2018 JROTC STEM Leadership Academy

Progress Report & Initial Findings

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Executive Summary

Academy Overview

The 2018 JROTC STEM Leadership Academy was held on June 3rd-8th, 2018. The purpose of the six-day residential JROTC STEM Leadership Academy was to engage a unique population of high school students, primarily 9th and 10th grade JROTC Cadets, in STEM content, skills, and fields of study needed by business and industry today. The Academy is designed to increase awareness of good-paying STEM career opportunities in our area for Mobile's youth and what it takes to secure these jobs. Cadets participated in area industry and university field trips, interacting with scientists, engineers and technicians who are designing innovative solutions to industry and community problems. The STEM Academy includes leadership development, critical thinking, and STEM skills as Cadets solve team engineering-focused design challenges and complete rappelling and land navigation exercises. Industry and education leaders provide motivational talks each evening. The 2018 STEM Leadership Academy built upon and expanded the inaugural 2015 and 2016 Academies, this year focusing on the maritime industry in the Mobile region.

Participants

The Academy set the goal of serving 160 9th and 10th grade students for the 2018 Academy. The rosters included 168 names, however, as in past years there was some attrition due to illness and other personal circumstances. A total of 155 cadets participated in the Academy, representing all 12 Mobile County high schools plus Chickasaw and Satsuma high schools. Of these students, approximately 80% were 9th and 10th graders, 52% were female, 44% were African-American, 37% were Caucasian, and 19% were either Asian, Native American, or multi-racial.

Data Collection Methods

As with other years, data collection activities focused on four major components (1) short-term impacts on Cadets' interest and attitudes toward STEM, (2) long-term impacts on Cadets' interest and attitudes toward STEM, (3) instructor satisfaction and rating of the Academy, and (4) communication impacts via social media. Additional data was collected related to the NSF research project. Specifically, a randomly assigned control group of 32 cadets were sent to the JCLC at Camp Shelby in Mississippi. The comparison group results will be reported in a separate report.

Short-Term Impacts on Cadets

Based on the analysis of quantitative and qualitative data, the 2018 JROTC STEM Leadership Academy experience increased Cadet awareness of and interest in STEM jobs available in the region. Furthermore, Cadets seemed to have more confidence in their ability to enter a STEM career field. Cadets also made gains in science, mathematics, and engineering content which further supports cadets' ability to be successful in STEM academics and careers.

Instructor Feedback

Overall instructors felt the Academy was a high-quality program that offered appropriate professional development, engaging and effective Academy activities, and were satisfied with the entire Academy experience. An improvement from previous years in the increased involvement of Cadre during the STEM challenge activities.

Social Media Impact

For three years, the JROTC STEM Leadership Academy has used Facebook and Twitter to highlight Academy activities. This year, a separate group of high school cadets volunteered as the "Media Specialists," to take pictures and make posts to Facebook. Facebook appears to be the most updated platform and thus has the most followers. Both platforms appear to be effective methods to (a) communicate to parents the types of activities Cadets are engaging in, (b) provide another outlet to highlight Academy partners, and (c) engage with the JROTC Cadets to remind them of the Academy experiences. However, it is easier to give posting privileges to the Media Specialist team on Facebook.

Recommendations

While the Academy certainly makes a positive impact on both Cadets and Instructors, there are some recommendations for improvement. The following is a list of specific recommendations the Academy leadership should consider when replicating the maritime engineering curriculum and related activities:

- Having the testing stations outside was logistically challenging. If possible, there may need to be work spaces provided closer to the testing station to facilitate teams improving their designs.
- One science question, question #4, needs to be reexamined as the diagram may have been confusing for students, thus most student missed this item.
- It may be beneficial to add items to the pre/post-assessment related to the JROTC activities.

The following is a list of recommendation the Academy should consider for all future camps:

- Create multiple mission achievements for each challenge.
- Continue using the General Achievements checklist, or something similar, as a strategy to engage Cadre in supporting cadet progress during the STEM challenges.
- STEM instructors should make daily schedules on chart paper and post it centrally in each room.
- As the budget allows, provide opportunities for instructors to attend the industry site visits.
- Continue to include Cadre in the STEM teacher professional development.
- Assign special guests a ballroom or platoon color to visit during the final day of the Academy to ensure all teams have a chance to present their posters.

Introduction

Academy Purpose

The purpose of the six-day residential JROTC STEM Leadership Academy was to engage a unique population of high school students, 9th and 10th grade JROTC Cadets, in STEM content, skills, and fields of study needed by business and industry today. The Academy is designed to increase awareness of good-paying STEM career opportunities in our area for Mobile's youth and what it takes to secure these jobs. Cadets participated in area industry and university field trips, interacting with scientists, engineers and technicians who are designing innovative solutions to industry and community problems. The STEM Academy includes leadership development, critical thinking, and STEM skills as Cadets solve team engineering-focused design challenges and complete rappelling and land navigation exercises. Industry and education leaders provide motivational talks each evening. The 2018 STEM Leadership Academy built upon and expanded the three prior years' Academies, this year focusing on the maritime industry in the Mobile region.

The Academy integrates five types of activities to ultimately increase the number of Mobile JROTC Cadets interest in and prepared for the technical and other STEM dependent jobs that are in high demand in our area. The five activity types (also referred to as *strategies*) are identified in Table 1.

Table 1. Five Strategies Employed in the JROTC STEM Leadership Academy

#	Strategy/Activity Type
1	Teambuilding, Communication, and Leadership Development Activities
2	Team STEM Design Challenges
3	Industry Site Visits and Guest Speakers
4	University, College, and Museum Experiences
5	JROTC Required Activities (rappelling, drown proofing, physical fitness)

Overview of the Academy Model

The JROTC STEM Leadership Academy is an innovation of the traditional JROTC Cadet Leadership Challenge (JCLC) summer experience. The foundation of the Academy lies in the JROTC character education curriculum and culture. Students who participate in the STEM Academy have all been exposed to the JROTC culture and curriculum for at least one school year prior to the summer experience. Teambuilding, Communication, and Leadership Development Activities are based on the traditional JROTC curriculum and mirror many of the traditional JCLC activities (e.g. rappelling, drown-proofing, land navigation, etc.). The STEM Learning component consists of a series of STEM experiences woven through the traditional summer JROTC activities. These STEM experiences include lab investigations and lessons that extend mathematics and science content knowledge and provide

first-hand experience with STEM technology and challenges in order to build interest and efficacy. Workforce Experiences, such as site visits to local colleges, area industries, and evening motivational guest speakers, reinforce the JROTC character traits and STEM learning. These workforce experiences are designed to engage students in vicarious STEM learning, meaning students learn about STEM and build a STEM identity by observing expert-level STEM professionals.

The Academy model can be conceived as tiered layers to represent the hierarchical structure of three essential components: (1) JROTC, (2) STEM Learning, and (3) Workforce Experiences. The three-component model, therefore, provides direct and vicarious experiences (Lent, 1994) that are likely to lead to the target outcomes identified in Figure 1.

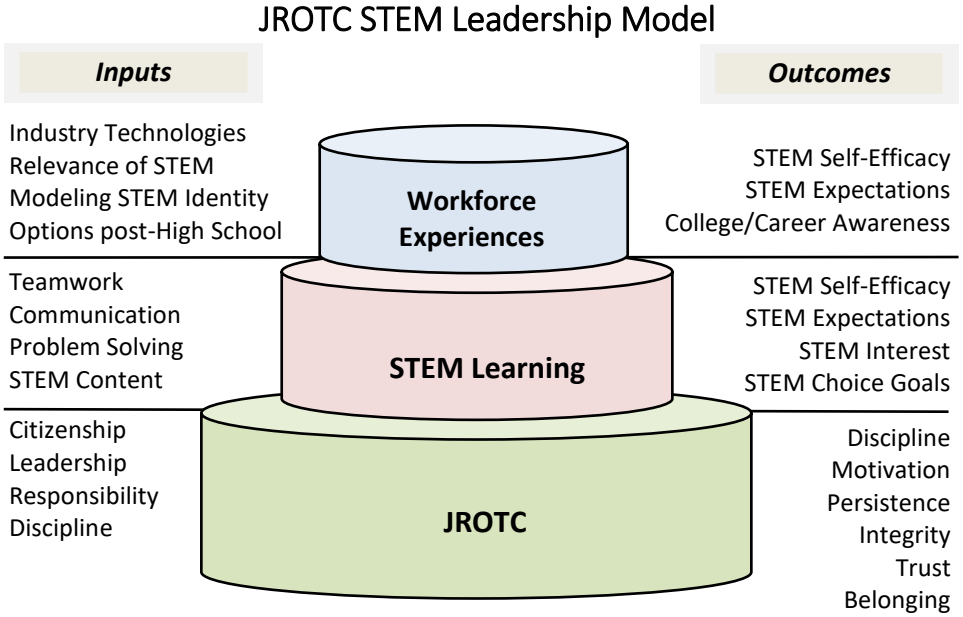


Figure 1. JROTC STEM Leadership Academy Model

Academy Data Collection and Analysis Methods

Data collection activities focused on detecting changes in (a) student attitudes and beliefs related to strategies 1, 3, and 4; and (b) gains in STEM content knowledge related to strategies 1, 2, and 5. Data collection methods included pre/post assessment, making observations of Academy activities, surveying teamwork and communication, and collecting student work such as team engineering notebooks and student reflection journals.

Additionally, JROTC STEM Academy instructors were interviewed as a focus group to gather feedback for future improvements to the teacher training workshops, logistics, organization of the program leadership, and identify other opportunities for strengthening the program.

Metrics were also gathered from the JROTC STEM Leadership Academy's two social media accounts, Facebook and Twitter, to help leadership see how the program engages community members (parents of Academy cadets, Academy cadets, volunteers, and community/industry partners).

Finally, additionally funding from the National Science Foundation (NSF) has enabled program leaders to plan and implement a three-year longitudinal study of the Academy on cadets. The study uses a randomized comparison group design to measure both short-term and long-term effects of the Academy.

Organization of the Report

This report begins by reporting on Cadet impacts which include a brief description of Cadet demographics and the five types of Academy activities. Each section includes findings from select items on the pre/post assessment. The quantitative data is supplemented with quotes from student interviews and journal entries. Observation notes from the research team are also included to provide additional context that could aid in understanding the effect of the JROTC STEM Leadership Academy. The report also includes instructor feedback and a report of the social media activity. Initial findings from year 1 of the research project will also be presented in this report. The report will conclude with a discussion of the overall impacts of the program which includes recommendations for future improvements to the project.

Academy Participants

The Academy set the goal of serving 160 9th and 10th grade students for the 2018 Academy. The rosters included 168 names, however, as in past years there was some attrition due to illness and other personal circumstances. Of this group, 155 students in 9th -12th grade participated in the academy and completed the pre/post assessment. Table 2 and Figures 2-4 provide an overview of the general characteristics of the Academy participants.

Table 2.
Academy Participants by School

School	Total
Baker HS	16
Blount HS	10
Bryant HS	9
Chickasaw HS	11
Citronelle HS	5
Davidson HS	8
LeFlore HS	6
Montgomery HS	15
Murphy HS	15
Rain HS	9
Satsuma HS	13
Theodore HS	19
Vigor HS	9
Williamson HS	6
Total	**151**

* 4 students did not report their school

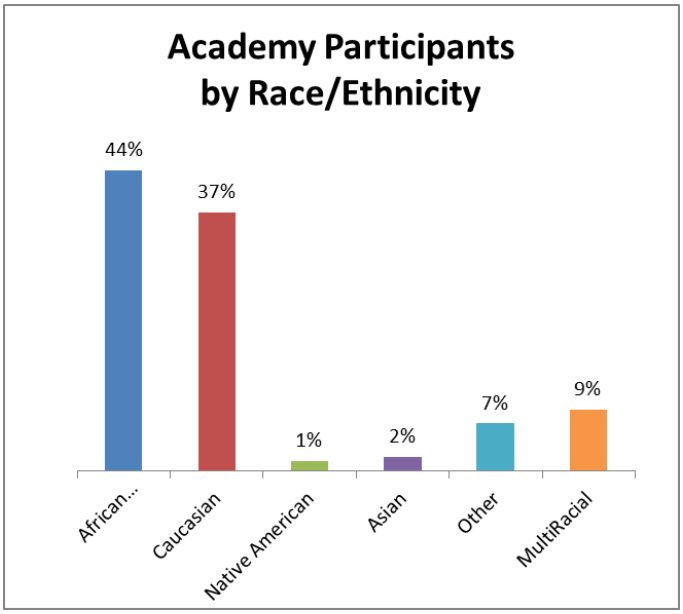


Figure 2. Academy Participants by Race/Ethnicity

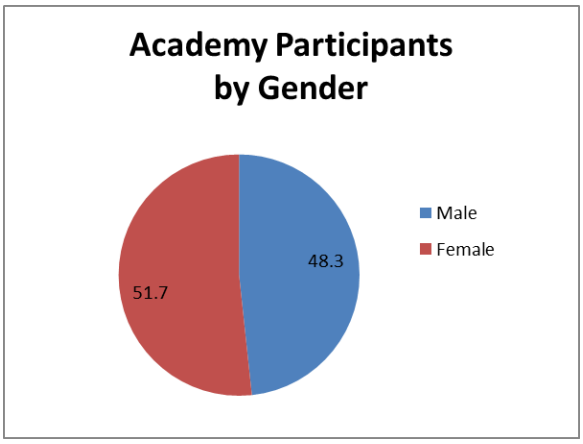


Figure 3. Academy Participants by Gender

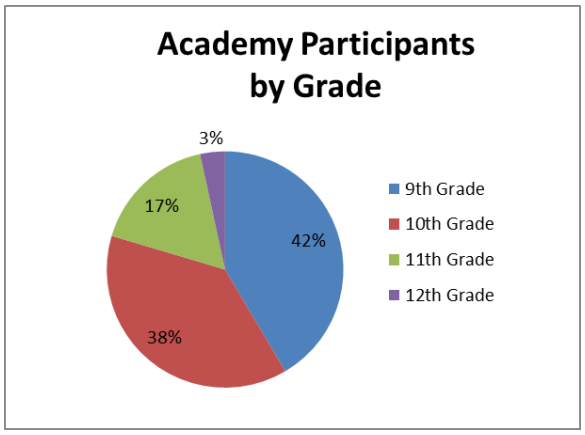


Figure 4. Academy Participants by Grade

Teambuilding, Communication, and Leadership Development

Activities

Carefully structured activities were planned for the Academy week to engage Cadets in valuing teamwork and communication skills and help them develop leadership skills needed to be a successful team member and leader. Cadets participated in a JROTC leadership and personality assessment, Winning Colors, to better understand themselves and other team members' leadership and communication strengths and to identify areas they needed to work on. Cadets also practiced these skills during various team challenges all weeklong. Cadets also responded to journal reflection prompts related to their ability to work in teams.

Results

Results from the pre/post assessment indicate students entered the Academy with fairly high levels of confidence in their ability to work in teams and maintained high levels of confidence. Three items on the pre/post assessment related to teamwork and communication can be seen below:

- For the statement, "Faced with a STEM challenge, I would be comfortable with my ability to work with a team to create a plan to address the challenge," students who indicated they "agree" or "strongly agree" remained relatively stable and high from pre (97%) to post (92%).
- For the statement, "I am skilled at working on a collaborative team," students who indicated they "agree" or "strongly agree" remained relatively stable and high from pre (89%) to post (87%).
- For the statement, "I value that other people have ideas that are different than mine," students who indicated they "agree" or "strongly agree" remained the same and high from pre (98%) to post (98%).

When asked to describe the <u>most valuable</u> experience cadets had at the Academy, some cadets reported:

- The most valuable thing that I've learned at STEM camp would have to be leadership and communication. Also, along with how important mathematics/science/engineering/and tech. was. - *Alyssa Tillman, 9th grader*
- The most valuable thing I did at STEM Camp was probably being with my team. It was fun working as a group and working to get task done. - Mason Woods,

When asked to describe their favorite experience, other cadets reported:

- team work building the robot because it helped me learn that it is easier to work together on a project, Cullen Farnell
- Being able to connect with my team in a new way because it was put to use for missions and keeping up team moral. - Sarah Stanley
- The teamwork and excited people, it is a good feeling when you're in an exciting team working environment. - Artez Threatt

Team STEM Design Challenges

STEM Challenge Learning Outcomes

Cadet teams tackled several STEM Design Challenges and investigations related to the maritime industry throughout the week. This year, the Academy customized an existing NSF-funded curriculum, WaterBotics. According to the WaterBotics website, "WaterBotics is an innovative, underwater robotics curriculum that can be used in traditional classroom settings or in after-school and summer camp programs. Teams of students work together to design, build, program, test and redesign underwater robots [also known as underwater remote operated vehicles], made of LEGO® and other components. Students engage in a series of design challenges or "missions" that gradually increases in complexity and ultimately leads to a fully functional underwater robot capable of maneuvering in a three-foot-deep pool. This introduces students to the concept of iterative design and demonstrates the value of testing and redesign (https://waterbotics.org/)."

The Waterbotics curriculum was designed for both classroom and summer camp applications, but the unique context of the JROTC STEM Leadership Academy, which blends JROTC curriculum with workforce development, the curriculum development team had to adjust the learning outcomes and curricula to fit within and support the broader Academy goals (see section Overview of Academy Model). The team identified three broad mathematics and science concepts to focus on using the Waterbotics curriculum: (1) Gear Ratios, (2) Center of Mass, and (3) Buoyancy. Table 1 lists the mathematics, science, and engineering learning outcomes targeted by this year's STEM Challenge curriculum. These outcomes were shared with faculty and staff at the University of South Alabama (USA) so the learning experiences at USA would support these outcomes. Thus, the learning outcomes served as a guide to all internal and external educators during development of STEM activities.

Table 3.
Summary of Academy Learning Outcomes

Learning Outcome	STEM Content Area
Identify the stages of the Engineering Design Process while working to complete a design challenge.	Engineering
Discuss the importance of knowing the constraints of a design challenge and how criteria are used to determine success.	Engineering
Apply proportional reasoning to relate gear ratios to a change in rotational speed of the propeller. Determine the gear ratio given a diagram with two gears Looking at gear diagrams, identify whether a gear set up will increase or decrease rotational speed Apply the impact of a gear ratio to predict the proportional change in rotational speed	Mathematics

Approximate the center of mass of an object. Given a diagram, identify the point that would be closest to the center of mass of an object	Science
Predict motion given the orientation of applied forces relative to the center of mass of an object. Given force diagrams, including the direction of forces applied to an object, select the diagram that relates to the resulting motion Which diagram depicts a force or set of forces that will NOT produce rotation.	Science
Define positive, negative, and neutral buoyancy. Given a description of a scenario (dropped a ball in water and it sinks until it hits the bottom of the pool), identify whether it is neutral, negative, or positive.	Science
Identify the relationship between the forces needed to achieve neutral, positive, and negative buoyancy. Given labeled diagrams (gravity and buoyancy forces on an object in a beaker of water), students determine whether an object is positive, negative, or neutrally buoyant.	Science

Results

Results from the pre/post-assessment indicate students made statistically significant gains in all three content areas-science, mathematics, and engineering. Scores were calculated by assigning 1-point value to each question answered correctly. There were four science questions, three mathematics questions, and four engineering questions. Therefore, the highest possible score for these items was 11 points.

A paired-samples t test was conducted to examine the difference between total STEM content scores before and after the JROTC STEM Leadership Academy. There was a statistically significant difference between the pre-test (M=5.11, SD=2.49) and the post-test (M=5.81, SD=2.79), t (192) = -3.07, p =.002. The eta squared statistic (.047) indicates a small to moderate effect size (Cohen's guidelines for interpreting this value are .01=small effect, .06=medium effect, .14=large effect). Figure 5 shows the shift in total scores by frequency of total scores. Note, scores of zero indicate a student did not take the pre or posttest.

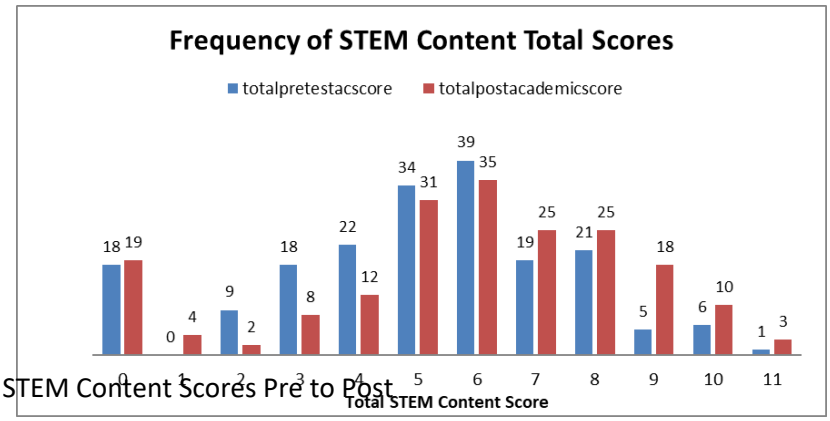


Figure 5. STEM Content Scores Pre to Post

A closer examination of each content question by subject is provided in Tables 4-6. Correct answers are formatted in bold and have an asterisk (*) beside the answer letter. Numeric values in the "Pre" and "Post" columns represent the *percent* of students who selected that answer. Diagrams and complete answer choices can be found in the complete version of the survey (See Appendix A).

Science Content Questions	
Q1	**Look at the diagram below and select the letter of the point that represents the best approximation of the object's center of mass.**

		Pre	Post
	A	7.4	1.7
	B	32.6	28.6
	C*	**60.0**	**68.0**
	D	0.0	1.7
Q2	**Look at the diagram below. Given the relationship to the force of the object's center of mass, select the diagram that represents the resulting motion of the object.**		
		Pre	**Post**
	A	14.9	10.3
	B	6.9	1.7
	C	40.6	31.4
	D*	**37.7**	**56.6**
Q3	**You throw a ball into a pool and it sinks until it finally rests along the bottom of the pool. Based on this observation, you conclude the ball is _____ buoyant.**		
		Pre	**Post**
	A	13.1	8.0
	B	6.3	2.3
	C*	**72.6**	**85.7**
	D	8.0	4.0
Q4	**Look at the diagram below. Based on the relationship between the buoyant force and the gravitational force, you would say the object is ____ buoyant.**		
		Pre	**Post**
	A*	**17.7**	**13.1**
	B	14.3	5.1
	C	21.1	5.1
	D	46.9	76.6

Mathematics Content Questions			
Q1	**Look at the diagram below. What is the gear ratio between these two gears?**		
		Pre	**Post**
	A	20.1	12.5
	B*	**50.6**	**56.6**
	C	23.0	17.7
	D	6.3	10.9
Q2	**In the diagrams below, the gear on the left is rotating at the same rate. In which diagram would the gear on the right be rotating the fastest?**		
		Pre	**Post**
	A	21.8	16.0
	B*	**44.3**	**51.4**
	C	17.2	25.7
	D	16.7	6.9
Q3	**The diagram below shows a motor connected to two gears. If the gear ratio is 5:1, how much faster will the propeller turn than the motor?**		
		Pre	**Post**
	A	10.3	17.7

B	24.1	22.3
C*	**50.6**	**55.4**
D	14.9	4.6

Engineering Content Questions			
Q1	**You've been presented with an engineering design challenge and given a list of criteria and constraints. Is the statement below part of the criteria or constraints? *For a design to be successful it must travel at least 50 ft in a straight line.***		
		Pre	**Post**
	Criteria*	74.4	70.3
	Constraints	25.6	29.7
Q2	**You've been presented with an engineering design challenge and given a list of criteria and constraints. Is the statement below part of the criteria or constraints? *The design cannot have more than two pieces of tape.***		
		Pre	**Post**
	Criteria	34.3	23.4
	Constraints*	65.7	76.6
Q3	**The team reviews data collected from previous tests and makes decisions to improve their prototype. They begin working on the improved design. What step in the engineering design process are you in?**		
		Pre	**Post**
	Test	11.6	6.9
	Plan	16.3	14.3
	Redesign*	65.1	75.4
	Create	7.0	3.4
Q4	**Your team is putting together a poster to report your results and final recommendations for a design. What step in the engineering design process are you in?**		
		Pre	**Post**
	Create	22.7	20.0
	Test	9.9	6.3
	Evaluate	40.7	45.7
	Communicate*	26.7	28.0

Industry Site Visits & Guest Speakers

Activities

On June 4th and 5th, the 2018 Academy Cadets visited Austal, Amazon, the Alabama State Porth Authority, the U.S. Coast Guard, Aker Solutions, and TechnipFMC. The goal of these visits was to help Academy Cadets see how STEM is used in the region's maritime industry and hear from human resource personnel as to requirements for hiring and key traits looked for in applicants and salaries of high demand jobs from technicians to engineers. To reinforce the importance of completing an education and securing jobs in the region, guest speakers from business, military, and higher education institutions shared personal stories highlighting their educational and career path. Additionally, these

guest speakers share stories of overcoming personal challenges as teenagers and young adults to model perseverance, leadership, and citizenship.

Results

Results from the pre/post assessment and journal entries indicate Cadets increased their awareness of STEM jobs in the region. Figure 6 is a summary of the number of industries that Cadets felt they could describe to a friend.

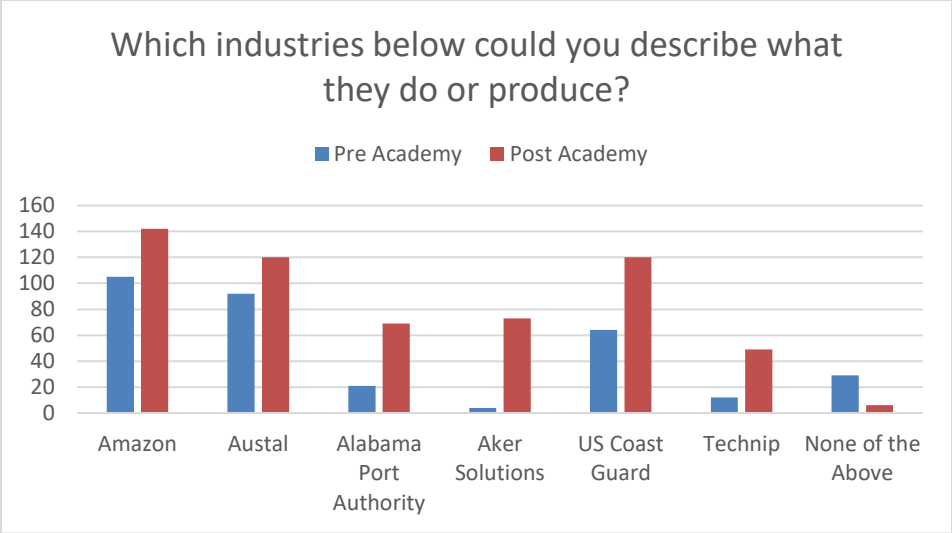


Figure 6. Frequency of students reporting they could describe what the company does or produces.

Additionally, Cadets increased their awareness of good paying jobs in the region and recognized that there are many STEM jobs that do not require a four-year college degree. Below are two items on the pre/post assessment related to STEM careers.

- For the statement, "To get a good paying job involving STEM in the Mobile area, you must have a four-year college degree," students who indicated "agree" or "strongly agree" decreased from 58% to 39%. As a workforce development program, raising awareness of the available, good paying STEM jobs that do not require a four-year degree is an important learning outcome.
- For the statement, "There are a wide range of good paying jobs available here in Mobile that involve STEM," students who indicated "agree" or "strongly agree" increased from 87% to 96%. Figure 7 provides more detail about how the frequency of agreement shifted as a result of the Academy.

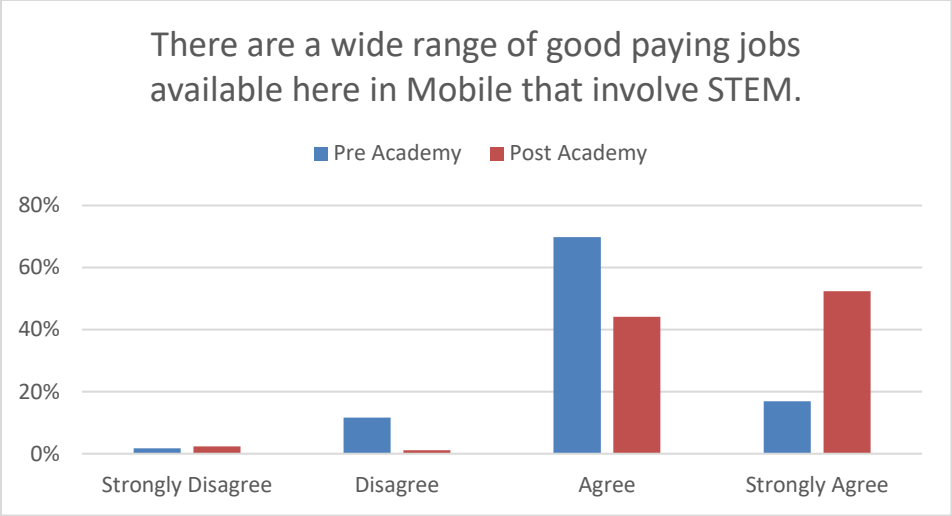


Figure 7. Level of agreement from pre to post assessment related to perceived availability of good paying STEM jobs in the region.

Cadets were also asked to select from a drop-down list of 25 different career fields, of which 11 were STEM-related, 13 were non-STEM related, and a final option to indicate "I do not know." Results (see Figure 8) show cadets also have fairly stable interests in careers after high school. However, it should be noted that fewer cadets reported "I do not know." As a major objective of the Academy is to help cadets set goals for after high school, a decrease in the "I do not know" option suggests the Academy is meeting this outcome.

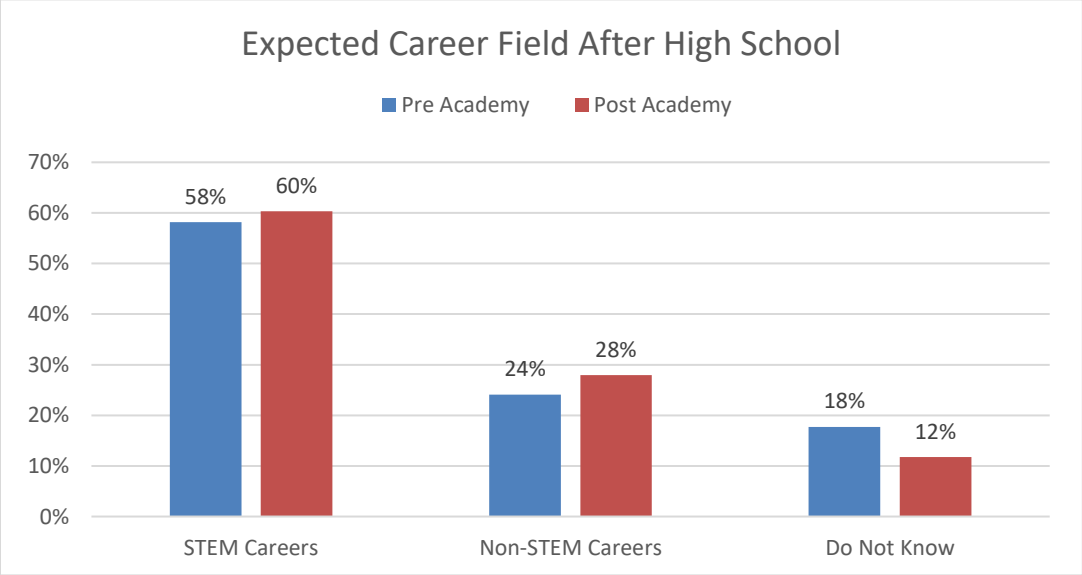


Figure 8. Cadets' career plans after graduating high school.

Several cadets reported the guest speakers or industry site visits to be their favorite or most valuable activity of the Academy. Responses included:

Industry Site Visits

- The most valuable thing I heard during this academy was that women in stem fields were accepted and normalized even though these fields are male dominated, it was reassuring to know that while there would still be challenges to face as a woman in stem many employers and employees saw women as competent and equal to men.
- Going to Aker solutions, it showed me I can have a good paying job and a tremendous career with just a high school diploma.
- My favorite part is going to the places where real work is going on that no one really talks about.
- Coast Guard trip, because it shows me that the Coast Guard is another option in Military Service.

Guest Speakers

- The guest speakers be we was able to meet outstanding people who are/were doing something that we want in our future.
- The most valuable thing was when I heard the speaker on Thursday I really enjoyed their story and they helped me realize that anyone can overcome their struggles.
- The most valuable thing in my opinion was the guest speakers who gave me insight on the future paths I could go.
- To me honestly all of the hard work everybody put in helped and meant a lot. The guest speakers helped me a lot and I had such a strong connection with each thing they said.

University, College, and Museum Experiences

Activities

Cadets resided on the Spring Hill College campus for the entire Academy, learning what life is like on a college campus, and participated in engineering investigations at University of South Alabama. Cadets participated in a series of six STEM investigations at the University of South Alabama on Wednesday, June 6th. Activities included (1) Lego Mindstorms robotics programming with LabVIEW; (2) evaluating hydrodynamic efficiency of different ship hull shapes and types; (3) learning about USA's cube satellite project with NASA; (4) investigating different strategies to purify water using different chemical coagulants; (5) learning about the concepts of stability and buoyancy to improve the performance of underwater remote operated vehicles (ROVs); and (6) learning about how to position motors and propellers relative to an ROVs center of mass. Cadets also toured 5 Rivers Delta and Gulf Quest to learn more about the maritime industry and the unique ecology of the Mobile Bay.

Results

Cadets seem to have a stable idea of what they plan to do after high school related to post-secondary education. The biggest shift in cadets' plans were an increased interest in enrolling in a 2-year or technical college (see Figure 9).

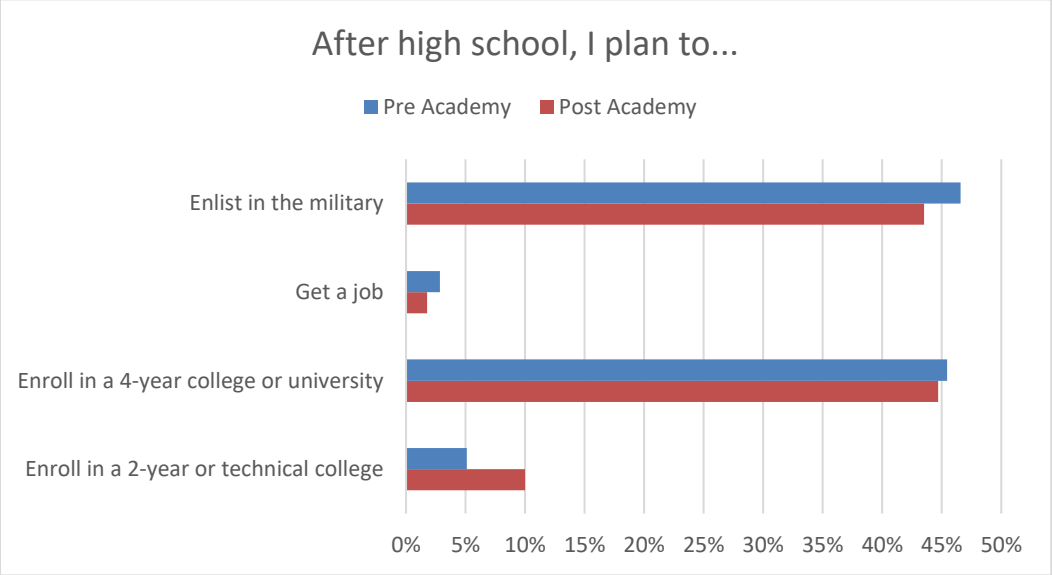


Figure 9. Cadets' academic plans after graduating high school.

Several cadets reported the educational field trips and university experiences to be their favorite or most valuable activity of the Academy. Responses included:

College & University Experiences

- During, the tour at South I realized I don't just want to work with animals and study them. I want to become an environmental engineer and create things to better their ecosystems and lives.
- …the college I will hopefully attend was better explained to me.
- The most valuable thing I did during STEM camp was visiting South Alabama. This is because my expectations about South Alabama originally were low but now I feel like I want to go there now. I tell you this because during civil engineering classes the instructor intrigued me with filtering water and how much civil engineers make right after they get out of college … and plus I've only been to one building in South but, now that I've seen the entire campus I'm more interested.

Educational Field Trips

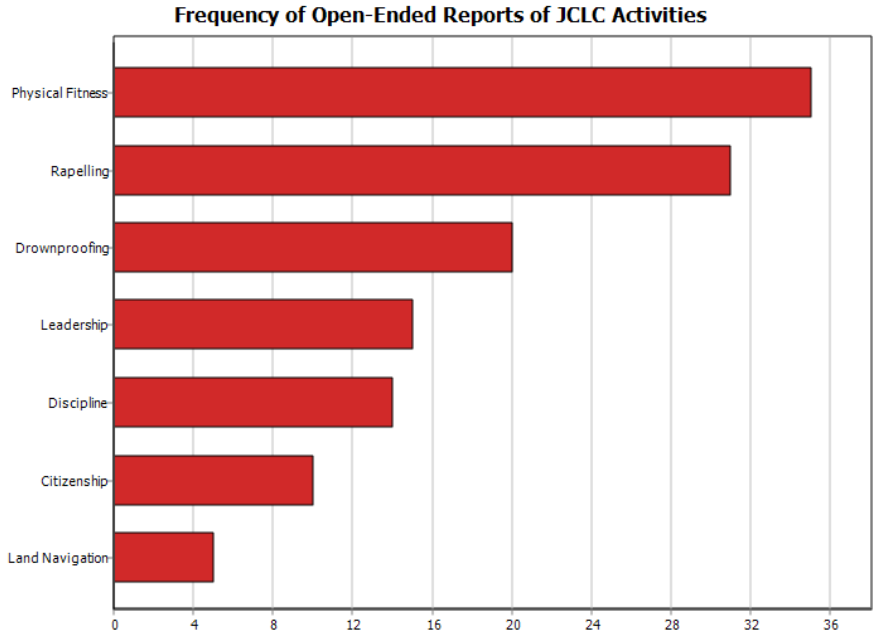
- The gulf quest museum. I thought it was pretty cool to see some old historic ships from the navy and I thought it would be good to know since I'm going into the navy.
- 5 RIVERS DELTA!!!!! I love animals and biology, so I found it very interesting!! I may even try to work there one day!!!
- My favorite part of camp was going to 5 Rivers and seeing the animals as well as the boat tour. It was my favorite because I got to see animals that I did not know lived in Alabama and got to learn more about them.

JROTC Required Activities

The foundation of the Academy lies in the JROTC character education curriculum and culture. Students who participate in the STEM Academy have all been exposed to the JROTC culture and curriculum for at least one school year prior to the summer experience. This curriculum is extended during the Academy to include:

- Rappelling
- Drownproofing
- Land Navigation
- Physical Training

The pre/post assessment does not include specific items related to these activities. However, over 30% of the open-ended responses from cadets regarding the most valuable or favorite activities during the Academy were related directly to the JROTC activities. Of these open-ended responses, most cadets reported Physical Training as their favorite JROTC activity (see Figure 10).



Cadet responses included:

- My favorite part of being here was **rappelling** because I felt like I can accomplish anything and not being afraid is the best
- My favorite part of camp was [**drownproofing**], because we learned how to float with our pants, not I can go home and teach my little cousins and siblings how to swim with pants.
- My favorite part of the camp was **land navigation** because it helped me use a compass.
- My favorite part was the **game night**. It was my favorite because you can really see how much our platoon bond d together and won games in just one night. It was also really fun.

Furthermore, several cadets indicated the JROTC culture and leadership development curriculum were valuable to them.

- Most of what I heard that leadership is important to us all as civilians working in different environments.
- The most valuable thing I did here was learn what it means to be a leader and what it means to work together I learned that I should never give up no matter how many times I failed.
- Platoons, because over this 1 week I feel like I've known these people for a year. There is a bond between each other that is great and encourages leadership.
- The most valuable thing I learned at this JROTC Academy is the details on leadership. I also learned that success comes with failure along the way.

Cadet Impact Conclusions

Based on the analysis of quantitative and qualitative data, the 2018 JROTC STEM Leadership Academy experience increased Cadet awareness of and interest in STEM jobs available in the region. Furthermore, Cadets seemed to have more confidence in their ability to enter a STEM career field. Cadets also made statistically significant gains in science, mathematics, and engineering content which further supports cadets' ability to be successful in STEM academics and careers. Finally, cadets valued and enjoyed the JROTC required physical activities. Additional impact findings will be presented in a separate report, sharing the results from the randomized control trial.

Academy Instructor Feedback

Results

A face to face debriefing was held on July 24th, 2018. The mathematics and science instructors attended this debriefing to discuss strengths and weaknesses of the Academy they observed throughout the week. Discussion items focused on (a) the perceived quality of the Academy, (b) satisfaction with professional development workshops, (c) strengths and weaknesses of the Academy activities, and (d) suggestions for improvements to future Academies.

Overall Academy Quality. There was consensus that the Academy was of the same high quality that the veteran teachers have come to expect over the years. On instructor stated, "Another good year with strong connections to workforce." Another instructor commented, "this was the smoothest of the three years I have taught." Furthermore, it should be noted that many of the instructors have worked for the Academy in previous years. Teachers' choice to continue to work for the Academy is yet another indicator of the quality and value teachers see in the Academy.

Satisfaction with Professional Development Workshops

Overall, instructors reported satisfaction with instructor training. As in previous years, some Cadre have requested to NOT participate in the STEM challenge professional development. However, feedback on the Cadre's role in supporting cadets during the STEM challenges indicates involving the Cadre has a positive impact.

- Cadres involvement was the best of all Academy years
- Having Cadre down at the pool helping kids was also very good and they were able to do it because they participated in the PD

Strengths and Suggestions for Improvement of Academy Activities

Table 7 presents some responses related to the strengths and weaknesses of the Academy activities. The table is organized by topic:

Table 7. Instructor Feedback on 2018 Academy Components

Category	Comment
Overall	
+	At the ALCT Conference, someone had a brochure about Mobile County
+	This was the smoothest of the three years I've taught
+	Another good year with strong connections to workforce
Δ	Can we get more kids involved?
STEM Challenges	
+	the goal was attainable.
+	Liked starting off with a challenge and how the science lessons were taught before applying content to the challenge
+	Challenges allowed for setting multiple goals
+	Students and teams managed their Lego robotics materials well
Δ	We need a little bit of STEM each day. This occurred this year but it's not always the case. Try to plan future years so that STEM is part of the daily agenda every day.
Δ	The logistics of working upstairs and testing downstairs was difficult.
Δ	Some STEM concepts may have benefitted from more scaffolding
Workforce Development	
Δ	We do a good job showing them careers available, but we don't show them how they can get that training.
Δ	We need to better differentiate between on the job training vs a technical degree
Logistics	
+	it was valuable to start charting student responses to field trip debriefing to both students and the special guests who attended the celebration
+	I liked the general achievements that cadre tracked over the whole week
+	Taking phones was a good thing
+	I loved seeing the daily schedule written on chart paper and posted in the ballrooms. Teachers and students found it helpful also.

+	Having a daily schedule posted in the ballroom is amazing
Δ	For this camp, logistics of testing was difficult. In the future, we don't want a back log for testing like we had this year. It's difficult to test, see something, and not immediately fix it.
Δ	On the first day, spending all day in the classroom is too much.
Δ	Red and Yellow platoons got the most guests on the last day. We need to figure out how to distribute guests so all kids get a chance to present their posters. Maybe can assign platoons and put it on each guest's nametag
Δ	Lanyards for nametags are too long. Can we have the cadets tie it up. We need them to learn their names.
Δ	Next year, after the Academy introduction, platoons will report to the Cadre. The Cadre will establish order and behavioral expectations for the week. This will take one hour so we need to add this to the detailed agenda.
Δ	Some students were still unhappy about not getting to keep their phones.
Δ	Next year, the media students will stay on campus
Δ	Instructors in ballroom A used and projected an online stopwatch app to keep everyone focused and on time. SP recommends we use the app in all ballrooms in future years.
Δ	Some of the field trips are just environmentally hot and humid. The rain was also uncomfortable.
Journals	
+	Having journal stickers helped it be easier for kids to start journaling
Δ	Maybe add an item on the pre/post assessment that asks cadets where they see themselves in the next 5-10 years, or maybe this is a question added to their journals.
Δ	Right now, we don't let the students keep their journals. Would it be possible for students to keep electronic journals?
Media Students	
+	Got a lot of good publicity
+	Having a "floating" media student was good.
+	The media students were fine
+	On the first day, the media students didn't really know what to do, but after the first day they did well
Δ	Do we need as many media students?
Δ	For the celebration video, I don't think we need club music.
Spring Hill College Student Assistants	
+	SHC students were great!
Δ	The SHC student coordinator did not perform well. He informally told Academy leaders that he did not enjoy the coordinator position as much as he enjoyed being a Platoon Leader like last year.

+	One SHS platoon leader sat with his kids at dinner. It was great!
Teacher Professional Development	
+	Cadres involvement was the best of all Academy years
+	I'm glad I went to Aker Solutions to under how tethers work for ROVs
+	Having Cadre down at the pool helping kids was also very good and they were able to do it because they participated in the PD
+	Going to field trips really helps teachers understand how to lead students into questions so students can better reflect on what they experienced
Δ	Because the Academy focuses on workforce development, teachers need to see the industries. It makes for a long day but it's worth it.

Conclusions from Instructor Feedback

Overall instructors felt the Academy was a high-quality program that offered appropriate professional development, engaging and effective Academy activities, and were satisfied with the entire Academy experience. There are some recommendations for improvement to logistics in the next which have already been incorporated into the 2019 Academy plans.

Social Media Impact

For three years, the JROTC STEM Leadership Academy has used Facebook and Twitter to highlight Academy activities. The reasons for using for social media include (a) communicate to parents the types of activities Cadets are engaging in, (b) provide another outlet to highlight Academy partners, and (c) engage with the JROTC Cadets to remind them of the Academy experiences. Parents drop off their children at the beginning of the week and do not participate in any Academy activities. Thus, social media outlets are an essential communication tool to parents. Many Academy partners have requested pictures to demonstrate the impact of their contribution to the Academy. Social media provides a central platform to share photos with Academy partners. Finally, because most students are avid users of social media, the Facebook and Twitter pages provide a way for them to stay involved with the Academy.

Facebook Metrics

During the 2017 Academy, the Facebook page had 233 followers. In the 2018 Academy, an additional 43 people followed the Academy page for a total of 276 JROTC STEM Academy followers. Figure 9 depicts the demographic data about the people who liked the Academy page based on the age and gender information they provided in their user profiles. Of these followers, the clear majority are in the state of Alabama.

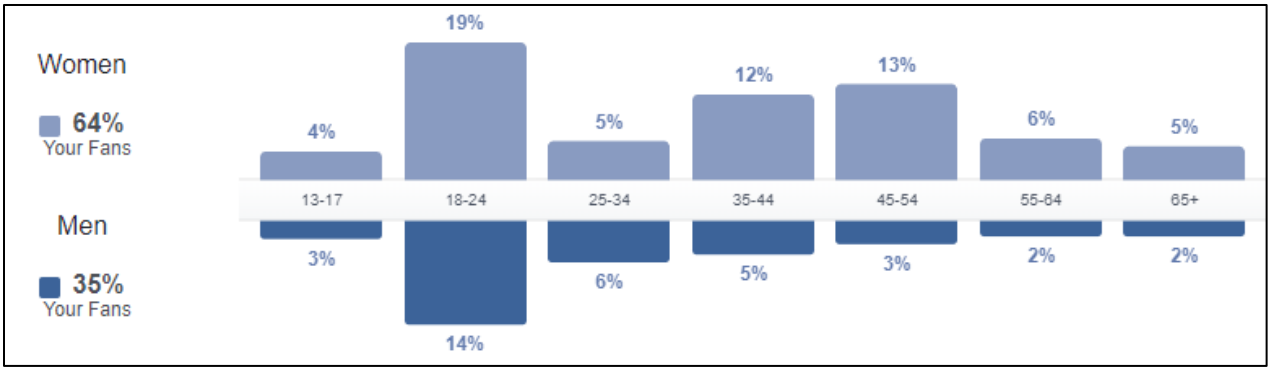


Figure 9. Demographics of Facebook Followers

The number of views, likes, and comments was much higher than in previous years. Figure 10 shows the number of people who saw posts to the Academy page. On average, each post was viewed by 100 Facebook users and had over 20 reactions (likes, comments, etc.). This number of views may be due to a special group of high school seniors who volunteered their time as "Media Specialists." These students followed each platoon, took a variety of pictures, and posted to the Academy Facebook page each evening. This group also put together the end-of-week celebration video.

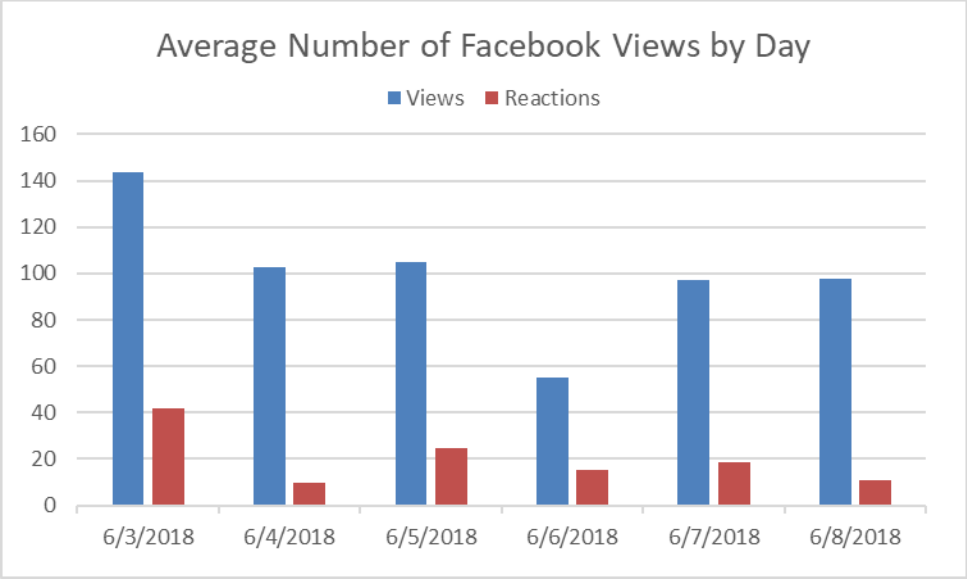


Figure 10. Average Number of Facebook View by Day

Given the purpose of the Facebook page is to engage viewers primarily during the week of the Academy, it appears this social media outlet is an effective tool.

Twitter Results

The Academy's Twitter account was not used by the Media Specialist team. Instead, some tweets were made by one of the Academy coordinators, but it was very infrequent. Therefore, the Twitter account seems to be less

effective than the Facebook account. Although, this could be due to the fact that more posts were made to Facebook rather than Twitter.

Conclusions & Recommendations

Overall Academy Conclusions

Overall, the JROTC STEM Leadership Academy increased Cadet awareness of and interest in STEM jobs available in the region. Furthermore, Cadets seemed to have more confidence in their ability to enter a STEM career field. Cadets also made statistically significant gains in science, mathematics, and engineering content which further supports cadets' ability to be successful in STEM academics and careers. Academy instructors were, on the whole, satisfied with their professional development training and view the Academy as an excellent summer educational program. Additionally, the Academy has developed a fairly robust community of followers via Facebook and Twitter social media strategies.

Recommendations

While the Academy certainly makes a positive impact on both Cadets and Instructors, there are some recommendations for improvement. The following is a list of specific recommendations the Academy leadership should consider when replicating the maritime engineering curriculum and related activities:

- Having the testing stations outside was logistically challenging. If possible, there may need to be work spaces provided closer to the testing station to facilitate teams improving their designs.
- One science question, question #4, needs to be reexamined as the diagram may have been confusing for students, thus most student missed this item.
- It may be beneficial to add items to the pre/post-assessment related to the JROTC activities.

The following is a list of recommendation the Academy should consider for all future camps:

- Create multiple mission achievements for each challenge.
- Continue using the General Achievements checklist, or something similar, as a strategy to engage Cadre in supporting cadet progress during the STEM challenges.
- STEM instructors should make daily schedules on chart paper and post it centrally in each room.
- As the budget allows, provide opportunities for instructors to attend the industry site visits.
- Continue to include Cadre in the STEM teacher professional development.
- Assign special guests a ballroom or platoon color to visit during the final day of the Academy to ensure all teams have a chance to present their posters.

Appendix A

2018 JROTC STEM Leadership Academy Pre/Post-Assessment

JROTC STEM LEADERSHIP ACADEMY

2018 JROTC POST Student Survey

Background

* 1. Background Information

First Name	
Last Name	
School	
Grade	
State ID# (This is a 10 digit number beginning with 19)	

* 2. Gender

- ◯ Male
- ◯ Female
- ◯ Other

* 3. Ethnicity (check all that apply)

- ☐ African-American
- ☐ Asian
- ☐ Caucasian
- ☐ Native American
- ☐ Other

The JROTC team would like to learn a bit about your knowledge and interests.
Thank you for your help!

About You- College and Career Goals

* 4. Which of the following best describes you?

- ◯ I plan on going to a two year or technical college.
- ◯ I plan on going to a four year college.
- ◯ I plan to get a job right after high school.
- ◯ I plan to have a career in the military.

* 5. I plan to take (or have taken) advanced math courses in high school.

Strongly Disagree	Disagree	Agree	Strongly Agree
◯	◯	◯	◯

* 6. I plan to enroll in (or have enrolled in) a STEM-related career pathway in high school.

Strongly Disagree	Disagree	Agree	Strongly Agree
◯	◯	◯	◯

* 7. I plan to take (or have taken) advanced science courses in high school.

Strongly Disagree	Disagree	Agree	Strongly Agree
◯	◯	◯	◯

* 8. I would like to have a job that allows me to use math, computer, engineering, or science skills.

Strongly disagree	Disagree	Agree	Strongly Agree
◯	◯	◯	◯

* 9. Working in a creative or artistic setting would be a good fit for me.

Strongly disagree	Disagree	Agree	Strongly Agree
◯	◯	◯	◯

* 10. Working in a STEM lab at a university or hospital would be a good fit for me.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 11. I would like to have a job that involves designing and developing technologies or products.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 12. I would like a career in construction or building

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 13. I would like to have a job in one of the Mobile top five industries (Aerospace, Manufacturing, Maritime, Healthcare, or Construction).

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 14. Which of the following best describes the the industry you plan to have a career in after graduating high school?

About You- Beliefs About Yourself

* 15. Faced with a challenge, I would be comfortable with my ability to work with a team to create a solution.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 16. I am good at speaking in front of people.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 17. I am skilled at working on a collaborative team.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 18. I value that other people have ideas that are different than mine.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 19. When challenges present themselves, I know failure is part of the path to success.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 20. I have a hard time persisting through difficult academic challenges.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 21. I am a strong and resilient student.

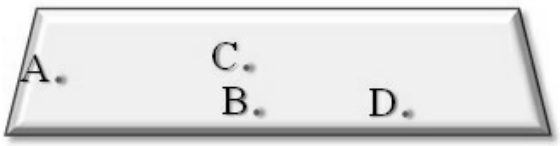
Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 22. I am a strong and resilient person.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

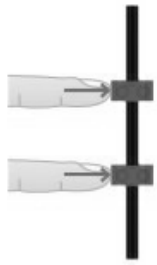
STEM Items- Science

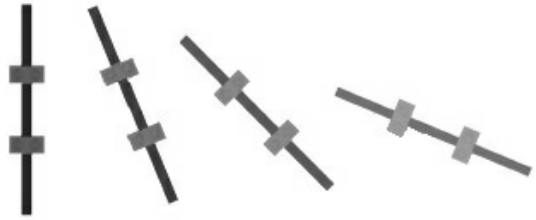
* 23. Look at the diagram below and select the letter of the point that represents the best approximation of the object's center of mass.

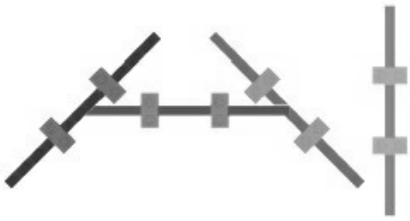


- A
- B
- C
- D

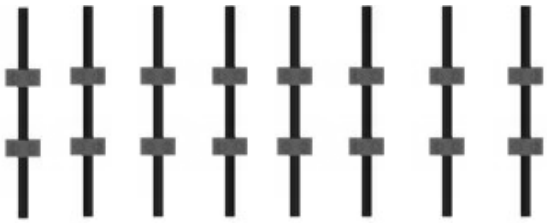
* 24. Look at the diagram below. Given the relationship of the force to the object's center of mass, select the diagram that represents the resulting motion of the object.



○ 

○ 

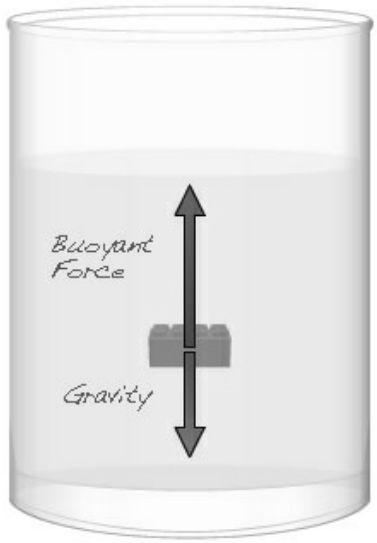
○

○ 

* 25. You throw a ball into a pool and it sinks until it finally rests along the bottom of the pool. Based on this observation, you conclude the ball is _____ bouyant.

- ◯ Positively
- ◯ Perfectly
- ◯ Negatively
- ◯ Neutrally

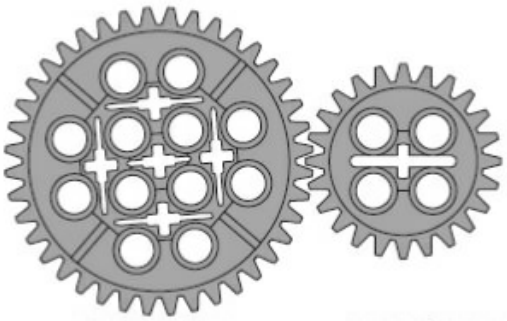
* 26. Look at the diagram below. Based on the relationship between the buoyant force and gravitational force, you would say the object is _____ buoyant.



- ◯ Positively
- ◯ Perfectly
- ◯ Negatively
- ◯ Neutrally

STEM Items- Math

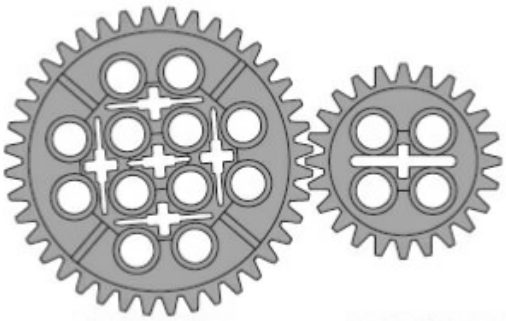
* 27. Look at the diagram below. What is the gear ratio between these two gears?



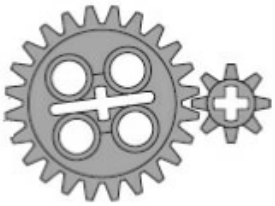
- ◯ 5:4
- ◯ 5:3
- ◯ 3:2
- ◯ 3:1

* 28. In the diagrams below, the gear on the left is rotating at the same rate. In which diagram would the gear on the right be rotating the fastest?

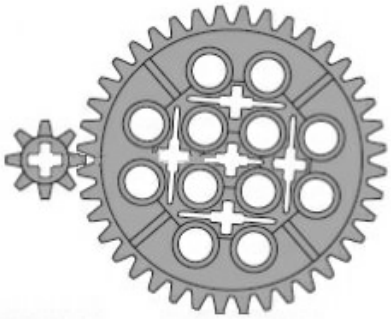
◯



◯

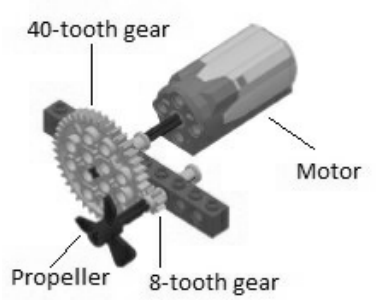


◯



◯ All gears on the right would rotate at the speed

* 29. The diagram below shows a motor connected to two gears. If the gear ratio is 5:1, how much faster will the propeller turn than the motor?



- ◯ 40 times faster
- ◯ 8 times faster
- ◯ 5 times faster
- ◯ It will spin at the same speed

STEM Items-Engineering

* 30. You've been presented with an engineering design challenge and given a list of criteria and constraints. Is the statement below part of the criteria or constraints?

For a design to be successful it must travel at least 50 ft in a straight line.

- ◯ Criteria
- ◯ Constraints

* 31. You've been presented with an engineering design challenge and given a list of criteria and constraints. Is the statement below part of the criteria or constraints?

The design cannot have more than two pieces of tape.

- ◯ Criteria
- ◯ Constraints

* 32. The team reviews data collected from previous tests and makes decisions to improve their prototype. They begin working on the improved design. What step in the engineering design process are you in?

- ◯ Test
- ◯ Plan
- ◯ Redesign
- ◯ Create

* 33. Your team is putting together a poster to report your results and final recommendations for a design. What step in the engineering design process are you in?

- ◯ Create
- ◯ Test
- ◯ Evaluate
- ◯ Communicate

STEM Items-Careers

* 34. If someone asked me, I would be able to explain how remotely operated vehicles can be designed to move in all directions - left, right, up and down - in the water.

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 35. Check the industries or labs below that you could describe to a friend what they produce or do. *You may check more than one or none.*

- ☐ Amazon
- ☐ Austal
- ☐ Alabama Port Authority
- ☐ Aker Solutions
- ☐ U.S. Coast Guard Aviation Training Center
- ☐ Technip
- ☐ None of the Above

* 36. There are a wide range of good paying jobs available here in Mobile that involve STEM.

Strongly Disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 37. To get a good paying job involving STEM in the Mobile area, you must have a four-year college degree.

Strongly Disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 38. Mathematics is critical for my success in STEM career fields

Strongly Disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 39. I think if I work hard, I can succeed in a STEM career field

Strongly disagree	Disagree	Agree	Strongly Agree
○	○	○	○

* 40. It is important for me to do well in math and science courses to increase my chances of getting a good paying job in a STEM field.

Strongly Disagree	Disagree	Agree	Strongly Agree
○	○	○	○

STEM Semantics Survey

* 41. To me SCIENCE is

Fascinating — Ordinary

* 42. To me SCIENCE is

Appealing — Unappealing

* 43. To me SCIENCE is

Exciting — Unexciting

* 44. To me SCIENCE

Means Nothing — Means A Lot

* 45. To me SCIENCE is

Boring — Interesting

* 46. To me MATH is

Boring — Interesting

* 47. To me MATH is

Appealing | Unappealing

* 48. To me MATH is

Exciting | Unexciting

* 49. To me MATH

Means Nothing | Means A Lot

* 50. To me ENGINEERING is

Appealing | Unappealing

* 51. To me ENGINEERING is

Fascinating | Ordinary

* 52. To me ENGINEERING

Means Nothing | Means A Lot

* 53. To me ENGINEERING is

Boring | Interesting

* 54. To me TECHNOLOGY is

Appealing | Unappealing

* 55. To me TECHNOLOGY

Means Nothing | Means A Lot

* 56. To me TECHNOLOGY is

Exciting | Unexciting

* 57. To me TECHNOLOGY is

Fascinating | Ordinary

* 58. To me a CAREER in STEM

Means Nothing | Means A Lot

* 59. To me a CAREER in STEM is

Boring | Interesting

* 60. To me a CAREER in STEM is

Exciting | Unexciting

* 61. To me a CAREER in STEM is

Fascinating Ordinary

* 62. To me a CAREER in STEM is

Appealing Unappealing

EYE Attitudes & Beliefs Scales

63. How do you complete school activities and assignments? In the following list, there are sentences about working to complete school activities or assignments. Mark the answer that best describes how you work on activities.

	Not at all	Sometimes	Often	Almost all of the time
When I see a new math problem, I can use what I have learned to solve the problem.	○	○	○	○
I can use what I know to design and build something mechanical that works.	○	○	○	○
In lab activities, I can use what I have learned to design a solution.	○	○	○	○
I can effectively lead a team to design and build a hands-on project.	○	○	○	○
I know where I can find the information that I need to solve difficult problems.	○	○	○	○
I can explain math or science to my friends to help them understand.	○	○	○	○
I can get good grades in math.	○	○	○	○
I can get good grades in science.	○	○	○	○

64. Please tell us your beliefs about yourself in the following activities. I am confident that...

	Not at all confident	Not very confident	Somewhat confident	Pretty confident	Very confident
I can apply knowledge of math, science, and technology to solve real world problems.	○	○	○	○	○
I can get good grades in math if I work hard.	○	○	○	○	○
I can be successful in working in a group to accomplish a task.	○	○	○	○	○
I can analyze and interpret data.	○	○	○	○	○
I can effectively use problem solving techniques.	○	○	○	○	○
I can identify problems.	○	○	○	○	○
I can communicate effectively with my team members when working on a group task.	○	○	○	○	○
I can learn to use new technology to help me succeed in the 21st century workplace.	○	○	○	○	○
I can continue to learn to do new things for success in the 21st century workplace.	○	○	○	○	○

65. What was the most valuable thing you did, saw, or heard during the Academy?