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Readying the Workforce: Engineering Veteran Graduate Student Experiences Pivoting Towards Research

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Readying the Workforce: Engineering Veteran Graduate Student Experiences Pivoting Towards Research

Abstract

Various incarnations of the G.I. Bill program have helped generations of veterans to pursue higher education post-discharge. In recent years, there has also been increased attention to the need for integrating military students into research. Industry and the military have long recognized that machines, materials, and processes constantly grow in complexity; customer expectations do as well. Many Student Veterans had exposure and familiarity with complex military systems and could put this practical experience to use in higher education. Such students are often well suited to engage in graduate research and bring technical knowledge from real world experiences. Once a veteran or active-duty student makes a commitment to attend a graduate program, there are a number of activities and processes employed both before they arrive and during their time on campus to make them part of the research community and to ensure they graduate in accordance with their professional timeline. The focus of these efforts is to create a culture of open communication with potential student veterans and to increase engagement of these students with faculty, engineering professionals, and peers to matriculate them into the graduate research community.

Through the lens of organizational theory, this work in progress report examines graduate engineering student experiences at Penn State University, a large, public, research-intensive institution in the northeast United States, with respect to graduate research pathways and research education using mixed methods surveys of both faculty and veteran graduate students. Preliminary findings from a prior study suggest a need for engineering faculty to reconceptualize how they approach the selection and retention of student veterans pursuing research-based graduate degrees. This paper will be useful to student veterans, faculty research advisors, and administrators alike to help inform policy, student support, and best practices.

Keywords: veterans, GI Bill, graduate students, diversity, exploratory factor analysis.

Introduction

Enacted in the 1940s, the Servicemen's Readjustment Act and its successors—commonly referred to as to the GI Bill—increased student veteran enrollments in college and contributed to increased diversity, perspectives, programs on campus [1]. Since then, the succession of GI Bills enacted since 1944 has facilitated over one million veterans attending college [1] and contributed substantially to the development of the U.S. skilled technical workforce. Despite historically high military student enrollments in college today [1], student veterans and service members (SVSMs) continue to be an understudied, underserved, and misunderstood population on campus.

While GI Bill funding provides material support, SVSMs do not always transition into a welcoming higher education environment [2] - [3]. As a group, SVSMs are more likely to be intersectionally diverse, with respect to minoritized racial and ethnic identities, than their civilian counterparts [4] - [5], and the character of their experiences in military service is likely to be just

as diverse [6]. SVSMs are more likely to be first generation college students [7] and live and work in rural regions [8] where access to resources is challenged than traditional undergraduates. Studies suggest that higher education institutional agents retain false perceptions [9] about veterans and, while not intentional, these misperceptions impact student veteran learning outcomes, transition experiences, and efforts to attract and retain them in STEM [10] - [12].

Student veterans continue to experience stereotypes and bias in campus and employment contexts despite federal-level protections against discrimination in civil and private organizations through the Uniformed Services Employment and Reemployment Rights Act (USERRA) and the Vietnam Era Veterans' Readjustment Assistance Act of 1974 (VEVRAA), respectively [13]. National calls to increase STEM diversity often focus on perceived learner deficits, K-12 STEM pathway challenges, and systemic barriers. For example, more than a decade ago, the American Council of Education recognized the important STEM preparation that was already implemented and sustained among our Armed Service branches [14]. This program introduced the ACE Military Evaluation program, paving the way for transfer credits: "400,000 servicemembers and veterans' transcripts were processed through the Army/American Council on Education Registry Transcript Service (AARTS) and the Sailor/Marine American Council on Education Registry Transcript (SMART) service," in an effort to optimize the military to STEM pipeline. In a 2024 policy brief, Rand-Fleming outlines a local-focused STEM pipeline network for Veterans, leveraging their inherent shared values and experiences as a potent force for matriculation through the program—resulting in closed gaps in the US STEM workforce, if implemented [15]. Successive reports in 2022 and 2024 [16] - [17] to US Congress call for VA-allocated support for Veterans pursuing STEM degrees, recommending that the VA and other support agencies step in where access gaps in Higher Education have persisted, and increase the proportion of Veterans seeking STEM degrees. Of note, only 15% of Veterans tracked in the 2018-2022 cohort applied their G.I. Bill support to obtaining Engineering degrees, as shown in Figure 1.

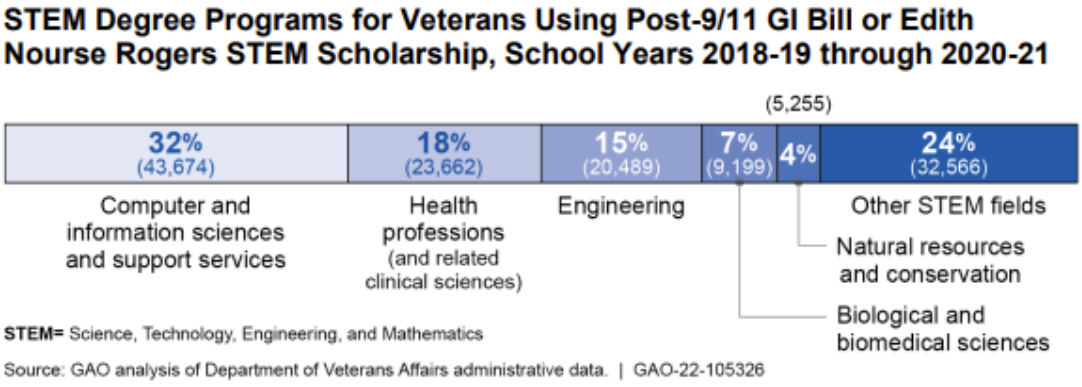

Figure 1. G.A.O. Report on Veteran in STEM [17]

While these efforts are laudable, more inquiry can be dedicated to mapping the terrain of STEM higher education, that is, the culture and climate that is reinforced by faculty, staff, and students in everyday, iterative interactions [18] - [20].

When SVSMs enter engineering majors, they may experience various push-pull factors that can challenge their core self-beliefs, prompting STEM exit and decreasing STEM retention.

Belonging, professional identity conflict [21] - [24], and imposter syndrome can all contribute to engineering students' choosing to exit the major. We posit that these same push-pull factors impact engineering recruitment of SVSMs. Fears or prior knowledge of military bias in higher education may be the final straw that keeps SVSMs out of STEM and/or out of college altogether. Applying an ecological lens, this work develops our understanding of institutional agents' experiences with and perceptions of SVSMs positions this project to provide actionable recommendations for STEM and engineering recruitment and retention.

Methods

Based on findings from a face-validated pilot survey instrument [25], we developed (1) a survey instrument for SVSMs and (2) another instrument for engineering faculty. Both instruments feature Likert-scale statements and open-ended qualitative questions about the SVSM educational experience. Designed to be implemented independently with several question items made identical for cross-comparison, the survey instruments seek to better understand the perceptions of the SVSM engineering education experience from the perspective of SVSMs themselves and from an engineering faculty audience.

Exploratory Factor Analysis (EFA) will be deployed to look for underlying constructs in the dataset relative to meaningful dimensions of SVSM experience including (1) academic advantages (discipline, leadership, technical preparation); (2) social integration challenges (connecting with peers, personal relationships); (3) institutional support (advising, faculty understanding); (4) classroom participation and engagement (participation levels, reluctance to disclose veteran status). EFA will be deployed first to see if hidden structures exist naturally in the dataset, resulting in reduced variables for further analysis. Following EFA, both instruments are designed to be amenable to Multivariate Linear Regression (MLR) analyses, where Likert-response items are modeled for SVSM and faculty characteristics and demographics.

A combination of hand-coding and natural language processing tools will be used to classify open-ended responses in terms of themes and sentiment analysis.

SVSM Instrument

The engineering graduate student veteran survey instrument is designed to address documented transition challenges in veteran education literature and provide feedback on student veterans' lived experience in STEM graduate education.

The following survey items request Likert-scaled responses (1-5), with 1 indicating 'strongly disagree' and 5 indicating 'strongly agree.' Demographic information educational history is also collected.

1) As a student veteran, I had more discipline and timeliness than my civilian peers.
2) As a student veteran, I had more teamwork skills than my civilian peers.
3) As a student veteran, I was more comfortable with leadership roles in the classroom than my civilian peers.

4) As a student veteran, my diversity of experience and perspectives gave me an advantage over my civilian peers in the classroom.
5) I found it difficult to connect with civilian peers in my classes.
6) I found my personal relationships strained as I transitioned into higher education.
7) I have avoided sharing my veteran status with faculty and staff to avoid any potentially negative interactions.
8) I participated less than my civilian peers in class.
9) I received the same amount of advising support from faculty and advising services as my non-student veteran peers.
10) I wish faculty had made more of an attempt to understand the student veteran experience.

The complete graduate student survey instrument can be found in Appendix A.

Engineering Faculty Instrument

The engineering faculty survey instrument is designed to address suspected faculty perceptions that have merged elsewhere in veteran literature as well as student-veteran-specific education challenges documented in the educational advising literature

The following survey items request Likert-scaled responses (1-5), with 1 indicating 'strongly disagree' and 5 indicating 'strongly agree.' Demographic information, veteran status, faculty rank, and institution type are also collected.

1) Students who identify as Veterans, Active Duty, or Reservists have mostly positive experiences in higher education.
2) Students who identify as Veterans, Active Duty, or Reservists have better academic advising than traditional college students.
3) Students who identify as Veterans, Active Duty, or Reservists have better financial advising than traditional college students.
4) Student veterans have better access to on and off campus resources than traditional students.
5) Student veterans do better academically than traditional students.
6) Student veterans graduate at higher rates than traditional students.
7) Student veterans are less likely to change majors than traditional students.
8) Student veterans are less likely to share their veteran status to avoid potentially negative interactions.
9) Student veterans connect easily with civilian peers in their classes.
10) Student veterans are more comfortable with leadership roles than their civilian peers.
11) Student veterans are more comfortable with teamwork than their civilian peers.
12) Student veterans are more prepared for STEM education than their civilian peers.

The complete faculty survey instrument can be found in Appendix B.

Faculty demographics

Based on prior work investigating engineering faculty experiences, we expect a relatively balanced faculty rank profile across categories: Tenured, Non-tenured, Full, Assistant, Associate, and Instructors. In fact, we saw less than a quarter of respondents are tenured (20.4%) and 17% are non-tenured, as seen in Figure 2.

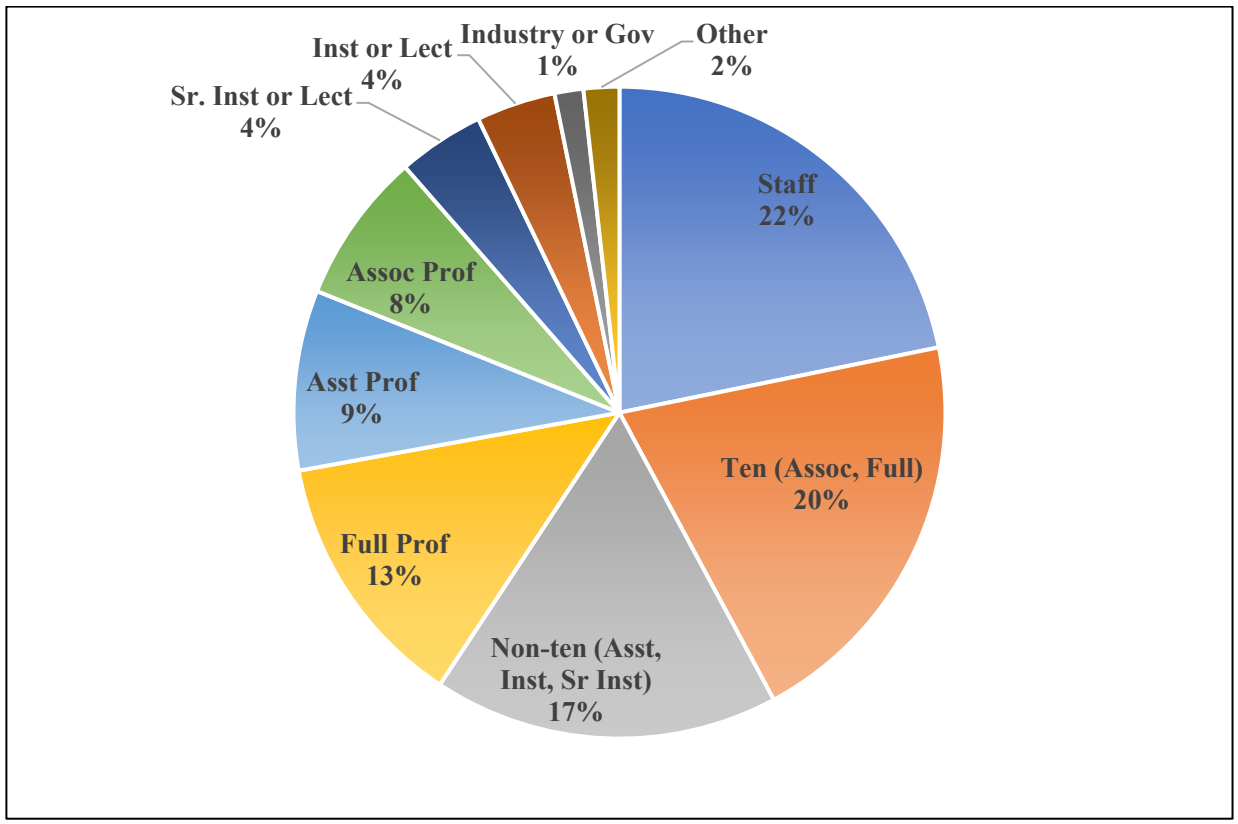

Figure 2. Faculty Rank Ratios

Similarly, we expect that most faculty will not have close contacts with veterans, which we find in Figure 3—only about 25% of faculty have a close personal connection with veterans. Close personal contact for this study is defined as having any of the following: spouse, parent, sibling, or child relationship.

Prior research also suggests most faculty are likely to not have participated in Green Zone or Military Allyship training, an offering used in higher education, government, and corporate environments to counter negative stereotypes of veterans and neutralize or mitigate bias against veterans [26]. This report shows 84% of faculty reported they had never participated in Green Zone or Military Allyship training.

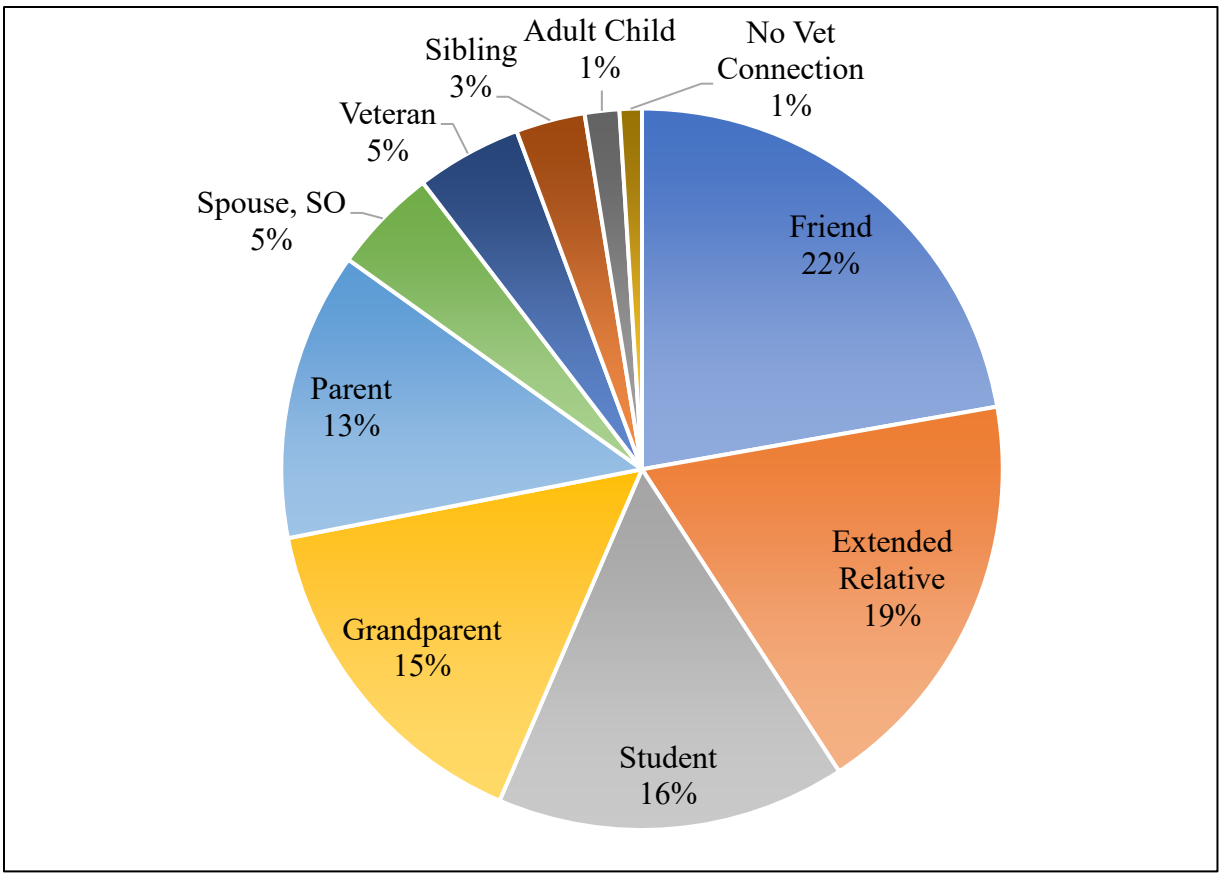

Figure 3. Faculty Veteran Connections

Approach

This study was approved by the lead authors' institutional review board, and all participants provided informed consent before completing the surveys. To distribute the survey to student veterans, the researchers relied on personal and professional contacts as well as a third-party data collection site. To meet the criteria for the graduate student veteran instrument, participants had to be at least 18 years of age, served in an active-duty component of U.S. military service, enrolled or have been enrolled in college within the past year (full or part-time) at an American institution of higher education. All data collection took place online using the survey platform Qualtrics. For the faculty perceptions instrument, all participants had to be faculty or staff and actively involved in recruiting, teaching, or working engineering students in some way.

Discussion

Veterans bring diversity to the organizations they join, including higher education organizations. Rivera [27] observed that firms in the labor market often seek surface-level diversity but often quietly want deep-level cultural homogeneity. Graduate admissions can at times mirror industrial job recruitment processes. After all, "hiring [in industry] is more than just a process of skills

sorting; it is also a process of cultural matching between candidates, evaluators, and firms" (p. 999). Substitute the words "admissions" and "graduate programs" and one perhaps at times might describe graduate admissions similarly. After all, a prospective graduate program admit with a 4.0 cumulative grade point average might still not be a good fit for a given graduate program given research interests, available faculty time, and other circumstances bespoke to a given graduate program.

Veterans can serve as an important counterbalance to the coercive isomorphic forces that drive similarly positioned organizations towards greater and greater similarity that DiMaggio and Powell [28] opined on several decades ago. SVSMs also boost institutional recruitment and enrollment statistics, an important performance indicator going forward in higher education. These forces are as present as ever across the higher education organizational field. They instructed that "[o]rganizations compete not just for resources and customers, but for political power and institutional legitimacy, for social as well as economic fitness" [28]. In the scholarship of higher education, students have long been thought of as "customers" [29]. Winston [30] posited that higher education institutions are best analyzed as non-profit firms operating in incomplete information markets for whom students are positioned as both inputs and products. The competition for students is as fierce as ever given the demographic cliff in higher education. Harvey [31] projected an expected 11% drop in undergraduate students between 2012 to 2029, with an even higher drop of 18% expected over time in the Middle Atlantic region from which this study originates.

Post-secondary institutions largely wish to do right by SVSMs. To the extent such students can be conceptualized as inputs into the enterprise, their life experiences and skills are unique and beneficial to STEM education. Ely and Thomas [32] advanced several perspectives on workplace diversity, one of which is particularly salient to the subject of graduate student veterans: integration-and-learning, where the functioning of groups is enhanced by cross-cultural exposures. In that spirit, given the transferability of student veterans' leadership skills and the demonstrated positive influence they have in team settings Main and colleagues [33] called for the use of an asset-based framework for post-secondary educational programming that utilizes the student veterans' skills to augment undergraduate curricula. Such approaches have already begun emerging across the organizational field, such as those at Senior Military Institutions like The Citadel where veteran students have proven an "invaluable resource [both] in and out of the classroom" [34].

Graduate Student Veterans as Best Fits for STEM

Prior research has found that holistic, multi-prong support structures for engineering veteran students are key [35]. As an example in that vein, Mobley [36] explored the use of institutional agents as tools for aiding student veterans as they navigated entry into engineering education. It is not just that engineering veteran students should fit themselves into STEM education; STEM education likewise needs to work to fit in engineering veteran students.

Graduate Student Veterans as Best Fits for Engineering Research

In examining student experiences with a team canoe competition, Rabb [37] described engineering veteran students as exhibiting and modeling key skills for other students, namely conflict resolution, teamwork, project management, and life skills mentoring. Not unironically, such skills readily translate to the graduate research setting.

Countering the Fixed Mindset Stereotype of Veterans

The importance of promoting a growth mindset for students is a key theme in the literature [38] - [40]. But the research focus usually is on the students themselves. The findings from this also suggest there may be degrees of fixed mindsets extant among faculty with respect to their assumptions of veteran students, in addition to fixed conceptualizations that the veterans have of themselves. More work clearly remains to be done in this space.

Future Work

This work in progress is a high-level conceptual paper that explores the experiences of engineering student veterans, many of whom have earned their bachelor's degrees while serving or have transitioned from active duty to further their education. Student veteran studies largely focus on undergraduate students, leaving a gap in understanding and support for graduate student veterans. Future work at the authors' research-intensive large university will be to create networks with other institutions similarly engaged in creating optimized graduate engineering pathways for student veterans. This work is invitational and longitudinal—due to the relatively low count of graduate student veterans at any one time, our best window for data collection begins now and in community with other veteran education researchers invested in tracking veteran-to-STEM outcomes and impacts.

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Appendix A: Graduate Student Survey

The purpose of this survey is to better understand beliefs and perceptions of veterans, current service members, and civilians. Your participation in this survey is voluntary and implicit in your completion. You can stop participation at any time by closing the browser.

S-Q01. I am a veteran and/or was a reservist or formerly served in the US Armed Forces.

- Yes /No

S-Q02. As a student veteran, I had more discipline and timeliness than my civilian peers.

- Likert 1-5

S-Q03. As a student veteran, I had more teamwork skills than my civilian peers.

- Likert 1-5

S-Q04. As a student veteran, I was more comfortable with leadership roles in the classroom than my civilian peers.

- Likert 1-5

S-Q05. As a student veteran, my diversity of experience and perspectives gave me an advantage over my civilian peers in the classroom.

- Likert 1-5

S-Q06. I completed an undergraduate, master's, or doctorate degree.

- Yes / No / In process

S-Q07. I engaged in higher education after or during my service contract.

- Yes / No

S-Q08. I found it difficult to connect with civilian peers in my classes.

- S Likert 1-5

S-Q09. I found my personal relationships strained as I transitioned into higher education.

- Likert 1-5

S-Q10. I have avoided sharing my veteran status with faculty and staff avoid any potentially negative interactions.

- Likert 1-5

S-Q11. I participated less than my civilian peers in class.

- Likert 1-5

S-Q12. I received the same amount of advising support from faculty and advising services as my non-student veteran peers.

- Likert 1-5

S-Q13. I wish faculty had made more of an attempt to understand the student veteran experience.

- Likert 1-5

S-Q14. [Select all that apply] My service status is best described as:

- Enlisted / Officer
- Active Duty / Reservist / National Guard
- Army / Navy / Air Force / Marine / Coast Guard / Space Force

In the final section of the survey, we would like to ask you a few questions about yourself. As a friendly reminder, you do not have to answer any questions you do not wish to answer.

S-Q15. What is your current graduate major? If you have more than one graduate major, please select your primary major.

[RESPONSE OMITTED TO BLIND]

S-Q16. [Select all that apply] Race/Ethnicity

- American Indian or Alaska Native /Asian or Asian American / Black or African American / Native Hawaiian / Other Pacific Islander / White / Another race/ethnicity not listed / Decline to answer

S-Q17. Which of the following best describes your age range?

- 18-24 / 25-34 / 35-44 / 45-54 / 55-64 / 65-74 / 75+ years old / I prefer not to say

S-Q18. What is your gender identity?

- Cis man or trans man / Cis woman or trans woman / Genderqueer, gender non-conforming, or non-binary / Not listed above or I prefer to self-describe: [edit textbox] / I prefer not to say (5)

S-Q19. Sexual orientation: Do you think of yourself as:

- Straight or heterosexual / Lesbian or gay / Bisexual / Queer, pansexual, and/or questioning / Other [edit textbox] / Questioning / Decline to answer

S-Q20. [Select all that apply] With which racial and ethnic group(s) do you identify? Select all that apply.

- Alaska Native, American-Indian, or Native American / Asian or Asian American / Black or African American / Latina/Latino/Latinx or Hispanic / Middle Eastern or Northern African / Pacific Islander / White / Multiracial / I prefer to self-describe: [edit textbox] / I prefer not to say

S-Q21. From what region of the world are you from?

- Africa / Asia /Central America, Latin America, or Carribean / Europe / Middle East / North America / Oceania / South America / I prefer not to say

S-Q22. Which of the following degree types best describes the (primary) degree you are currently working towards?

- Master of Engineering (M.Eng.) / Master of Science (M.S.) / Doctor of Philosophy (Ph.D.) / Doctor of Engineering (D.Eng.) / Other (please specify): [edit textbox]

S-Q23. Researchers define a first generation college student as a student with no immediate family members (e.g., parent, grandparent) other than siblings who attended college. Are you a first generation college student?

- Yes / No / Unsure or prefer not to say

S-Q24. [Free response] Could you briefly describe your military service?

S-Q25. [Free response] Why did you choose to come to STATE UNIVERSITY?

S-Q26. [Free response] How did you pick your degree program and major? Is there any connection to your prior military service?

S-Q27. [Free response] Has your military service helped prepare you for graduate education?

S-Q28. [Free response] How comfortable do you feel disclosing your veteran status to faculty, staff, and other students?

S-Q29. [Free response] How do people tend to react to finding out that you are a veteran, including faculty?

Appendix B: Faculty Survey

The purpose of this survey is to better understand beliefs and perceptions of veterans, current service members, and civilians. Your participation in this survey is voluntary and implicit in your completion. You can stop participation at any time by closing the browser.

F-Q01. Do you teach, train, tutor or advise student veterans?

- Yes / No

Please indicate your level agreement for each statement below.

F-Q02. Students who identify as Veterans, Active Duty, or Reservists have mostly positive experiences in higher education.

- Likert 1-5

F-Q03. Students who identify as Veterans, Active Duty, or Reservists have better academic advising than traditional college students.

- Likert 1-5

F-Q04. Students who identify as Veterans, Active Duty, or Reservists have better financial advising than traditional college students.

- Likert 1-5

F-Q05. Student veterans have better access to on and off campus resources than traditional students.

- Likert 1-5

F-Q06. Student veterans do better academically than traditional students.

- Likert 1-5

F-Q07. Student veterans graduate at higher rates than traditional students.

- Likert 1-5

F-Q08. Student veterans are less likely to change majors than traditional students.

- Likert 1-5

F-Q09. Student veterans are less likely to share their veteran status to avoid potentially negative interactions.

- Likert 1-5

F-Q10. Student veterans connect easily with civilian peers in their classes.

- Likert 1-5

F-Q11. Student veterans are more comfortable with leadership roles than their civilian peers.

- Likert 1-5

F-Q12. Student veterans are more comfortable with teamwork than their civilian peers.

- Likert 1-5

F-Q13. Student veterans are more prepared for STEM education than their civilian peers.

- Likert 1-5

Please indicate your level of agreement for each statement below.

F-Q14. Veterans and service members are more likely to suffer from PTSD than civilians.

- Likert 1-5

F-Q15. Veterans and service members are more likely to be educated than civilians.

- Likert 1-5

F-Q16. Veterans and service members are more likely to be organized than civilians.

- Likert 1-5

F-Q17. Veterans and service members are more likely to take initiative on their own than to follow directives as compared to civilians.

- Likert 1-5

F-Q18. Veterans and service members are more likely to participate in community and social events than civilians.

- Likert 1-5

F-Q19. Veterans and service members are more likely to seek help or advice than civilians.

- Likert 1-5

F-Q20. Most veterans and service members have served in combat roles.

- Likert 1-5

F-Q21. Veterans and service members are more likely to have dermal art (tattoos, piercings) and unique hair styles than civilians.

- Likert 1-5

F-Q22. Veterans and service members are more likely to be diverse or members of underrepresented minority groups than civilians.

- Likert 1-5

F-Q23. Veterans and service members are more likely to be rigid thinkers than civilians.

- Likert 1-5

F-Q24. Veterans and service members are more likely to expect special recognition because of their service status.

- Likert 1-5

F-Q25. Veterans and service members are more likely to have relevant job skills than civilians.

- Likert 1-5

F-Q26. Civilians are less likely to suffer from PTSD than veterans and service members.

- Likert 1-5

F-Q27. Civilians are more likely to be educated than veterans and service members.

- Likert 1-5

F-Q28. Civilians are more likely to have relevant job skills than veterans and service members.

- Likert 1-5

F-Q29. Civilians are less likely to be organized than veterans and service members.

- Likert 1-5

F-Q30. Civilians are more likely to take initiative on their own than to follow directives as compared to veterans and service members.

- Likert 1-5

F-Q31. Civilians are more likely to participate in community and social events than veterans and service members.

- Likert 1-5

F-Q32. Civilians are more likely to seek help and advice than veterans and service.

- Likert 1-5

F-Q33. Civilians are less likely to have dermal art (tattoos, piercings) and unique hair styles than veterans and service members.

- Likert 1-5

F-Q34. Civilians are less likely to be diverse or members of underrepresented minority groups than veterans and service members.

- Likert 1-5

F-Q35. Civilians are more likely to be rigid thinkers than veterans and service members.

- Likert 1-5

F-Q36. [Select all that apply] Identify the following personal connections that you have to a veteran and/or service members. Check all that apply.

- I am a veteran. / My spouse, significant other, or former spouse is/was a veteran. / My parent is/was a veteran. / My grandparent is/was a veteran. / My adult child is/was a veteran. / My sibling is/was a veteran.

/ My extended relative is/was a veteran. / A friend of mine is/was a veteran. / A former or current student is/was a veteran. / I have no personal connection with veterans.

F-Q37. [Select all that apply] Identify your current role. Check all that apply.

- Instructor or Lecturer / Senior Instructor or Lecturer / Assistant Professor (of Practice, Research, or Tenure Track) / Associate Professor (of Practice, Research, or Tenure Track) / Full Professor (of Practice, Research, or Tenure Track) / Staff / Industry or Government Stakeholder / Other [edit textbox]

[If any of choices 1-6 in F-Q37 were selected, display the next question.]

F-Q38. [Select all that apply] Describe your institution. Check all that apply.

- Teaching focused / Research focused / 2-year institution / 4-year institution / Land grant / Private / Public / Other [edit textbox]

F-Q39. Have you ever completed military cultural awareness or military ally training (e.g. Green Zone training)

- Yes / No

F-Q40. [Select all that apply] Identify any features that may apply to your personal experience and background.

- Member of an underrepresented minority group / First-generation college student / First-generation American, or child of parents who emigrated to the US / Speak English as a second language

F-Q41. [Select all that apply] Race/Ethnicity (check all that apply):

- American Indian or Alaska Native / Asian or Asian American / Black or African American / Native Hawaiian / Other Pacific Islander / White / Another race/ethnicity not listed / Decline to answer

[If choice 6 in F-Q41 was selected, display the next question.]

F-Q42. [Edit textbox] Place identity your race or ethnicity here.

F-Q43. Are you Hispanic or Latino?

- Yes / No

F-Q44. Do you think of yourself as

- Male / Female / Transgender man/trans-man / Transgender woman/trans-woman / Gender queer/gender nonconforming/neither exclusively male or female / Additional category or other [edit textbox] / Decline to answer

F-Q45. Sexual orientation: Do you think of yourself as:

- Straight or heterosexual / Lesbian or gay / Bisexual / Queer, pansexual, and/or questioning / Other [edit textbox] / Questioning / Decline to answer

F-Q46. Are you ready to submit your responses?

- Yes / No