Board 150: AFRL Career STREAM Implementation at NMT (Work in Progress)

Destiny J. Crawford, New Mexico Tech Mechanical Engineering Department

Destiny Crawford is a current graduate student at New Mexico Tech studying Chemical Engineering for a Master's of Engineering degree. She was a pathways mentor during the Summer 2022 AFRL Career STREAM apprenticeship program in the Mechanical Engineering Department.

Jett C. Emms, New Mexico Institute of Mining and Technology

Jett Emms is a current Graduate student at the New Mexico Institute of Mining and Technology in Socorro New Mexico working towards a PhD in Mechanical Engineering with a dissertation in intelligent energetic systems centered around shock physics. Jett has been working on the NMT Robotic Combat STEM Outreach team since early 2020 and has helped the program grow.

Raechelle Sandoval

Raechelle Sandoval is a graduate student at New Mexico Institute of Mining and Technology, working on a PhD in Intelligent and Energetic Systems. She has been a teachers assistant for the Intro to Mechanical Engineering course for three years.

Dr. Curtis John O'Malley, New Mexico Institute of Mining and Technology

Assistant Prof at NM Tech since 2016. Teach junior/senior design clinic as well as 1st semester introduction to mechanical engineering design. As part of these courses I work closely with national labs and industry to maintain course projects with real

AFRL Career STREAM implementation at NMT (Work in Progress)

Abstract

The New Mexico Institute of Mining and Technology (NMT) partnered with the Air Force Research Laboratory (AFRL) to provide a STEM experience for late-year high school students. This paper will evaluate the program in terms of implementation, results of apprentice growth, and lessons learned. The AFRL NM Career STREAM program aims to provide an industrial environment on a college campus, demonstrating what a career would be like, to apprentices coming from rural New Mexico and other underserved groups. The paid apprenticeship allows students to conduct research in various STEM related topics on a college campus under the mentorship of college students. The program is geared towards underserved and underrepresented groups that may have fewer science and engineering opportunities in their area. Every college campus has mentors that oversee the apprentices' day to day progress on a STEM related research project developed by the mentors. The program sought to train the mentors to run a research project by identifying a topic, setting the parameters, and managing the project. The NMT campus mentors focused on a research topic related to robotics. These mentors had four weeks before the apprentices came onto the campus to plan how to assist the apprentices in finishing a college level project. Apprentices were challenged to work in two teams of six to seven to design and code an autonomous robot that mapped a given area (Team 1) and retrieve a payload in said area (Team 2). The program lasted a total of six weeks where the teams learned and implemented skills needed to complete the above challenges. Within each week, a pathways mentor would coordinate a presentation on how to manage in a professional environment. The pathways mentor also organized guest speakers to present on topics related to their field. The apprentices filled out pre and post surveys for AFRL to keep track of the performance of the program. Apprentices showed growth in skill, self efficacy, and a sense of belonging in STEM.

About AFRL

The Air Force Research Laboratory (AFRL) is the main center for research and development for the Department of the Air Force. This division of the Air Force focuses on developing new technology and processes for air, space, and cyberspace. In 2021, AFRL launched a new research opportunity, AFRL Career STREAM, targeted towards highschoolers from underserved parts of New Mexico [1]. This is a paid apprenticeship and mentorship program. The apprenticeship provides highschoolers the opportunity to work on a research project on a college campus. College students act as mentors and program managers to guide the apprentices on how to tackle a project and learn tips on how to be a college student along the way. There are two kinds of mentors, a pathways mentor and project mentors. The pathways mentor is tasked with helping the apprentices navigate their path into STEM and curating their own identity. The project

mentors are tasked with developing a project and guiding the apprentices on how to split up tasks and work on a team project. In the summer of 2022, five mentors from NMT led this program. This paper shares details about how the program was managed, reporting both successes and lessons learned during the program.

The Hiring Process

AFRL takes care of all the hiring processes for both the apprentices and the mentors. They also do most of the advertising for the program. For the apprenticeship advertisement, a flier is sent to highschools across the state and is listed on the AFRL website. For the mentorship here at NMT, they got into contact with professors to see who was interested in running the program and acquiring mentors. The application for the position is online. Once mentors and apprentices have applied, there is an interview held to get to know the person applying and to make sure the standards of the program are understood. Overall, there were three campuses participating in Summer 2022, NMT, UNM, and UTEP. Each campus had their own set of mentors composed of students from that college. There were five open positions for mentors at each location and sixteen apprentice positions at each location.

The apprentices were responsible for getting themselves on campus everyday. Most of the apprentices on NMT campus were part of another program that either housed them in the dorms or paid for travel. A typical day was 8am- 5 pm with one hour for lunch. And while on campus, they would work off of computers provided by AFRL.

Overview of 2022 Summer Program

The goal of this program is to create a project for highschoolers which can be completed in six weeks.This was the second year of the program, the first year was all remote due to Covid-19. Program mentors were four mechanical engineering students and one chemical engineering student. The mentors selected two autonomous robotics projects. The apprentices were split up into two groups of six to seven, where Team 1 would design a robot to map a given area and Team 2 would design a retrieval robot to use the data from the mapping robot. The goal of these autonomous robots is that the robots can map and retrieve objects in areas that are too hazardous for humans. An example would be a highly radioactive area, thereby avoiding human exposure.

Along with the project, the apprentices listened to weekly pathways talks and talks from guest speakers. Presented topics included STEM Pathways, Team Building, and Mental Health and STEM. The guest speakers included the NMT Campus Principal Investigator (PI), Dr. O’Malley, a Sandia National Labs researcher, a Cybersecurity graduate student, NMT Admissions, and a Technical Communication professor in the NMT Mechanical Engineering department. The variety of guest speakers showed apprentices some of the options that are available to them in the STEM fields and especially here in New Mexico. In addition, the Technical Communication professor taught apprentices how to create and deliver a professional presentation.

On the NMT campus, there were interesting demographics among the thirteen apprentices. 77% of the apprentices were male and 23% were female. The vast majority of these students were Hispanic at 69%. The rest were 23% Caucasian and 7% Asian American. 62% of the apprentices were first generation college students and 47% were from a low income home.

Implementation

Prior to the apprentices arriving on campus, the mentors had four weeks to plan and take training through AFRL. They used Canvas, a course management platform, to complete training and upload curriculum plans. The project mentors split into teams of two to work on their project ideas. The pathways mentor used this time to coordinate and schedule guest speakers. All together, they worked as a team to make sure ideas aligned and were relevant to the program. Everyone was pretty nervous for the apprentices to show up as some of them were not used to teaching or working with high school students. Mentors shared concerns that the projects were either too hard, leading to uncompleted projects, or too easy, which would lead to the apprentices being bored. At the end of the program, they realized there was no need to be scared and that they were able to make a positive impact on the apprentices.

The AFRL program provided the apprentices with some basic STEM training through Canvas that included Onshape,a modeling software, and Arduino,a coding software. The training also included basic data retrieval tips and spreadsheet usage. The NMT mentors required the apprentices to go through this training for the first week they were at NMT since they would need these skills for their project. As for the project, the apprentices were tasked with appointing team leads and safety officers for each team. Then, they began researching their projects on their own and designing their robots. Each team broke up into smaller sections to split up the work, these sub-teams were devoted to modeling, wiring, and coding.

The apprentices were given access to the mechanical engineering 3D printing farm to print the body and parts they designed in Onshape. This program allowed for nice looking parts and creative freedom for the design. In regards to wiring and coding, the apprentices were able to find online resources to use as a starting point and get help from the mentors when they were stuck.

Every Friday the mentors had the apprentices present the week’s completed work to all of the mentors and the other team. These intermittent presentations helped a lot when it came to the final presentation, as the apprentices were more comfortable talking about their project in front of an audience. A Technical Communication professor attended one of the Friday presentation sessions near the end of the program to give apprentices tips on revising their presentation.

Results

Through the basic STEM training on Canvas, the apprentices learned the basic skills of coding and modeling. The mentors added some supplementary tools to help the apprentices achieve their goals in the project and were available for questions when needed. For the most part, the apprentices were on their own to do the research needed for the project. All apprentices showed growth in understanding how to conduct research and perform STEM tasks, as well as social skills like working in a team. On the Canvas page the apprentices completed pre and post surveys provided by AFRL so AFRL could assess the program's success and the progress of the apprentices. The questions and answers from those surveys are shown in the appendix on a Likert scale. The AFRL team did a statistical analysis of the responses, concluding that the apprentices had a growth of .40 in self efficacy and a growth of .31 in sense of belonging in STEM on a Likert scale. There were a few questions about how important the apprentices felt while working on a team and if their opinions were taken into consideration. The vast majority of these answers were yes, they felt important on the team and that their voices were heard.

Both teams successfully created working robots by the end of the six weeks and delivered a presentation to an audience including AFRL administrative staff, the program mentors, the Campus PI, and multiple NMT administrators and faculty. The apprentices each participated in their team's presentation, and their delivery was very professional. When asked "Would you recommend this program to other people?" most of the apprentices said yes. They went on to explain that even if the project content wasn't necessarily what they would consider for a future career, it was a good experience. Apprentices noted appreciating the opportunity to see how college research works and learning to work as a team. They also explained how they were able to work through communication challenges and collaborate with teammates to complete the project together. They learned important tools on team building, how to apply to college, what to look for when deciding on a path, and how to communicate properly on a project. Overall, the program seemed to be a success and the apprentices learned a lot about the professional world.

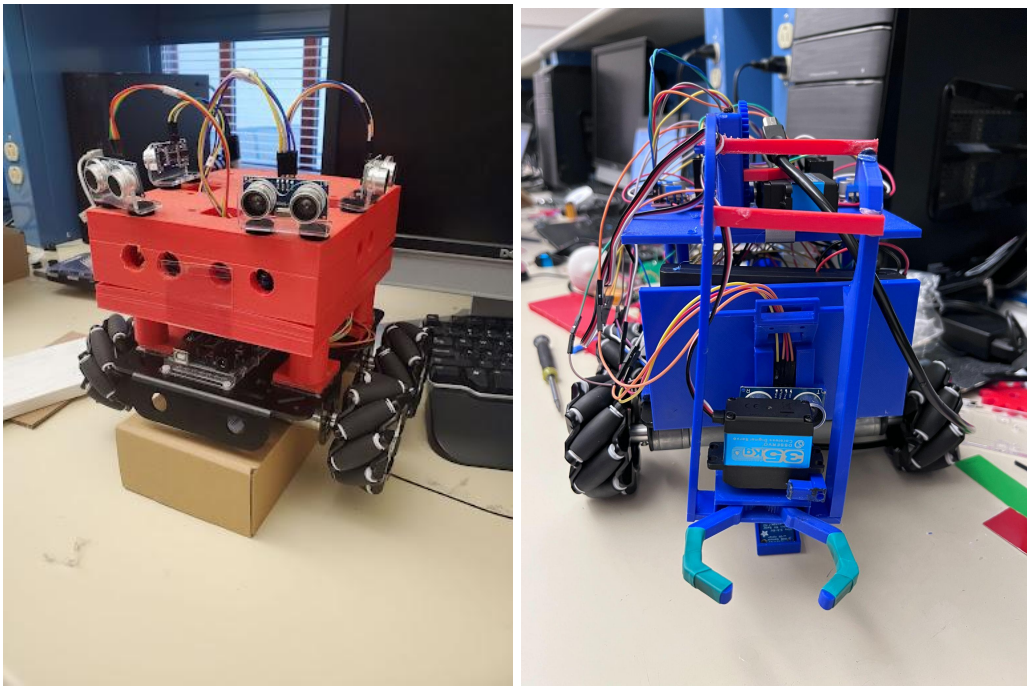


Figure 1: The finished robots of Team 1 (left) and Team 2 (right)

Lessons Learned

The basic framework of the AFRL worked and was helpful for the apprentices to gain a sense about what research entails. A few things the mentors noticed during the summer were the need for more Arduino training, conflict resolution training for the mentors, and fixing an issue with Canvas. The mentors have provided ARFL with our feedback from the program to help other mentors in the future.

The basic training AFRL put together for the students addressed basic needs but did not have quite enough content for our specific project. For instance, content included ‘making a light blink’ but it did not include more advanced components. To make up for the missing pieces, the mentors added a few assignments to help them with motor control and ultrasonic sensor work. But there was still a need to teach them how to create a code that others could read and follow. To achieve repeatable code, comments in the code matter greatly, and the mentors wish they had emphasized this importance more, especially when working in a group where others will read and use your code. Next year the mentors will explain to the apprentices how to comment their code effectively for others to use.

Upon reflection, it would have been helpful to have conflict resolution training for the mentors to better help the apprentice teams that were having interpersonal issues. Most issues were easy to handle but there were some more complex issues. The mentors did have weekly meetings with the AFRL supervisor which was helpful to get more insight on the situation and have another

opinion on how to move forward. Conflicts within a group will always come up and it was helpful having support from our supervisor.

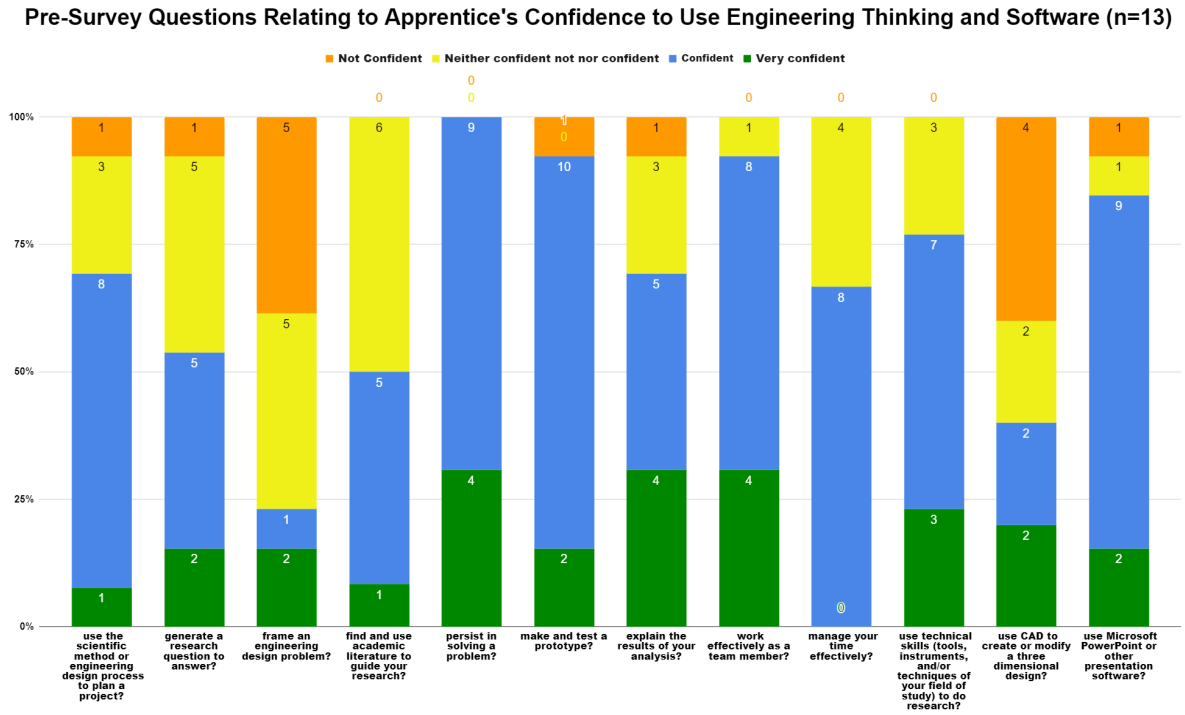
The last important thing we noticed is that AFRL had put all campuses in the same Canvas page, leading to other campuses accidentally deleting or hiding NMT materials. It would have been more effective to have separate Canvas pages for each campus so each institution's files remained intact.

Conclusion

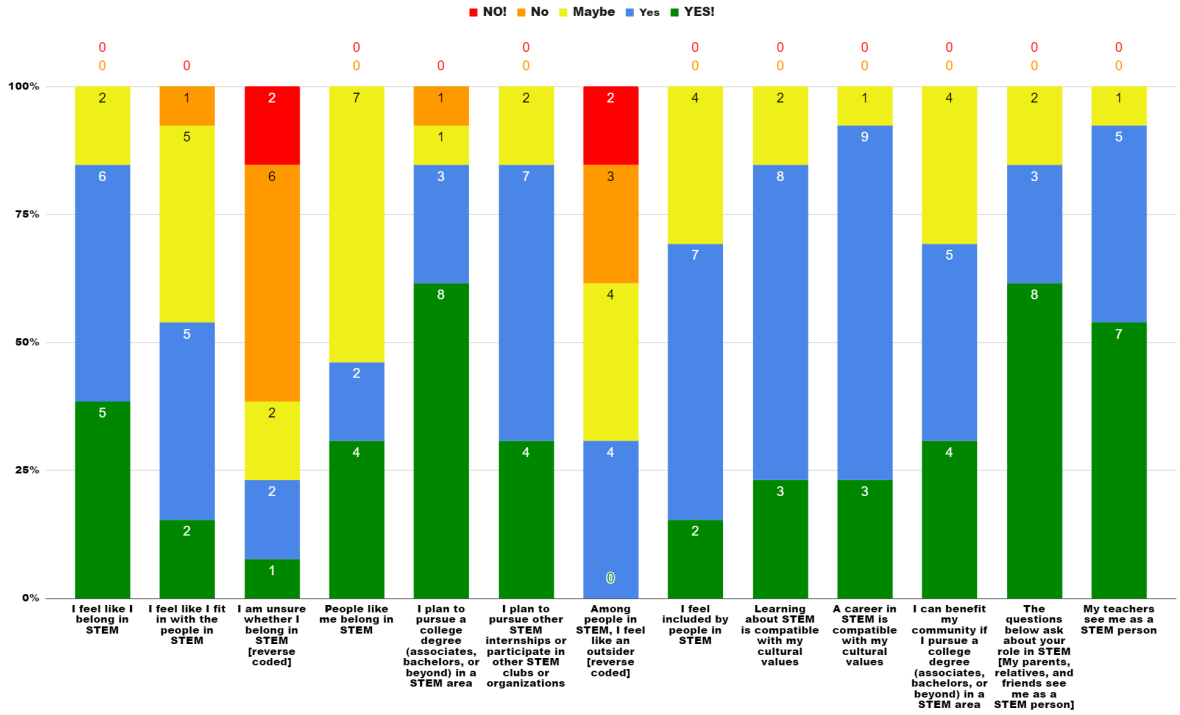
Overall, the experience was rewarding both for mentors and apprentices. The apprentices learned valuable STEM skills and teaming and communication skills through the experience. The mentors learned a lot about creating a project and how to manage a class. The program was very impactful on both sides. NMT hopes to work with AFRL more and even expand the reach of the program to include remote apprentices next summer. With the post surveys mentioned previously, the apprentices were asked how their experience in the program was. One of the apprentices stated "I had a great experience, especially going into this program with little to almost no knowledge but gaining that knowledge and putting that into the project". Others had said that they learned a lot and had gained a new appreciation for STEM research and themselves. An example of this growth was beautifully put by this quote "It was very eye opening and fun, I realized what my boundaries were and how I work in stressful situations, this program helped me a lot in becoming a better person". A majority of these apprentices are now looking into more engineering and science courses or programs that they can be a part of in the future.

Appendix

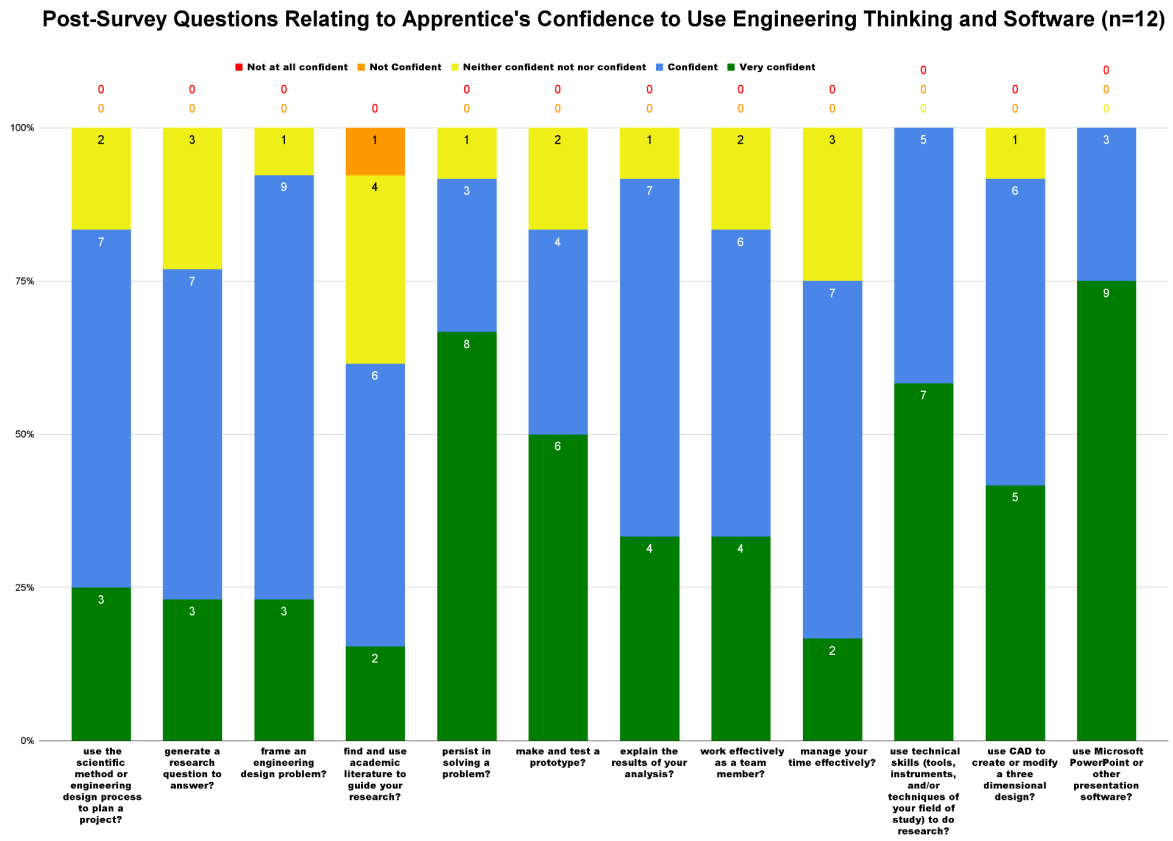
Pre-Survey Questions and Answers



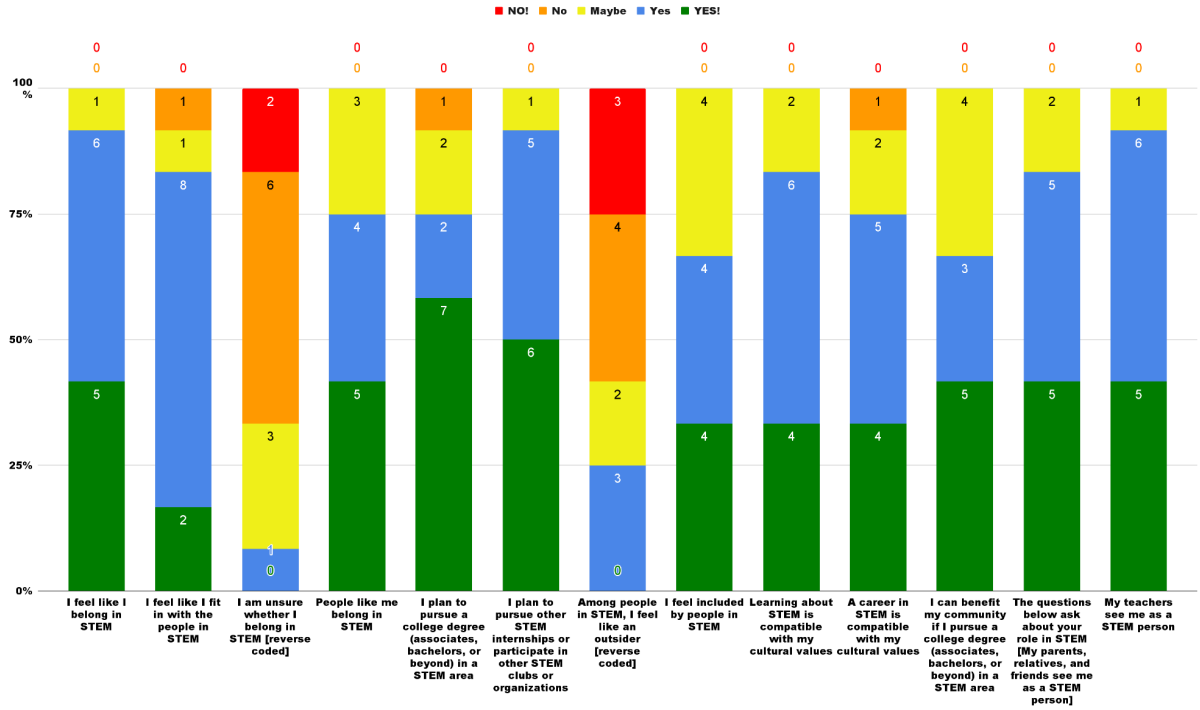
Pre-Survey Questions Relating to Apprentice's Belonging in STEM (n=13)



Post-Survey Questions and Answers



Post-Survey Questions Relating to Apprentice's Belonging in STEM (n=12)



References

[1] Ortiz, S. (2021, June 30). *Stem Academy builds career stream program to bring positive change in STEM Workforce*. ONE AFRL / TWO SERVICES. Retrieved December 8, 2022, from https://www.afrl.af.mil/News/Article/2675735/stem-academy-builds-career-stream-program-to-bring-positive-change-in-stem-work/