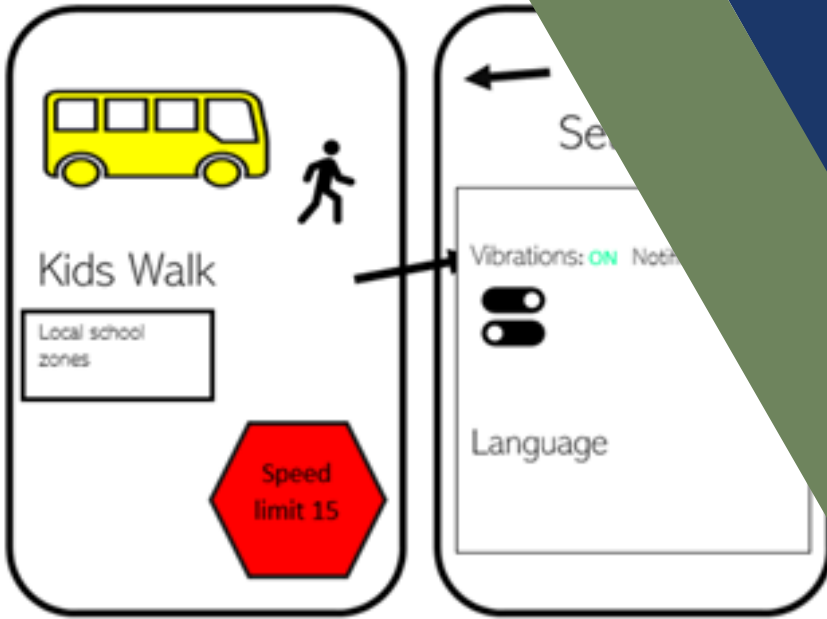


FINAL REPORT

K-12 OUTREACH

2020



Home screen of the app

Settings page

K-12 Educational Outreach and Transportation Workforce Development at The Citadel

Dimitra Michalaka, Ph.D, P.E., M.S., The Citadel

STRIDE

Southeastern Transportation Research,
Innovation, Development and Education Center

UF | Transportation Institute
UNIVERSITY of FLORIDA

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. K-12 Final Report the Citadel		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle K-12 Educational Outreach and Transportation Workforce Development at The Citadel				5. Report Date 2020	
				6. Performing Organization Code	
7. Author(s) Dr. Dimitra Michalaka, Ph.D., P.E., M.S., The Citadel Dr. William J. Davis, Ph.D., M.S., The Citadel Dr. Kweku Brown, Ph.D., M.S., The Citadel				8. Performing Organization Report No.	
9. Performing Organization Name and Address The Citadel 171 Moultrie Street Charleston, SC 29409				10. Work Unit No.	
				11. Contract or Grant No. Funding Agreement Number - 69A3551747104	
12. Sponsoring Agency Name and Address University of Florida Transportation Institute Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE) 365 Weil Hall, P.O. Box 116580 Gainesville, FL 32611 U.S Department of Transportation/Office of Research, Development & Tech 1200 New Jersey Avenue, SE Washington, DC 20590 United States				13. Type of Report and Period Covered June 1, 2019 to September 20, 2020	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract 1) Coordinate, organize and conduct 1-week Summer Camp on multimodal mobility, connected vehicles and congestion mitigation for targeted population of 15-20 student cohorts. 2) Host Introduce a Girl to Engineering Day, an event for 80 Girl Scouts each year to learn about engineering through an engaging 3-hour program including interaction with college student mentors, and resulting in participants earning a Girl Scout Engineering Badge. 3) STEM Outreach and Events, including hosting bridge breaking competitions, conducting student workshops, hosting special student groups on campus, engaging college students in outreach activities.					
17. Key Words K-12 education outreach, workforce development, STEM, civil and transportation engineering				18. Distribution Statement No restrictions to all.	
19. Security Classif. (of this report)		20. Security Classif. (of this page)		21. No. of Pages 31 Pages	22. Price

Form DOT F 1700.7 (8-72)

Reproduction of completed page authorized

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated in the interest of information exchange. The report is funded, partially or entirely, by a grant from the U.S. Department of Transportation's University Transportation Centers Program. However, the U.S. Government assumes no liability for the contents or use thereof.

ACKNOWLEDGEMENT OF SPONSORSHIP AND STAKEHOLDERS

This work was sponsored by a grant from the Southeastern Transportation Research, Innovation, Development, and Education Center (STRIDE). Resources were also used from the Center for Connected Multimodal Mobility (C²M²), The Citadel, the South Carolina (SC) Governor's School for Science and Mathematics, the Girl Scouts of Eastern SC, and the Lowcountry Society of Women engineers.

Funding Agreement Number - 69A3551747104

LIST OF AUTHORS

Lead PI:

Dimitra Michalaka, Ph.D., P.E.

The Citadel, Civil and Environmental Engineering

Dimitra.Michalaka@citadel.edu

ORCID Number: 0000-0001-7001-0579

Co-PI:

William J. Davis, Ph.D., P.E.

The Citadel, Civil and Environmental Engineering, Construction Engineering

davisj7@citadel.edu

ORCID Number: 0000-0002-3812-8654

Additional Researchers:

Kweku Brown, Ph.D.

The Citadel, Civil and Environmental Engineering

kbrown16@citadel.edu

ORCID Number: 0000-0001-6497-8479

TABLE OF CONTENTS

DISCLAIMER.....	2
ACKNOWLEDGEMENT OF SPONSORSHIP AND STAKEHOLDERS.....	2
LIST OF AUTHORS.....	3
ABSTRACT.....	7
EXECUTIVE SUMMARY	8
1.0 INTRODUCTION.....	9
2.0 Tour of Engineering Summer Camp.....	10
2.1 Narrative	10
2.2 Collaborations.....	12
2.3 Impacts.....	12
2.4 Recommendations.....	13
3.0 Keynote Address “Construction Engineering at The Citadel”.....	14
3.1 Narrative	14
3.2 Collaborations.....	14
3.3 Impacts.....	14
3.4 Recommendations.....	14
4.0 Citadel (Pre-Knob) High School Student Recruitment Program	15
4.1 Narrative	15
4.2 Collaborations.....	16
4.3 Impacts.....	16
4.4 Recommendations.....	16
5.0 East Cooper Montessori Charter School, Bridge Competition	17
5.1 Narrative	17
5.2 Collaborations.....	17
5.3 Impacts.....	17
5.4 Recommendations.....	17
6.0 FIRST Lego League Club of James Island.....	18
6.1 Narrative	18
Figure 1: Students participating in FIRST LEGO Competition6.2 Collaborations.....	18

6.3 Impacts..... 18

6.4 Recommendations 19

7.0 National Engineers Week Event at The Citadel 19

7.1 Narrative 19

7.2 Collaborations 20

7.3 Impacts..... 20

7.4 Recommendations 20

8.0 Introduce a Girl to Engineering, Merit Badge Event..... 21

8.1 Narrative 21

8.2 Collaborations 22

8.3 Impacts..... 22

8.4 Recommendations 22

9.0 Charleston Science, Technology, Engineering & Math (STEM) Festival 23

9.1 Narrative 23

9.2 Collaborations 23

9.3 Impacts..... 23

9.4 Recommendations 24

10.0 Summer 2020 Civil/Construction High School Recruitment 24

10.1 Narrative 24

10.2 Collaborations 25

10.3 Impacts..... 25

10.4 Recommendations 25

11.0 Engineering Project Lead The Way (PLTW) Presentations..... 25

11.1 Narrative 25

11.2 Collaborations 26

11.3 Impacts..... 26

11.4 Recommendations 26

12.0 A semester-long Architecture Construction Engineering (ACE) Mentorship program.. 26

12.1 Narrative 26

12.2 Collaborations 27

12.3 Impacts..... 27

12.4 Recommendations 27

13.0 CONCLUSION 27

14.0 ATTACHMENTS 29

15.0 REFERENCES 29

ABSTRACT

An effectively crafted program of K-12 educational outreach events and student engagement activities is strategically important to civil and transportation engineering. Implementation of a coordinated K-12 program provides an effective means for attracting a well-qualified future workforce and inspiring talented students to choose transportation-related fields as their academic and career paths forward to successful and fulfilling professional futures. Through a variety of partnerships, The Citadel has organized, coordinated and orchestrated a robust program of Science, Technology, Engineering & Math (STEM) centric events and K-12 engagement activities focused on education, recruitment and workforce development outcomes, supporting advancement of civil and transportation engineering, and related technical fields. Principal stakeholder institutions include South Carolina Governor's School for Science and Mathematics; Girl Scouts of Eastern South Carolina, Lowcountry Chapter of Society of Women Engineers; The Citadel STEM Center of Excellence; and Engineering Project Lead The Way (PLTW). The Citadel's Civil, Environmental, and Construction Engineering faculty K-12 outreach program involved sponsoring and hosting nine consequential student-focused initiatives, emphasizing a civil and transportation engineering educational theme, reaching over 600 students, during the period from June 1, 2019 to July 31, 2020.

Keywords: K-12 student education outreach, workforce development, student engagement

EXECUTIVE SUMMARY

To advance the field of transportation engineering and support the STRIDE UTC Region 4 theme “Reducing Congestion,” The Citadel organized, coordinated, sponsored and conducted STRIDE affiliated activities to provide K-12 outreach engagement and educational enrichment in conjunction with a wide variety of stakeholders and partners in South Carolina. Nine student-focused initiatives, emphasizing a civil and transportation engineering, were conducted during June 1, 2019 to July 31, 2020. Outreach initiatives included: 1) Two (one in-person and one online), week-long Tour of Engineering summer camps offered in coordination with SC Governor School of Science and Mathematics; 2) A keynote address, “Construction Engineering at The Citadel,” at the Charleston Contractors Association Annual Scholarship Award Ceremony 3) Eight Citadel (pre-knob) high school recruitment programs; 4) One East Cooper Montessori Charter School, Bridge Competition; 5) Two FIRST Lego League Club of James Island meetings; 6) A National Engineers Week full of events, 7.) One Introduce a Girl to Engineering event collaborating with Girl Scouts of Eastern SC, and Lowcountry Society of Women Engineers; 8) One Charleston Region Science, Technology, Engineering & Math (STEM) Festival event; 9) Five Summer 2020 Civil/Construction Freshman Recruitment online sessions; 10) Two Project Lead the Way presentations; 11) A semester-long Architecture Construction Engineering (ACE) Mentorship program.

All STEM-centric educational outreach programs conducted during the reporting period collectively reached over 680 K-12 students in the Lowcountry region surrounding Charleston, SC, across the State of South Carolina, and beyond. Beneficial impacts of our K-12 program include: 1) reaching students at an early age in their intellectual development; 2) sparking student curiosity and interest through energetic face-to-face active learning activities; 3) introducing students to emerging technological advances and compelling challenges of engineering, transportation and mobility; 4) reaching a broad audience of students through cooperative stakeholder partnerships; 5) generating student interest in transportation academic and career pathways for making meaningful contributions to society; and 6) taking constructive and strategic steps to address future work force development for transportation professions.

Recommendations for future improvement and effective continuation of K-12 outreach program initiatives include: 1) Conduct systematic assessment, and identify resources and faculty time needed to conduct program activities; 2) Continue to develop and deliver creative events and hands-on learning experiences to spark student interest and imagination in the compelling challenge of technological advancements needed for efficient and sustainable transportation in the future; and 3) Continue to build and strengthen partnerships with STEM education organizations to broaden the scope and influence of The Citadel’s STRIDE K-12 outreach program, raise awareness with our stakeholders, and build a coalition of like-minded ambassadors for furthering the persuasive need to attract bright students into transportation-related academic and professional fields.

1.0 INTRODUCTION

Engineering is an amazing, challenging, and very broad field. It is divided into several disciplines and sub-disciplines. Currently, there are up to 40 different engineering degrees (types of Engineering Degrees, 2021). A country needs highly educated professionals in engineering and more broadly in science, technology, engineering and mathematics (STEM) fields in order to be economically competitive in the global market. Recruiting students in STEM majors is not an easy task and several efforts have been undertaken in the U.S. and abroad. For example, the U.S. department of education committed to support and improve STEM education by supporting educational institutions, teachers and students in those areas (U.S. Department of Education, 2015). Numerous studies (Reis et. al, 2012; Hanson et. al, 2010; Ekevall e. al, 2010 a and b) have shown that exposing students to STEM fields early in their education is the best time to increase their interest for science, engineering, and technology. Furthermore, students in an early age may have the wrong perception of what professionals in those fields do (Bevins et. al, 2005). Usually, for example, they associate engineering with just building or fixing things or a profession for people who are good in math. Not having a clear picture of the wide range of possibilities after going into those fields, may discourage students from willing to pursue an engineering or science degree for a career. Studies have shown that even though young people do recognize the importance and contributions of science and technology into the betterment of society and improvement of our lives (ROSE, 2016; OECD, 2007; Schreiner and Sjøberg), more than 65% are reluctant to select STEM fields for a career due to that lack of knowledge of what are the possibilities after entering into those fields (Ekevall e. al, 2010 a). Therefore, it is apparent that adults should focus more on introducing what selecting a STEM major may entail and the different professional options to young kids while they are still in the secondary education level.

The Citadel has worked collaboratively with a wide variety of stakeholders to organize, facilitate, host, and support a broad-based program of K-12 educational outreach events and activities. The overarching focus of these educational engagements has been to provide K-12 students with active learning experiences to better understand the compelling and challenging opportunities in transportation engineering. Events are structured to emphasize the promise of emerging technological advancements to revolutionize mobility, traffic operations, safety and sustainability for a host of transportation related professional fields and industries. K-12 outreach initiatives are focused on providing encouragement and support for students to develop their math and science proficiencies needed as foundational knowledge to prepare them for successfully pursuing academic pathways leading to meaningful and rewarding transportation professions. Energetic instructional engagements are also focused on sparking student curiosity and inherent interest to explore new frontiers and contribute to making the world a better place. During the period from June. 1, 2019 to July 31, 2020, The Citadel's K-12 educational program supporting STRIDE's research theme of efficient mobility congestion

reduction, included nine primary concentration tracks, for which an overview of each initiative is described in the following sections.

2.0 Tour of Engineering Summer Camp

2.1 Narrative

During the reporting period, two “Tour of Engineering” summer camps were offered. One in summer 2019 in person and one in summer 2020 online due to COVID-19 restrictions. More specifically, on June 23-29, 2019, Dr. Michalaka offered a ‘Tour of Engineering’ week-long (30 hrs) summer camp on engineering at the South Carolina Governor’s School of Science and Mathematics (SCGSSM) in Hartsville, SC to 16 rising 9th and 10th graders. Students learned about engineering and participated in hands-on projects. Topics covered included what engineers do, types of engineering, necessary skills to be successful, civil engineering, mechanical engineering, computer/software engineering, sustainability, and others. In civil engineering, emphasis was given to bridge design and construction, complete streets, multimodal mobility, connected vehicles and congestion mitigation. Along with getting introduced to the theoretical concepts, students were involved with many hands-on activities. They had to design bridges using Bridge Designer 2018 (Ressler, 2017), construct their bridge designs using K’nex, design and build a section of a complete street (street for all users), build autonomous vehicles using Lego Mindstorm EV3 (LEGO Education, 2021), and program their vehicles to autonomously travel between complete street sections crossing the bridges. Additionally, students participated in a “Curb your Congestion” challenge where they had to understand how design can meet the needs of different users, design a curb management plan, develop a financial strategy for supporting the curb space, and create a marketing campaign to make citizens aware of the new design. Furthermore, students played board games focused on transportation engineering including “Tokyo Highway” and “Railroad Ink.”



During the week of June 22-26, 2020, Dr. Michalaka taught a “Tour of Engineering” virtual summer camp organized by SCGSSM. Sixteen rising 8th and 9th graders participated and learned about what engineers do, types of engineering, necessary skills to be successful, civil engineering, transportation engineering, mechanical engineering, computer/software engineering, sustainability, and others. The camp included lecture time and hands-on work sessions. Students worked on exercises like developing a protocol for safely returning to school , designing a classroom that allows social distancing, designing a bridge using Bridge Designer software, and building one bridge using office material and one with edible material. One student used lasagna and fondant and another spaghetti and cheese to create sturdy truss bridges. Students were also encouraged to think about the accessibility of their neighborhood streets by taking an inventory of what they currently look like and transforming them to complete streets (streets for all) using Streetmix.net (Streetmix, 2021), a free, online tool. “Civil engineers also design roads which I like so I was excited when we got to map the roads in my neighborhood and create a scaled drawing of them. We did this so that we could redesign the roads, and make them safer and more complete. Most roads are not safe and don’t have sidewalks, bike lanes, or curb ramps. This can be unsafe to people who want to walk, ride a bike, or have a disability and can’t get up the curb. When I redesigned my road I added a sidewalk, bike lane, and curb ramp to improve safety. That is why this activity was one of the highlights of my week”, a student said. The camp included a special guest speaker from Volvo cars, Emanuele Gogli, who introduced students to automotive engineering and more

specifically manufacturing and metrology. He presented the state-of-the-art technology to ensure quality and dimensional control in manufacturing including Coordinate Measuring Machine, scanner, laser tracker, and cameras attached to robotic arms. Following, participants honed their engineering design skills with a challenge to design and build a safety collision device for an egg using just pieces of paper (IIHS HLDI, 2021). “This was another project that we did at home. I really liked this project because it went along with what our guest speaker that day was talking about with car collisions. And it also allowed us to use house materials to protect a raw egg from a 3ft drop. Just like how people tested cars for protection!” another student reported. Students dropped their eggs from a height of 3 ft and shared videos with the class. Some students achieved heights as tall as 5 ft. A final activity of the week was to work in groups and design a phone application to promote safe driving through school zones. Students learned what type of data is needed to design such an app and also learned about research at the University of Florida Transportation Institute that is studying the effectiveness of existing apps. In all activities, students used the engineering design process to brainstorm, build, and improve their ideas. The camp also included fun activities such as Kahoot quizzes, short videos about different careers in transportation, and final presentations from each of the students about their favorite activities.

2.2 Collaborations

This annual K-12 outreach initiative relies upon collaboration with South Carolina Governor’s School of Science and Mathematics (SCGSSM) and their affiliated corporate sponsors. SCGSSM is a high school for academically motivated juniors and seniors pursuing studies in science, technology, engineering and math, one of only 12 specialized, residential high schools in the nation. GSSM's week-long residential summer camps are open to rising 8th, 9th and 10th graders and provide hands-on experience for students interested in science, technology and engineering.

2.3 Impacts

Students attending the in-person camp have to take a pre and post evaluation survey answering several questions about their experience at the camp, the class they have taken, the instructor, and the material they have learned in class. Data are then collected and analyzed by the SCGSSM in Hartsville, SC and are available upon request. Students joining the camps at the SCGSSM are motivated and want to participate and learn. The majority of them, usually, more than 90% are highly satisfied with the course. For the online version of the camp offered for the first time in 2020, both students and parents were asked to take a post evaluation survey. Students were asked the following questions:

- 1) What was your favorite part of your Summer STEM with GSSM experience and why?
- 2) What was your least favorite part of your Summer STEM with GSSM experience and why?
- 3) How challenged were you by the camp material?
- 4) Would you recommend Summer STEM with GSSM to your classmates?

- 5) What would you tell them about Summer STEM with GSSM?
- 6) After attending Summer STEM with GSSM, how would you classify your interest in participating in more STEM learning experiences or courses?
- 7) What was the most amazing thing you learned this week?
- 8) What did you appreciate most about your instructor?
- 9) What improvements could be made to the course?
- 10) What else would you like to share about your Summer STEM with GSSM experience?

Parents were asked to rate their level of agreement with the following statements regarding to the Summer STEM with GSSM course experience.

- 1) My child was excited to participate in the real time (virtual) instruction each day.
- 2) My child gained new knowledge during the course.
- 3) My child enjoyed completing the course projects.
- 4) This content of the course was age-appropriate for my child.
- 5) The course was a beneficial learning experience for my child.
- 6) Participating in the course increased my child's interest in STEM fields.
- 7) Participating in the course increased my child's interest in GSSM.
- 8) Overall, I was pleased with my child's experience.
- 9) The other online learning tools incorporated into the course by the instructor supported the learning experience.

And answer the following questions:

- 1) What conversations did you and your student(s) have about Summer STEM with GSSM during the learning experience?
- 2) What did your child like best about Summer STEM with GSSM?
- 3) What did your child like least about Summer STEM with GSSM?
- 4) How can we improve the Summer STEM with GSSM curriculum and learning experience?
- 5) Please provide any additional comments that would help us improve the course delivery model or the technology used.

The online camp was very well rated with more than 90% positive feedback.

2.4 Recommendations

STRIDE faculty should continue to offer a similar engaging summer camp in subsequent years focused on student development and engagement using energetic hands-on active learning methods and instructional material. After this year's positive experience with the online format of the camp, the camp in subsequent years can be offered both in-person and online. Work with SCGSSM administration to investigate and identify additional opportunities to engage with students including the possibility of sponsoring events during the school year, participating in

statewide outreach programs for middle schools, becoming a college sponsor, and establishing a recruiting presence.

3.0 Keynote Address “Construction Engineering at The Citadel”

3.1 Narrative

On July 1, 2019, Dr. Davis gave a keynote Address, “Construction Engineering at The Citadel,” presented during the Charleston Contractors Association Annual Scholarship Award Ceremony. The Ceremony was attended by 40 participants including general contractors, engineers, business leaders, college students, and high school students.

3.2 Collaborations

The Annual Scholarship Award Ceremony was organized by the Charleston Contractors Association. <http://www.charlestoncontractors.net/> The purpose of this organization is to advance, protect, educate, and serve the business of construction contracting in general in the Charleston, Berkeley and Dorchester Counties by the dissemination of related information, presenting a united front in the interest of its business, and by taking action in the name of the association in the best interest of its membership.

3.3 Impacts

Engagement with the construction industry strategically raises awareness about construction/civil engineering challenges, compelling academic programs of study, aspirational career pathways, and student preparedness for future success. Students, and their families, reached through engagement with the construction industry are encouraged to further their understanding of how foundational knowledge of math and science can be used to build a better society and create stronger communities through construction, engineering design and problem solving. A total of 5 students were reached through this initiative during the stated reporting period.

3.4 Recommendations

Continue engagement, maintain productive partnerships, continue ongoing communication with contractors, engineers, and professionals in the local construction industry to 1) promote STEM student outreach to the community, 2) organize enrichment activities supported by local professionals, 3) leverage scholarship opportunities and 4) publicly recognize student success through similar events.

4.0 Citadel (Pre-Knob) High School Student Recruitment Program

4.1 Narrative

The Civil Engineering Department continues to welcome prospective Citadel students (popularly known on campus as pre-knobs). The ongoing Pre-Knob Program is a unique enrichment and recruiting opportunity for high school students, 16-18 years old, to interact with The Citadel, through firsthand observation and engagement. Student recruits (pre-knobs) declare an academic major in which they are interested and spend time at that department when they come for an on-campus visit. Additionally, high school students shadow a civil engineering freshman student and spend the night in The Citadel dormitories (barracks), joining in family style dining at the campus Mess Hall, and attending engineering classes. The Citadel Department of Civil, Environmental, and Construction Engineering opens their doors to host cohorts of pre-knobs introducing them to the civil engineering profession and allowing students to attend engineering classes. Pre-knobs learn about transportation engineering, highway design, research projects, and typically attend a transportation engineering course while visiting the Department. Five to fifteen students attend per date scheduled. Dates of the pre-knob recruitment program hosted by STRIDE faculty included Oct. 10-11, 2019, Oct. 31-Nov.1, 2019, Nov. 14-15, 2019, Dec. 5-6, 2019, Jan. 23-24, 2020, Feb. 6-7, 2020, Feb. 20-21, 2020, Feb. 27-28, 2020.

High school student recruiting also includes providing prospective students with a list of top 10 reasons why Civil Engineering and Construction Engineering degrees at The Citadel prepare students for highly successful and rewarding careers:

1. Well-traveled path of graduates to business ownership, or senior leadership of engineering and construction companies.
2. Emphasis on achieving registration as Professional Engineer, and Land Surveyor, provides tremendous strategic value for career advancement, financial success, and independence.
3. You lead consequentially important and highly visible engineering/ construction projects.
4. You benefit from being able to work (practically) anywhere you want to live.
5. You frequently work outdoors and interact with a wide variety of people including citizens, public agencies, decision makers, owners, specialized experts, and many other professions.
6. Effective engineering and construction projects protect and preserve the natural environment.
7. Successful engineering and construction projects serve to improve communities and promote quality of life for citizens.

8. Work includes public infrastructure projects that demand a high calling of the engineering profession to ensure complex projects are safe, equitable, sustainable, cost effective, environmentally responsible, constructible, and serve to meet critical long-term needs.
9. Multidisciplinary nature of the profession prepares you for career advancement into upper management of large-scale projects and consequential business enterprises.
10. Great professional gratification and personal satisfaction from serving the public and working to deliver projects that make a big difference for many people.

4.2 Collaborations

This ongoing K-12 outreach initiative is conducted in association with The Citadel Office of Admissions and School of Engineering. The program is solely focused on high school students who would enter the program as cadets; however, on rare occasions also includes college transfer students, typically during their sophomore year academically.

4.3 Impacts

The conversion rate of students participating in the high school (pre knob) recruitment program is considered by the Office of Admissions to be very high, meaning a large portion of students will enter The Citadel as freshman. Providing an effective and engaging orientation program that introduces prospective students to compelling challenges and rewarding career opportunities of civil and transportation engineering is an effective means to attract qualified and capable students into the program. Recruitment activities also include follow-up communication with prospective students emphasizing how our program provides a great foundation for successful careers in engineering planning, management, design and construction and offers 1) a great undergraduate student-focused learning environment, 2) highly qualified and dedicated teaching faculty, 3) rigorous design-oriented academic curriculum, and 4) engaging student enrichment opportunities; all of which prepare graduates for outstanding careers in a wide range of engineering professions. A total of 56 students were reached through this K-12 initiative during the stated reporting period.

4.4 Recommendations

Faculty should continue to improve recruitment messaging and effectiveness and extend program publicity to high school guidance counselors, STEM coordinators, and AP credit curriculum teachers. Faculty should continue to host Citadel pre-knob programs in coordination with Office of Admissions and School of Engineering. Faculty should modify recruitment materials, orientation program and messaging for high school students who may not be interested in military academic program, but rather our parallel 2+2 evening civilian academic program. Partner with Citadel Graduate College and other stakeholders to recruit and attract perspective students for the civilian evening program that allows students to gain work experience with local engineering companies during their junior and senior years. Use social

mediums more effectively to reach targeted student recruitment populations including Facebook, Instagram, LinkedIn and Twitter.

5.0 East Cooper Montessori Charter School, Bridge Competition

5.1 Narrative

In this competition, teams of three or four 7th and 8th graders adhered to published rules in constructing model bridges using popsicle sticks that concluded with a load testing event of eight bridge entries. The event was held on Oct. 21, 2019 with a total of 25 middle school kids participating. Bridges were tested to failure using a custom load testing device where Citadel faculty carefully poured sand into a bucket attached to the end of a lever arm. The interaction between faculty and K-12 students during the load testing is the most impactful aspect of the competition, where K-12 students receive feedback and encouragement from faculty. Using the bridge weight and test load held, a strength-to-weight ratio is calculated and used as the basis for ranking structural efficiency. Recognitions are presented to recipients to provide positive affirmation and recognition of K-12 efforts in preparing for the competition and participating in this engaging learning event.

5.2 Collaborations

This event was hosted by The Citadel in conjunction with Citadel STEM Center and East Cooper Gifted and Talented Program. The program used bridge competition rules from Storm The Citadel, National Engineers Week K-12 STEM outreach events.

5.3 Impacts

Students were exposed to civil engineering and more specifically to structural, construction and transportation engineering. Students' interest in engineering educational and career paths is usually sparked after participating in this or similar events. This event provided an opportunity to raise awareness about civil engineering disciplines, application of foundational math and science skills, importance of engineering design, and student preparedness for future success. A total of 25 students were reached through this K-12 initiative during the reporting period.

5.4 Recommendations

Faculty should continue to engage with STEM and Gifted and Talented Program through local schools in Berkeley, Charleston and Dorchester Counties. Event organizers should improve collection of data on participating students, including contact information of teachers for continued STEM education engagement and student recruitment. Faculty should also solicit formal participant feedback and suggestions for event/competition improvement and assessment.

6.0 FIRST Lego League Club of James Island

6.1 Narrative

On October 24, 2019, two Citadel faculty met with five elementary school aged, homeschooled children from the FIRST Lego League Club of James Island, SC and their parents, to discuss the club's innovation project addressing needs in their local community. After an hour discussion, students decided to focus their project on providing alternative transportation options to solve traffic congestion to Folly Beach, SC during summer months. Students worked on their project for several weeks and presented their plan at the FIRST Lego League competition in Summerville on November 23, 2019. At the end of the meeting, Citadel professors gave a STEM Starters for Kids Engineering Activity Book to kids that participated.



Figure 1: Students participating in FIRST LEGO Competition

6.2 Collaborations

This activity was conducted in collaboration with the Lowcountry Homeschool Association group in James Island, SC.

6.3 Impacts

Students had the opportunity to discuss different engineering projects that could address needs in their local community. The discussion was very productive starting simply from listing needs in students' community and then directing students to think like engineers coming up with potential solutions to a problem, evaluating the solutions, and deciding on the best solution. After the meeting, students departed with activities to do to complete their project and an activity book focused on engineering. Students presented their complete project at the FIRST Lego League competition.

6.4 Recommendations

Collaborating with the Lowcountry Homeschool Association has been very fruitful over the years, therefore, continuing to do so is highly recommended. Expanding on the activities executed through the years is also suggested for greater positive impact to the homeschooled community.

7.0 National Engineers Week Event at The Citadel

7.1 Narrative

Civil engineering student volunteers and faculty hosted an engaging bridge and transportation competition event focused on K-12 outreach and workforce development event during national engineering week on February 8, 2020. Event metrics included: 27 bridge entries, eight student volunteers, two graduate student judges, three faculty, 200 bridge event participants, students, teachers, parents; and 1,500 overall Storm The Citadel participants including robotics, water bottle rockets, & trebuchet. Charleston mayor, John Tecklenburg attended as dignitary. The event involved students from public and private schools across the Lowcountry Region to participate in “Storm The Citadel”, a K-12 outreach event held annually during National Engineers Week focused on engaging students in educational contests involving trebuchet, bridge building, robotics and water bottle rocket competitions. The event promotes STEM education and allows students to use skills they learn in the classroom in a novel and exciting context. Faculty and students serve as competition organizers, judges, competition officials, and engineering mentors to engage with K-12 student teams participating in the academic-oriented competitions. The model bridge building competition focuses on transportation. Students adhere to rules in constructing bridges using popsicle sticks, which concludes with aesthetic judging and load testing. The highlight of the event is having engineering students discuss bridge designs with K-12 teams and talk with students about their bridges during load testing. Bridges are tested to failure using a custom load testing device where college students carefully pour sand into a bucket attached to the end of a lever arm. The interaction between college and K-12 students during the load testing is the most impactful aspect of the competition, where college students serve as ambassadors and role models for engineering education, and K-12 students receive feedback and encouragement from successful college students. Using the bridge weight and test load held, a strength-to-weight ratio is calculated and used as the basis for ranking structural efficiency. Prior to the load testing, bridges are judged by an expert engineering panel based on best architectural design and best technical design for middle school and high school divisions. Awards are presented to recipients in four categories to provide positive affirmation and recognition of K-12 efforts in preparing for the competition and participating in this engaging learning event (Table 1). Additional details describing the event and listing 2020 results are provided at this Google hosted site:

<https://sites.google.com/site/stormthecitadelcompetitions/>

Table 1: 2020 Competition winners

Best Architectural Design		
1 st Place	Burke Bulldogs	Burke High School
2 nd Place	The Holders	Westview Middle School
Technical Design Document		
1 st Place	The Suspenders	Porter-Gaud School
2 nd Place	Summerville Cows	Summerville High School
Structural Design – Middle School		
1 st Place	Half & Half	Westview Middle School
2 nd Place	Bison Whistlers	Camp Road Middle School
3 rd Place	Hurricanes	Orange Grove Middle School
Structural Design – High School		
1 st Place	The Suspenders	Porter-Gaud School
2 nd Place	Burke Bulldogs	Burke High School
3 rd Place	The Put it Together Girls	Miracle Academy

7.2 Collaborations

The event involved students from public and private schools across the Lowcountry Region as well as homeschooled groups. The Citadel STEM center of excellence along with School of Engineering, Zucker Family School of Education, and Swain Family School of Science and Mathematics are critical in organizing and executing the event. Other important partners include the local school districts, area private schools, home school associations, Engineering Project Lead The Way (PLTW) programs, STEM Centers, and STEM teachers.

7.3 Impacts

This event reaches a wide range of K-12 target audiences on a regional basis and provides an opportunity to raise awareness about civil engineering disciplines, application of foundational math and science skills, importance of engineering design, and student preparedness for future success. Students, their families, and teachers participating in this event express enthusiasm for learning about engineering principles and understanding how students can successfully prepare for STEM academic pathways. A total of 200 students were reached through this K-12 initiative during the reporting period.

7.4 Recommendations

Faculty should take a more active role in promoting competition events to target audiences and encouraging STEM oriented K-12 school programs to take advantage of this great learning opportunity. Event organizers should improve collection of data on the number of participating teams, number of schools represented, number of students, and total number of participants attending, including contact information of teachers from participating schools for continued

STEM education engagement and student recruitment. Faculty should also solicit formal participant feedback and suggestions for event/competition improvement and assessment.

8.0 Introduce a Girl to Engineering, Merit Badge Event

8.1 Narrative

The Citadel Civil, Environmental and Construction Engineering, School of Engineering, and Society of Women (SWE) student chapter collaborated with Girl Scouts of Eastern SC, and Lowcountry SWE professional chapter to plan, organize and host “Introduce a Girl to Engineering Day,” a three-hour outreach event designed to excite middle-school-aged females about engineering through high-energy, hands-on learning activities. The event is hosted annually in conjunction with National Engineers Week activities hosted by The Citadel. Up to 120 Girl Scout juniors and cadettes register for the highly publicized event. For optimal engagement and learning, Girl Scout participants are organized in teams of two, three or six and work together to complete assigned educational tasks at a circular worktable of six. Each worktable also includes one college student from The Citadel School of Engineering, usually a junior or senior, and one professional volunteer (either a Citadel professor or professional from SWE professional chapter). Girl Scouts are encouraged to not sit with members from their own troop, so they get to know other students and make new collaborations. The event begins with an overview of engineering and continues with interactive, hands-on, uniquely created student learning activities. Midway through the program, Girl Scouts take a break for snacks and networking. A series of novel hands-on activities are created each year and developed around relatable familiar cultural themes covering fundamental aspects of engineering problem solving, and frequently focusing on transportation engineering challenges. The overall program of learning activities is presented within a themed dramatically performed, college student acted skit that links educational subject matter and assigned engineering design challenges with popular cultural icons whom Girl Scouts are familiar with, to make the event more fun and engaging.

This year, 36 Girl Scouts participated in the event along with 26 engineering students and professional volunteers. Each students group was given a 22”x28” poster board, glue sticks, markers, colorations construction paper pack, tissue paper, scissors, paper cups, and tape to construct a two-story Princess castle following the Disney building code modified to fit the comprehension level of the students. Then, students had to build a crane to reach the castle’s second floor and design and build a road around the castle. Finally, they had to program an ozobot to navigate the road. All learning activities and engineering design challenges were introduced to Girl Scout participants using the theme “Disney Princesses.” Several SWE student volunteers and faculty dressed as Disney Princesses for the skit. Pictures from this event are included in the Dropbox folder shared later.

8.2 Collaborations

This annual K-12 outreach initiative relies on collaboration with two key stakeholder partnerships including Girl Scouts of Eastern South Carolina, and Lowcountry SWE professional chapter. Other important partners are student officers and members of Citadel SWE Chapter and students/faculty in Citadel School of Engineering. As this K-12 outreach initiative involves hosting students under 18 years of age at a location on campus (Mark Clark Hall Auditorium), the event is coordinated with The Citadel's Child Protection Officer and a number of administrative steps are required to obtain appropriate review and institutional permission approvals.

8.3 Impacts

This program introduces female middle school students from across our region to compelling engineering topics, problem solving skills within a team setting, and persuasive motivation and encouragement to pursue STEM academic and career pathways. Citadel female engineering students plan, organize and deliver the high-energy K-12 education program. Their performance as enthusiastic engineering ambassadors and admired role models are crucial to the success of this event and effectiveness in generating interest from Girl Scout participants. Students obtain a merit badge to wear on their Girl Scout uniform upon completion of the program, providing a visible memento reminder of the experience they gained and point of pride for their accomplishment of learning about engineering and participating in assigned team competitions. A total of 36 students were reached through this K-12 initiative during the stated reporting period.

8.4 Recommendations

STRIDE faculty should continue to offer a similar annual K-12 female student outreach education program under the title "Introduce a Girl to Engineering" as a programmed event for National Engineers Week and in collaboration with Girl Scouts of Eastern South Carolina, and Lowcountry SWE professional chapter. Faculty should continue to work with Citadel SWE Chapter student members to develop and plan creative K-12 learning activities, using an energetic theme with skits, costumes, props, videos and music to spark excitement in participants for engineering-based education and team competition assignments. Faculty should work to expand event publicity and marketing mediums for reporting impactful outcomes effective in promoting student interest in engineering education and subsequent careers. A strategy to increase participation could be to include hands-on activities selected based on the Girl Scout engineering curriculum, so girl scouts have the opportunity to complete the engineering activities and earn engineering scout badges in addition to the event badge. Faculty should obtain and analyze data from feedback surveys with respect to learning objectives, desired program outcomes and adoption of future event improvements.

9.0 Charleston Science, Technology, Engineering & Math (STEM) Festival

9.1 Narrative

Citadel Civil, Environmental, and Construction Engineering faculty participated in the 5th and 6th Annual Charleston Science, Technology, Engineering & Math (STEM) Festival (Charleston STEM Festival, 2020), held March 7, 2020. The annual STEM Festival celebration attracts over 10,000 K-12 students, and their families (participation approximately reduced by half in 2020), from surrounding counties (Berkeley, Charleston and Dorchester Counties) extending across the SC Coastal Lowcountry, a region with a population over 802,000 residents in 2019. The widely popular and successful event received strong support from industry, manufacturing, trade professions, business, and educational institutions, with over 80 exhibitors, hands-on activities, live performances, interactive demonstrations, and family-oriented STEM engagement. The festival comprises a well-publicized and highly visible marquee K-12 community supported event to provide targeted populations with a welcoming environment for educational engagement and academic exchange, focused on sparking imagination and interest through a friendly forum connecting children, teens, and families with local STEM-centric stakeholders, academic institutions, and prospective careers.

In 2020, the festival was held at Ladson Exchange Park Fairground and attracted over 12,000 K-12 students and participants interested in STEM educational programs and learning opportunities. STRIDE faculty planned, developed, and organized The Citadel's student engagement program to include bridge design, fabrication and testing, using K'nex rods and connectors educational building sets. During the 5-hour event approximately 250 students participated in The Citadel program and were introduced to foundational principles of civil engineering, specifically including the fields of structural and transportation engineering.

9.2 Collaborations

Charleston STEM Festival is an initiative of the Lowcountry STEM Collaborative, previously managed by South Carolina's Coalition for Mathematics and Science (SCCMS) at Clemson University. A new STEM team was in place for the 2020 Festival, with a steering team lead by College of Charleston Lowcountry Hall of Science and Math. The Citadel has a Steering Team representative, Dr. Jennifer Albert, director of The Citadel STEM Center of Excellence.

9.3 Impacts

This event reaches a wide range of K-12 target audiences on a regional basis and provides an opportunity to raise awareness about civil engineering, compelling academic programs of study and aspirational career pathways, and student preparedness for future success. Students, and their families, participating in this event express interest in understanding how their foundational knowledge of math and science can be used to build a better society and create

stronger communities through engineering design and problem solving. A total of 250 students were reached through this K-12 initiative during the stated reporting period.

9.4 Recommendations

Faculty should promote our involvement through social media, to better engage stakeholders and reach target audiences. When the event does not occur during spring break, faculty should solicit participation of college engineering students to serve ambassadors and admired role models in generating increased interest from event participants as in the past. Faculty should distribute informational material about civil engineering and available academic programs in the area.

10.0 Summer 2020 Civil/Construction High School Recruitment

10.1 Narrative

The department of civil and environmental engineering and construction engineering held an entire series of virtual recruiting/orientation meetings over the summer to recruit high school students into the civil and construction engineering programs. Five sessions, with each having 2 groups, involving a total of 40 students were held. The schedule, faculty and students involved are presented at the following table.

Table 2: Schedule, Faculty and Students Involved at Summer 2020 Civil/Construction High School Recruitment

Scheduled Interaction	2 Sections	Student	Faculty
Tues., July 7, 7-8 pm (led by students, supported by faculty, involving 40 high school students)	CE/CONE Session 1	Anthony Sands	1. Dr. Jeff Davis
	CE/CONE Session 2	Emily Perkins	3. Dr. Simon Ghanat 4. Dr. John Ryan
Mon., July 13, 7-8 pm (led by students, supported by faculty, involving 40 high school students)	CE/CONE Session 1	Anthony Sands	1. Dr. Jeff Davis 2. Dr. Tim Mays
	CE/CONE Session 2	Emily Perkins	3. Dr. Dimitra Michalaka 4. Dr. Timothy Wood
Tues., July 14, 7-8 pm (led by students, supported by faculty, involving 40 high school students)	CE/CONE Session 1	Anthony Sands	1. Dr. Jeff Davis
	CE/CONE Session 2	Emily Perkins	3. Dr. Dimitra Michalaka 4. Dr. Ryan Giles
Wed., July 22, 7-8 pm (led by students, supported by	CE/CONE Session 1	Anthony Sands	1. Dr. Dimitra Michalaka 2. Dr. Jeff Davis

faculty, involving 40 high school students)	CE/CONE Session 2	Emily Perkins	3. Dr. Mary Katherine Watson 4. Dr. Stephanie Laughton
Thurs., July 23, 7-8 pm (led by students, supported by faculty, involving 30 high school students)	CE/CONE Session 1	Anthony Sands	1. Dr. Simon Ghanat 2. Dr. Stephanie Laughton
	CE/CONE Session 2	Emily Perkins	3. Dr. Jeff Davis 4. Dr. Dan Nale

10.2 Collaborations

This event was organized and held in collaboration with The Citadel School of Engineering and other student recruiting and cadet leadership functions.

10.3 Impacts

This program focused on reaching individuals who recently graduated from high school and have declared interest in pursuing a civil or construction engineering degrees and recruiting them to follow their interests and join The Citadel engineering programs. Providing an effective and engaging program introduces high school students to compelling challenges and rewarding career opportunities of civil/construction engineering is an effective means to attract qualified and capable students into the program. A total of 40 students were reached through this educational initiative during the stated reporting period.

10.4 Recommendations

The Civil, Environmental and Construction Engineering Department should continue to impress upon campus organizers the value of this event for recruiting students and work to maintain faculty buy-in to support this strategically important engineering education program, as an effective means for promoting compelling and engaging aspects of our profession and attracting prospective students into our undergraduate program. Additionally, faculty should investigate giving surveys to students who attended these sessions to evaluate how informative and helpful such sessions are to their success.

11.0 Engineering Project Lead The Way (PLTW) Presentations

11.1 Narrative

Civil engineering faculty organized and gave two presentations for the PLTW program (PLTW, 2021). The first presentation was at the Wando High School in Mount Pleasant, SC on March 6, 2020 and the second one was at Fort Dorchester high school in North Charleston, SC on March 9, 2020. Both presentations focused on providing students with an understanding of (1) purpose and diversity of disciplines in Civil Engineering, (2) career opportunities available in Civil Engineering, and (3) academic pathways for pursuing Civil Engineering careers, highlighting opportunities at The Citadel.

11.2 Collaborations

This K-12 outreach initiative relies on collaboration with teachers affiliated with the Engineering Project Lead the Way in the Charleston and Dorchester counties.

11.3 Impacts

These initiatives reach a highly strategic and critically important target audience of motivated and capable high school students who have a demonstrated interest in engineering, and whose families reside in the surrounding local area. Providing meaningful K-12 outreach activities, events, and engagements that introduces prospective local high school students to compelling challenges and rewarding career opportunities of civil and transportation engineering, is an effective means to attract students, from a student population with proven interest and awareness in engineering education, into undergraduate degree programs at our institution. A total of 100 students were reached through this K-12 initiative during the stated reporting period.

11.4 Recommendations

Faculty should continue to encourage, engage, facilitate and host K-12 outreach initiatives for Engineering PLTW programs at local area high schools. Furthermore, faculty should develop a comprehensive plan to establish on-going, face-to-face or virtual contact and engagement with teachers and students in Engineering PTLW programs at Wando HS, Summerville HS, West Ashley HS, James Island Charter HS, Burke HS, North Charleston HS, Goose Creek HS, Stratford HS, and Fort Dorchester HS. Lastly, faculty should consider creating targeted engineering educational engagement and student recruitment material for use with South Carolina statewide and national PLTW programs, the significance of which is shown through their website: <https://www.pltw.org/our-programs/pltw-engineering> and potential schools connections shown by this link: <https://www.pltw.org/about-us/pltw-state-presence>.

12.0 A semester-long Architecture Construction Engineering (ACE) Mentorship program.

12.1 Narrative

Citadel Civil, Environmental, and Construction Engineering faculty participated as ACE Mentors at Wando high school in Mount Pleasant, SC during spring 2020 semester. This program provides a semester long engagement between students and design and construction professionals. The function of each discipline, along with pathways and opportunities within each profession is presented by the professionals. Under the supervision of the design professionals, a project which incorporates all disciplines is chosen by and designed by each school and then presented by each school to all schools upon completion at the end of the term.

12.2 Collaborations

This program is organized by local volunteer Engineers, Architects, and Contractors. Engineering faculty collaborate with high schools sponsors, who are most often teachers of technology and engineers programs.

12.3 Impacts

Specific understanding of the function of professions, as well as career pathways is gained by the students.

12.4 Recommendations

This program is beneficial to high school students so involvement every semester is recommended. Planning for 2021 includes increasing the number of students served and reached through the program.

13.0 CONCLUSION

The Citadel's Civil, Environmental, and Construction Engineering faculty planned, developed, organized, promoted, coordinated, facilitated, conducted, hosted and sponsored a wide-ranging K-12 outreach program involving nine consequential student-focused initiatives, emphasizing a civil and transportation engineering educational theme, reaching over 680 students, during the period from June 1, 2019 to July 31, 2020. The K-12 outreach program was strategically crafted to promote civil and transportation engineering student recruitment and support the STRIDE UTC Region 4 theme "Reducing Congestion." K-12 educational outreach events and student engagement activities are strategically important to civil and transportation engineering. Implementation of a systematic K-12 outreach plan provides an effective means for attracting a well-qualified future workforce and inspiring talented students to choose civil and transportation engineering as their academic and career paths forward to successful and fulfilling futures. Outreach initiatives planned, developed, organized and conducted by faculty, as part of an overall K-12 program included:

1. Two (one in-person and one online), one week-long Tour of Engineering summer camps focusing on bridge design and construction, complete streets, multimodal mobility, connected vehicles, collision device design and construction, school zone safety application development, and congestion mitigation, offered in coordination with SC Governor's School of Science and Mathematics, Hartsville, SC.
2. A keynote address, "Construction Engineering at The Citadel," at the Charleston Contractors Association Annual Scholarship Award Ceremony covering what construction engineering entails and the engineering academic programs offered by The Citadel.
3. Eight Citadel (pre-knob) high school recruitment programs, offering a unique enrichment and recruiting opportunity for students interested in civil or construction engineering to learn about transportation engineering, highway design, research projects, and attend college engineering courses on the Citadel campus.

4. One East Cooper Montessori Charter School Bridge Competition where teams of three or four 7th and 8th graders constructed model bridges using popsicle sticks that later got load tested.
5. Two FIRST Lego League Club of James Island meetings where elementary school aged homeschooled children and their parents met with Citadel faculty to discuss the club's innovation project addressing needs in their local community.
6. A National Engineers Week full of events, where middle and high school students were engaged in civil and transportation engineering activities.
7. An Introduce a Girl to Engineering event, involving themed high-energy, hands-on team-oriented engineering learning activities, earning a merit badge upon competition offered in collaboration with Girl Scouts of Eastern SC and Lowcountry SWE on the Citadel campus.
8. Participation in the Charleston STEM Festival, a well-attended regional K-12 event, providing an individual student engagement activity involving bridge design, fabrication and testing, using K'nex rods and connectors educational building sets, Ladson, SC.
9. Five virtual summer 2020 Civil/Construction Freshman Recruitment sessions to recruit high school students into the civil and construction engineering programs.
10. Two Project Lead the Way presentations to introduce students to the purpose and diversity of disciplines in Civil Engineering, career opportunities available in Civil Engineering, and academic pathways for pursuing Civil Engineering careers.
11. A semester-long Architecture Construction Engineering (ACE) Mentorship program to introduce high school students to the functions of each discipline, along with pathways and opportunities within each profession.

The need for effective K-12 outreach and strategic workforce development initiatives for target student populations is of paramount importance for ensuing future sustained success in civil and transportation engineering professions. Critical considerations and elements for providing effective K-12 outreach include:

- Reaching students at an early age in their intellectual development is critical through programs that inspire students to consider the future advent of technological advances and learn about the compelling transportation and mobility challenges of facing our communities.
- Sparking student curiosity and interest through energetic face-to-face active learning activities are optimal and, when feasible, including college students to serve ambassadors and admired role models in generating increased interest from event participants is highly desirable.
- Providing encouragement and support for K-12 students to develop their math and science proficiencies needed as foundational knowledge to prepare them for successfully pursuing engineering academic programs in higher education.

- Raising awareness about civil and transportation engineering challenges to inspire talented students to choose transportation-related fields as their academic and career paths forward to successful and fulfilling professional futures.
- Developing a plan to provide adequate support, necessary resources and faculty time to lead and conduct K-12 outreach, is a crucial consideration in making these potentially high impact educational endeavors repeatable and sustainable over time.
- Establishing ongoing stakeholder partnerships is a crucial consideration for sustained success to reach a broad audience of interested parties, identify meaningful outreach opportunities, publicize and promote events, create productive alliances for achieving shared goals, pooling resources and energizing volunteer efforts, synergizing across like-minded professions, and accomplishing collaborative objectives in advancing K-12 student outreach.

The Citadel's Civil, Environmental, and Construction Engineering faculty will continue to provide a far-reaching program of K-12 outreach events and activities as an effective means for taking positive, constructive and strategic steps to inspire and attract talented students into our program, and to address future work force development needs for civil and transportation engineering. The importance of the ongoing and sustainable success of these outreach and student recruitment initiatives for our profession, cannot be overstated.

14.0 ATTACHMENTS

Products, presentations, media and photos are included in the dropbox folder The Citadel K-12_June 2019_July 2020,

https://www.dropbox.com/sh/gk23iwzjewjk5z1/AABYvpTE_9cPkhqMkola9Qoba?dl=0.

- a. Photos of K-12 outreach activities and events
- b. Excel table summarizing activities and events
- c. Tour of Engineering 2019 and 2020 Summer Camp Material
- d. Slides from the "Introduce a girl to engineering" event

15.0 REFERENCES

1. Types of Engineering Degrees, 2021. <http://typesofengineeringdegrees.org/> Accessed on Feb. 2, 2021.
2. Science, Technology, Engineering and Math: Education for Global Leadership. United States Department of Education, 2015. <https://www.ed.gov/stem> Accessed on Feb. 2, 2021.
3. Reis, A., D. Patrocínio and P. Lourtie. Attracting students to science, technology and engineering higher education., 2012. <http://www.sefi.be/conference-2012/Papers/Papers/028.pdf>

4. Hanson, M., E. Engström, A. Kairamo, and Var, Enhance the attractiveness of studies in science and technology, 2010. Joint International IGIP-SEFI Annual Conference, IGIP-SEFI, Trnava, Slovakia. <http://www.sefi.be/conference-2012/Papers/Papers/028.pdf>
5. Ekevall, E., E. L. Hayward, G. Hayward, G. MacBride, J. Magill, and E. Spencer. Engineering – What’s that?, 2010. <http://www.sefi.be/wp-content/abstracts2009/Ekevall.pdf>
6. Ekevall, E., E. L. Hayward, G. Hayward, G. MacBride, J. Magill, E. Spencer, G. MacBride, C. Bryce, and B. Stimpson. Engineering – young people want to be informed, 2010. The Higher Education Academy Engineering Subject Centre, Inspiring the next generation of engineers. EE2010. <https://pure.strath.ac.uk/portal/files/3695504/406034.pdf>
7. Bevins, S.C., M. Brodie, and E. Brodie, UK Secondary School Pupils’ Perceptions of Science and Engineering: A Report submitted to the Engineering and Physical Sciences Research Council and the Particle Physics and Astronomy Research Council, 2005. Sheffield Hallam University.
8. ROSE: The Relevance of Science Education, 2016. <http://www.ils.uio.no/english/rose/about/rose-brief.html> Accessed on Feb. 2, 2021.
9. OECD, Executive Summary PISA 2006: Science Competencies for Tomorrow’s World, in The Programme for International Student Assessment (PISA), 2007, OECD.
10. Schreiner, C. and S. Sjøberg. Science education and youth's identity construction - two incompatible projects? In D. Corrigan, Dillon, J. & Gunstone, R. (Eds.), The Re-emergence of Values in the Science Curriculum. Rotterdam: Sense Publishers, 2007.
11. Ressler, S. J. The Bridge Designer, 2017. <https://bridgedesigner.org/> Accessed on Feb. 2, 2021.
12. LEGO Education, LEGO MINDSTORMS Education EV3. <https://education.lego.com/en-us/start/mindstorms-ev3#Setting-Up> Accessed on Feb. 2, 2021.
13. Streetmix, <https://streetmix.net/-/1377298>. Accessed on Feb. 2, 2021.
14. Insurance Institute for Highway Safety Highway Loss Data Institute (IIHS HLDI) in the classroom. Egg Crash! Designing a collision Safety Device, 2021 <https://classroom.iihs.org/egg-crash/> Accessed on Feb. 2, 2021.
15. Charleston STEM Festival, 2020 <http://www.charlestonstemfest.org/> Accessed on Feb. 2, 2021.
16. Project Lead The Way (PLTW), Inc., 2021 <https://www.pltw.org/> Accessed on Feb. 2, 2021.