

Bridging the Gap between STEM Professionals and K-12 Education

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Abstract

Industry, government, and academia are becoming more alarmed by the lack of students pursuing careers in science, technology, engineering and math (STEM). Many education reformers are looking for non-traditional educational approaches to solve this problem; however little research explores the importance of STEM professionals and their role in this educational process. This research study identified factors preventing more collaboration between K-12 education and Air Force Research Laboratories (AFRL) STEM professionals using a qualitative and quantitative survey of both STEM Professionals and K-12 teachers. Of the teacher respondents, it was discovered that 42% never use STEM professionals in their classroom. The number one contribution cited was inability to find readily available STEM volunteers. Data collected from AFRL Scientists and Engineers indicated 45% had not volunteered in any K-12 educational setting in the last year. Sixty three percent cited they are too busy to volunteer and 16% say they would not know what to do or how to prepare for that role. A STEM demonstration lending library was developed to mitigate factors preventing AFRL volunteerism with the hypothesis that scientists and

engineers may feel more comfortable in the classroom if they had something to present and did not have to prepare materials for a presentation.

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Introduction

The Air Force Research Laboratories (AFRL) is a National Research Laboratory located on Kirtland Air Force Base and employs more than 1700 people. AFRL employees are encouraged to volunteer in the community and volunteerism is part of many employee evaluation requirements. This requirement provides a large pool of experts in science, technology, engineering, and math (STEM). As a branch at the Air Force Research Laboratories (TECH Outreach), our goal is to facilitate the pipeline of students in K-12 education to pursue STEM field degrees, with of an emphasis in DoD technologies (mostly physics and engineering). K-12 school teachers are under pressure to boost student's interest in STEM due to a lack of scientists and engineers (S&E's) in the workforce and the ramifications of that for our future as the leading country in innovation. State reform models include non-traditional classroom practices as a method for boosting STEM interest. Some outreach organizations are working to build this gap at the state and national level. However, more can be done to fill the need for exposing students to an array of STEM careers available to them, while helping to break down the social stereotypes associated with STEM fields.

This study seeks to understand why teachers and STEM professionals are not working together to boost student awareness of STEM careers. Surveys were developed for teachers and AFRL S & E's with the goal to find the commonalities in goals for three organizations (AFRL, AFRL TECH Outreach, and K-12 Education) and develop a procedure for meeting the goals for all three. For example, AFRL S&E's need volunteer hours and teachers need S & E volunteers to help spur interest in these potential careers. The hypothesis is if a demonstration lending library is developed, then STEM professional volunteerism will increase and more students will be impacted. Thus, bridging the gap between STEM professionals and K-12 education settings.

Literature Review

Industry, government, and academia are becoming more alarmed by the lack of students pursuing careers in science, technology, engineering, and math (STEM). STEM careers are a key to American prosperity and innovation, and lack of student interest in these careers has been a major focus of government policy and education reform. Many education reformers are looking for non-traditional educational approaches to solve this problem; however little research

explores the importance of scientists and engineers working in the field and their role in this educational process. Most areas of study have focused on the collaboration between University and Industry, while ignoring the role professionals play in K-12 education. (Beckman, Coulter, Khajenoori & Mead 1997-Mowery & Sampat, 2005). The purpose of this independent study is to explore the missing link between professional scientists and engineers and the lack of volunteerism in the schools to boost student interest in STEM related fields. The body of research cites many reasons why these large gaps exist between students interested in STEM careers and the need for more students focusing on these subjects in education. This review begins by defining the problem: What is the disparity between STEM careers and STEM majors? It then discusses some social reasoning for why this problem exists. Concluding with reform efforts in education and how volunteerism can help meet reform goals and boost student interest in STEM careers.

Disparity between STEM Careers and Students Pursuing STEM Education

The US Census defines STEM workers as those “employed in science, technology, engineering, and math occupations. This includes computer and mathematical occupations, engineers, engineering technicians, life scientists, physical scientists, social scientists, and science technicians.” (Landiver 2013)

Many have become alarmed at the number of women and minorities entering these fields. The number of women in these fields has increased since the 1970's but these numbers are still far lower in the fields of computer occupations and engineering, which account for 80% of STEM careers. Also, women in computer related fields have decreased since the 1990's. The highest rates of growth for women in the STEM fields were between 1970 and 1990. Younger women are not going into STEM fields. Blacks and Hispanics are also underrepresented in STEM employment. In 2011, 11% of the workforce was black of that 6% of STEM workers were black. Hispanic workers were 7% of the workforce in 2011 of those 7% was in STEM fields. In 2011 there were 7.2 million STEM workers in America. Most of those jobs were in computer occupations. Women make up half the American workforce, but only 26% in STEM fields. The highest representation of women in STEM careers were in social sciences, life sciences, and math (NSF, 2013). Sixty seven percent of the total workforce is white, non-Hispanic, but they had 71% of STEM jobs in 2011. Native Americans showed a dismal .4% of STEM jobs and Hispanics held 7%.

Occupations in the STEM fields are among the highest paying and fastest growing. People with STEM jobs have a lower unemployment rate and have greater job security (Langdon, McKittrick, Beede, Khan, & Doms, 2011). So, why are so few students entering into these fields? Historically, only a small

percentage of the population pursues STEM degrees. Females and minorities are less likely to be in science or engineering majors and even less likely to remain in these majors (Landivar, 2013). Women's interest in science careers is improving. ACT reports that 46% of students listed science and engineering as some interest to them in a post-secondary education. Surprisingly, more female than male students are interested in STEM, although the opposite is true among higher-achieving students. The overall percent of females interested in STEM majors and occupations is a surprising 46%, of which the largest fields are nursing. Students interested in STEM have higher educational aspirations, and their parents are more likely to have attended college than those not interested in STEM (ACT 2013).

Possible Social Factors That Affect Lack of Students Seeking STEM Careers

A large body of research has been done on the psychological and social factors contributing to the lower numbers of women and minorities pursuing STEM careers. Research suggests that female do not perceive themselves as scientists and engineers. This could be due to the fact that in the media, scientists and engineers are not female (Buday 2011). Buday also suggests that females lack the self-confidence to pursue more challenging careers and instead still choose traditional female careers. The number one predictor of career choice in

woman is whether they feel they can balance a family life with a career life. Science and engineering careers are not perceived as a good career choice if a woman wants a family.

Another strong career indicator among both men and women is whether their parents wanted them to pursue STEM fields (Rodrigues, 2011). Some other limiting factors according to Rodrigues are perceived usefulness of a science degree, lack of relevance to the student's life, lack of science work in school, negative perceptions about science, and cultural perceptions of science and engineering careers. Many view science and engineering careers as boring and solitary. Continuing on this theme, students were found to major in STEM fields in college if they had confidence in their academic abilities and if they had parents working in these fields (Moekler & Kim, 2014). Moakler and Kim also postulate that women and minorities have a lack of role models in STEM fields which perpetuate the lack of women in STEM. Females and minorities in STEM could possibly be increased by developing confidence in math and science in middle schools, developing positive self-images, promoting career links to STEM in school, and interacting with positive female and minority role models and mentors.

Additionally, Millennials, those born between 1982 and 2000, are especially interested in having a balance between work and family. The majority of this population grew up with both parents working and saw firsthand how parents tried to juggle work life and home life (DeFraine, Williams, & Ceci, 2014). Millennials, both males and females, prefer professional and personal lives with flexibility and collaboration. Many perceive STEM careers as imbalanced towards work and opt out of STEM careers. Science is viewed as solitary and goal oriented. Though many tech companies (Evernote, Google, Cisco, et. al) are changing from traditional working environments to more Millennial friendly by implementing flexible hours, family child care, free meals for employees and families working late, hair stylists, gyms, and other family friendly perks. The college and university (academia) is still very traditional and rigid. This perpetuates this life/work imbalance perception of STEM careers.

Education Reform

There is no shortage of research focusing on the growing disparity of students pursuing STEM careers and the need for STEM professionals. Research has pinpointed several findings as to why the gap exists. Five current findings that states are addressing are inconsistent standards in math and science, lack of qualified teachers, failure to motivate students in STEM fields, lack of

preparation for colleges, and failure of colleges and Universities to meet STEM job needs (Thomasian, 2011). Many state politicians and education reformers have focused heavily on implementing state STEM education agendas. One of the main focal points has been to adopt more rigorous standards in math and science. The Common Core State Standards (CCSS) and Next Generation Science Standards (NGSS) have been the state reformers choice. The CCSS and NGSS focus heavily on application and are aligned with college and work expectations (Thomasian, 2011). Education reformers also suggest states need to recruit and retain more qualified and effective teachers, open STEM specialty schools, offer early college courses, use online STEM learning, and use informal learning to expand math and science outside the classroom.

Of the state reformer suggestions, only the last reform measure addresses the social factors that affect many student's decision to not pursue STEM degrees. Informal learning consists of hands on math and science in the field, real world problem solving in the classroom through collaborative projects, and students observing professionals in the field. Students and teachers engage in enrichment opportunities through outreach opportunities provided by museums and science centers. During these experiences, teachers are able to improve skills and science content knowledge and see how science can be applied to real world scenarios and jobs. Students are able to explore STEM concepts out of the

classroom. Many virtual learning programs have been developed as well. Many of these virtual learning programs connect scientists and researchers to students (Thomasian, 2012). It seems if a pool of scientists and engineers were available from the business sector, national laboratories, or universities then the real deal would be better than virtual anything. Students must be given the opportunity to see connections between STEM knowledge and the real world so they can envision careers. There isn't enough time in formal setting to learn STEM content, apply the ideas, and also relate it to potential STEM careers (Thomasian, 2012).

The literature cites some national programs as best practice models in fulfilling the out of classroom or non-traditional classroom reform including FIRST Lego League, YES, Girl Scouts, MathCounts, and After-School Math (Thomasian, 2012). All of these rely on outreach programs that are not a part of the school itself, although many take place at schools as after school programs or in school outreach. Several informal and outreach efforts have been made by museums, research centers, and other programs to bring science into the classroom to teach STEM skills and increase student interest. Some even include visiting scientists to demonstrate and discuss concepts. However, most states do not consistently make informal learning a part of school reform agenda because they do not directly fund these programs. This would indicate that informal

science institutions are high impact low cost options for states. Additionally, this part of the reform model may need to be more industry driven, as the schools cannot dictate what out of classroom options should be developed for their communities.

There seems to be a lack of connection between scientists and engineers working in the field and volunteerism in schools and communities.

Opportunities exist for more interaction between the two populations. For example school science nights, science classrooms, careers nights, field trips, and engineering and math classes are all good opportunities for interaction. Many of the social problem perceptions associated with students choosing STEM careers could potentially be addressed by increasing the number of S & E's willing to share their knowledge of the "real world of science and technology" and putting a face to a job. More women and minorities are especially needed in the schools. This study seeks to understand how to bridge the gap and connect scientists and engineers to teachers. Research suggests that females and minorities would greatly benefit from positive role models that come from similar backgrounds, gender, race, or ethnicity. The research also suggests that STEM careers need to be demystified, appear more attainable and flexible in order to attract a larger pool of potential scientists and engineers.

Purpose

The study attempted to identify factors preventing more collaboration between K-12 educators and STEM professionals. Are STEM professionals volunteering in K-12 School? If not what is preventing them from doing so. Are teachers using STEM professionals to boost student interest in STEM careers? Do teachers see a link between education reform and using STEM professionals to meet new reform requirements? It is hypothesized that STEM professional and teacher collaboration is minimal due to lack of time and resources. Likewise it is hypothesized that if a demonstration lending library is developed and materials were readily available, then STEM professional volunteerism will increase and more students will be impacted.

Methods

Both quantitative and qualitative data was gathered and analyzed in a mixed methods study. Data collection began with a qualitative and quantitative survey given to scientists and engineers working at the Air Force Research Laboratories (see Appendix A). Scientists and Engineers from AFRL were asked to respond to the survey through a blanket organizational email and an online

newsletter sent to AFRL staff. The survey was purely voluntary. The survey was administered through survey monkey.

The same methods were used to collect data from teachers working in K-12 education (see Appendix A). Teachers were asked to respond to a survey through an email list derived from the Masters in Science Teaching program at New Mexico Tech and AFRL La Luz Academy teacher email database. Data was analyzed using Survey Monkey and comparative graphs.

Data collected from the first study was used to justify and guide further implementation for an outreach effort at the AFRL La Luz Academy.

Collaborating with scientists and engineers at AFRL, a physics-based demonstration lending library was developed at the AFRL La Luz Academy. The purpose of this library was to collect high interest physics demos and develop them for use in classrooms by AFRL STEM professionals. A total of 89 demonstrations were ordered in the following categories: mechanics, thermodynamics, electromagnetism and electricity, and sound and light. The materials for each demonstration were added as inventory and put in labelled bins according to concept. A summary of each demonstration was created, organized into labelled binders, and put into their corresponding bins. The binders also contained safety information and instructions for how to use each demonstration. A master binder was created, and organized with all the demo

information. All information was saved on the AFRL network and was made accessible to employees. Talking points were developed to focus the guest talks to benefits of STEM careers.

With the support of the Chief Scientist of AFRL Space Vehicles Division an open house was held to demonstrate a few of the demonstrations available for check out. All AFRL S & E's were invited via electronic newsletter and announced in email by both Directors of AFRL Space Vehicles and Directed Energy. Posters and signs were posted in buildings where AFRL S & E's work, the news stations were invited, and an event was held.

Additionally, some demonstrations were chosen to be displayed for scientists and engineers at AFRL in the lobby of the Battlespace Environment Laboratory Building. People were encouraged to "play" with the demos and information was displayed about the lending library and the La Luz Academy.

Upon completion of a school visit, participating scientists and engineers were asked to complete a survey describing the demos used, number of students impacted, and rating the demos used in the school. The survey asked for feedback to improve demos and the lending library (see Appendix A). The data collected was analyzed and recorded.

Outcomes

Teacher Survey

One hundred and one teachers responded to the teacher survey. Of those responding, 35% identified as primary educators (K-5), 27% middle educators (6-8), 32% secondary educators (9-12), and 7% as other. Twenty four percent of respondents reported they never use volunteers of any kind in their classrooms. Fifty percent responded that they use volunteers occasionally; 12% use volunteers once a month while 3% have volunteers daily. Nineteen percent use parents to assist while 56% indicated they use professionals as guest speakers. Other answers given were seniors in high schools volunteering for service learning, fieldtrips, or a mix of activities. Forty percent of respondents never use STEM professionals in their classrooms. While another 40% use STEM professionals once or twice a year. The vast majority (59%) responded they did not use professionals because they do not know how to find or arrange for them to come to their classroom. Some teachers openly responded they felt like they are limited in their time due to only teaching the Common Core Standards (CCS). Teachers using STEM professionals generally rated the experience as positive; however 24% did not see a correlation between meeting NGSS and CCS

and having STEM professionals in their classrooms. Additionally, 25% found their speakers dry and boring.

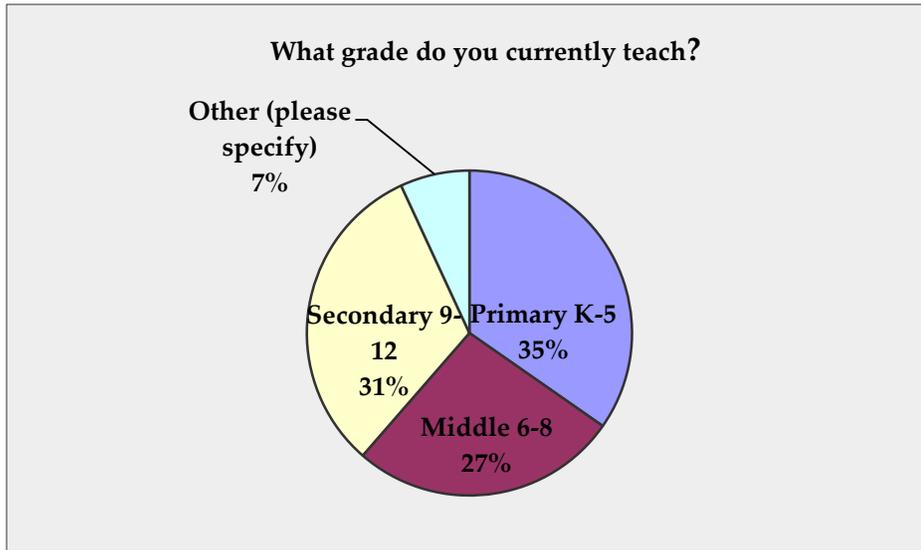


Figure 1: Teacher Grade Level

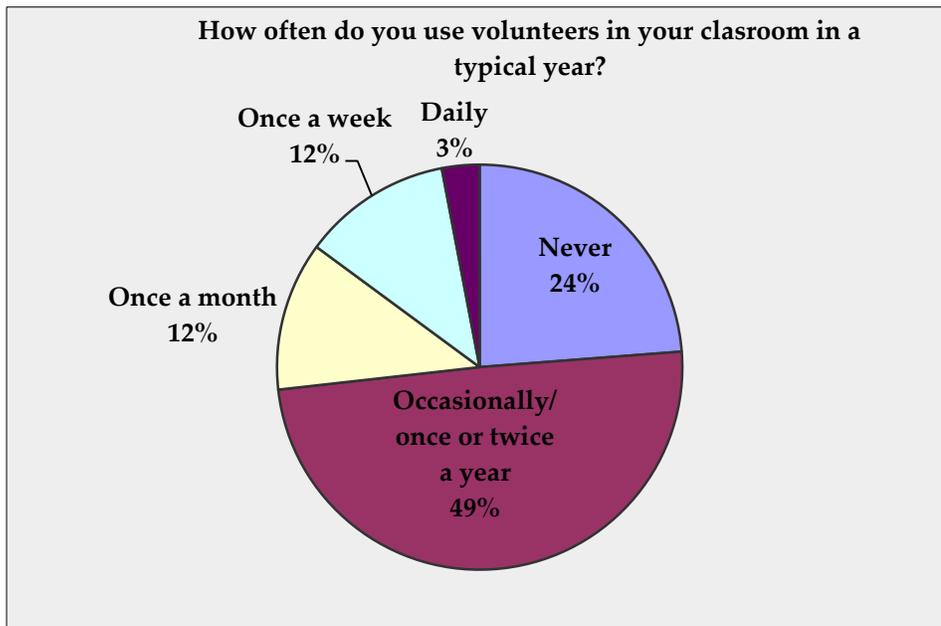


Figure 2: Volunteer Use

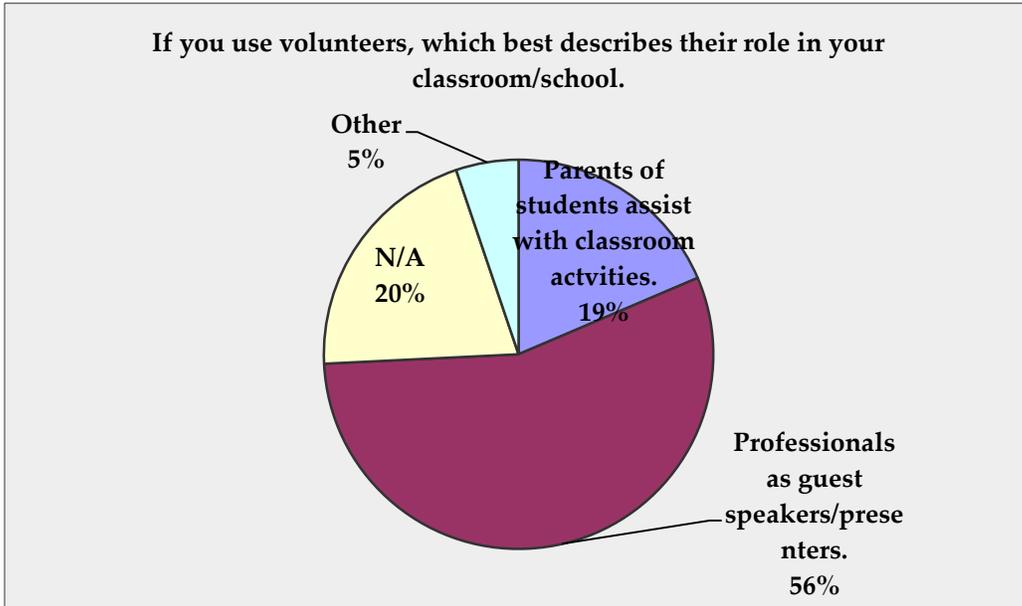


Figure 3: How Volunteers are used

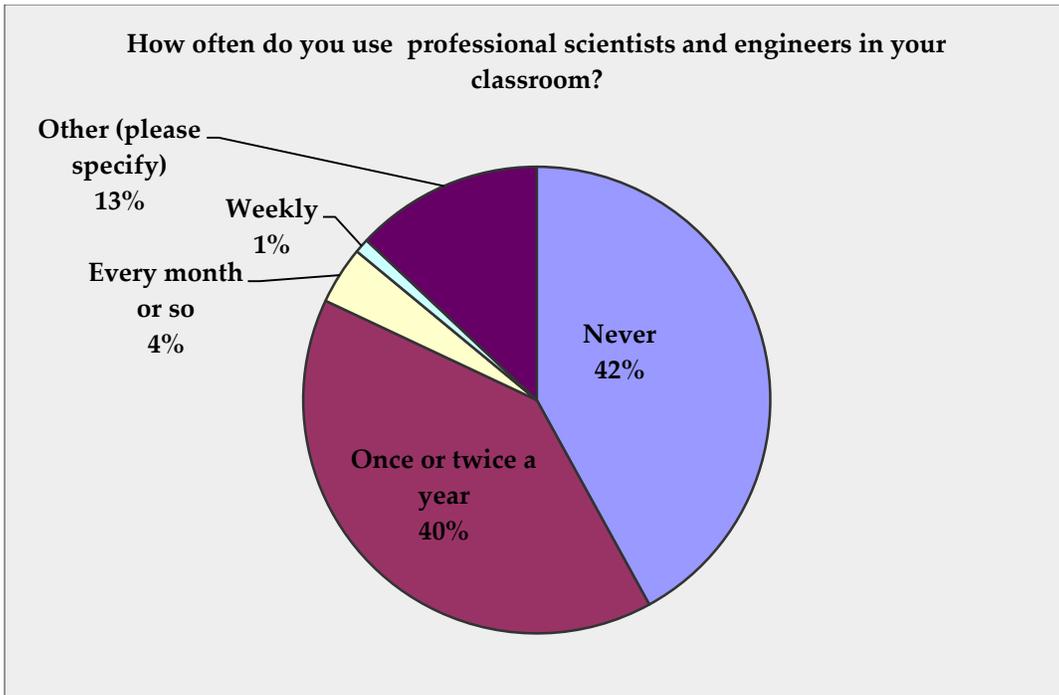


Figure 4: Scientist and Engineers as volunteers

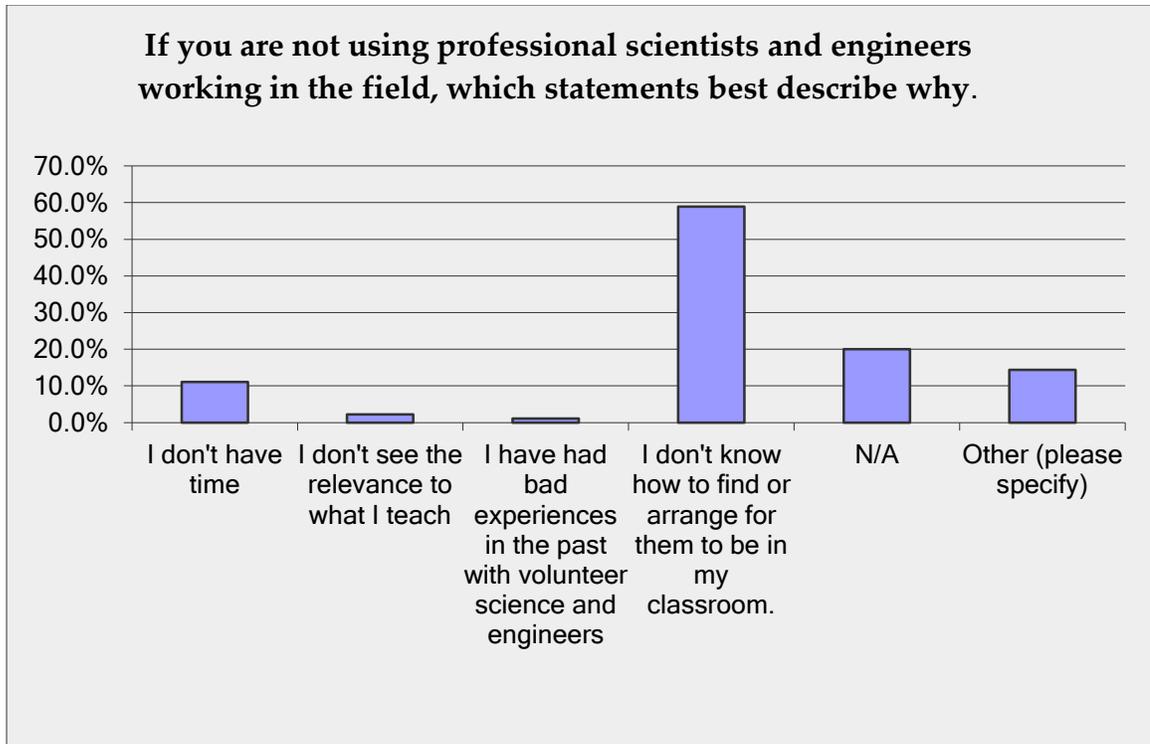


Figure 5: Reasons for using S&E's

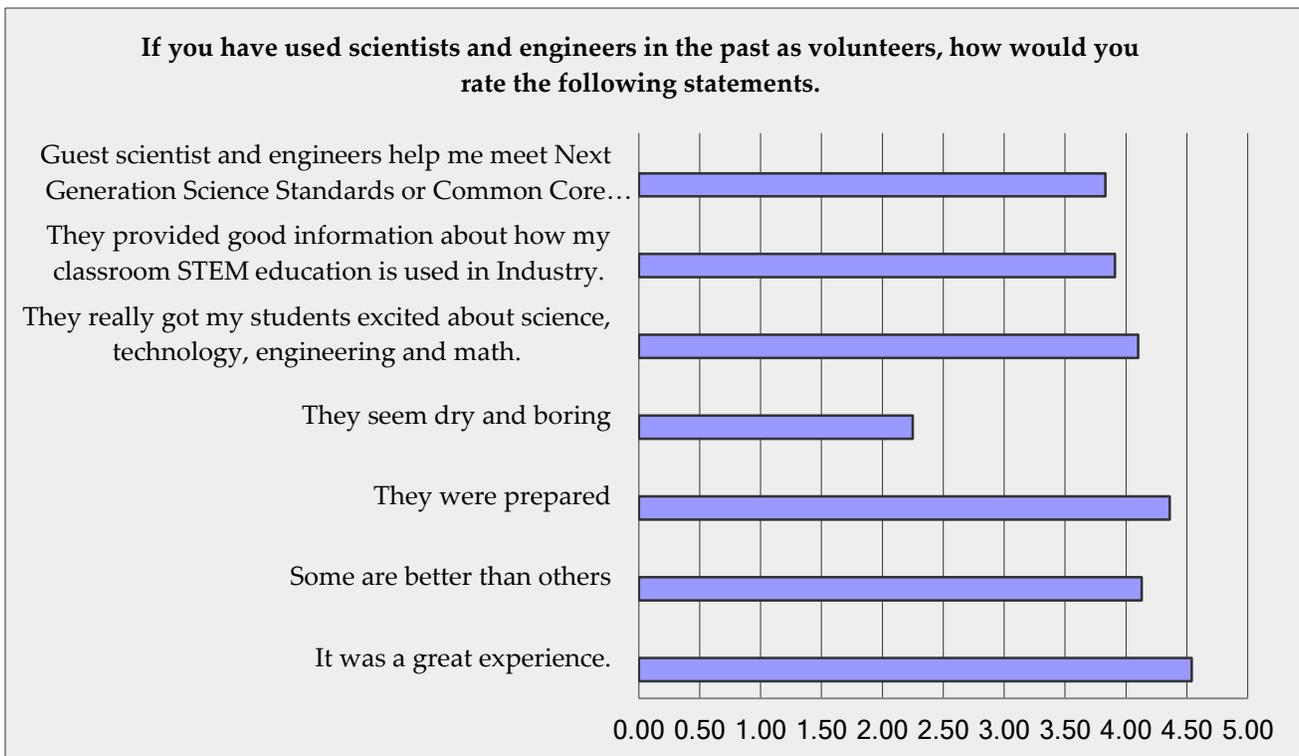


Figure 6: Rated Experience Using S&E's

Engineering Survey

Data collection from AFRL Scientists and Engineers indicated 59% of the 51 respondents have never volunteered with the La Luz Academy which is the K-12 STEM outreach for AFRL. Thirty nine percent say they are volunteering, but not with K-12 education. Sixty three percent cite they are too busy to volunteer and 16% say they would not know what to do or how to prepare for that role. The free response data was also very telling. Many S&E's at this organization feel volunteerism is not supported by superiors. However, volunteerism is encouraged as a part of the employee's evaluation process.

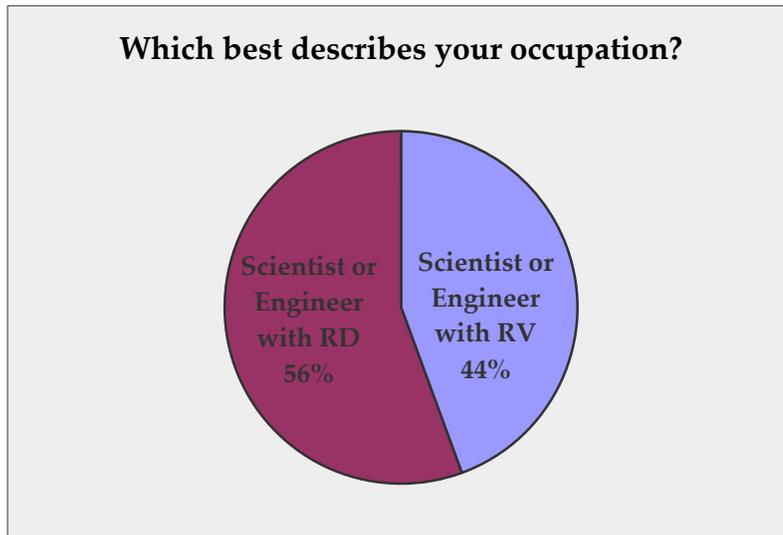


Figure 7: AFRL S&E Branch

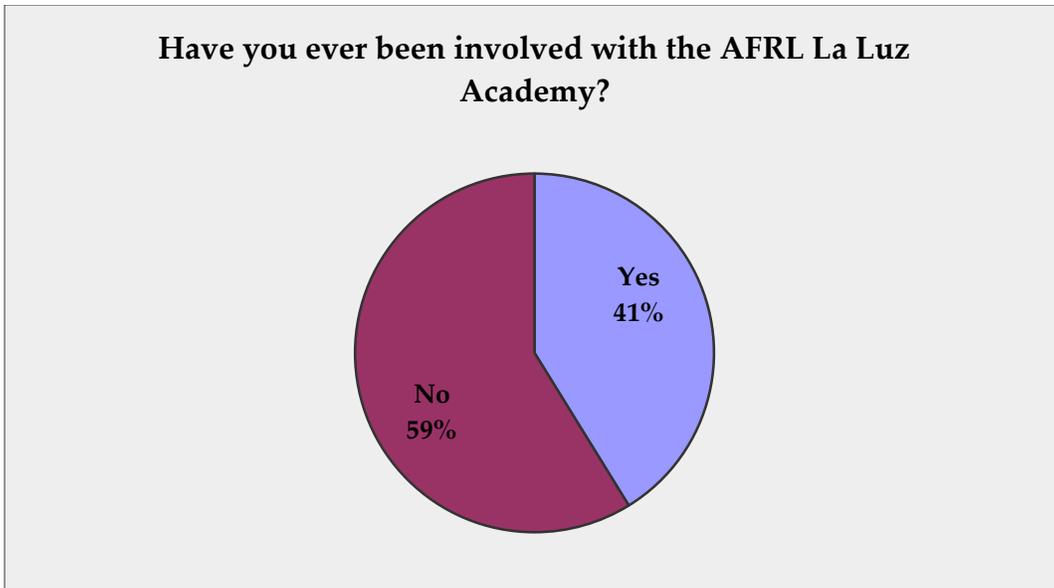


Figure 8: La Luz and AFRL S&E's

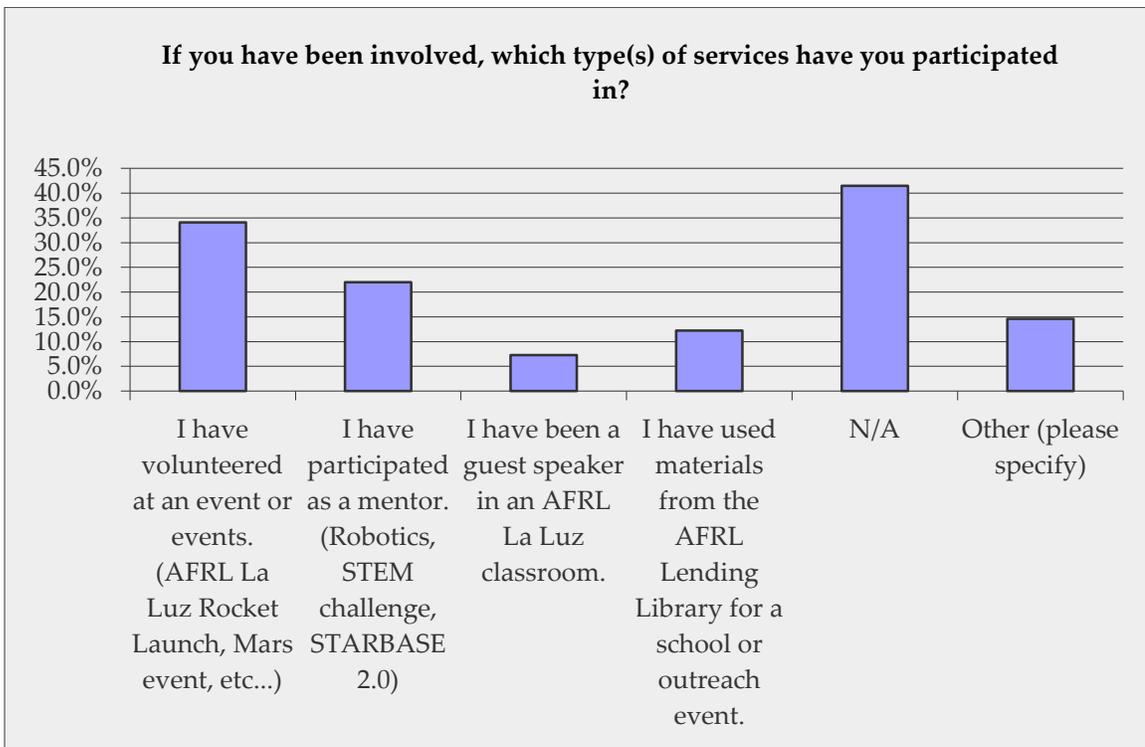


Figure 9: AFRL S&E's participation with La Luz

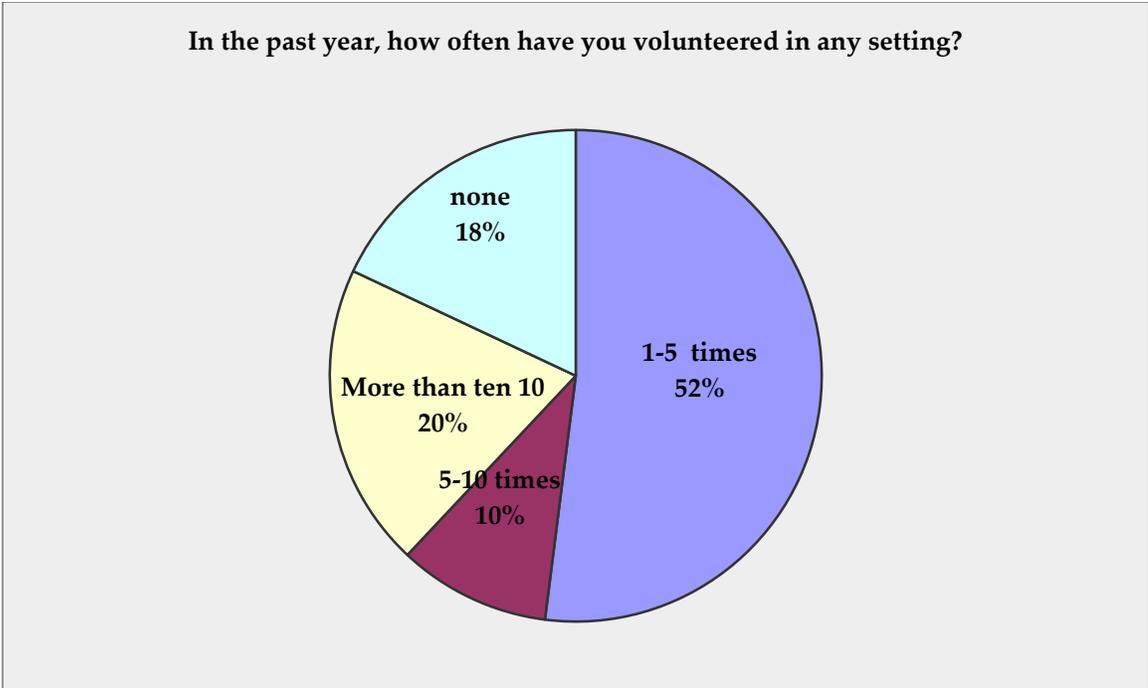


Figure 10: AFRL S&E general volunteerism

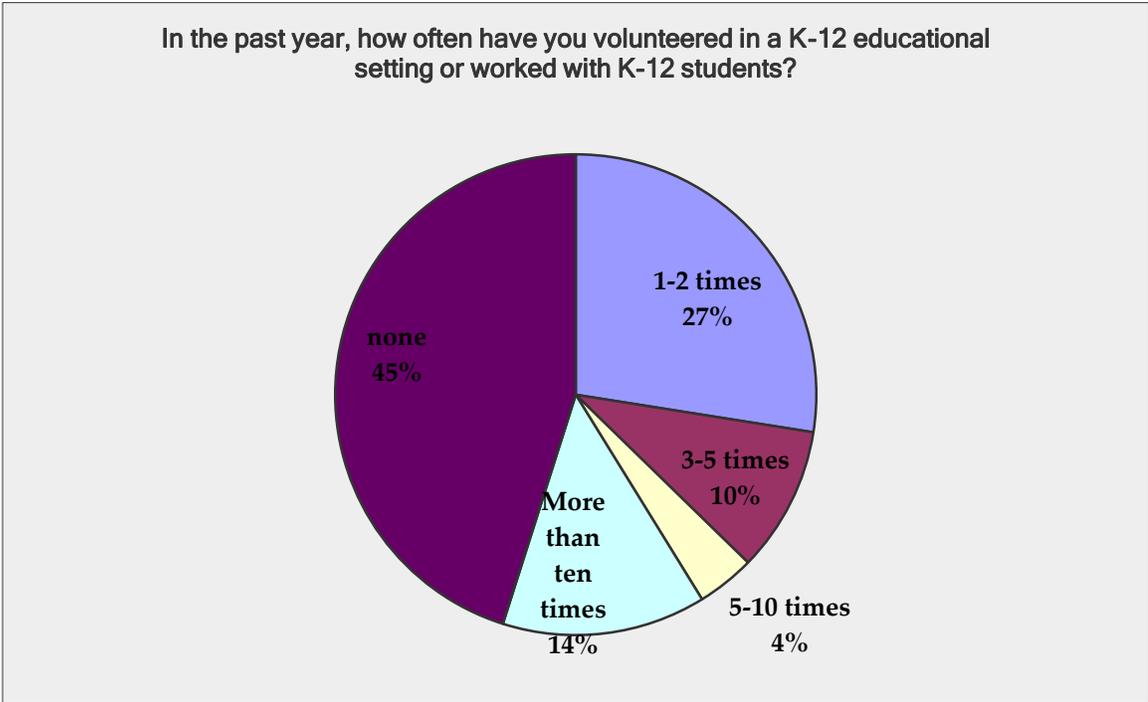


Figure 11: AFRL S&E K-12 volunteerism

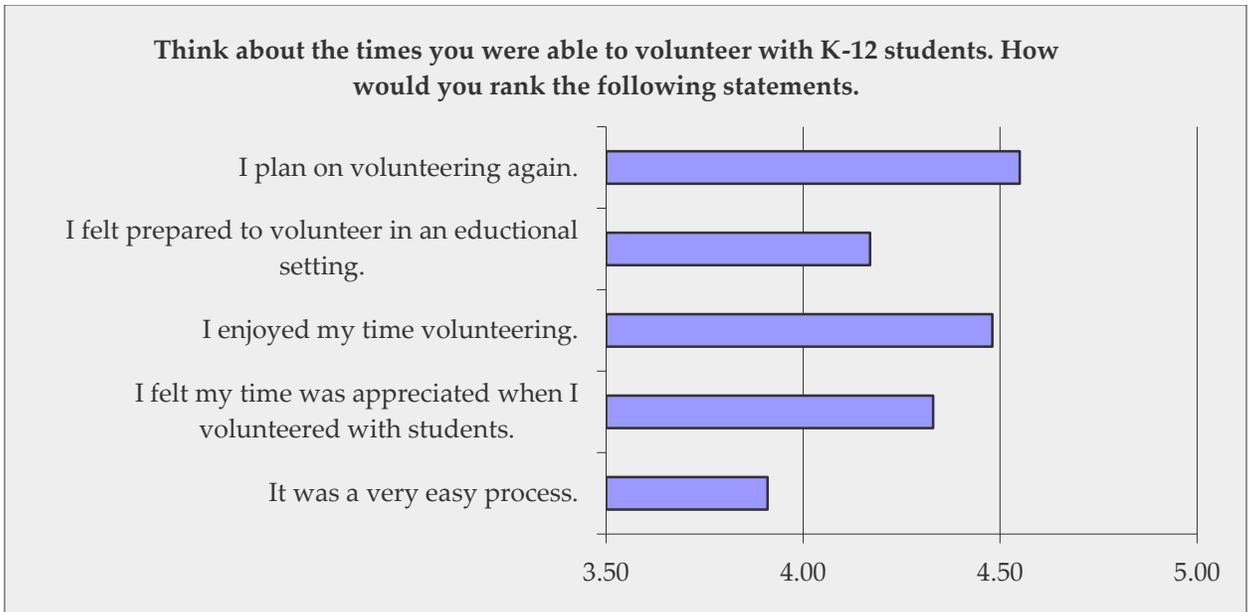


Figure 12: Scaled response to volunteer experience

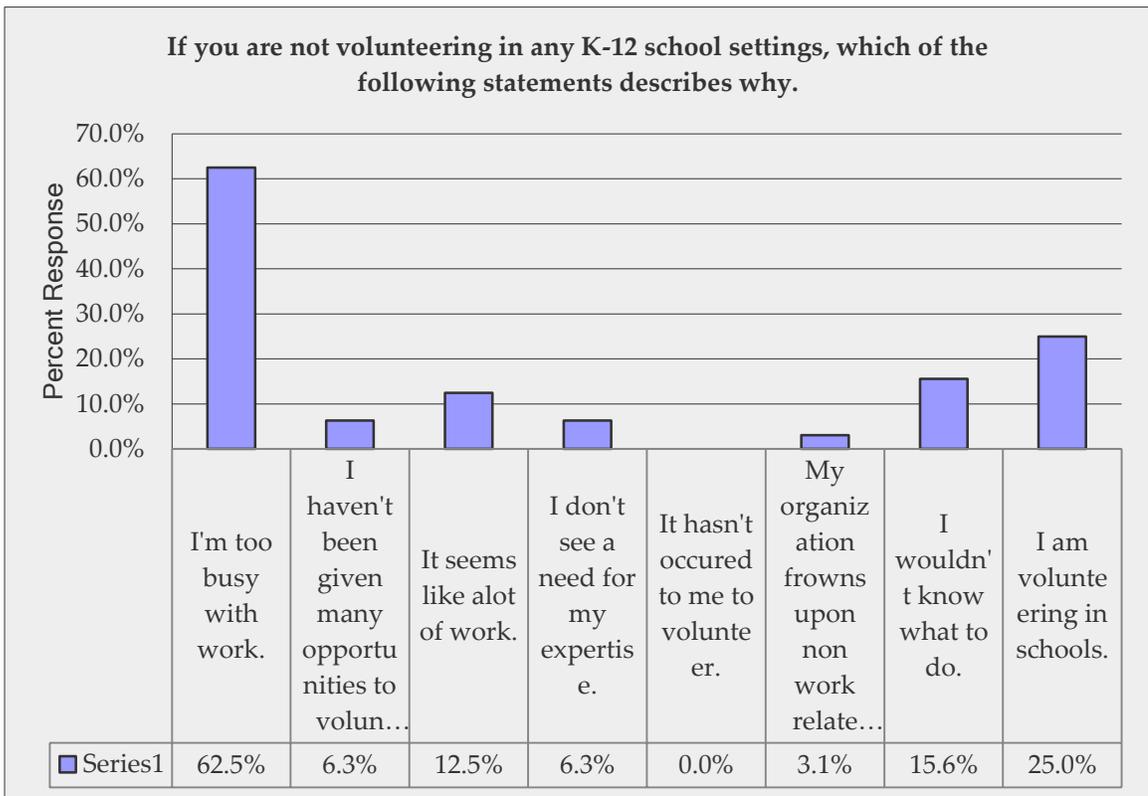


Figure 13: Reasons for not volunteering

STEM Demonstration Library

From April, 2014, to April 1, 2015, ten STEM Professionals from AFRL checked out materials and used them at various events. Approximately 1,435 students were impacted by STEM professionals from AFRL presenting with materials from the AFRL La Luz Academy STEM Demo lending library.

Community and school events where the demos were used are: girl/boy scouts, in class presentations, after school or summer programs, conferences for students, career fairs in schools, and a Physics class taught at CNM.

All available demos have been used at least once by AFRL S&E's volunteers. On fourteen different occasions bins were checked out. Twenty bins were checked out over the period studied. Of those, sound and light demos were utilized most often with 6, then mechanics and electricity and electromagnetism with 5 each, and thermodynamics with 4. S&E's rated the demos on a scale from 1 to 5, 5 being excellent and 1 being poor. Of the 28 individual demos rated, 61% were rated 5, 37% rated 4, with only one demo being rated as a 2.

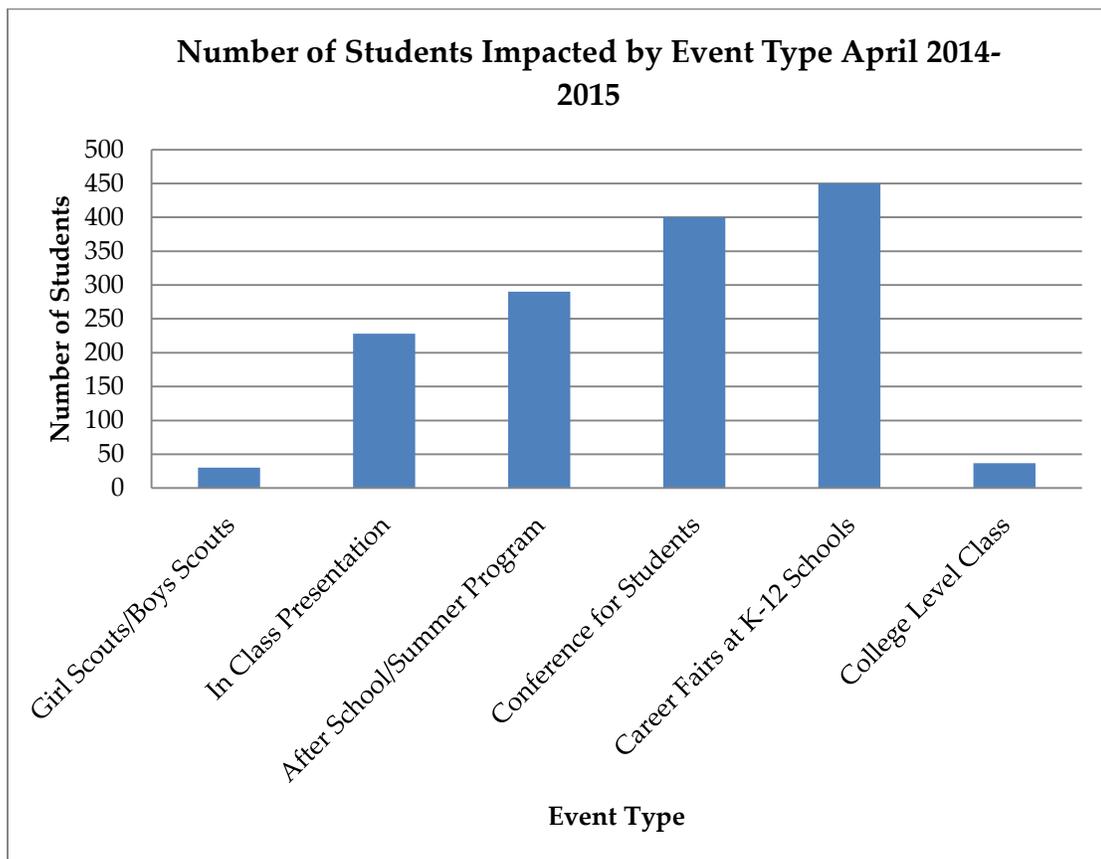


Figure 15: Number of Students Impacted

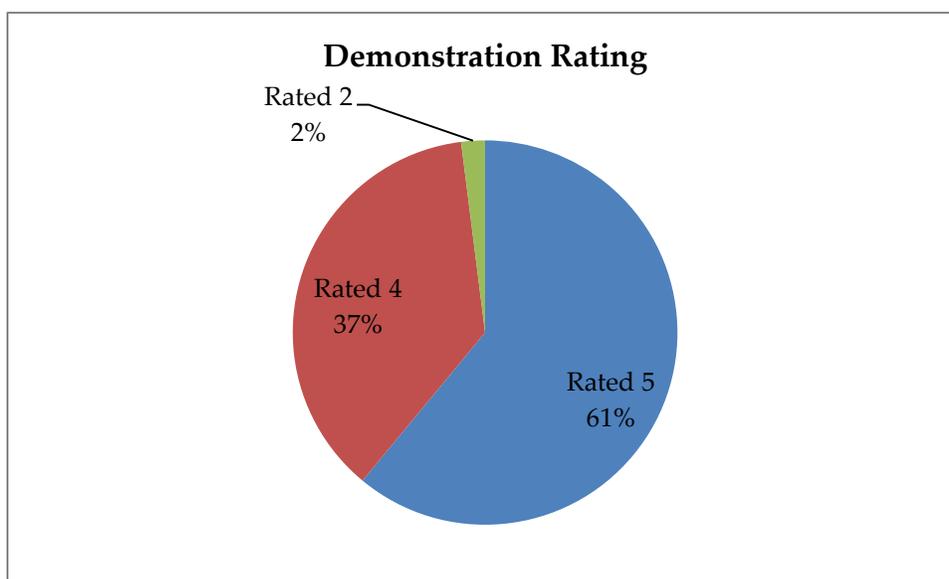


Figure 14: Demonstration Ratings

Conclusions

The teacher survey indicated 42% of K-12 teachers never use STEM professionals in their classrooms while another 40% may use them once or twice a year. This denotes a huge area for growth. Many teachers responded that having STEM professionals was a positive experience, but they may not know how to find or arrange for them to be in classrooms. Very few (2%) felt they were irrelevant to what they were teaching. This implies teachers may be more willing to use STEM professionals in all grade levels to enhance curriculum if they were readily available, prepared, and willing. While many S&E's felt they were too busy with work to volunteer, if the process became easier, less time would be needed to prepare for an event or demonstration at a local school. Some S&E's also felt they would not know how to prepare or what to do with students in a K-12 classroom. If they were given the tools of their trade and were called upon to share their expertise, which is where they could feel comfortable and effective, then perhaps more S & E's would volunteer. Career fairs, science nights, and schools science fairs are an ideal venue to highlight STEM careers and can be enhanced through easy demonstrations that capture student's attention

Consequently, all the data supported intervention as viable solution and could increase student's enthusiasm with regards to STEM careers. STEM

professionals need to feel prepared; they need to be interesting to students and the careers presented need to look fun and accessible to all. The AFRL STEM Demonstration Lending Library was developed to address these issues and encourage AFRL S & E's to not feel they need to be the teachers, but can use their experiences to put a human face to a traditionally intimidating career choice.

The STEM demo lending library that was developed to support STEM professionals as they interact with students and was utilized by 10 different S & E's over a one year period. During that time, 1435 students were impacted from elementary through college level. The demonstrations were rated good to excellent 98% of the time. The optional feedback from AFRL professionals utilizing demonstrations was very positive.

Further work needs to be done to encourage more STEM professionals from AFRL to volunteer and share their experiences to encourage youth to pursue science and engineering. The AFRL La Luz Academy does not have the resources at this time to set up a system to pair teachers willing to utilize AFRL S & E's with willing volunteers. According to survey results, this would possibly be the best way to increase the actual number of STEM professionals in the classrooms. The Lending Library will continue to evolve to meet the needs of AFRL and allow more scientists and engineers to interact and excite students.

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Appendix A: Surveys

Teacher Survey

The Institutional Review Board for the Protection of Human Subjects at NM Tech has reviewed and approved this research project. By completing this survey, you agree to participate in this project. Your participation in this research project is strictly voluntary and you may choose not to participate by simply not completing the survey. You may also refuse to answer specific questions on this survey if you so desire. If you have any questions or concerns about this survey / questionnaire, please contact the researcher at 505-934-3840 or the New Mexico Tech IRB Administrator at 575-835-5690.

1. What grade do you currently teach?

- Primary K-5
- Middle 6-8
- Secondary 9-12
- Other (please specify)

2. How often do you use volunteers in your classroom in a typical year?

- Never
- Occasionally/once or twice a year
- Once a month
- Once a week
- daily

3. If you use volunteers, which best describes their role in your classroom/school.

- Parents of students assist with classroom activities.
- Professionals as guest speakers/presenters.
- N/A
- Other (please specify)

AFRL Scientist and Engineer Survey

The Institutional Review Board for the Protection of Human Subjects at NM Tech has reviewed and approved this research project. By completing this survey, you agree to participate in this project. Your participation in this research project is strictly voluntary and you may choose not to participate by simply not completing the survey. You may also refuse to answer specific questions on this survey if you so desire. If you have any questions or concerns about this survey / questionnaire, please contact the researcher at 505-846-3303 or the New Mexico Tech IRB Administrator at 575-835-5690.

1. Which best describes your occupation

- Scientist or Engineer with RV
- Scientist or Engineer with RD

Other (please specify)

2. Have you ever been involved with the AFRL La Luz Academy?

- Yes
- No

3. If you have been involved, which type(s) of services have you participated in?

- I have volunteered at an event or events. (AFRL La Luz Rocket Launch, Mars event, etc...)
- I have participated as a mentor. (Robotics, STEM challenge, STARBASE 2.0)
- I have been a guest speaker in an AFRL La Luz classroom.
- I have used materials from the AFRL Lending Library for a school or outreach event.
- N/A
- Other (please specify)

4. In the past year, how often have you volunteered in any setting?

- 1-5 times
- 5-10 times
- More than ten 10
- none

AFRL Scientist and Engineer Survey

5. In the past year, how often have you volunteered in a K-12 educational setting or worked with K-12 students?

- 1-2 times
- 3-5 times
- 5-10 times
- More than ten times
- none

6. Think about the times you were able to volunteer with K-12 students. How would you rank the following statements.

| | Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree | N/A |
|--|-----------------------|-----------------------|-------------------------------|-----------------------|-----------------------|-----------------------|
| It was a very easy process. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I felt my time was appreciated when I volunteered with students. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I enjoyed my time volunteering. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I felt prepared to volunteer in an educational setting. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I plan on volunteering again. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

7. If you are not volunteering in any K-12 school settings, which of the following statements describes why.

- I'm too busy with work.
- I haven't been given many opportunities to volunteer.
- It seems like alot of work.
- I don't see a need for my expertise.
- It hasn't occured to me to volunteer.
- My organization frowns upon non work related activities.
- I wouldn't know what to do.
- I am volunteering in schools.

Other (please specify)

Additional Teacher Survey Results/Raw Data

| What grade do you currently teach? | | | |
|------------------------------------|-----------------------|--------------------------------|----------------|
| Answer Options | | Response Percent | Response Count |
| Primary K-5 | | 34.7% | 35 |
| Middle 6-8 | | 26.7% | 27 |
| Secondary 9-12 | | 31.7% | 32 |
| Other (please specify) | | 6.9% | 7 |
| <i>answered question</i> | | | 101 |
| <i>skipped question</i> | | | 0 |
| Number | Response Date | Other (please specify) | Categories |
| 1 | Oct 14, 2014 2:11 AM | Physical Education k-8 | |
| 2 | Oct 14, 2014 12:01 AM | Head Start Administrator | |
| 3 | Oct 13, 2014 5:42 PM | 5-6 combo | |
| 4 | Oct 9, 2014 11:46 PM | Museum Education | |
| 5 | Oct 7, 2014 4:20 AM | Kinder through 8th | |
| 6 | Oct 6, 2014 11:59 PM | Pre-K through 6th | |
| 7 | Oct 6, 2014 7:24 PM | I teach 7th through 12 graders | |

| How often do you use volunteers in your classroom in a typical year? | | |
|--|------------------|----------------|
| Answer Options | Response Percent | Response Count |
| Never | 23.8% | 24 |
| Occasionally/once or twice a year | 49.5% | 50 |
| Once a month | 11.9% | 12 |
| Once a week | 11.9% | 12 |
| Daily | 3.0% | 3 |
| <i>answered question</i> | | 101 |
| <i>skipped question</i> | | 0 |

| If you use volunteers, which best describes their role in your classroom/school. | | | |
|--|------------------|----------------|--|
| Answer Options | Response Percent | Response Count | |
| Parents of students assist with classroom activities. | 18.6% | 18 | |
| Professionals as guest speakers/presenters. | 55.7% | 54 | |
| N/A | 20.6% | 20 | |

| | | | | | | | | |
|------------------------|----------------------|---|-------------------|--|--|--|--|--|
| Other (please specify) | 5.2% | 5 | | | | | | |
| | | <i>answered question</i> | 97 | | | | | |
| | | <i>skipped question</i> | 4 | | | | | |
| Number | Response Date | Other (please specify) | Categories | | | | | |
| 1 | Oct 13, 2014 9:11 PM | As guest speaker | | | | | | |
| 2 | Oct 10, 2014 9:40 PM | Both as volunteers and presenters according to individual comfort | | | | | | |
| 3 | Oct 7, 2014 9:51 PM | The first two | | | | | | |
| 4 | Oct 7, 2014 4:27 AM | Fieldtrips | | | | | | |
| 5 | Oct 6, 2014 6:19 PM | Seniors volunteering for service learning credit | | | | | | |

| How often do you use professional scientists and engineers in your classroom? | | | | | | | | | |
|---|-----------------------|---|-------------------|--|--|--|--|--|--|
| Answer Options | Response Percent | Response Count | | | | | | | |
| Never | 42.0% | 42 | | | | | | | |
| once or twice a year | 40.0% | 40 | | | | | | | |
| every month or so | 4.0% | 4 | | | | | | | |
| weekly | 1.0% | 1 | | | | | | | |
| Other (please specify) | 13.0% | 13 | | | | | | | |
| | | <i>answered question</i> | 100 | | | | | | |
| | | <i>skipped question</i> | 1 | | | | | | |
| Number | Response Date | Other (please specify) | Categories | | | | | | |
| 1 | Oct 21, 2014 3:54 PM | I use professionals to support the classroom instruction. | | | | | | | |
| 2 | Oct 21, 2014 3:53 PM | I use professionals to support the classroom instruction. | | | | | | | |
| 3 | Oct 13, 2014 9:11 PM | Very hard to get people during school hours | | | | | | | |
| 4 | Oct 13, 2014 12:22 AM | I've never done this, but I would like to. | | | | | | | |
| 5 | Oct 12, 2014 10:14 PM | Don't know any. | | | | | | | |
| 6 | Oct 11, 2014 8:36 PM | I have had some parents that are scientist or engineers come in the past. Not in a few years, however. | | | | | | | |
| 7 | Oct 10, 2014 6:22 PM | They perform math tutoring once a week in another room. | | | | | | | |
| 8 | Oct 10, 2014 4:05 PM | Maybe once a year. | | | | | | | |
| 9 | Oct 10, 2014 1:16 PM | They listen to student project presentations and give feedback once a year. This replaces our science fair. | | | | | | | |
| 10 | Oct 7, 2014 9:51 PM | For Supercomputing Challenge and Botball | | | | | | | |
| 11 | Oct 7, 2014 4:27 AM | 1 or 2 but I would more if I have a list or access to more. | | | | | | | |
| 12 | Oct 6, 2014 3:46 PM | 3-4 times a year | | | | | | | |
| 13 | Oct 6, 2014 3:31 PM | Occasionally through the years | | | | | | | |

| If you have used scientists and engineers in the past as volunteers, how would you rate the following statements? | | | | | | | | |
|---|-------------------|----------|----------------------------|-------|----------------|-----|----------------|----------------|
| Answer Options | Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree | N/A | Rating Average | Response Count |
| It was a great experience. | 1 | 0 | 2 | 13 | 40 | 20 | 4.54 | 77 |
| Some are better than others | 0 | 3 | 5 | 30 | 18 | 21 | 4.13 | 77 |
| They were prepared | 0 | 0 | 4 | 27 | 24 | 19 | 4.36 | 74 |
| They seem dry and boring | 15 | 20 | 16 | 2 | 3 | 22 | 2.25 | 78 |
| They really got my students excited about science, technology, engineering and math. | 1 | 1 | 8 | 29 | 19 | 20 | 4.10 | 78 |
| They provided good information about how my classroom STEM education is used in Industry. | 0 | 3 | 7 | 28 | 16 | 23 | 3.91 | 79 |
| Guest scientist and engineers help me meet Next Generation Science Standards or Common Core Standards. | 1 | 3 | 16 | 16 | 16 | 28 | 3.83 | 80 |
| <i>answered question</i> | | | | | | | | 84 |
| <i>skipped question</i> | | | | | | | | 17 |

Additional Science and Engineering Survey Results/Raw Data

| AFRL Scientist and Engineer Survey | | | |
|--------------------------------------|------------------|----------------|--|
| Which best describes your occupation | | | |
| Answer Options | Response Percent | Response Count | |
| Scientist or Engineer with RV | 44.4% | 20 | |
| Scientist or Engineer with RD | 55.6% | 25 | |
| Other (please specify) | | 6 | |
| <i>answered question</i> | | 45 | |
| <i>skipped question</i> | | 6 | |
| | | | |

| Number | Response Date | Other (please specify) | Categories | | |
|--------|----------------------|---|------------|--|--|
| 1 | Nov 6, 2014 2:51 AM | RV | | | |
| 2 | Nov 3, 2014 7:45 PM | ex-scientist, now working HR | | | |
| 3 | Oct 30, 2014 7:28 PM | non-technical program management and analysis | | | |
| 4 | Oct 30, 2014 6:25 PM | Technician/Support with RD | | | |
| 5 | Oct 17, 2014 6:18 PM | Contractor | | | |
| 6 | Oct 9, 2014 8:21 PM | AFRL Contractor | | | |

| AFRL Scientist and Engineer Survey | | |
|---|------------------|----------------|
| Have you ever been involved with the AFRL La Luz Academy? | | |
| Answer Options | Response Percent | Response Count |
| Yes | 41.2% | 21 |
| No | 58.8% | 30 |
| <i>answered question</i> | | 51 |
| <i>skipped question</i> | | 0 |

| AFRL Scientist and Engineer Survey | | | | | | |
|---|------------------|------------------------|------------|--|--|--|
| If you have been involved, which type(s) of services have you participated in? | | | | | | |
| Answer Options | Response Percent | Response Count | | | | |
| I have volunteered at an event or events. (AFRL La Luz Rocket Launch, Mars event, etc...) | 34.1% | 14 | | | | |
| I have participated as a mentor. (Robotics, STEM challenge, STARBASE 2.0) | 22.0% | 9 | | | | |
| I have been a guest speaker in an AFRL La Luz classroom. | 7.3% | 3 | | | | |
| I have used materials from the AFRL Lending Library for a school or outreach event. | 12.2% | 5 | | | | |
| N/A | 41.5% | 17 | | | | |
| Other (please specify) | 14.6% | 6 | | | | |
| <i>answered question</i> | | 41 | | | | |
| <i>skipped question</i> | | 10 | | | | |
| | | | | | | |
| Number | Response Date | Other (please specify) | Categories | | | |

| | | |
|---|-----------------------|--|
| 1 | Nov 6, 2014 2:51 AM | Mars |
| 2 | Oct 31, 2014 12:56 PM | I have supported my children in attending and encouraged the school that my kids attend to participate in La Luz Academy events. |
| 3 | Oct 30, 2014 9:56 PM | in the past, I have done adjunct teaching positions and received excellent student reviews |
| 4 | Oct 30, 2014 5:50 PM | volunteered several years ago for Science Fair Judge and mentor projects through AIAA |
| 5 | Oct 27, 2014 6:03 PM | supported child participating in La Luz Rocket Launch and Mars event. |
| 6 | Oct 27, 2014 6:02 PM | Used Legos for outreach event |

| AFRL Scientist and Engineer Survey | | |
|--|------------------|----------------|
| In the past year, how often have you volunteered in any setting? | | |
| Answer Options | Response Percent | Response Count |
| 1-5 times | 52.0% | 26 |
| 5-10 times | 10.0% | 5 |
| More than ten 10 | 20.0% | 10 |
| none | 18.0% | 9 |
| <i>answered question</i> | | 50 |
| <i>skipped question</i> | | 1 |

| AFRL Scientist and Engineer Survey | | |
|--|------------------|----------------|
| In the past year, how often have you volunteered in a K-12 educational setting or worked with K-12 students? | | |
| Answer Options | Response Percent | Response Count |
| 1-2 times | 27.5% | 14 |
| 3-5 times | 9.8% | 5 |
| 5-10 times | 3.9% | 2 |
| More than ten times | 13.7% | 7 |
| none | 45.1% | 23 |
| <i>answered question</i> | | 51 |
| <i>skipped question</i> | | 0 |

| AFRL Scientist and Engineer Survey |
|------------------------------------|
|------------------------------------|

| Think about the times you were able to volunteer with K-12 students. How would you rank the following statements? | | | | | | | | |
|---|-------------------|----------|----------------------------|-------|----------------|--------------------------|----------------|----------------|
| Answer Options | Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree | N/A | Rating Average | Response Count |
| It was a very easy process. | 0 | 2 | 7 | 16 | 8 | 17 | 3.91 | 50 |
| I felt my time was appreciated when I volunteered with students. | 0 | 2 | 0 | 16 | 15 | 17 | 4.33 | 50 |
| I enjoyed my time volunteering. | 0 | 1 | 1 | 12 | 19 | 17 | 4.48 | 50 |
| I felt prepared to volunteer in an educational setting. | 0 | 1 | 4 | 14 | 11 | 19 | 4.17 | 49 |
| I plan on volunteering again. | 0 | 0 | 1 | 13 | 19 | 16 | 4.55 | 49 |
| | | | | | | <i>answered question</i> | | 50 |
| | | | | | | <i>skipped question</i> | | 1 |

| AFRL Scientist and Engineer Survey | | | | | | | |
|---|------------------|--------------------------|-----------|--|--|--|--|
| If you are not volunteering in any K-12 school settings, which of the following statements describes why. | | | | | | | |
| Answer Options | Response Percent | Response Count | | | | | |
| I'm too busy with work. | 62.5% | 20 | | | | | |
| I haven't been given many opportunities to volunteer. | 6.3% | 2 | | | | | |
| It seems like a lot of work. | 12.5% | 4 | | | | | |
| I don't see a need for my expertise. | 6.3% | 2 | | | | | |
| It hasn't occurred to me to volunteer. | 0.0% | 0 | | | | | |
| My organization frowns upon non work related activities. | 3.1% | 1 | | | | | |
| I wouldn't know what to do. | 15.6% | 5 | | | | | |
| I am volunteering in schools. | 25.0% | 8 | | | | | |
| Other (please specify) | | 16 | | | | | |
| | | <i>answered question</i> | 32 | | | | |
| | | <i>skipped question</i> | 19 | | | | |
| | | | | | | | |

| Number | Response Date | Other (please specify) | Categories | | | | | |
|--------|-----------------------|--|------------|--|--|--|--|--|
| 1 | Nov 3, 2014 7:45 PM | need more volunteer activities outside normal business hours! | | | | | | |
| 2 | Oct 31, 2014 4:25 PM | My current expertise and job responsibilities are not something that can be interesting to students. (I am basically a staff wienie--how interesting is that to students?) | | | | | | |
| 3 | Oct 30, 2014 10:32 PM | The need in schools is obviously huge. I worry about it becoming a major commitment of time and energy beyond my ability to follow through effectively. | | | | | | |
| 4 | Oct 30, 2014 9:56 PM | I think better volunteering at undergraduate level for students from small colleges | | | | | | |
| 5 | Oct 30, 2014 9:26 PM | 1) Busy volunteering in other capacities 2) Not sure of how to go about volunteering | | | | | | |
| 6 | Oct 30, 2014 8:17 PM | I volunteer in other venues. | | | | | | |
| 7 | Oct 30, 2014 7:36 PM | I volunteer after work, because there is no JON for doing it during work. | | | | | | |
| 8 | Oct 30, 2014 7:14 PM | often times volunteer opportunities do not fit with my work scheduled meetings/travel | | | | | | |
| 9 | Oct 30, 2014 6:03 PM | I primarily volunteer with undergrad and graduate students | | | | | | |
| 10 | Oct 30, 2014 6:01 PM | My typical work "crises" and TDYs seem to coincide a fair bit right now with the opportunities that come up for some sort of volunteer activity. | | | | | | |
| 11 | Oct 30, 2014 5:50 PM | Already volunteering time for NFS sponsored collage STEM activities | | | | | | |
| 12 | Oct 30, 2014 5:37 PM | Too busy and lack of interest | | | | | | |
| 13 | Oct 30, 2014 4:25 PM | Time & effort commitment; out of comfort zone | | | | | | |
| 14 | Oct 29, 2014 12:30 AM | There is no reward for volunteering; to change that, there has to be a JON to charge to, and CCS has to include a phrase suggesting that it is considered a contribution. | | | | | | |
| 15 | Oct 27, 2014 6:41 PM | Too much emphasis appears on activities other than work. | | | | | | |
| 16 | Oct 24, 2014 12:33 AM | I'd love to volunteer, but my unit still expects a high level of production, regardless of "other pursuits". So theoretically, the org supports STEM outreach, but the reality is there's just no way to accomplish both high production and volunteer. So in essence, my unit really doesn't really value STEM as much as they might articulate. | | | | | | |



New Mexico Tech Master of Science for Teachers

Bridging the Gap between STEM Professionals and K-12 Education

Esti Gutierrez

Candidate for Master of Science for Teachers



Introduction

Purpose:

This study attempted to identify factors preventing more collaboration between K-12 educators and STEM professionals at the Air Force Research Laboratory.

A Demonstration Lending Library was created to encourage STEM Professionals from AFRL to interact more with students in grades K-12.

- It was hypothesized that STEM professional and teacher collaboration is minimal due to lack of time and resources.
- If an outreach program is developed that is able to address scientist's and engineer's concerns, then they will be more willing to volunteer in K-12 educational settings, thus exposing students to STEM careers.



Literature Review

Who is working in STEM?

- 6% of the Black workforce
- 7% of the Hispanic workforce
- 0.4% of the Native American workforce
- 26% of Women
- 71% of all STEM jobs held by white non-Hispanic workers.

(NSF,2013)

Why Not?

- Parental Influence
- Usefulness
- Lack of relevance
- Lack of confidence
- Lack of role models
- Negative perceptions



Literature Review (cont.)

Five current finding that states are addressing:

- Inconsistent standards in math and science
- Lack of qualified teachers
- Failure to motivate students in STEM fields
- Lack of preparation for colleges
- Failure of colleges and universities to meet STEM job needs.





Literature Review (cont.)

Why volunteerism to address the problem?

- Meets reform models
- Low cost for states
- Addresses many of the social factors associated with lack of interest in STEM Careers
- Real people making a difference and demystifying STEM careers
- Classroom teachers may gain more technical knowledge and are able to make connections between the subjects they teach and real world application of content



Methods

Mixed Methods Study

- Qualitative and quantitative survey of both STEM Professionals at AFRL & Teachers

Teacher Survey

The Institutional Review Board for the Protection of Human Subjects at NM Tech has reviewed and approved this research project. By completing this survey, you agree to participate in this project. Your participation in this research project is strictly voluntary and you may choose not to participate by simply not completing the survey. You may also refuse to answer specific questions on the survey if you so desire. If you have any questions or concerns about this survey's questionnaires, please contact the researcher at 505-534-3640 or the New Mexico Tech IRB Administrator at 575-835-5550.

1. What grade do you currently teach?

Primary K-5

Middle 6-8

Secondary 9-12

Other (please specify): _____

2. How often do you use volunteers in your classroom in a typical year?

Never

Occasionally/once or twice a year

Once a month

Once a week

Every day

3. If you use volunteers, which best describes their role in your classroom/school.

Parents of students assist with classroom activities.

Professionals in guest appearances/classes.

N/A

Other (please specify): _____

Page 1

AFRL Scientist and Engineer Survey

5. In the past year, how often have you volunteered in a K-12 educational setting or worked with K-12 students?

12 times

5-11 times

4-3 times

More than ten times

None

6. Think about the times you were able to volunteer with K-12 students. How would you rank the following statements.

| | Strongly Disagree | Disagree | Neither Disagree nor Agree | Agree | Strongly Agree | N/A |
|---|-----------------------|-----------------------|----------------------------|-----------------------|-----------------------|-----------------------|
| It took a very long process. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I felt my time was appreciated and valued. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I enjoyed my time volunteering. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I felt prepared to volunteer in an educational setting. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I spent on volunteering. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

7. If you are not volunteering in any K-12 school settings, which of the following statements describes why.

I'm too busy with work.

I haven't been given many opportunities to volunteer.

It seems like a lot of work.

I don't see a need for my expertise.

It hasn't occurred to me to volunteer.

My organization focuses upon non-work related activities.

I wouldn't know what to do.

I am volunteering in schools.

Other (please specify): _____

Page 2

5. If you are not using professional scientists and engineers working in the field, which statements best describe why.

I don't have time.

I don't see the relevance to what I teach.

I have had too experience in the past and volunteer science and engineers.

I don't have time to find or arrange for them to be in my classroom.

N/A

Other (please specify): _____

6. If you have used scientists and engineers in the past as volunteers, how would you rate the following statements.

| | Strongly Disagree | Disagree | Neither Disagree nor Agree | Agree | Strongly Agree | N/A |
|---|-----------------------|-----------------------|----------------------------|-----------------------|-----------------------|-----------------------|
| It was a great experience. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Some are better than others. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They were prepared. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They were fun and boring. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They really got my students excited about science, technology, engineering and math. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| They provided good information about how my classroom STEM education is used in industry. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Guest scientists and engineers help us meet Next Generation Science Standards or Common Core Standards. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

The Institutional Review Board for the Protection of Human Subjects at NM Tech has reviewed and approved this research project. By completing this survey, you agree to participate in this project. Your participation in this research project is strictly voluntary and you may choose not to participate by simply not completing the survey. You may also refuse to answer specific questions on the survey if you so desire. If you have any questions or concerns about this survey's questionnaires, please contact the researcher at 505-534-3640 or the New Mexico Tech IRB Administrator at 575-835-5550.

1. Which best describes your occupation?

Scientist or Engineer with BS

Scientist or Engineer with MS

Other (please specify): _____

2. Have you ever been involved with the La Luz Academy?

Yes

No

3. If you have been involved, which type of services have you participated in?

I have volunteered at an event or activity (STEM, field-based, etc. event, etc.)

I have volunteered as a teacher, librarian, STEM challenge, STEMBS 1-2.

I have been a guest speaker in a La Luz classroom.

I have used materials from the AFRL Lending Library for a school or outreach event.

N/A

Other (please specify): _____

4. In the past year, how often have you volunteered in any setting?

12 times

5-11 times

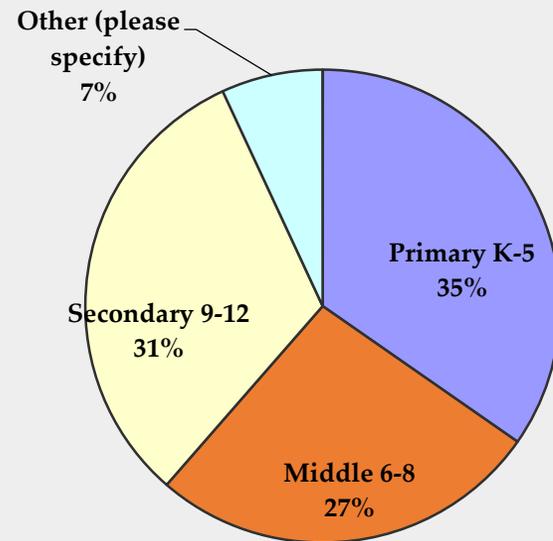
More than ten times

None

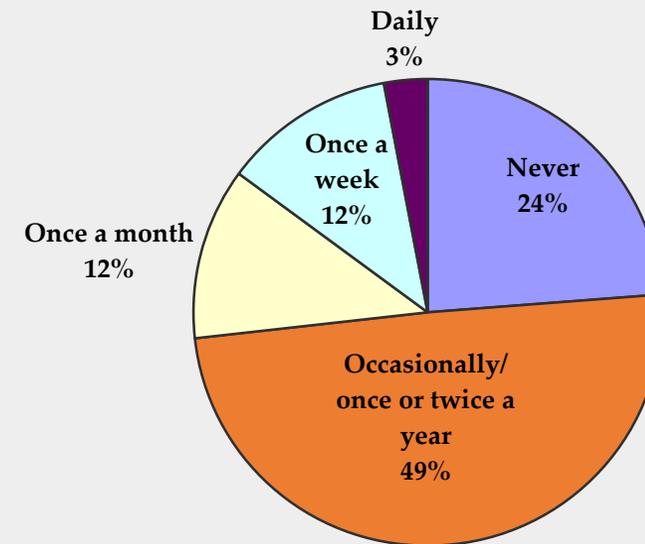


Outcomes

What grade do you currently teach?



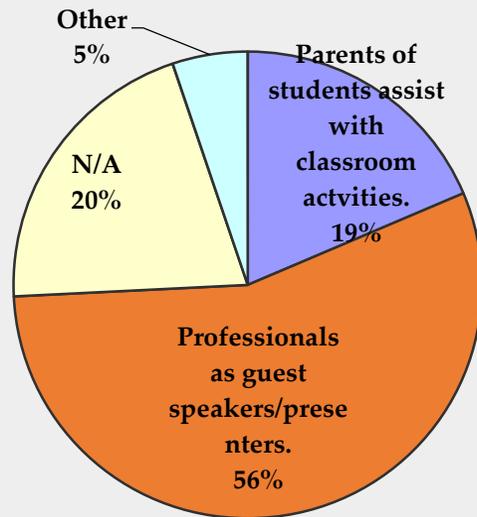
How often do you use volunteers in your classroom in a typical year?



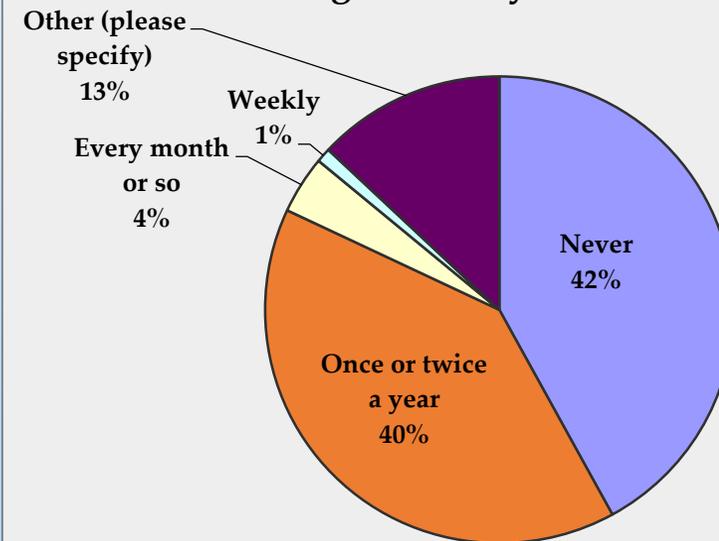


Outcomes (cont.)

If you use volunteers, which best describes their role in your classroom/school.



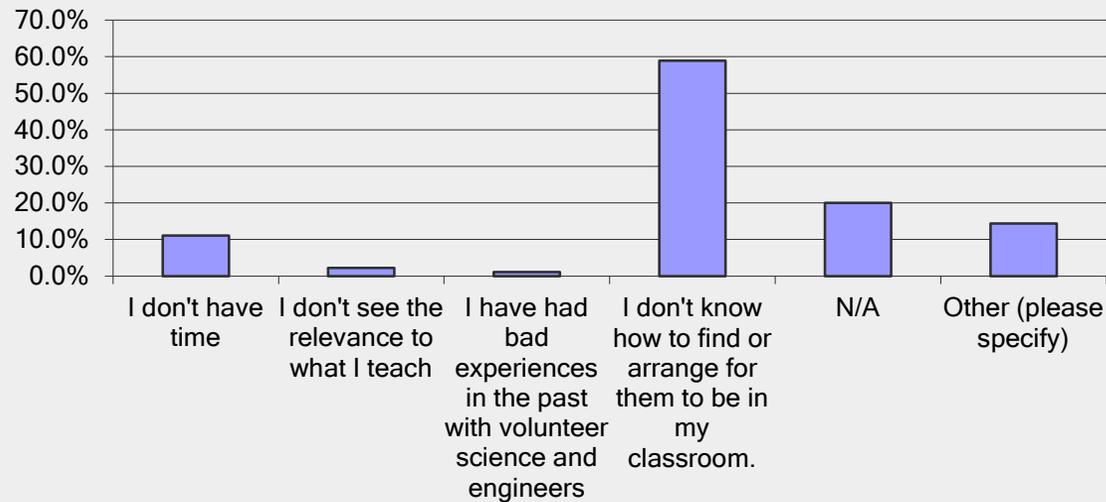
How often do you use professional scientists and engineers in your classroom?



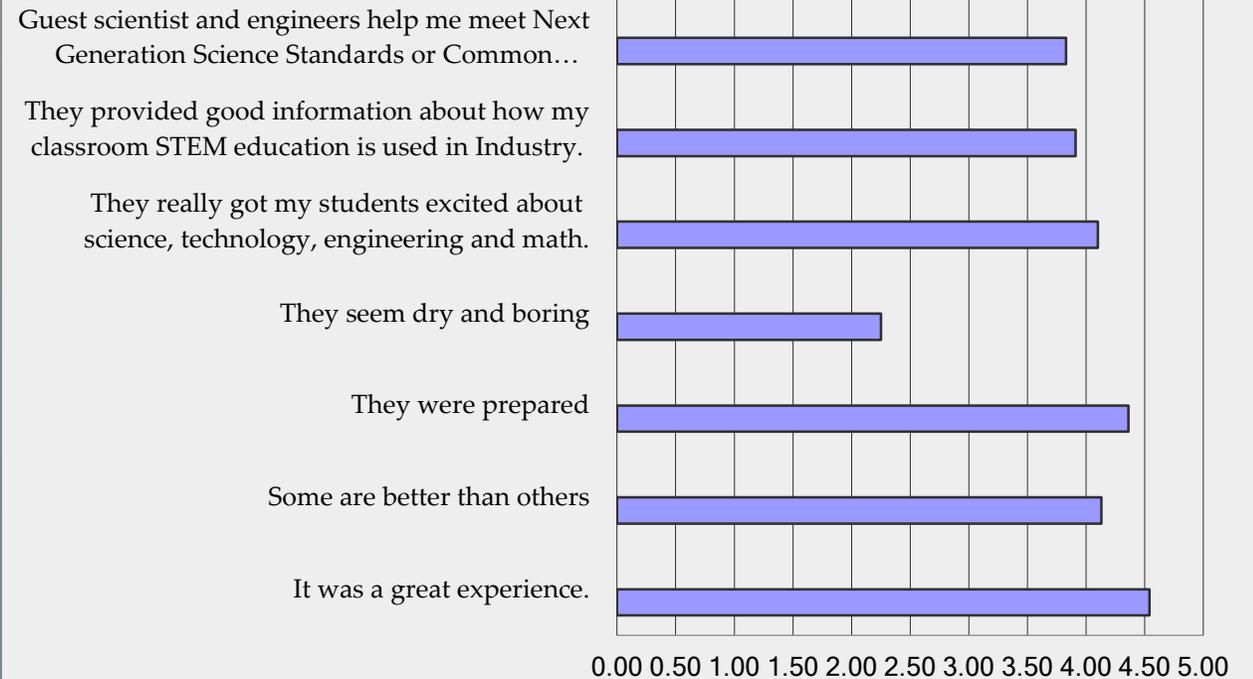


Outcomes (cont.)

If you are not using professional scientists and engineers working in the field, which statements best describe why.



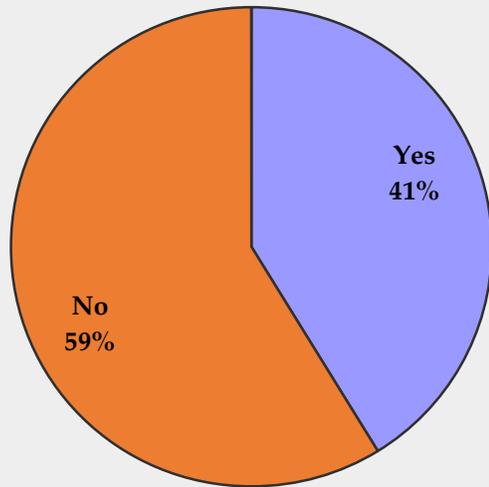
If you have used scientists and engineers in the past as volunteers, how would you rate the following statements.



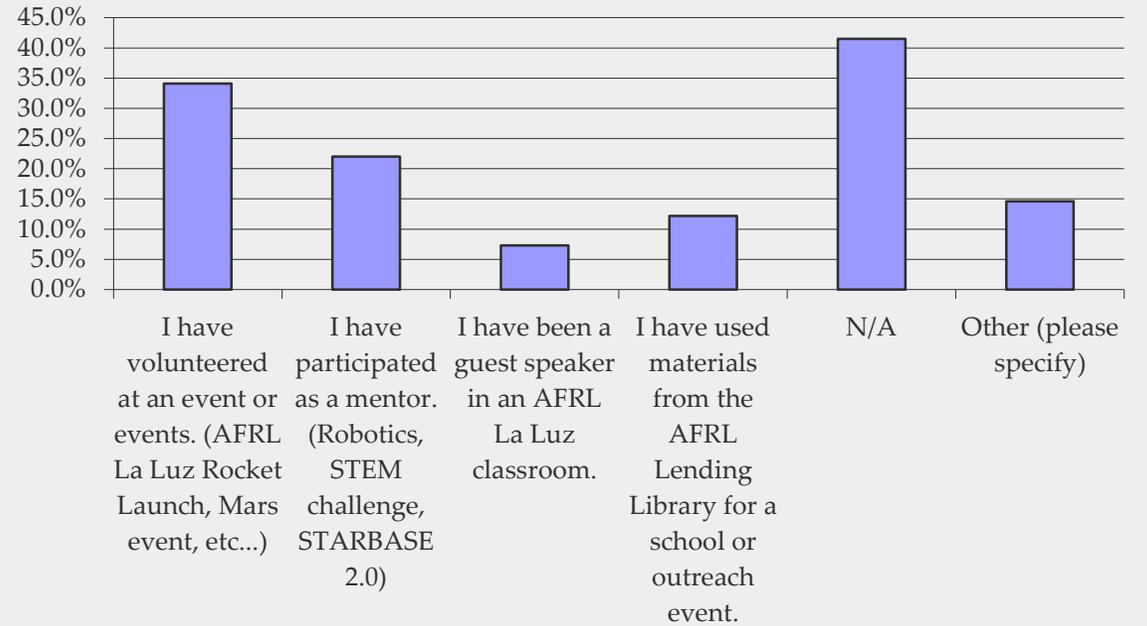


Outcomes (cont.)

Have you ever been involved with the AFRL La Luz Academy?



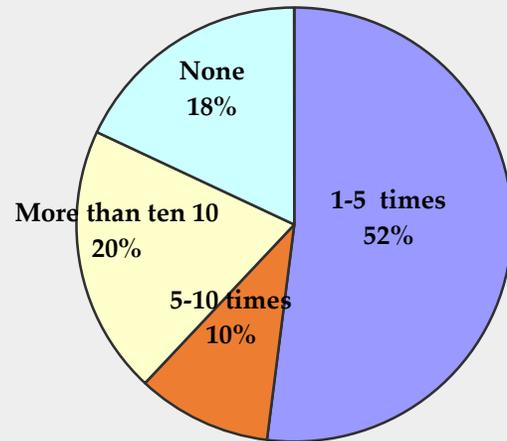
If you have been involved, which type(s) of services have you participated in?



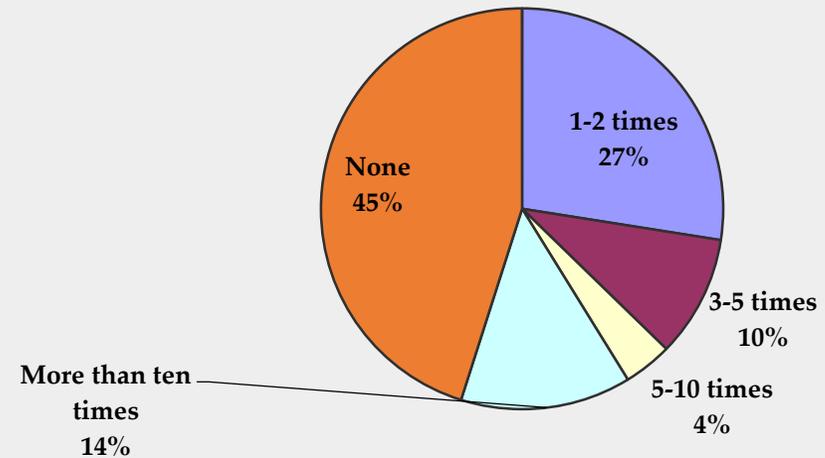


Outcomes (cont.)

In the past year, how often have you volunteered in any setting?

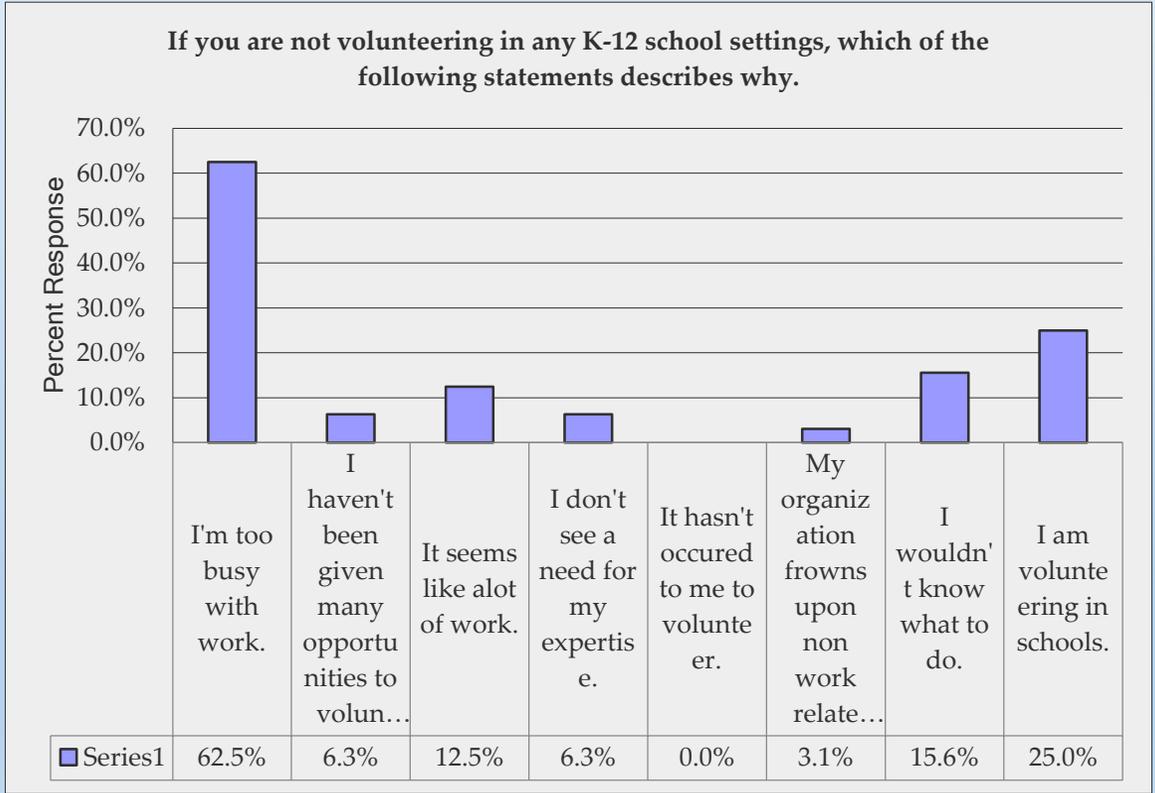
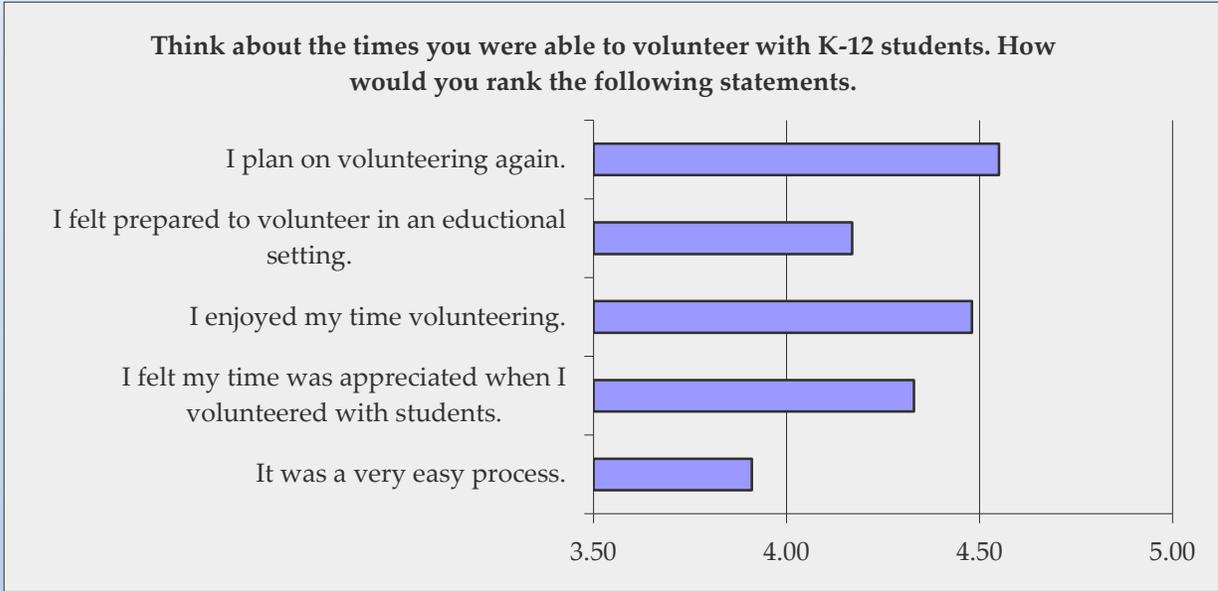


In the past year, how often have you volunteered in a K-12 educational setting or worked with K-12 students?





Outcomes (cont.)

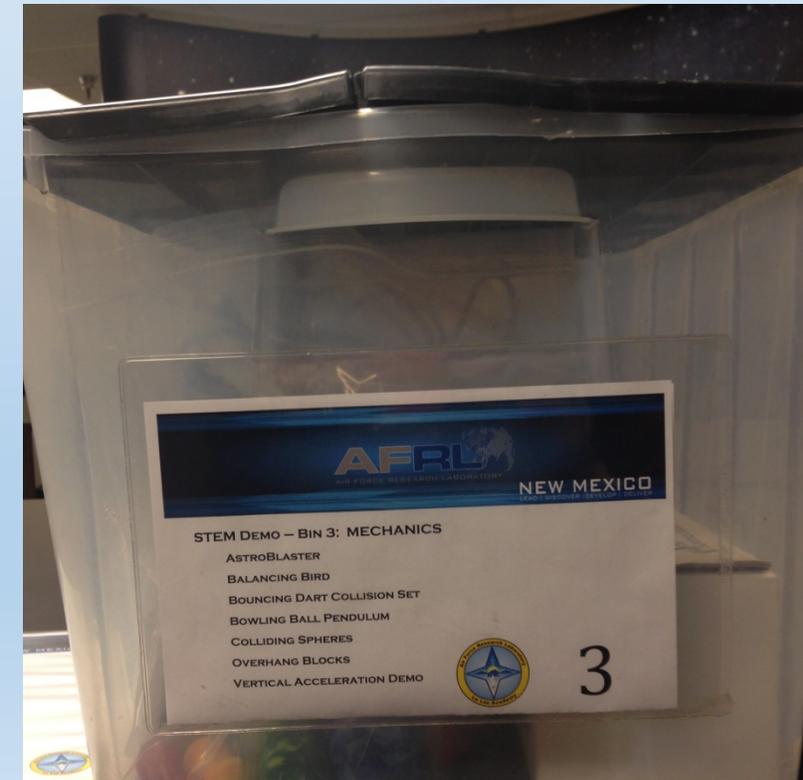
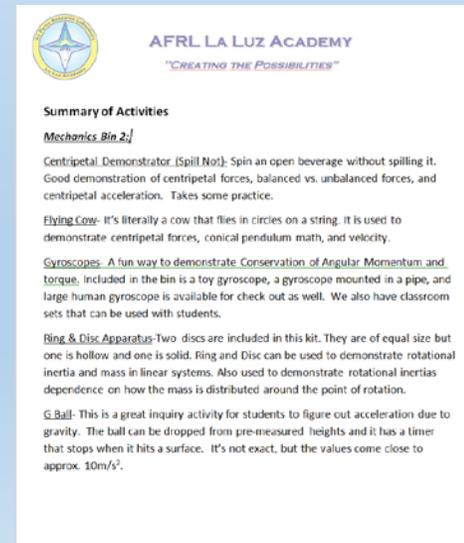
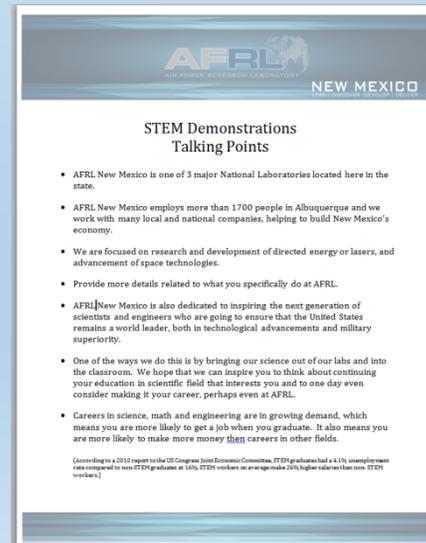
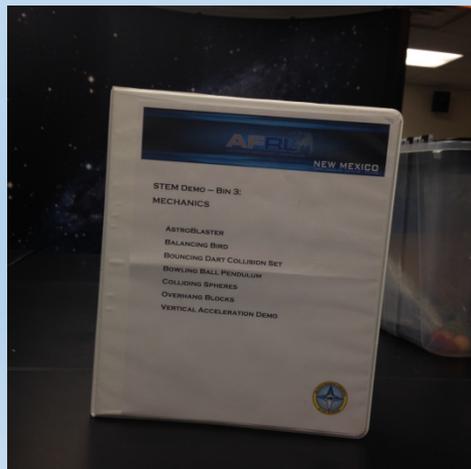




Methods Part 2

AFRL STEM Demonstration Lending Library Developed

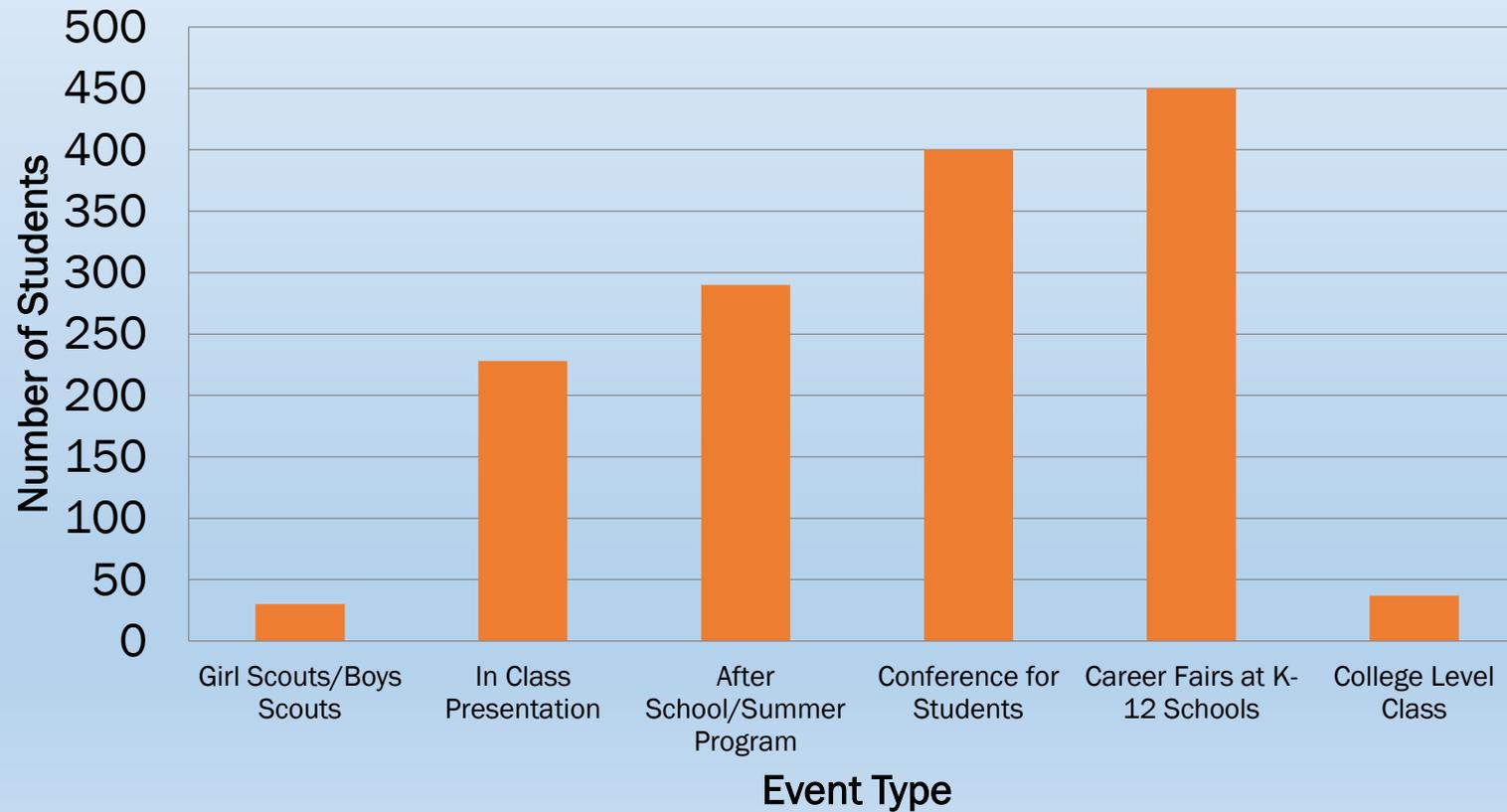
- Physics based
- 98 physics based demonstrations in mechanics, thermodynamics, electromagnetism and electricity, and sound and light.





Outcomes Part 2

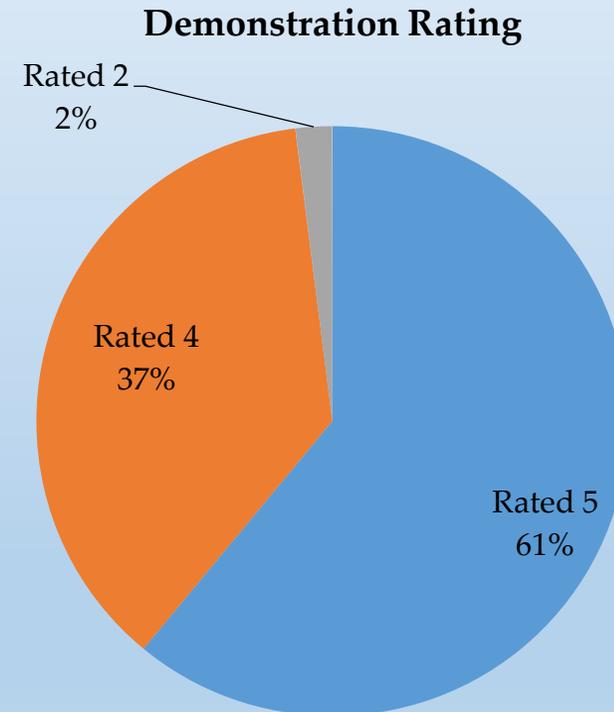
Number of Students Impacted by Event Type April 2014-2015





Outcomes Part 2 (cont.)

Survey results for demonstration rating
1-5, 5 being best.





Conclusions

Further work needs to be done to encourage more STEM professionals from AFRL to volunteer and share their experiences to encourage youth to pursue science and engineering careers.

The AFRL STEM Demonstration Lending Library will continue to evolve to meet the needs of our organization.



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