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NSF S-STEM Project Update: A Pathway to Completion for Pursuing Engineering and Engineering Technology Degrees

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NSF S-STEM Project Update: A Pathway to Completion for Pursuing Engineering and Engineering Technology Degrees

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Dr. Bullington is an experienced and accomplished leader in higher education and university administration with strong expertise in program management, organizational development, and student and academic affairs administration, with over two decades of university experience.

Dr. Bullington's research interests include student success - especially in the veteran and non-traditional student realm, higher education policy, and student access to higher education resources.

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Dr. Vukica Jovanovic is a Batten Fellow and an Associate Professor of Engineering Technology in Mechanical Engineering Technology Program. She holds a Ph.D. from Purdue University in Mechanical Engineering Technology, focuses on Digital Manufacturing, Magistar (Ph.D. candidate) degree in Indsutrial Engineering and Management, focused on Production Systems Design, and dipl.ing. degree in Industrial Engineering focused on Mechatronics, Robotics and Automation. She went through engineering pathways herself, completing master electrician degree when completing Technical School in Uzice, Serbia, focusing on pre-engineering program on high power voltage systems and maintenance of electromechanical systems. Her research is focuses on engineering pathways, career and technical education, digital thread, cyber physical systems, mechatronics, digital manufacturing, broadening participation, and engineering education. She is a Director of Mechatronics and Digital Manufacturing Lab at ODU and a lead of Area of Specialization Mechatronics Systems Design. She worked as a Visiting Researcher at Commonwealth Center for Advanced Manufacturing in Disputanta, VA on projects focusing on digital thread and cyber security of manufacturing systems. She has funded research in broadening participation efforts of underrepresented students in STEM funded by U.S. Department of Education, focusing on computer science and cybersecurity pathways, and from Office of Naval Research, focusing on mechatronic pathways. She is part of the ONR projects related to the additive manufacturing training of active military. She is also part of the research team that has multiple projects funded from NSF focusing on veteran pathways and their success in engineering. She leads the team that delivers the summer program to nine graders that focus on broadening participation of underrepresented students into STEM (ODU BLAST), funded by the Virginia Space Grant Consortium.

Dr. Anthony W Dean, Old Dominion University

Dr. Anthony W. Dean has had several roles in academia. He is currently Assistant Dean for Research, Batten College of Engineering and Technology (BCET) at ODU. His previous appointments include Associate Professor of Engineering Technology and as Associate Director of the Institute for Ship Repair, Maintenance, and Operations at Old Dominion University (ODU).His research has focused mostly on control systems (integration and testing) and the reliability and maintainability of complex systems. He has been selected as both a NASA and an ONR Faculty Fellow. He regularly teaches courses in Marine Engineering and in Maintained Systems. Most recently Dr. Dean was on the Headquarters Staff the American Society of Naval Engineers. He received his Ph.D. from the Department of Engineering Management and Systems Engineering, and a B.S. in Nuclear Engineering Technology, from the Batten College of Engineering and Technology at Old Dominion University. Additionally, Dr. Dean received an MBA from the College of William and Mary. Prior to is academic career Dr. Dean was Director of Operations and Business Development for Clark-Smith Associates, P.C., and served as an Electrician in the US Navy aboard the USS South Carolina and the USS Enterprise.

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Dr. Landaeta is an Associate Professor with tenure in the Department of Engineering Management and Systems Engineering at Old Dominion University in Norfolk, Virginia. He holds a Ph.D. in Industrial Engineering and an M.S. in Engineering Management from the University of Central Florida, as well as, a B.S. in Mechanical Engineering from UNITEC Venezuela.

NSF S-STEM Project Update: A Pathway to Completion for Pursuing Engineering and Engineering Technology Degrees

This poster showcases the progress of students who are receiving scholarships from the National Science Foundation S-STEM project: A Pathway to Completion for Pursuing Engineering and Engineering Technology Degrees. Thus far, 20 academically high-achieving students who demonstrate financial need have participated in the project. Thirty-six scholarships have been awarded to date, in which a maximum of twelve scholarships are awarded per semester; some students have received scholarships multiple times. Students are from electrical engineering, computer engineering, mechanical engineering, civil engineering, civil engineering technology, and modeling and simulation majors. As part of this S-STEM project, students also receive academic support, mentorship related to the development of professional workforce skills, career search skills, and opportunities to participate in industry-related field trips. Role models, many of whom are practicing engineers with STEM degrees and are military veterans, serve as presenters and share their personal career pathways and answer students' questions in the required one-hour weekly seminar. Although the students participating in this project meet the strenuous academic criteria set by the project (3.0/4.0), many of the students struggle financially, due to having expended their G.I. benefits, which can impede their academic performance and graduation. While many student success programs focus on freshman and sophomore students, what makes this project unique is its focus on enabling student success at the junior and senior years. This project provides a portfolio of different activities for the more mature student, e.g. financial aid through scholarships, community-based learning opportunities, and academic success strategies that enable stronger retention and student completion rates. Project activities are tailored to veterans and adult learners as this group of students is particularly vulnerable given their need to simultaneously juggle academic, family, and financial obligations.

Introduction

A pilot program funded by the National Science Foundation, grant #1742118 [1], S-STEM project named "A Pathway to Completion for Pursuing Engineering and Engineering Technology Degrees," led by Principal Investigator Dr. Anthony W. Dean, is a five-year grant at the end of its second year. To date, 20 academically successful students with financial need have benefitted from this program. Students in the Old Dominion Batten College of Engineering and Technology are eligible for this program. This project provides eligible students with a scholarship and academic/student success experiences designed to enhance their workforce readiness and develop their engineering identity. By the end of the project, a total of 70 scholarships will be awarded. The G.I. Bill has long provided educational benefits to service members who are returning to education. Since 1944, active duty military and veterans have been able to help finance their education through this legislation [2], however G.I. Bill educational benefits are only valid for 36 months, with the recent exception for STEM students,

who can apply for the Rogers STEM Scholarship extension for an additional nine months of Post-9/11 G.I. Bill benefits [3]. This recent extension accepted its first applications in August 2019 [3] and is still in its infancy. From 2009-2016, over 7.4 million people used G.I. Bill education benefits, and from 2013-2016, the numbers average at over one million users per year [4]. As military veterans transition to student veterans, they must navigate a cultural shift that is at first difficult to navigate but that gets easier over time [5]. Student veterans are unique and have different needs than other students, so their programming should be more tailored for their success [6]. This program, unique because of its focus on the junior and senior years of engineering students, allows participants to increase their networks, prepare for their future careers as engineers, and build their engineering identities while increasing their engineering self-efficacy.

Project Description and Participants

This S-STEM program is open to all qualified STEM students who have a GPA above 3.0 and demonstrated financial need. So far, scholarships have been given to the twenty STEM academically high-achieving students with high financial need. Old Dominion University has a large population of student veterans in Batten College of Engineering and Technology. There were 228 veteran and active duty military students enrolled in engineering and technology programs in 2019, as shown in Table 1. The total number of students in the college was 2,328 students.

TABLE 1 - BCET Military and Veteran Undergraduate Enrollment Data in Fall 2019.

Categories		Veterans and Active Duty	Total Number Students
Gender	Male	228	1977
	Female	36	346
Major	Civil Engineering	24	274
	Civil Engineering Technology	30	272
	Computer Engineering	9	190
	Electrical Engineering	38	260
	Electrical Engineering Technology	41	172
	General Engineering Technology	2	3
	Mechanical Engineering	66	743
	Mechanical Engineering Technology	50	348
	Computational Modeling and Simulation	4	66
	Undecided	0	24

Program Objectives

Participants were required to take a weekly one-hour seminar course where they had opportunities to learn about academic support and mentorship, student success, and career success skills. During the weekly seminar, students were able to learn methods to be more academically successful, become more aware of professional skills development, perform effective job searches, go on industry field trips, and meet with veterans employed in various engineering career fields. Throughout the program and the tools provided within it, participants are able to create a portfolio of knowledge to help ensure their career readiness as they prepare to graduate and enter the engineering workforce. The program aims to cover six objectives: development of camaraderie, career awareness, engineering identity, professionalism, financial security, and engineering self-efficacy [6].

Camaraderie

Camaraderie, defined as "friendship and encouragement to other like-minded military veteran students" [6] is a major objective of this project. Camaraderie has played a leading role in the success of the program. The weekly seminars provide a platform where students come together and share their personal and academic challenges and successes; it provides student veterans an opportunity to build a social network among similar students. A senior majoring in civil engineering said,

> *Through this [weekly] meeting, I was able to identify other people I had not realized were service/prior service members and [expand] my support system within my field with people who were like-minded."*

Other participants discussed the ability to vent to people who "understand", which is contrary to what they were taught in the military: to just "push through" obstacles and deal with them. Another participant said that he still struggled with reconciling past identities with the ones he was currently building. However, the students are building a strong network within and outside of the classroom. One of the student-led activities was an all-engineering veteran lunch gathering, where the students planned and invited veteran engineering students, currently not in the Pathways project, to join them in a social and networking event.

Career Awareness

Career awareness, defined as "navigating job and scholarship applications, identifying suitable engineering careers, meeting with working engineers" [6] is a topic of discussion almost every week. Students commented that they have were surprised to learn of new jobs, such as bridge inspectors, that showed them something they had never heard about before. Students were also

Fig. 1. Smithfield Foods, Inc. Headquarters Trip.

Engineering Identity

Engineering identity, defined as "interacting with practicing engineers, attending field trips, listening to guest speakers (veterans)" [6] is an area where the participants are still struggling. Identify formation is continuing during this stage, and we had differing levels of confidence in participants' engineering identity. One participant said that he can see himself being "successful and happy in this field" and others said they did not currently feel like engineers and that certifications, such as the Fundamentals of Engineering (FE) qualification would help reinforce their engineering identity. There was a lot of discussion on the importance of the FE, whether it was necessary for what they ultimately wanted to do, how to prepare for the examination, and how to best study for it. One of the takeaways from this is the students all agreed that the conversation about the FE should begin as soon as their engineering education began, rather than closer to graduation. Some students noted that it might be hard to switch their identity to a new form of identity. Engineering culture varies from different company to company, academia or industry [7]. Different engineers might not necessarily share the same opinion on how to define an engineering identity.

Etiquette Dinner. Students attended a formal dining gathering in which they practiced table manners and formal behavior rules that are important for job searches and the future workplace. There are many things that potential employers can obtain from observing the applicants' behavior at the dinner table [8, 9]. A discussion on how to behave and how to focus on the interview and not only on food and social aspects of the professional interactions was included in this event. Students were able to ask questions like which glass was theirs, how to introduce their significant others who were present, and whether drinking alcohol was permitted, for example.

Fig 2. Etiquette Dinner with Significant Others and Professors.

Professionalism

Professionalism is defined as "developing resumes, preparing for interviews, developing follow-up contacts, and learning professional etiquette" [6]. Many veterans are first generation engineers and may not always be well prepared to navigate the job market. A job search might be an overwhelming task since engineering coursework gets more demanding the closer the students are to graduation. On top of that, engineering students have to complete a senior design project that spans multiple semesters and might impede their ability to prioritize the time needed to be devoted to searching for the right job, preparing cover letters, and tailoring a resumé specific to a chosen job. Military culture is more collective in its nature and it is built around teamwork, objectives, trust, and mission completion; it does not emphasize individuality as strongly as does the civilian workforce [10]. Some students mentioned that their introverted nature might require even more preparation for reaching out to prospective employers during a career fair and overcoming the mental overload of talking with so many people during large events.

Financial Security

Financial security is defined as "acquiring resources to decrease anxiety due to financial constraints [11]. Much has been written about the positive impact of the GI Bill on college access for student veterans [12]. Nonetheless, student veterans continue to experience high rates of financial anxiety. According to [13], student veterans are more likely to be married with dependents (33.7%) than are nontraditional students (23.0%). Thus, as a function of their family status, student veterans are more likely to experience family-related financial obligations that impede their degree completion. Participating student veterans in the current

Pathways Project voiced that the scholarships they had received helped to alleviate their financial stress and allowed them to focus on their studies.

> *With the financial aid, I was able to afford a second car for my family, specifically my wife, which helped me exponentially. It saved me hours of commuting with my wife which was better spent time toward studying and working.*

Other students discussed the fact that they could graduate without any student loan debt thanks to this program, and the time they saved by not having to work allowed them to commit more time to their studies. It was also mentioned that the scholarship created a feeling of relief and a reduction in stress levels.

Engineering Self-Efficacy

Engineering self-efficacy is defined as "believing in one's ability to complete the degree and become a successful engineer" [11]. Research has indicated that there are correlations between self-efficacy and achievement outcomes, in this case, degree completion. According to [14], students who feel successful in learning tend to participate more readily and persist longer. Additionally, other critically important factors associated with student persistence in degree completion have been identified including individual, institutional, academic, nonacademic, and social support factors [15]. While the impact of learning communities is often discussed in terms of its impact on younger students, e.g., first-year students [16], in the context of the Pathways Project, a learning community for participating juniors and senior student veterans was developed in which students met weekly to discuss academic and personal challenges and successes, hear from successful practicing engineers in the field, and gain important professional information. Vicarious learning - learning that occurs from hearing and watching others, according to [14], is one way in which students gain confidence; they watch others who are successful with whom they identify. Participating student veterans in the current Pathways Project voiced that their participation in the program had a positive impact on their self-confidence; that they gained a greater sense of their ability to be successful engineering in the future as they saw seniors graduate with good jobs, and the presenters, who were all successful practicing engineers, talk about their student days.

> *This program helped give me the confidence that I'll be successful in the field due to speaking to many professionals in the field. Hearing stories from the many professionals was amazing.*

Students also reported that it was comforting to realize that they did not need to know everything about engineering at this point in their careers. They were relieved to hear that they should be focusing on what they've accomplished while continuing to develop skills while in the workforce. While there was a sentiment of confidence in the students' potential success, the students were

aware that just because they were about to graduate, they still had to "earn their stripes" through a combination of their academic work, military experience, and performance on the job. Nonetheless, the presenters shared that graduates with military experience were often times more prepared that students without a military background.

Conclusion

In summary, the Pathways to Completion Project appears to be on target in regard to having identified areas of interest that student and faculty agree are critical to future professional success. The project provides a financial scholarship to student veteran participants and, in the context of a learning community, provides a portfolio of different activities related to camaraderie, engineering career awareness, engineering identity, and professional development that positively impacts students' sense of engineering self-efficacy.

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