both formal education, which is generally viewed as classroom education focused on grades and standards, and informal science education, which occurs beyond the classroom in settings like museums, aquariums or planetariums or in programs such as summer camps, scouts or science festivals. The theoretical framework underpinning the current idea of role models draws significantly from psychology and sociology. Social Learning Theory, as first described by Bandura (1977), emphasizes the social nature of human learning. Bandura argues that humans can learn certain concepts or behaviors simply by having them modeled by another person. They then copy the model and continue to repeat the action if it is reinforced (Nauta & Kokaly, 2001). Use of role models is popular in many industries including nursing (Faugier, 2005; Gopee, 2011) and higher education (Rockquemore, 2011, 2016). For youth, role models can range from media celebrities, to family members and other adults in their community, to peers they look up to (MacCallum & Beltman, 2002). The idea of role modeling, however, must be differentiated from the process of mentoring. Some researchers have argued that role modeling is one aspect of mentoring (Gopee, 2011; Rockquemore, 2011), while others see mentors as the most deeply engaged form of role models (MacCallum & Beltman,

2002). All agree that mentoring requires a relationship built over a longer time frame. A role model, on the other hand, is defined as someone who provides an example that others strive to achieve (Nauta & Kokaly, 2001).

Role models from the world of STEM have been embraced by the informal education realm as well as by formal education for a variety of reasons. One goal discussed in the majority of literature on this topic is increasing the diversity of people choosing STEM careers (Bybee, 2016; Dooley, Bardwell, & Bethea, 2000; Grossman & Porche, 2014; Hill, Corbett, & St Rose, 2010; McCallie et al., 2009; Mosatche, Matloff-Nieves, Kekelis, & Lawner, 2013; Weber, 2011; Zirkel, 2002). Researchers seek to increase the number of girls, minorities, students with disabilities and students coming from low socioeconomic backgrounds. Within the formal classroom setting, increased STEM content knowledge and interest by students are an additional high priority for educators introducing STEM role models (Habash & Suurtamm, 2010; Lake, 2012; Laursen, Liston, Thiry, & Graf, 2007; Mitchell et al., 2003; Olesik, 2009; Orr, 2012; Siegel, Mlynarczyk-Evans, Brenner, & Nielsen, 2005). In informal science education, increasing the scientific literacy of the public, young and old alike, is highly valued. Role models brought in were able to help the public make personal connections with research and the impact it has on their lives (Bybee, 2016).

While students are considered the primary beneficiaries of STEM role model interaction, two additional audiences are also being served: Formal Educators and STEM role models themselves. For educators, STEM role models can help increase their content knowledge, introduce new teaching strategies, provide closer connections with college

and university research departments, and increase educator interest and excitement for current research (Habash & Suurtamm, 2010; Laursen et al., 2007; Mitchell et al., 2003; Olesik, 2009; Orr, 2012; Siegel et al., 2005).

STEM role models gain a variety of benefits depending on their experience prior to visiting the classroom setting. For graduate students and others involved with teaching at the university level, many participants report increased STEM communication skills, in particular the ability to explain complex topics. The National Science Foundation's GK-12 program assigned graduate students to a single school or classroom for an entire year. During evaluation, those role models emphasized their improved classroom management skills and their ability to form close relationships with teachers and students (Mitchell et al., 2003; Siegel et al., 2005). In contrast, other programs gave graduate students the opportunity to visit many classrooms and schools. In these cases, role models reported benefits that included the opportunity to refine their STEM topic presentation and a feeling of excitement and novelty amongst students with each visit (Laursen et al., 2007). Another successful program model was one in which teachers at a given elementary school were trained in hands-on STEM activities. Then, volunteer scientists and university students visited the teachers' classrooms to help with STEM implementation. Undergraduate students expressed positive feelings from the experience and some even changed their area of study to education after participating (Olesik, 2009).

STEM role models have been used in K-12 education with differing outcomes. For elementary students, role models in the formal classroom bring excitement and interest for STEM topics, especially given the fact that many elementary teachers have

limited training regarding science and engineering (Olesik, 2009). In middle school, with the exception of boys and girls of Southeast Asian descent whose culture encourages STEM careers for both genders, the emphasis shifts to maintaining student interest in STEM, especially for girls and minority students (Betz & Sekaquaptewa, 2012; Grossman & Porche, 2014; Hill et al., 2010; Mosatche et al., 2013). At this age, popularity and fitting into expectations of one's gender or ethnic background begin to take precedence (Buunk & Gibbons, 2006). Because of increased self-consciousness, middle school students are more likely to conform to what they perceive to be societal standards for their behavior. In the case of many girls and male minority students, this leads to a decreased interest in STEM in school as well as decreased self-efficacy, a person's belief in their ability to be successful at a task or in a particular situation, regarding STEM activities and careers (Bandura, Freeman, & Lightsey, 1999). This is also the age when students begin to have more choices regarding which classes they will take and may opt out of the math and science classes that would provide a firm foundation for college STEM majors. Research by Spindler (2010) found the interaction with local females with STEM careers during an all-girl after school program slightly increased interest in STEM subjects and confidence in the girls' ability to pursue those subjects in school. While role models who more closely resemble students have been shown to have the greatest impact on them, role models in general are still able to exert a positive influence on all students if students are willing to recognize their role models as having enough overlapping traits or experience to be comparable to themselves (Buunk & Gibbons). Role models who fall on an extreme end of the stereotype spectrum may

actually reduce a student's interest. One study found that women in STEM fields who exude extreme femininity may have deterred some female middle school students as the role models set expectations beyond what the girls expected they could achieve (Betz & Sekaquaptewa, 2012).

The need for appropriate STEM role models is still strong in high school as students continue to choose their courses and begin to make decisions regarding college and future career options (Dooley et al., 2000; Grossman & Porche, 2014; Habash & Suurtamm, 2010; Mosatche et al., 2013; Orr, 2012; Siegel et al., 2005). In a recent survey, the National Science Teachers Association found that 26% of teachers bring STEM professionals of color into their class to show cultural sensitivity to their students' needs ("Ensuring science classrooms are culturally relevant," 2016). Fifty-five percent also said they include the scientific and engineering contributions of STEM professionals of color in their lessons. Even after students entered college, STEM stereotypes continued to play a role in whether older STEM majors were perceived as role models, especially for females (Cheryan, Siy, Vichayapai, Drury, & Kim, 2011).

Bringing a variety of STEM role models into the classroom setting increases the probability that all students will find at least one person with whom they feel they can compare themselves. For some, that connection will occur simply because the presenter looks like them, is from their community or is in a field that the student finds interesting (Lake, 2012). However, teachers may not always have access to bring in someone who can make that connection. Studies have shown that training provided to STEM professionals prior to their interaction with youth or the public in general is key to

making the experience as impactful as possible. Longer-term projects have involved in-depth training (Mitchell et al., 2003; Mosatche et al., 2013; Olesik, 2009; Tisdal, 2011). But even in some of those cases, the training did not adequately address the potential for disconnect between role models and youth (MacCallum & Beltman; Mitchell et al., 2003). Collaborative efforts work best when expectations and goals are defined beforehand, roles and responsibilities are delineated, necessary resources are available and communication lines are open (Dierking et al., 1997; Mitchell et al., 2003; Tisdal, 2011). Planning and preparation prior to the visit of a STEM professional plays a critical role in determining their level of success connecting with students.

Role models can play a crucial role in helping students gain STEM interest and self-efficacy, especially when the students are traditionally underrepresented in STEM fields. Very few STEM professionals, however, receive training to help them connect with young people. Evaluation of programs that included role model training has shown a positive impact on the role models, youth and educators involved.

METHODOLOGY

Prior to the start of the formal part of this study, I used Google Forms to create the Formal Educator Survey Regarding STEM Role Models (Appendix A). For ease of understanding, the term Formal Educator, when it refers to participants in the study, as well as the fields of the Role Models who participated in the study, will be capitalized in this paper. As I am not a formal educator, I distributed the survey to middle and high school educators from across the country to gather information about how STEM role models were being used in their classrooms. I picked the questions and answer choices

based on my experience training STEM professionals, working with teachers and bringing STEM professionals into the informal STEM programs I have coordinated. Twenty-one educators responded to the survey and their answers generally supported my expectations. One of the critical questions in the survey listed potential goals that an educator might have for a STEM professional classroom visit and asked the educator to indicate how important that goal was to them. Answer choices were: *extremely important*, *important*, *somewhat important* and *not important*. Looking at the percentage of respondents who chose *extremely important* or *important* for each goal, it was evident that all the answer options were significant to most of the teachers (Figure 1). The goals with the highest number of respondents selecting *extremely important* or *important* were: *Increase overall interest in STEM* (100%), *Increase interest in topics covered in your class* (95.2%), *Learn about potential jobs* (90.5%) and *Build a STEM identity* (90.5%). These answers helped guide decisions about what attitudinal factors to measure following the role model visit.

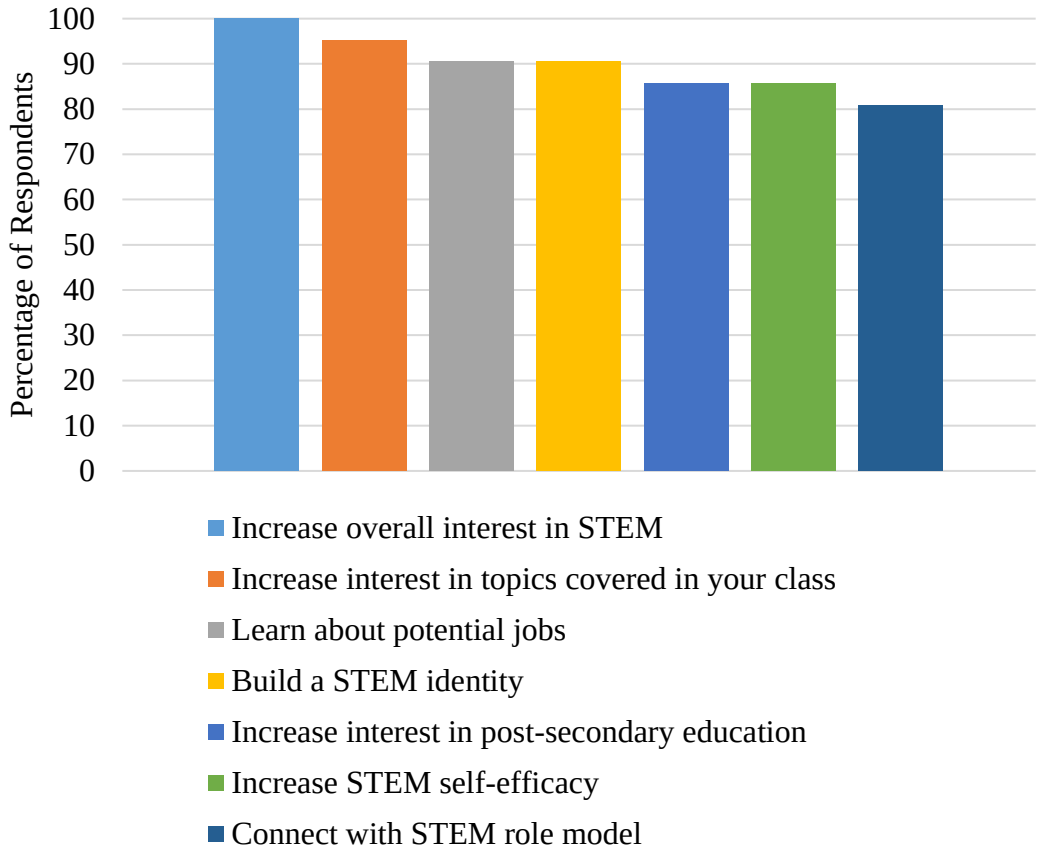

Figure 1. Formal Educator responses regarding the importance of the stated goals for bringing a STEM professional into the classroom with the percentage of those who chose "extremely important" and "important" responses combined, (*N*=21).

The desire to impact multiple aspects of student attitude is a noble goal, but I wondered whether educators would feel that this is truly achievable in the one- to two-visit time frame chosen for this study. I sent everyone who filled out the original survey a link to the Formal Educator Follow-Up Survey, which was also created with Google Forms (Appendix B), and 10 educators responded. I asked them, *What type of student attitudinal changes do you think are feasible for a visiting STEM role model to achieve during one or two visits?* Multiple respondents still felt that it was possible to bring about significant change in just one visit. One said, "Dramatic changes are possible. Many

attitudes are the result of quickly-removed ignorance." Thirty percent specifically mentioned increased interest in STEM careers as something that was likely to change in the given timeframe.

The Formal Educator Survey Regarding STEM Role Models also reinforced my experience that STEM role models often struggled to create an appropriate presentation for the age of the students. Nearly two-thirds of educators said that students were "bored with the presentation" when role models visited. Just over half said that presentations were "too advanced or use(d) too much jargon" and a third felt that "role models didn't discuss relatable concepts."

At the end of the Formal Educator Follow-Up Survey, educators were asked whether they would like to be involved with the formal portion of this research project by having one or more STEM professionals visit their classroom(s) between mid-January and March 2017. Flyers with information about participating in the study were also distributed to educators and a total of three Formal Educators signed on. I followed up with emails to find out which class(es) they would like to have a STEM role model visit and when this would be best for them. They were given the option of finding the role model themselves or having me find someone for them. All of them chose to have me find a role model for the topics they were covering in their classes. Four role models were volunteers and the other two were part of the We Are Montana in the Classroom program. These are University of Montana faculty, staff and graduate students who receive a small stipend and have travel and meal expenses covered when they visit Montana K-12 classrooms.

To begin the formal portion of my research, I used the concerns expressed by educators as well as those addressed by other role model training programs (Billington et al.; "Implementation manual," 2011; Kekelis & Joyce, 2013) to create a one-hour webinar. The goal of the training was to teach the role models best practices in engaging, inspiring and communicating with middle and high school students so that they could form the strongest possible connection with the students during their classroom visit. STEM role models were encouraged to attend the training live, but it was also recorded for later viewing for those unable to participate (available at http://montana.adobeconnect.com/p528us0nn5v/). Three attended the live session and three watched the recording. The training focused on creating excitement and interest among the student population. Role models were encouraged to share what made them excited about their work and the activities they did for fun outside of work. School presentations were differentiated from other types of presentations STEM professionals normally do. Charts and slides consisting of text only were discouraged. Pictures and videos were encouraged, especially pictures showing various people and interesting environments that students couldn't normally visit. The use of pictures of people was specifically targeted as a means of showing diversity in the range of people who work in the STEM role model's field. Students seeing someone who looked like them in the pictures, especially if the role model did not look like them, might feel more confident in their ability to work in that field. Students might also feel a greater connection to the role model because the role model is friends with or works with someone more like them. Role models were encouraged to ask questions of the students throughout their

presentation to gauge interest level and understanding. The importance of seeming “real” was emphasized and various techniques for achieving that- such as including humor, talking about areas of struggle when in school, and discussing hobbies—were mentioned. Differentiation based on the type of students (middle school vs. high school or honors students vs. general population)—was also discussed. Role models who had visited classrooms before were asked to look at their previous presentations with a critical eye, making changes from the topics discussed during the webinar. In the end, being energetic and practicing ahead of time were stated as required elements of a successful visit.

Role models were given a form with questions they needed to discuss with the teacher prior to their visit to coordinate logistics and align the teacher’s goals with theirs (Appendix C). They were told that they needed to create a PowerPoint presentation that took at least 30 minutes of their visit, followed by a Q & A session. Depending on the goals of the Formal Educator and the time they were going into the classroom, they were also encouraged to have an interactive, ideally hands-on, activity for the students. I offered my assistance finding an activity but was not contacted by any of the role models for help. They were asked to complete the STEM Role Model Post-Training Survey through Google Forms (Appendix D) to begin the evaluation process of the training program’s strengths and weaknesses. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix E).

All classroom visits occurred between February 23 and April 5, 2017. Information regarding these visits is displayed in Table 1. A total of 6 role models visited 6

classrooms and more than 100 students were engaged, though not all students' survey responses were able to be used in this analysis for the reasons listed in the next paragraph. The role models came from the fields of Veterinary Science/Pharmacy, Biochemistry/Biophysics, Electrical Engineering, Management Information Systems (software programming) and Educational Leadership and Innovation (STEM-based learning, digital and virtual instruction).

Table 1
Classes Visited by STEM Role Models

School (State)	Subject	Topic	Grade Level(s)	# of Students*
Pusch Ridge Christian Academy (AZ)	Physics	Electrical Engineering	$10^{th}/11^{th}/12^{th}$	16 (16)
Pusch Ridge Christian Academy (AZ)	Honors Physics	Circuitry	$11^{th}/12^{th}$	7 (8)
Amphitheater Middle School (AZ)	Coding	Software Programming	$7^{th}/8^{th}$	5** (19)
Amphitheater Middle School (AZ)	Engineering	Engineering	$6^{th}/7^{th}/8^{th}$	22 (37)
Seeley Lake Elementary School (MT)	Life Science	Pharmacy	7^{th}	15 (16)
Seeley Lake Elementary School (MT)	Chemistry	Biochemistry	8^{th}	13 (15)

Note. *First number represents students who fully completed all surveys, number in parenthesis represents number of students who completed the connectedness survey, with or without including a name
**See comment on page 18 regarding student numbers for this class

Formal Educators were instructed to give students the appropriate version of the Modified Test of Science-Related Attitudes (Modified TOSRA) at some time in the week prior to the role model's visit (Appendix F). Questions from the actual TOSRA which focused on the topics of *Normality of Scientists*, *Leisure Interest in Science* and *Career*

Interest in Science (Fraser, 1981) were chosen based on educator responses to the Formal Educator Survey Regarding STEM Role Models question about goals for role model visits. Three versions of the test were created. Version A closely followed the TOSRA with the number of questions reduced to six for each topic in order to take less time during the class period. Version B was modeled after the TOSRA but looked at engineers and engineering for the students with an engineer visiting their classroom. Version C was similarly adjusted with a focus on technology. Formal Educators were told to give the students the same test version within three days after the visit as well as the Student Post-Visit Connectedness Survey (Appendix G), though this instruction was not followed for all classes.

I converted the Modified TOSRA student responses from ordinal values to numbers which could be analyzed with parametric tests. I considered this to be an appropriate approach because the original TOSRA Likert-scale statements had been shown to be internally consistent and were only slightly modified for this research. For questions representing a positive attitude towards the factor being measured (i.e., *I would like to belong to a technology club*), the response options *SA* (*strongly agree*), *A* (*agree*), *N* (*neutral*), *D* (*disagree*) and *SD* (*strongly disagree*) were scored 5, 4, 3, 2 and 1, respectively. For questions representing a negative attitude towards the factor being measured (i.e., *I would dislike being a scientist after I leave school*), the response options *SA* (*strongly agree*), *A* (*agree*), *N* (*neutral*), *D* (*disagree*) and *SD* (*strongly disagree*) were scored 1, 2, 3, 4 and 5, respectively.

Using these numbers, I averaged each student's scores for the six questions regarding the specific scale-item topics, *Normality of STEM Professionals, Leisure Interest in STEM* and *Career Interest in STEM*, to come up with three pre-visit and three post-visit scores. I then plotted the three topics' pre-visit and post-visit scores for all six role models using box and whisker plots, with eighteen total plots created. To decide whether parametric analysis would accurately evaluate the statistical significance of changes in student attitude, I created bar charts for all 36 averaged scale response scores to see if they were normally distributed. Even though only two of the six role models had normal distributions for both the pre- and post-visit, I still chose to perform Wilcoxon Signed Rank Tests because parametric analyses have been found to give accurate answers in cases of non-normal distribution (Sullivan, 2013). The only data sets on which Wilcoxon Signed Rank Tests were not performed were the situations where fewer than five students had a change in their averaged scale response score. This was the case for all three topics for two of the role models.

The Student Connectedness Survey was analyzed with an overall connectedness score, C-Score, calculated for each student. The questions were Likert-type items, but each dealt with a different aspect of connectedness and were not designed to be internally consistent. For questions representing a positive connection with the role model (i.e., *The STEM role model talked about things that are interesting to me*), the response options *SA* (*strongly agree*), *A* (*agree*), *N* (*neutral*), *D* (*disagree*) and *SD* (*strongly disagree*) were scored 5, 4, 3, 2 and 1, respectively. For questions representing a lack of connection with the role model (i.e., *The STEM role model comes from a completely different background*

from me), the response options *SA* (*strongly agree*), *A* (*agree*), *N* (*neutral*), *D* (*disagree*) and *SD* (*strongly disagree*) were scored 1, 2, 3, 4 and 5, respectively.

Each student's overall sense of connectedness to the role model was calculated by adding up the scores for the ten questions. An additional point was added if the student was the same gender as the role model. The result was given as a percent and was referred to as the C-Score. A higher score indicated a better connection to the role model, as felt by the student. On the survey, the term "gender" was used due to the varied maturity levels of the students and the potential response to seeing the word "sex" on the form. Two female role models and four male role models participated in the research project and all were gender normative. Students were given a blank to fill in with their "gender" in the event that any students were gender fluid. One student responded that they did not feel comfortable discussing their gender but when the teacher was asked if the student was gender fluid, he indicated that he was not. The extra point for being the same gender was based on research which has shown that a connection can felt by students simply because of a shared gender (Lake). The median and average C-Score for each STEM role model was calculated and compared. Correlation between each student's C-Score and the change for each of the factors measured in the Modified TOSRA (*Normality of STEM Professionals*, *Leisure Interest in STEM* and *Career Interest in STEM*) was calculated using Pearson's r.

Not all students who interacted with the role models and completed surveys were included in the analysis. There were multiple reasons this occurred. Some students did not complete either the pre-visit or post-visit survey so the change in attitude was not

possible to measure. Others chose to answer with a pattern (ex. all responses *Neutral* or entire first page *Strongly Agree* and entire last page *Strongly Disagree*) for either the pre-visit or post-visit survey so their responses were discarded. One instructor did not completely understand the instructions for distributing the survey and did not have students include their names, even though a line was included on the last page of the survey for collecting this information. This is the reason why only five student survey results were available from the coding class. Student Connectedness Surveys with and without student names were analyzed to see the overall perceived level of connectedness felt by the classes towards their visiting role model.

Role models and Formal Educators were also surveyed in the week following the visit to find out their perceptions of the success of the interaction. Responses to the STEM Role Model Post-Visit Survey (Appendix H) and Educator Post-Visit Survey (Appendix I) were analyzed for themes and used to support other data. Trends and overlap in role model and Formal Educator responses, both numerical and open-ended, were analyzed to either support or refute correlation between the two groups' perception of the visit and the success of the training. Comparison was also made between role model and Formal Educator assessment of student interest and engagement versus student-reported feelings.

A Training Adherence Score Form (Appendix J) was created to analyze how closely the role model followed the required and suggested elements given in the online training and was filled out using information from the Role Model and Formal Educator Post-Visit Surveys, email interviews with the role models, phone interviews with Formal

Educators and visual inspection of the role models' PowerPoint presentations. Each element was rated on a scale from *1* (not at all) to *4* (completely). Ratings for the required elements were multiplied by 2 and the rating for each element was added together. The resulting score was given as a percent. Correlation between the Adherence Score and the C-Score was calculated for each role model using Pearson's r and displayed in a scatterplot with a line of best fit.

Answers from the Role Model and Formal Educator Post-Visit Surveys were used to decide what portions of the training were the strongest and the weakest. The correlation between Adherence Score and Connectedness Score was also used to confirm that critical elements for building connection were addressed in the training. A Connectedness Factor Survey (Appendix K) was created and distributed online to a semi-random group of 57 adults. The Connectedness Factor Survey asked participants to evaluate how controllable (through training and preparation) the different factors measured in the Student Connectedness Survey were. These results were used to confirm that training put enough emphasis on the most controllable elements. Table 2 shows how these methods were triangulated to answer the primary and secondary research questions.

Table 2
Data Triangulation Matrix

Focus Question	Data Source 1	Data Source 2	Data Source 3
Primary Question: 1. Impact of connection on student attitudes	Pre-Visit and Post-Visit Modified Test of Science Related Attitudes (Modified TOSRA)	Student Post-Visit Connectedness Survey	Formal Educator and STEM Role Model Post-Visit Surveys
Sub-Questions: 2. Impact of training on role model-student connection	Student Post-Visit Connectedness Survey	Formal Educator and STEM Role Model Post-Visit Surveys	Training Adherence Score Form
3. Strongest and weakest part of training	Formal Educator and STEM Role Model Post-Training Surveys	Training Adherence Score Form	Formal Educator and STEM Role Model Interviews

DATA AND ANALYSIS

Only 1 of 30 Wilcoxon Signed Rank Tests performed on the Modified TOSRA showed a statistically significant change in student attitudes pre- and post-visit. This was the *Career Interest in Engineering* measured for the Biochemist who visited an eighth-grade chemistry class. The role model was a graduate student working on a master's degree in biochemistry and biophysics. Because the sample size was fairly low, 10, the w-value was best used to check for statistical significance. The w-value was five and the critical value for n=10 at $p \leq 0.05$ is eight, implying that the result is significant. The p-value was .022, so that also bolsters the argument that the change was statistically significant. Looking at the box and whisker plot for this set of scores, shown in Figure 2, it is evident that the change in attitude was in a negative direction with less interest in the analyzed STEM field; in this case, engineering (N=13).

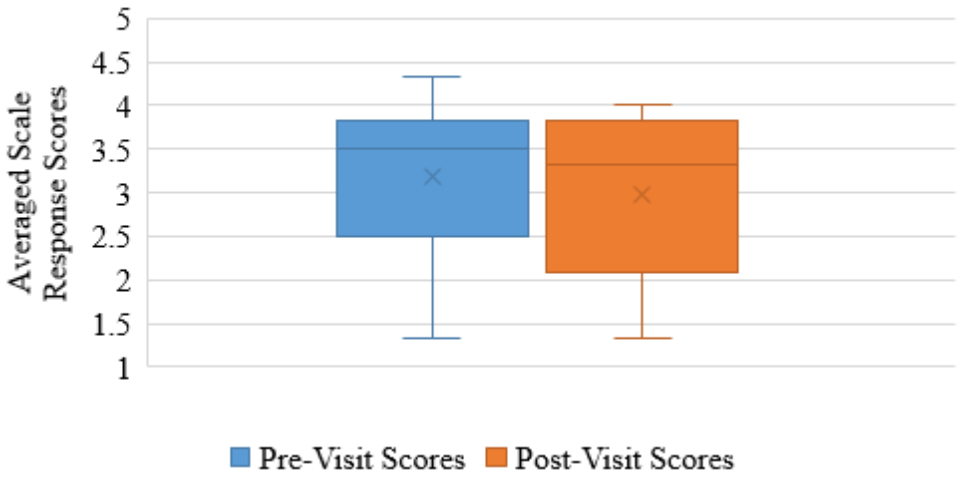

Figure 2. Box and whisker plot of pre- and post-visit averaged scale response scores for questions regarding career interest in engineering, (*N*=13).

In the Formal Educator Post-Visit Role Model Survey, some Formal Educators did notice a continued interest in elements of the role models' visits in the days afterwards (Question 8). Two of the classes continued to discuss the interactive STEM activity their role model did in the days after of the visit. One class discussed the portion of the talk where the role model discussed the lifestyle his STEM career allowed him to live. The Formal Educator said the students found the lifestyle appealing. Another class discussed the inappropriate design of their role model's presentation with the Formal Educator noting, "they mentioned how it was at a higher level than they were ready for." For the remaining two classes, the Formal Educators said their students did not mention the role model in the days following the visit, at least not that they heard.

The Connectedness Survey was used to analyze each class's general sense of connection to their visiting role model. I calculated both the median and the average of the C-Score values for the role models, and both numbers gave the same ranked order.

Figure 3 show the top four role models' scores were fairly tightly packed, with the bottom two scores a bit lower. In the Formal Educator Post-Visit Survey, the educators who had the two lowest scoring role models both noted that those role models used vocabulary that the students didn't understand. The Biochemist's presentation was described as "pretty far above the students." The Formal Educator who hosted Electrical Engineer #2 in his honors physics class said, "most of the material presented was entirely over the heads of the class." In a follow-up phone interview, the same educator said that the presentation was "more appropriate for a room full of engineers." The PowerPoint presentations of these role models were full of jargon and charts. The Biochemist was aware of this fact and commented in his Post-Visit Survey, "I could have made the talk simpler." Median C-Scores for each of the role models are in Table 3.

Table 3
STEM Role Model Information and Median C-Scores

Role Model	Class visited	Grade Level(s)	Gender	Median C-Score (out of 41)	Median C-Score (%)
Electrical Engineering #1	Physics	10-12	M	33	80.5%
STEM Education	Engineering	6-8	F	32.5	79.3%
Computer Programming	Coding	6-8	M	32	78%
Pharmacy	Life Science	7	F	31	75.6%
Biochemistry & Biophysics	Chemistry	8	M	28	68.3%
Electrical Engineering #2	Honors Physics	11-12	M	26.5	64.6%

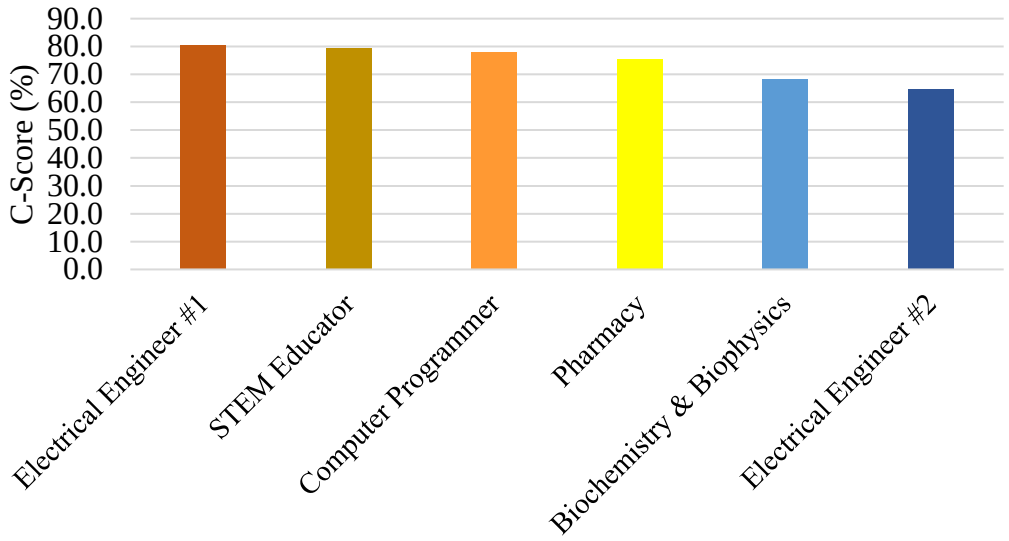

Figure 3. Chart of STEM role model C-Scores (%), (Electrical Engineer #1, *N*=16; STEM Educator, *N*=37; Computer Programmer, *N*=19; Pharmacy, *N*=16; Biochemistry & Biophysics, *N*=15; Electrical Engineer #2; *N*=8).

On their respective Post-Visit Surveys (Question 4), role models and Formal Educators were asked to evaluate how well, in general, that the role model connected with the students on a scale of 1 to 5, with 1 being *not at all* and 5 being *perfectly*. The results as displayed in Table 4 show that Formal Educator scores closely match the C-Score. Thirty-three percent of the role models gave themselves a score equal to the score given by their Formal Educator, fifty percent gave themselves a score one point below the Formal Educator's and seventeen percent gave themselves a score two points above their Formal Educator's score.

Table 4
STEM Role Model and Formal Educator Post-Visit Survey Responses Regarding Role Model's Level of Connection with Students

Role Model	Role Model Response	Formal Educator Response
Electrical Engineering #1	4	5
STEM Educator	4	4
Computer Programmer	3	4
Pharmacy	3	4
Biochemistry & Biophysics	3	3
Electrical Engineering #2	4	2

Note. Question answered on a scale of 1 to 5, with 1 being *not at all* and 5 being *perfectly*.

The final step in analyzing the student data to answer my primary question was to look at the correlation between the change in student attitude for each topic and their sense of connection to the STEM role model. Ninety-four percent of the Pearson's r values were positive. Students with a greater sense of connection to the role model saw a larger positive change in attitude towards the given topic. The one exception is the correlation between connection and the change in attitude regarding *Normality of Technologists* for the students who saw the Computer Programmer. The students who felt more connected to the role model tended to see a decrease in their perception of normality of people working in technology fields. The factors which had the greatest correlation (more than 0.5) were *Leisure Interest in Technology* and *Career Interest in Technology* for the students who saw the Computer Programmer, and *Leisure Interest in Engineering* for students who saw Electrical Engineering #2. The Pearson's r values are displayed in Figure 4.

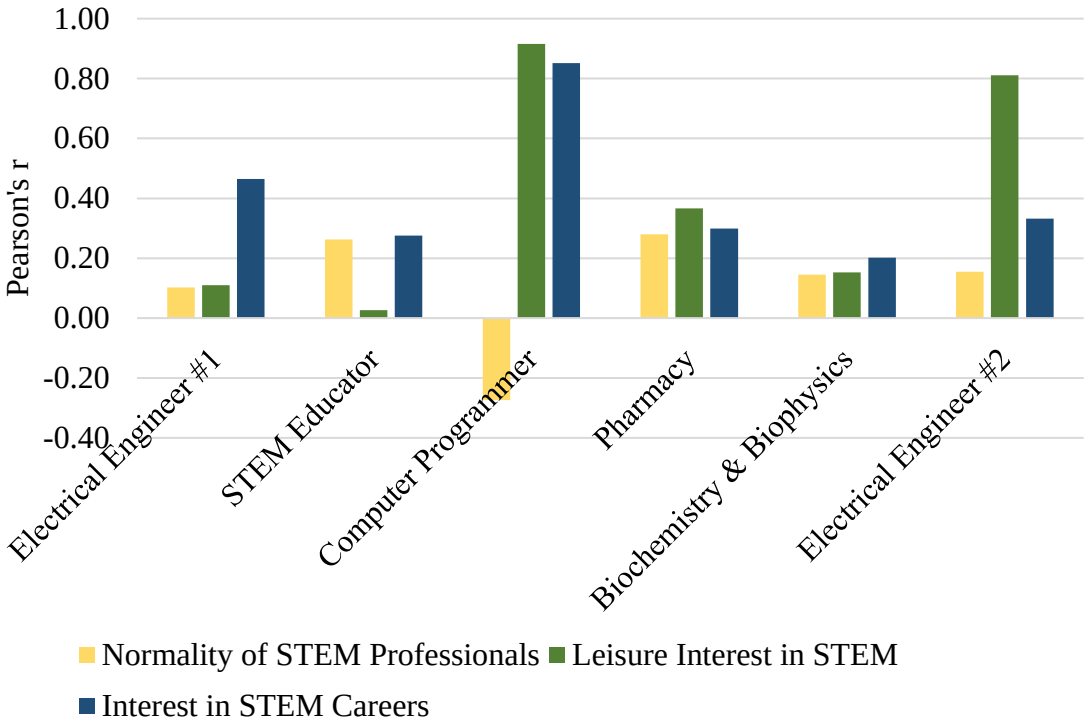

Figure 4. Pearson's r values for STEM role models broken down by Modified TOSRA topics: Electrical Engineer #1, (*n*=16); STEM Educator, (*n*=22;, Computer Programmer, (*n*=5); Pharmacy, (*n*=15); Biochemistry & Biophysics, (*n*=13); Electrical Engineer #2, (*n*=7).

To answer my secondary question regarding the impact of the training on student-role model interactions, I used the Training Adherence Score Form. It evaluated how many of the elements discussed during the online training each role model accomplished, rating each element from *1* (not at all) to *4* (completely). To weight the score based on the topics I emphasized the most in the training, anything I told role models they were required to do was given twice the point value of the elements only strongly suggested. Correlation between this score and the role model's median C-Score was calculated using Pearson's r and was found to be 0.83 (Table 5). Figure 5 contains a scatter plot with the two scores and the line of best fit.

Table 5
STEM Role Model Median C-Scores and Training Adherence Score

Role Model	Median C-Score (%)	Training Adherence Score (%)
Electrical Engineering #1	80.5%	87.5%
STEM Education	79.3%	100%
Computer Programming	78.0%	76%
Pharmacy	75.6%	79.6%
Biochemistry & Biophysics	68.3%	75.5%
Electrical Engineering #2	64.6%	56.3%

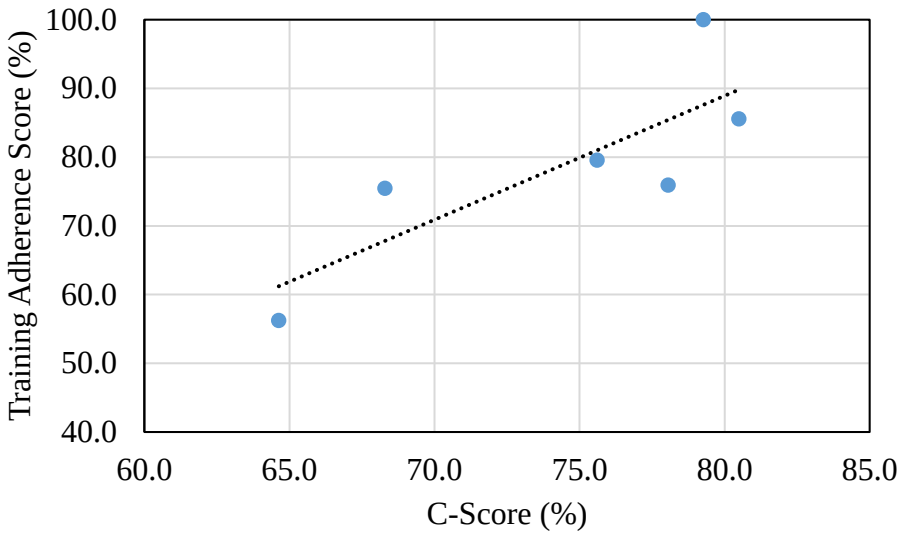

Figure 5. Connection between STEM role model median C-Score and Training Adherence Score. (*N*=6).

The correlation would be even stronger if one variable were adjusted. During the training, I emphasized that the role models should have high energy during their presentation. For the role models with the highest and third highest C-Scores, Electrical Engineer #1 and Computer Programmer, their respective educators gave them their lowest scores for this variable. For Electrical Engineer #1, the Formal Educator noted he was “not exuding huge energy but was comfortable and confident” and gave him a score of 2.5. The Computer Programmer’s Formal Educator made a similar comment, saying

he was “mellow but engaging” and gave him a 2. If the scores for this factor are increased to four, given the fact that the Formal Educators felt that the energy level was appropriate, Pearson’s r increases to 0.92. Role models who more strictly adhered to the training’s required and recommended elements for their classroom visit were perceived by the students to be more connected with them. However, the emphasis in the role model training on having high energy during the presentation seems unnecessary given the Formal Educators’ responses that presenters with mellow personalities but who exuded confidence were equally appropriate and successful.

During the STEM role model online training, I emphasized that some factors that lead students to feel connected with a role model are easier to control than others. For example, a role model has no control over the fact that a student may feel some degree of connection to them because they are the same sex. However, the other ten variables measured in the Post-Visit Connectedness Survey lie on the spectrum between *can’t control* and *completely controllable*. To find where on this spectrum these variables were located, I posted the Connectedness Factors Survey online and collected responses from 57 semi-random adults. Results are in Table 6, with lower scores representing more controllable factors (N=57). When compared to what was covered in the training, all topics that received a median weighted factor of 1 or 2 were addressed in the training, although not necessarily directly. For example, role models were not explicitly told to be friendly, but techniques such as smiling and making eye contact were discussed. Also, use of the Educator-Role Model Coordinator Form, which included questions for the

teacher regarding the students' interests, was mentioned as a requirement for the visit coordination process.

Table 6
Average and Median Values for Connectedness Factor Survey Responses

Connectedness Factor	Average Weighted Factor	Median Weighted F actor
Seeming friendly	1.21	1
Using words the students will understand	1.29	1
Making the student feel comfortable asking questions and making comments during the visit	1.4	1
Talking about things that are interesting to the students	1.61	2
Showing that they share many characteristics with the students	1.91	2
Showing that they have similar interests to the students	2	2
Seeming like they would be friends with the students if they were the same age	2.53	2
Showing that they come from a background similar to the students	2.58	3
Looking like the students	3.14	4
Reminding the students of someone in their family	3.47	4

Note. 1=Completely Controllable, 2=Somewhat Controllable, 3=Slightly Controllable, 4=Can't Control. (*N*=57).

As discussed previously, the role models who struggled with connection the most used too much jargon and discussed topics that were well above the students' level of understanding. While I recommended during the training that the role models be aware of jargon, not use graphs in their presentation, and not worry about trying to tell the students exactly what they did for their job, these items were only recommended once and not listed as a requirement at the end of the presentation. The items that were required for all role models were use of the Coordination Form, having high energy, practicing out loud ahead of time (ideally with an audience) and having a Q & A session at the end of the presentation.

In the Post-Visit Survey, each role model listed a different part of the training that they found to be most helpful in hindsight. Making a PowerPoint presentation with images, asking students questions, having a hands-on activity, discussing their background and thinking about their STEM super power were all mentioned. Sixty-six percent of the role models did not think the training needed any modifications based on their experience. One noted, "It is good to cover all the areas because volunteers come from various backgrounds."

INTERPRETATION AND CONCLUSION

When I began my research, I did not expect to see significant changes in most students' attitudes from a single STEM role model visit. While this experience might have had a profound impact on one or two students, because attitude changes were averaged across an entire class, I expected those numbers to be balanced out. When I calculated the statistically significant change in *Career Interest* for the Biochemist (which was, in fact, a negative change), I was surprised. As I looked at the survey, I realized that the wrong survey was administered for this class. I thought the role model was going to discuss engineering, but I realized that he did not. I reached out to the teacher for her opinion on what happened. When I asked whether she thought that this negative attitude change indicated a decrease in her students' interest in engineering careers (with an offsetting transformation to less interest in science careers given the fact that the role model was a scientist) or was due to the lack of connection with the role model, she strongly agreed with the latter. I also asked about the role model's status a graduate student, a less than glamorous position. She again emphatically stated that "they

were turned off to STEM [careers] in general" while filling out the survey the day after the visit because of the low quality of the presentation.

The Wilcoxon Signed Rank Test for *Leisure Interest in Engineering* for this role model gave a result that was close to but not quite at the value to be considered statistically significant. Both pre- and post-visit scores were normally distributed and showed a decrease. The critical value was 8 with a w-value of 10.5 and the p-value was 0.084. This drop surprised the Formal Educator as she said, "My kids are great engineers; they just did Rube Goldberg machines." She again believed this was due to the disconnect with the role model, not a "direct reflection on engineering."

I believe that these results signify that a one- or two-hour visit to a classroom is unlikely to increase the STEM attitudes of a significant portion of the students, even if the role model does an excellent job of connecting with them. However, if a role model does a poor job, they may be able to cause a widespread attitude change in a negative direction. Students were also very perceptive of whether the role model was enjoying the visit. One educator noted that the role model in her classroom acted like he "had to be there" and the role model's negative attitude may have skewed the post-visit student attitudes in a negative direction. The statistically significant drop in interest was noticed for the middle school students but not for the high school students whose role model struggled with connection. This may be due to the fact that high school students are more set in their feelings and confident in their interests compared to middle school students. However, with only two examples analyzed, stronger statements cannot be made. Further research in this topic is needed.

The strong correlation between student connectedness and strict adherence to the topics discussed in the role model training indicates that this training can impact student attitudes via role model connection techniques. This is also supported by the fact that 94% of the Pearson's r values, correlating student connectedness and change in attitude for the three topics, were positive values. The one negative r value may be due to the fact that the role model showed the students all of the interesting and potentially abnormal activities his financial success as a computer programmer has allowed him to do. One of his hobbies was building full-size airplanes in his garage, something he showed the students in the one-minute video he recorded and asked the Formal Educator to show the day before he visited the class as an interactive introduction.

In terms of evaluating the strengths of the training, overall I feel like it was very appropriate. The STEM Educator role model found it least helpful because she was already trained regarding how to connect with students. However, the fact that three of the role models who had received little previous training were able to achieve a C-Score nearly as high and, in one case, even higher than the STEM Educator's C-Score indicated that this training was successful.

In the future, I will make two major changes to my training to address weaknesses. First, I will change the emphasis from having a high energy level to having an appropriate energy level and being comfortable and confident, which comes from practice. Because I have spent more than half of my career working with elementary students, I have a bias towards the high-energy types of presentations which engage young students but realize that it is more important to have the right energy level. My

second change will be putting a greater emphasis on speaking at an appropriate level for the students. The fact that the Formal Educators specifically mentioned these factors as being the primary reason for the decreased level of connectedness indicates this is needed. I may even strongly suggest or require the training participants either send the first draft of their presentation to the teacher for feedback or, if I am hired to lead the training and any follow-up activities, have them send it to me for evaluation.

VALUE

Teachers' desire to increase their students' interest in STEM and STEM careers is going to continue and will likely increase as STEM jobs become more and more important to the economy. However, if an educator is going to give up one to two hours of the limited time they have with their students, they want to be sure that the role model visiting their classroom will have the greatest positive influence possible. In the past, I have enjoyed training STEM role models for primarily informal science environments and I would like to begin a second career as a consultant working in both informal and formal environments. I have always felt confident that I could create my own training program based both on trainings I have participated in and led and my own experiences working with STEM professionals. I am hoping that the rigorous analysis from this research project will provide the evidence others need to feel confident hiring me.

By recruiting and coordinating role model visits, I gave students an opportunity to meet and interact with STEM professionals that they likely would not have otherwise had. While I didn't measure any statistically significant positive changes in the STEM attitude topics I chose to analyze, there may have been changes in other areas, or changes

on a more individual basis. The Formal Educator who hosted Biochemist (who had the second lowest connectedness score) told me that after the visit she had a conversation with one of her students who was failing. The student was feeling frustrated and wanted to give up. The Formal Educator was able to remind the student of what the role model said. He was also from a small town, had failed classes in high school and struggled as an undergraduate, but he had reached the level of graduate student in a rigorous science field. The Educator reported that this seemed to buoy the student and give her hope.

The role models all expressed appreciation for the opportunity to participate in the training, as well. All of them said they were able to take away useful new ideas. The topics discussed in the training also opened their eyes to new issues. The Computer Programmer, who is Caucasian, visited an Arizona middle school that was predominantly non-Caucasian. He received the third best C-Score and the Formal Educator said his students really liked the programmer's lifestyle. However, the Formal Educator said, "some (students) think it is due to a race factor." The programmer had asked me to share the feedback I received from the Formal Educator. I told him about this response from the students and he said, "Pretty certain my ability to do the things I do is not tied to my race but also pretty certain that's a conversation that I'm not permitted to engage in because of my race so I'll bow out peacefully." I responded by referring back to something addressed in the online training which he didn't do. When I gave him feedback regarding his PowerPoint, the only suggestion I had for improving it was to look through and count the number of pictures of males (excluding the picture of himself) versus the number of pictures of females. I also suggested that he look at the ethnicity of the people in his

pictures and evaluate how diverse it was. He said, “most (of my pictures) were either just of me or stock photos taken from the first ones that came up in Google images without deliberately searching/sorting. My bad obviously.” I let him know that this was something most people did not think about often. I suggested that including more diverse images might be a way for him to circumvent the fact that he didn’t feel comfortable getting into the race conversation. I explained that the images could send a subconscious message regarding what a computer programmer looks like and in a phone interview, the Formal Educator reiterated this idea.

My greatest a-ha moment occurred when I began to analyze the Connectedness Surveys and compare the responses to the topics covered in the webinar. I realized that I needed more information to understand what impact my training had and which elements I could “teach” someone to incorporate. I designed the training based on topics I had seen in other trainings and had researched prior to beginning my project, but I had a narrow view of controllability. I naively thought that everything could be controlled (i.e., taught) or wasn’t controllable (beyond using secondary means such as showing diverse images to send a subconscious message that a given STEM field is a career potential for people of a different sex or race from the role model). I realized there was much more nuance involved. I created the Connectedness Factor Survey in hopes of getting an overview of how others felt about the controllability of the factors I was discussing. I was shocked by the wide-ranging responses for some of the factors. For example, when asked how controllable “looking like the students” was, 45.6% chose *Can’t Control*, 28.1% chose *Slightly Controllable*, 21.1% chose *Somewhat Controllable* and 5.3% felt it was

Completely Controllable (*N*=57). I discussed the results with a friend who is a formal educator and he pointed out that it would be just as important, if not more, to see how middle and high school students felt about the controllability of these factors, using Likert-scale questions to look for conscious and subconscious beliefs. More research is needed into the role of stereotypic responses noted by the Formal Educators, related to factors such as sex, race, age, body type, etc., and how to overcome them as quickly as possible.

For my job at the University of Arizona, I am currently assisting with the evaluation of a grant-funded program that seeks to increase the number of secondary mathematics teachers. During a focus group I was leading, the participants discussed the fact that they found it very valuable to learn about and practice forming connections with youth as part of the program. They said teacher training involved a significant amount of emphasis on forming connections with students because without those connections, students won't put forth the effort to succeed. However, educators in their own classroom have the element of time on their side. I realize that, when it comes to the type of brief interactions I am training role models for, time is the biggest barrier. The type of specialized training I have created is critically important and something that I assume most formal educators do not have the explicit training to do. They inherently understand the principles at play, but the factors that need the greatest emphasis as well as the subconscious attitude responses must be taken into account. The educator's most important part in the training process is helping the role model understand as much as

possible about their students, the students' interests and the concepts and vocabulary they have already learned.

The nature of this project gave me more experience working collaboratively with Formal Educators and STEM professionals. My chosen field necessitates group work with coordination and communication skills critical to the success of any effort. All experiences I have working on complicated projects with others help me improve these skills and hone my craft. As with all good research, this project has left me with more questions than answers. I wonder how much of an impact being the same gender has on the students' sense of connection to the role model. An entire research project on the variables which lead students to have a sense of connection with a role model could come out of this project. The opportunity for future collaborative research on this topic is very exciting for me and will give me more opportunities to burnish my reputation in the field of professional development.

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APPENDICES

APPENDIX A

FORMAL EDUCATOR SURVEY REGARDING STEM ROLE MODELS

FORMAL EDUCATOR SURVEY REGARDING STEM ROLE MODELS

(This was an online survey using Google Forms)

Please note that by agreeing to complete this survey, you are agreeing to participate in this study. If you have any questions or concerns, please contact the researcher, Sara Kobilka, at t83z411@montana.edu.

IMPORTANT INSTRUCTIONS

In this survey, the researcher will be asking a number of questions regarding your experience as a formal educator (middle or high school) providing opportunities for your students to interact with STEM (science, technology, engineering and mathematics) role models. For the purpose of this study, a STEM role model is defined as a working professional or an expert (such as a graduate student or amateur astronomer) in a STEM field who interacts with students a limited number of times. This person may visit the classroom as a guest speaker or you may take students to a special event (such as a career introduction day) where they are in a classroom-like setting with the role model. This event may or may not involve an interactive activity but at a minimum should involve the role model speaking to the students about their work. This differentiates a role model from a STEM mentor or someone embedded in a classroom over a longer time period where relationship building is emphasized.

1. Place a check mark next to each grade level you have taught.

5^{th} 6^{th} 7^{th} 8^{th} 9^{th} 10^{th} 11^{th} 12^{th}

2. For the following items, please rate how important the listed outcome is to you when your students interact with STEM role models (1 extremely important, 2 important, 3 somewhat important, 4 not important).

A. Learn about potential jobs

B. Build a STEM identity

C. Connect with the role model even if the student isn't interested in the role model's field

D. Increase overall interest in STEM

E. Increase interest in topics covered in your class

F. Increase interest in post-secondary

G. Increase STEM self-efficacy

3. In what manner have you had STEM role models interact with your students? (check all that apply)

Presentation without question and answer opportunity

Presentation with question and answer opportunity

Interactive elements involving discussions

Interactive elements involving engineering or design challenges

Interactive elements similar to a lab assignment (with a correct answer known)

Interactive elements involving investigations of unknowns or unexplored areas

Other

4. Which of the above types of interaction has been the MOST common for STEM role models in your classroom/at events? (pick one)

Presentation without question and answer opportunity

Presentation with question and answer opportunity

Interactive elements involving discussions

Interactive elements involving engineering or design challenges

Interactive elements similar to a lab assignment (with a correct answer known)

Interactive elements involving investigations of unknowns or unexplored areas

Other

5. What is the average length of time STEM role models are speaking/interacting with students? (choose one)

Less than 1 hour

1-2 hours

3-5 hours

6-10 hours

10+ hours

6. Where do you see STEM role models struggling the most when interacting with your students? (choose up to 3 answers)

Students are bored by the presentation style

Role model's presentation is too advanced or uses too much jargon

Role model's presentation is too simple

Students can't connect with role models because of issues like age, gender, socio-economic situation etc.

Role model only talks and doesn't ask questions/engage students

Role model doesn't discuss relatable concepts

Other

7. What type of person makes the best STEM role model? (choose up to 3 answers)

Someone who is as similar to the students as possible (ex. age, gender, socio-economic background, etc.)

Someone who is extremely excited about what they are discussing

Someone who asks students many questions

Someone who has children of their own or has a great deal of experience working with children

Someone who seems “real” and multi-dimensional to the students

Someone who leaves the students with more questions than answers

Someone who is good at simplifying complex concepts

Other

8. How would you describe the demographics of the school(s) you currently work in? (choose one)

Urban

Suburban

Rural

9. Would you be willing to answer additional follow-up questions if the researcher contacted you in the next couple months?

Yes

No

10. Would you be interested in learning how you can participate in the STEM role model research study during the 2016-2017 school year?

Yes

No

11. If you answered yes for question 9 or 10, please provide your name and preferred email address or phone number below.

12. Do you have any additional comments regarding STEM role models that you'd like to share with the researcher?

Thank you so much for taking the time to participate in this survey. Results will be used by the researcher to create STEM role model training. If you have any further questions or concerns, please contact the researcher, Sara Kobilka, at t83z411@montana.edu.

APPENDIX B

FORMAL EDUCATOR FOLLOW-UP SURVEY

FORMAL EDUCATOR FOLLOW-UP SURVEY

(This was an online survey using Google Forms)

Please note that by agreeing to complete this survey, you are agreeing to participate in this study. If you have any questions or concerns, please contact the researcher, Sara Kobilka, at t83z411@montana.edu.

IMPORTANT INSTRUCTIONS

In this survey, the researcher will be asking a number of questions regarding your experience as a formal educator (middle or high school) providing opportunities for your students to interact with STEM (science, technology, engineering and mathematics) role models. For the purpose of this study, a STEM role model is defined as a working professional or an expert (such as a graduate student or amateur astronomer) in a STEM field who interacts with students a limited number of times. This person may visit the classroom as a guest speaker or you may take students to a special event (such as a career introduction day) where they are in a classroom-like setting with the role model. This event may or may not involve an interactive activity but at a minimum should involve the role model speaking to the students about their work. This differentiates a role model from a STEM mentor or someone embedded in a classroom over a longer time period where relationship building is emphasized.

1. If you have a STEM role model presenting to your class and they want to quickly connect with your students, what advice would you give them?
2. What grade level(s) does the above suggestion(s) apply to?

3. What type of student attitudinal changes do you think are feasible for a visiting STEM role model to achieve during one or two visits?

Continued Involvement with Research

When you completed the original Formal Educator Survey, you expressed interested in being involved with the STEM role model research study this school year. Participants must be willing to commit to the following terms:

- This research is being designed following IRB guidelines so that parent permission notes will not be required. However, educators must be willing to talk to their school administrator to get approval for this. A letter explaining the details will be provided by the researcher and must be signed by administrators in order for educators to participate.

- Educators must have a STEM professional (of their choosing or found with the assistance of the researcher) visit at least one of their classes for a minimum of one class period and a maximum of two (half a class period is allowed if following block scheduling). This visit must occur between early January and the end of March.

- Educators must administer a short pre-visit survey (less than 10 minutes) to students prior for the STEM professional's visit. Then, after the visit, there is a slightly longer post-visit survey (less than 15 minutes) students must complete within a few days of the STEM professional's visit.

- Educators must complete a short post-visit survey and may be asked to answer follow up question either through email or by phone (optional).

- All surveys must be mailed to the researcher by the end of March.

4. If you are able to commit to the above requirements, please put your name and phone number below.

Thank you so much for your assistance!

APPENDIX C

EDUCATOR-ROLE MODEL COORDINATION FORM

EDUCATOR-ROLE MODEL COORDINATION FORM

In order to make your visit as successful as possible, please reach out to the teacher you will be visiting and complete the below form. This does not need to be returned to the researcher, it is for your own use.

Teacher Name:

School Name and Address:

Date and Time for Visit (also note exactly how long role model will have for presentation Q&A and any activity if occurring):

Parking information:

Classroom Arrangement (Tables? Desks?)

Subject:

Approximate Number of Students:

Important information to know about these students (ex. honors section, half are ELL, 1 student in front row is deaf etc.):

What types of things interest or excite these students? What are they curious about?

How should the presentation be brought in (ex. emailed to educator, thumb drive, accessed online)? Will presenter have internet access?

What topic(s) will the students have covered in the days leading up to the visit?

What are the educator's primary goals in having a STEM role model visit his or her class?

APPENDIX D

STEM ROLE MODEL POST-TRAINING SURVEY

STEM ROLE MODEL POST-TRAINING SURVEY

(This was an online survey using Google Forms)

This survey should be completed after you participate in the role model webinar and before you visit your assigned class.

1. Name

2. How prepared are you feeling for your classroom visit?

    A. Complete unprepared

    B. Somewhat unprepared

    C. Somewhat prepared

    D. Completely prepared

3. Why do you feel the level of preparedness you indicated in the last question?

4. What information in the training was new to you?

5. What do you think will be the most useful information from the training for your classroom visit?

6. Are there any parts of the training that you feel should be dropped? If yes, what are they and why?

7. What do you think will be your greatest challenge with your classroom visit?

8. Do you have any additional questions for the researcher before you visit the classroom? If yes, what are they? (the researcher will contact you with answers)

Thank you for taking time out of your busy schedule to participate in this research. If any questions or concerns arise, please contact the researcher, Sara Kobilka, right away via email t83z411@montana.edu or phone 608-698-2395. You will receive a reminder email a week before your classroom visit with any additional information you need.

APPENDIX E

IRB APPROVAL FORM

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

960 Technology Blvd. Room 127
c/o Microbiology & Immunology
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4303
E-mail: cherylj@montana.edu

Chair: Mark Quinn
406-994-4707
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-4706
cherylj@montana.edu

MEMORANDUM

TO: Sara Kobilka and John Graves

FROM: Mark Quinn Mark Quinn ojf

DATE: January 4, 2017

SUBJECT: *"The Impact of Pre-Visit Training for STEM Role Models Visiting Formal STEM Classrooms"* [SK010417-EX]

The above research, described in your submission of January 4, 2017, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

__X__ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

__X__ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement}, survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX F

MODIFIED TEST OF SCIENCE-RELATED ATTITUDES

(MODIFIED TOSRA) INSTRUCTIONS

VERSION A (SCIENCE)

VERSION B (ENGINEERING)

VERSION C (TECHONOLOGY)

TEST OF SCIENCE-RELATED ATTITUDES (TOSRA)

Normality of Scientists
1 (+)
4 (-)
7 (+)
10 (-)
13 (+)
16 (-)

Leisure Interest in Science
2 (+)
5 (-)
8 (+)
11 (-)
14 (+)
17 (-)

Career Interest in Science
3 (-)
6 (+)
9 (-)
12 (+)
15 (-)
18 (+)

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively.
For negative items (-), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5, respectively.
Omitted or invalid responses are scored 3.

TEACHER DIRECTIONS

1. Give students **Version __** of the Modified Test of Science-Related Attitudes (TOSRA). This version will look at student attitudes regarding _____. The pre-visit test should be given *no more than 1 week before* the STEM role model visits and should *not* be given during the class period the role model is visiting.

2. When you give the test, make sure students know that it is *optional*. If you want to give students participation credit for completing it, please offer another activity they can do for credit if they don't want to take the test. Explain that there are no "right" or "wrong" answers, they should just give their honest opinion. If they are uncertain as to what they are supposed to do or what a question is asking, they are welcome to ask you for help.

3. When they turn in their test, please check to make sure they *put their name on it*. This is *critically* important because I will be comparing their pre-visit scores with the post-visit scores to see what impact the visit has on their attitudes.

4. The post-visit test should be given *within 3 days* of the STEM role model's visit and should *not* be given during the class period the role model is visiting unless you have block scheduling. You will be giving students **Version __** of the Modified TOSRA *and* the Student Post-Visit Connectedness Survey.

5. Remind students of all of the above instructions. Make sure they put their name on *both* surveys.

6. After this has been completed, please mail all surveys back to me in the provided postage-paid envelope. These must be sent *by March 31*st at the latest.

VERSION A TEST BOOKLET

STUDENT DIRECTIONS

Participation in this research is voluntary and participation or non-participation will not affect your grades or class standing in any way.

1. This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

2. For each statement, draw a circle around:

SA	If you STRONGLY AGREE with the statement
A	if you AGREE with the statement
N	if you are NOT SURE
D	if you DISAGREE with the statement
SD	if you STRONGLY DISAGREE with the statement

Practice Item

It would be interesting to learn about boats.

Suppose that you AGREE with this statement, then you would circle A on your Answer Sheet, like this:

SA (A) N D SD

3. If you change your mind about an answer, cross it out and circle another one.

4. Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.

SURVEY ITEMS

For each statement, draw a circle around:

SA	*If you STRONGLY AGREE with the statement*
A	*if you AGREE with the statement*
N	*if you are NOT SURE*
D	*if you DISAGREE with the statement*
SD	*if you STRONGLY DISAGREE with the statement*

1. Scientists are about as fit and healthy as other people.
   SA A N D SD

2. I would like to belong to a science club.
   SA A N D SD

3. I would dislike being a scientist after I leave school.
   SA A N D SD

4. Scientists do not have enough time to spend with their families.
   SA A N D SD

5. I get bored when watching science programs on TV at home.
   SA A N D SD

6. When I leave school, I would like to work with people who make discoveries in science.
   SA A N D SD

7. Scientists like sport as much as other people do.
   SA A N D SD

8. I would like to be given a science book or a piece of scientific equipment as a present.
   SA A N D SD

9. A career in science would be dull and boring.
   SA A N D SD

10. Scientists are less friendly than other people.
    SA A N D SD

For each statement, draw a circle around:

SA	*If you STRONGLY AGREE with the statement*
A	*if you AGREE with the statement*
N	*if you are NOT SURE*
D	*if you DISAGREE with the statement*
SD	*if you STRONGLY DISAGREE with the statement*

11. Talking to friends about science after school would be boring.

SA A N D SD

12. A job as a scientist would be interesting.

SA A N D SD

13. Scientists can have a normal family life.

SA A N D SD

14. I would like to do science experiments at home.

SA A N D SD

15. I would dislike becoming a scientists because it needs too much education.

SA A N D SD

16. Scientists are less interested in art and music as other people are.

SA A N D SD

17. I would dislike visiting a science museum on the weekend.

SA A N D SD

18. I would like to be a scientist when I leave school.

SA A N D SD

Name: _____ Teacher: _____

VERSION B TEST BOOKLET

STUDENT DIRECTIONS

Participation in this research is voluntary and participation or non-participation will not affect your grades or class standing in any way.

1. This test contains a number of statements about engineering. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

2. For each statement, draw a circle around:

SA	If you STRONGLY AGREE with the statement
A	if you AGREE with the statement
N	if you are NOT SURE
D	if you DISAGREE with the statement
SD	if you STRONGLY DISAGREE with the statement

Practice Item

It would be interesting to learn about boats.

Suppose that you AGREE with this statement, then you would circle A on your Answer Sheet, like this:

SA (A) N D SD

3. If you change your mind about an answer, cross it out and circle another one.

4. Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.

SURVEY ITEMS

For each statement, draw a circle around:

SA	*If you STRONGLY AGREE with the statement*
A	*if you AGREE with the statement*
N	*if you are NOT SURE*
D	*if you DISAGREE with the statement*
SD	*if you STRONGLY DISAGREE with the statement*

1. Engineers are about as fit and healthy as other people.
   SA A N D SD

2. I would like to belong to an engineering club.
   SA A N D SD

3. I would dislike being an engineer after I leave school.
   SA A N D SD

4. Engineers do not have enough time to spend with their families.
   SA A N D SD

5. I get bored when watching shows where people build things on TV.
   SA A N D SD

6. When I leave school, I would like to work with people who solve problems using engineering.
   SA A N D SD

7. Engineers like sport as much as other people do.
   SA A N D SD

8. I would like to be given a building or construction set as a present.
   SA A N D SD

9. A career in engineering would be dull and boring.
   SA A N D SD

10. Engineers are less friendly than other people.
    SA A N D SD

For each statement, draw a circle around:

SA	*If you STRONGLY AGREE with the statement*
A	*if you AGREE with the statement*
N	*if you are NOT SURE*
D	*if you DISAGREE with the statement*
SD	*if you STRONGLY DISAGREE with the statement*

11. Talking to friends about engineering projects after school would be boring.

SA A N D SD

12. A job as a engineer would be interesting.

SA A N D SD

13. Engineers need to be creative people.

SA A N D SD

14. I would like to do engineering projects at home.

SA A N D SD

15. I would dislike becoming an engineer because it needs too much education.

SA A N D SD

16. Engineers are less interested in art and music as other people are.

SA A N D SD

17. I would dislike competing in an engineering competition on the weekend.

SA A N D SD

18. I would like to be an engineer when I leave school.

SA A N D SD

Name: _____ Teacher: _____

VERSION C TEST BOOKLET

STUDENT DIRECTIONS

Participation in this research is voluntary and participation or non-participation will not affect your grades or class standing in any way.

1. This test contains a number of statements about technology. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

2. For each statement, draw a circle around:

SA	If you STRONGLY AGREE with the statement
A	if you AGREE with the statement
N	if you are NOT SURE
D	if you DISAGREE with the statement
SD	if you STRONGLY DISAGREE with the statement

Practice Item

It would be interesting to learn about boats.

Suppose that you AGREE with this statement, then you would circle A on your Answer Sheet, like this:

SA (A) N D SD

3. If you change your mind about an answer, cross it out and circle another one.

4. Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.

SURVEY ITEMS

For each statement, draw a circle around:

SA *If you STRONGLY AGREE with the statement*
A *if you AGREE with the statement*
N *if you are NOT SURE*
D *if you DISAGREE with the statement*
SD *if you STRONGLY DISAGREE with the statement*

1. People who work in technology are about as fit and healthy as other people.
SA A N D SD

2. I would like to belong to a technology club.
SA A N D SD

3. I would dislike being a person who works with technology after I leave school.
SA A N D SD

4. People who work in technology do not have enough time to spend with their families.
SA A N D SD

5. I get bored when watching programs about technology on TV.
SA A N D SD

6. When I leave school, I would like to work with people who solve problems using technology.
SA A N D SD

7. People who work in technology like sport as much as other people do.
SA A N D SD

8. I would like to be given a piece of technology I need to program as a present.
SA A N D SD

9. A career in technology would be dull and boring.
SA A N D SD

10. People who work in technology are less friendly than other people.
SA A N D SD

For each statement, draw a circle around:

SA *If you STRONGLY AGREE with the statement*
A *if you AGREE with the statement*
N *if you are NOT SURE*
D *if you DISAGREE with the statement*
SD *if you STRONGLY DISAGREE with the statement*

11. Talking to friends about technology after school would be boring.

SA A N D SD

12. A job working with technology would be interesting.

SA A N D SD

13. People who work in technology can have a normal family life.

SA A N D SD

14. I would like to do computer programming at home.

SA A N D SD

15. I would dislike becoming a programmer because it needs too much education.

SA A N D SD

16. People who work in technology are less interested in art and music as other people are.

SA A N D SD

17. I would competing in a programming competition on the weekend.

SA A N D SD

18. I would like to be a person who work in technology when I leave school.

SA A N D SD

Name: _____ Teacher: _____

APPENDIX G

STUDENT POST-VISIT CONNECTEDNESS SURVEY

STUDENT POST-VISIT CONNECTEDNESS SURVEY

For each statement, draw a circle around:

SA	*If you STRONGLY AGREE with the statement*
A	*if you AGREE with the statement*
N	*if you are NOT SURE*
D	*if you DISAGREE with the statement*
SD	*if you STRONGLY DISAGREE with the statement*

1. The STEM role model talked about things that are interesting to me.

SA A N D SD

2. The STEM role model comes from a completely different background from me.

SA A N D SD

3. I share many characteristics with the STEM role model.

SA A N D SD

4. The STEM role model looks like me.

SA A N D SD

5. The STEM role model reminds me of someone in my family.

SA A N D SD

6. I think the STEM role model and I have completely different interests.

SA A N D SD

7. The STEM role model seemed friendly.

SA A N D SD

8. I did not feel comfortable asking questions and making comments during the STEM role model's visit.

SA A N D SD

9. The STEM role model used many words I didn't understand.

SA A N D SD

10. If I were the same age as the STEM role model, I think we'd be friends.

SA A N D SD

Name _____ Teacher _____

Grade _____ Gender _____

APPENDIX H

STEM ROLE MODEL POST-VISIT SURVEY

STEM ROLE MODEL POST-VISIT SURVEY

(This was an online survey using Google Forms)

1. Name

2. School Visited and Teacher Name

3. What did you do during your visit (pick all that apply)
___ Presentation with PowerPoint slides
___ Question/answer session
___ Interactive hands-on activity
___ Interactive verbal activity

4. On a scale of 1 to 5, with 1 being "not at all" and 5 being "perfectly", in general how well would you say that you connected with the students in the class you visited?
1) not at all 2) a little 3) a moderate amount 4) a large amount 5) perfectly

5. What made you choose your above response?

6. When during your visit did you find students were most engaged?

7. What information from the training ended up being most useful for you?

8. Are there any parts of the training that you now feel should be dropped? If yes, what are they and why?

9. If you were to visit this teacher's classroom again next year, what would you change about what you did during your visit?

Thank you!!
Thank you for taking time out of your busy schedule to participate in this research. I may contact you in the coming months if I have additional questions regarding the answers you provided. If any questions or concerns arise for you, please contact me right away via email t83z411@montana.edu or phone 608-698-2395.

APPENDIX I

FORMAL EDUCATOR POST-VISIT SURVEY

FORMAL EDUCATOR POST-VISIT SURVEY

(This was an online survey using Google Forms)

1. Name

2. How many role models visited your classes? 1 or 2

3. Class(es) Visited and Student Grade Level(s)

4. What did your presenter do during his/her visit (pick all that apply)
   ___ Presentation with PowerPoint slides
   ___ Question/answer session
   ___ Interactive hands-on activity
   ___ Interactive verbal activity

5. On a scale of 1 to 5 with 1 being "not at all" and 5 being "perfectly", how well would you say that the role model connected with the students in your class(es)?

6. What made you choose your above response?

7. When during your visit did you find your students were most engaged?

8. What could the role model have done differently to get your students engaged?

9. Did your students continue to talk about the role model's visit in the following days? If yes, what comments did they make?

10. Would you be willing to have the researcher contact you either by email or by phone to answer additional questions in the coming months?

Thank you!!

Thank you for taking time out of your busy schedule to participate in this research. If any questions or concerns arise, please contact me right away via email t83z411@montana.edu or phone 608-698-2395.

APPENDIX J

TRAINING ADHERENCE SCORE FORM

TRAINING ADHERENCE SCORE FORM

Each element is rated from 1 (not at all) to 4 (completely). In the final calculation, scores for the required elements are multiplied by 2.

Role Model Name: _____

Required Elements

__ Used the Educator Role Model Coordination Form

__ High energy level

__ Q&A session

__ Practice out loud ahead of time (ideally with audience)

Strongly Suggested Elements

__ Began with an interactive activity

__ No charts

__ Limited jargon

__ Limited time focused on exactly what role model does

__ Images of diverse people, ideally happy

__ Primarily images, limited text

__ "Real" ness factors, i.e., humor, interests outside of work, academic struggles, interests at students' age, things they can do "right now", other interesting STEM careers

__ Maintained eye contact

__ Asked students' opinions (ideally 1 question for every 4 slides)

__ Interactive element (students can touch/smell/see/manipulate)

APPENDIX K

CONNECTEDNESS FACTOR SURVEY

CONNECTED FACTORS SURVEY

(This was an online survey using Google Forms)

For my master's research I created an online training module for STEM (science, technology, engineering and mathematics) role models who were going to visit middle and high school classrooms. The teachers in those classrooms gave their students surveys about the interaction and I'm analyzing how connected those students felt to the visiting role models after just one visit. I realize that there are some variables which the role model can control during their visit (ex. talking about things that matter to students) vs variables that they can't control (ex. being the same ethnicity as a student). Please read the statements below and indicate how much YOU think a role model could be trained to control the listed factor.

1. Talking about things that are interesting to the students
    a. Can’t Control
    b. Slightly Controllable
    c. Somewhat Controllable
    d. Completely Controllable

2. Showing that they come from a background similar to the students
    a. Can’t Control
    b. Slightly Controllable
    c. Somewhat Controllable
    d. Completely Controllable

3. Showing that they share many characteristics with the students
    a. Can’t Control
    b. Slightly Controllable
    c. Somewhat Controllable
    d. Completely Controllable

4. Looking like the students
    a. Can’t Control
    b. Slightly Controllable
    c. Somewhat Controllable
    d. Completely Controllable

5. Reminding the students of someone in their family
    a. Can’t Control
    b. Slightly Controllable
    c. Somewhat Controllable

   d. Completely Controllable

6. Showing that they have similar interests to the students
   a. Can't Control
   b. Slightly Controllable
   c. Somewhat Controllable
   d. Completely Controllable

7. Seeming friendly
   a. Can't Control
   b. Slightly Controllable
   c. Somewhat Controllable
   d. Completely Controllable

8. Making the student feel comfortable asking questions and making comments during the visit
   a. Can't Control
   b. Slightly Controllable
   c. Somewhat Controllable
   d. Completely Controllable

9. Using words the students will understand
   a. Can't Control
   b. Slightly Controllable
   c. Somewhat Controllable
   d. Completely Controllable

10. Seeming like they would be friends with the students if they were the same age
   a. Can't Control
   b. Slightly Controllable
   c. Somewhat Controllable
   d. Completely Controllable

11. Any additional comments, thoughts about this topic?

12. Your Age
   a. Less than 18
   b. 29-25
   c. 26-35
   d. 36-55
   e. 56+