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Technically and Tactically Proficient: How Military Leadership Training and Experiences are Enacted in Engineering Education*

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Based on in-depth qualitative interviews with student veterans in the United States pursuing Bachelor's degrees in engineering across four institutions, we present findings relating military leadership and its application to engineering education. Our findings address three themes: (1) how leadership skills are learned, (2) motivation to be a leader, and (3) translation into, and enactment of military leadership skills in, engineering education. The interviews show that leadership skills and experiences acquired in the military play an important role in the academic experiences and success of student veterans in engineering (SVEs). Findings can help inform strategies and programs to encourage more SVEs to translate their leadership skills to an academic setting in an asset-based framework. Providing leadership opportunities for SVEs in the classroom has the potential to increase their engagement in engineering, strengthen their pathways to professional engineering practice, and provide important role models of servant leadership for the other engineering undergraduates who work with them.

Keywords: military veterans; leadership; engineering students

1. Introduction

Although military veterans have valuable leadership and developmental experiences [1–4], these experiences may not always translate seamlessly into civilian life [5] or may go unnoticed in academic settings, such as engineering education [6]. While a few colleges have started to offer educational credits for military leadership experiences [1, 7], student veterans' leadership experiences and their associated potential in this area may often go undocumented. In recent years, there has been increased attention to the success of student veterans in engineering, including the American Society of Engineering Education's (ASEE) establishment of a Military and Veteran Division [8]. Thinking ahead to the future of engineering education, some scholars, such as Jovanovic and colleagues, propose that engineering programs should create degree pathways for student veterans that capitalize on their military leadership training, since leadership skills have the potential to enhance students' prospects in higher education and the workforce [9]. In this study, we use 12 in-depth interviews to examine how military veterans apply their leadership skills in the engineering classroom. Our study aims to identify whether and under what conditions student veterans in engineering (SVEs) enact their acquired leadership skills and experiences in the engineering classroom. In so doing, we contribute to the literature by highlighting the assets that diverse students, here military veterans, bring to the engineering classroom.

Leadership skills are particularly relevant in engineering education due to the importance of teamwork and collaboration in solving engineering problems and generating design solutions. Given the emphasis on leadership skills in both military and engineering education settings, this study uncovers how military leadership training and experiences translate to academic engineering study. As the number of military veterans in engi-

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neering education increases, it is critical to identify ways to engage veterans' military experience and skills to enrich their academic experiences. Research findings have the potential to inform academic administrators, course instructors, SVEs, and other key stakeholders about how military leadership training and experiences can be translated and leveraged in engineering education. Such applications have important implications for enhancing the experiences and engagement of SVEs in engineering and for diversifying the engineering student population and workforce.

Within the science, technology, engineering, and mathematics (STEM) research community, there is growing interest in moving away from deficit-based models to asset-based frameworks when researching the experiences of diverse students in higher education and developing programs and interventions to support them [e.g., 10–12]. Research findings can contribute to the development of more robust programs and policies to support veterans in higher education using asset-based frameworks. Our study also has the potential to extend the literature on transferability of leadership skills across multiple domains, thus adding to conversations regarding the transition of military personnel to civilian life. Engineers who combine technical expertise and strong leadership capabilities have the potential to make significant contributions to solving important interdisciplinary problems, such as the U.S. National Academy of Engineering's Grand Challenges [13]. Learning more about how SVEs combine these skills may help engineering educators develop such capabilities in all engineering students.

2. Literature review

2.1 Student veterans in STEM and engineering

The number of military veterans enrolling in undergraduate education in the United States is increasing, such that it is estimated that their numbers will reach 5 million by 2020 [14, 15]. There are also efforts to promote STEM as fields of study for military veterans to help address areas of national need [e.g., 16, 17]. For example, the U.S. House of Representatives introduced a bipartisan bill authorizing up to nine months of additional post-9/11 educational assistance to veterans pursuing a STEM degree [16]. This is particularly salient because the average time to degree for many STEM fields can often exceed four years. Bringing more veterans into engineering may also contribute to increasing diversity in the field because veterans are more likely to be older, first-generation college students, disabled, African American, or Latino [18]. Although military veterans share some attributes with non-military transfer students, their intense socialization into and through the military, as well as experiences with specialized training, deployment, and/or combat, distinguish their pathways and experiences in engineering education [19].

Many military veterans have important technical skills that they gained in the military that can be applied in engineering. Zoli, Maury, and Fray indicated that 43% of student veterans surveyed reported that their military work was STEM-related and two-thirds felt that their military occupational specialty (MOS) (or "ratings" for the Navy and "Air Force Specialty Codes" for the Air Force) promoted their interest in STEM careers [20]. Nonetheless, a relatively small percentage (8%) of student veterans reported pursuing engineering degrees [15]. This small percentage of military veterans pursuing engineering may be due to a number of reasons, such as military veterans not perceiving engineering as a good match for their military-related experience, or having insufficient knowledge of STEM higher education degree programs [20]. Academic institutions may also inadvertently add to this disconnect by designating most military training as equivalent to only physical training or basic vocational training [21]. Yet, through their MOS, military veterans may have gained important technical and professional skills in communication, teamwork, and leadership [22].

Researchers have also identified that student veterans face challenges in translating their military experiences to specific civilian career paths [23, 24]. There is limited research on the military-to-academic pathway among veterans and how important professional skills, such as leadership, are gained and translated across these contexts [25, 26]. More information regarding the dynamics of leveraging professional skills in different contexts using an asset-based framework could help to highlight the leadership skills and assets veterans bring to higher education and engineering education [27].

2.2 Military leadership training and importance of leadership to engineering education

Previous studies have found that some military veterans transitioning out of active duty may have challenges in determining how their military-gained skills can potentially translate to civilian, as well as academic, life [19, 23]. Hayden and Scholl argue that career development for military veterans should more effectively integrate experiences, job skills, and personal characteristics gained through military experiences [28]. In particular, leadership is integral to military training and practice. The acquisition of leadership skills is also often used as a recruitment strategy to encourage individuals to join the military. Each branch has its own unique approach to teaching leadership principles and

skills, including the Army, whose leadership principles are summarized in the acronym LDRSHIP, meaning "loyalty, duty, respect, selfless service, honor, integrity, and personal courage" [5, p. 357]. The United States Armed Forces identifies 11 principles of leadership in the training and engagement of enlisted personnel and officers in the Army, Marine Corps, Air Force, and Navy. The embedded values, such as "set the example, know your people and look out for their welfare, and develop a sense of responsibility among your people," have been critical to the successful functioning of the military. Commonly used in basic training in the Armed Forces, this list of 11 "Timeless Principles of Leadership" was developed in 1948 and first published in a 1951 Army Field Manual [29]. These principles remain relatively unchanged and are used by all ranks from entry-level enlisted personnel to officers across military branches.

A recent publication by the RAND Corporation maps key military leadership training and competencies to skills that are valued in the workplace [30]. For example, basic training courses for Army and Marine Corps recruits focus on "being dependable and reliable," "persistence," and "teamwork and team-building." At a higher level, "decision making/decisiveness," "leading, motivating, and inspiring others," and "managing and supervising the work of others" are emphasized. Given these emphases, it is particularly important to better understand how these leadership skills can be translated to civilian life.

ABET accredits engineering programs that meet criteria for the preparation of engineers [31]. Among its criteria are that students who complete engineering programs graduate with "an ability to function on multidisciplinary teams, an ability to communicate effectively, and an understanding of professional and ethical responsibility" (student outcomes d, g, and f, respectively). These ABET criteria resonate with many of the 11 principles of military leadership, including "train your people as a team, keep your people informed, seek responsibility and take responsibility for your actions, and develop a sense of responsibility among your people." The ability of military veterans to transfer their leadership skills to civilian life, as well as to engineering study, has important implications for their academic outcomes and career prospects.

Many military veterans recognize the value of their military leadership experiences to their college experiences [32]. Russell's research demonstrated that faculty are also aware of student veterans' unique leadership experiences—faculty responding to his survey indicated that student veterans apply leadership and teamwork in their school assignments more than non-military students [33]. There is also literature on the application of military leadership principles to a variety of educational pathways and career options, including business disciplines [34–36]. Although it is widely accepted that leadership skills are critical to engineering study and professional practice [31, 37–40], more research about the application of military leadership skills could enhance SVE's experiences in engineering education.

2.3 Development of leadership skills in engineering education

Leadership training in engineering education has become increasingly important. Previous studies describe several approaches to the professional development of leadership skills in engineering education, such as, development of a leadership curriculum combined with team-based leadership experiences [41, 42]; participation in leadership roles through extracurricular activities such as student organizations; focus on leadership training through curriculum [43]; and engagement in cooperative education programs or internships [44]. A number of programs integrate leadership development into the engineering curriculum and in experiential learning experiences [45, 46]. Penn State, for example, also offers a minor in engineering leadership, which is distinctive given its emphasis on self-awareness as a key leadership skill [47]. University of Texas at El Paso (UTEP) also developed and launched the first Bachelor's degree in engineering education and leadership [48].

Leadership training programs in undergraduate engineering education have implications for post-graduation employment [49]. Farr and Brazil advocate for a developmental model of leadership training for undergraduate engineering majors, to increase opportunities to hone leadership or entrepreneurial skills, critical to successful engineering practice [50]. Farr and Brazil suggest that "Leadership development in industry can best be described as ad hoc with 'on the job training' being the primary mechanism" [50, p. 4], such that more emphasis on leadership preparation in undergraduate programs would be of particular benefit to engineering students.

3. Leadership frameworks

While it is commonly accepted that leadership skills are critical in a variety of contexts, there are multiple definitions for *leadership*, with limited consensus on a single definition, especially within engineering education. To further highlight the complexities around the construct of leadership, there are also multiple ways of enacting leadership skills. Leadership theories evolved significantly from the early

1900s through the 1940s; these early theories suggested that personal traits, such as appearance, athleticism, personality, health, wealth, and education, correlated positively with leadership [51]. These "personal dispositions of leadership" models tended to be shaped by a socio-economic bias, since those in power tended to be wealthier and to have more education. The undertone of these ideas suggested that leaders were "naturally born" to lead. Another traditional image is of a single charismatic leader with a group of followers on a common mission. The "great man" theory or "heroic" leader model suggested that leadership skills are embodied by a superior few [52]. This classic conceptualization, also called the "warrior model," continues to align with common images of leadership in military settings, which necessitate strong strategic skills often grounded in a mindset of victory [53].

However, after the 1940s, paradigms of leadership began to shift to incorporate a greater focus on followers. Sociologist Max Weber's analysis of religious leaders highlighted behaviors of followers, and their reverence for charismatic religious leaders [54]. Weber's perspective influenced a new paradigm of "transformational" leadership, a more dynamic model in which leaders are not simply engaged in "transactional" tasks of management; rather, they empower followers to go above and beyond their own self-interests [55, 56]. Among the newer leadership theories and approaches that arose by the 1970s is situational leadership, which focuses more on leadership in situations, rather than the embodiment of leadership attributes within an individual. Situational leadership proposes that different situations require different kinds of leadership, and therefore, leaders need to adapt their approach, or different leaders are better suited to meet the needs of a given situation [57]. Relatedly, leaders need to focus on and evaluate their followers in order to best strategize toward the attainment of their objectives/goals. Situational leadership therefore is a balance between adapting leadership styles (directive or supportive) to the level of competence and commitment of their followers [57]. Whereas directive approaches tend to generally involve one-way communication from leader to follower in regard to task completion, supportive approaches involve two-way communication to leverage input from both leaders and followers. Although situational leadership is widely recognized and utilized, Vecchio, Bullis, and Brazil did not find strong evidence of this approach in a military setting [58].

Perhaps more relevant to undergraduates in engineering education, with its high reliance on teamwork in engineering coursework and professional practice, team leadership, or shared leadership, incorporates a flatter, more horizontal leadership structure focusing more on processes compared to other leadership approaches used in organizations with vertical leadership structures (based on rank and hierarchy). Team leadership distributes leadership and influence across team members to maximize efficiency and achievement of shared goals [59, 60]. While situational leadership can occur in a team leadership environment, the shift of power and influence in a team leadership model is more fluid and heterarchical [61]. Primarily, team leadership emphasizes that leadership roles can be assumed by any member of the team, and that the main functions of leadership are to monitor and diagnose the relative effectiveness of the team and to determine whether and how to take action on group processes and activities. In the best scenario, the leadership team understands the importance of collaboration, and the leader assigned to delegating assumes a position of servant leader.

4. Methods

Our qualitative approach focuses on providing military student veterans an opportunity to narrate their own stories of military service and transition into and through engineering education. It also addresses Kato, Dinkerson, Holland, and Soper's call for more qualitative studies on student veterans to inform the development of policies to support veterans in higher education [62]. Our approach provides important insights into how military service shapes the educational and leadership experiences of student veterans.

4.1 Data collection

We collected data from four universities across the United States after receiving Institutional Review Board (IRB) approval. The four universities represent a variety of educational contexts—three are public, land grant institutions with relatively large enrollment (>20,000), whereas one is a private, liberal arts institution with enrollment around 8,000 students. Three of the institutions have major military installations near the campus, but all four institutions have a student veterans center on campus. We recruited student veteran participants through student services professionals in veteran-affiliated centers, by posting flyers and e-mail announcements through engineering programs, and through veteran-centered social media. Interview volunteers completed an online survey providing demographic, educational history, and military service information. The survey provided context for our interviews, as well as facilitated scheduling of the individual interviews. We conducted 60 interviews across the four institutions in

Fall 2016 and Spring 2017, and interviews ranged from 60 to 90 minutes. All interviews were audio recorded and later transcribed by a professional transcriptionist. We used a semi-structured interview protocol designed to elicit rich narratives regarding experiences in the military, path from the military to higher education, choice of engineering as a major, and, importantly, leadership experiences and perspectives both while in the military and in engineering education. To further enhance the narrative regarding leadership, we provided each participant with a list of the 11 "Timeless Principles of Leadership." The principles provided a basis for the interview participants to describe their leadership experiences in the military and how these might translate to engineering academic study and practice.

For this study, we randomly selected three interview transcripts from each of the four institutions, such that our analysis focuses on the narratives of 12 engineering undergraduate students, 10 of whom are male and two of whom are female. While most identified as military veterans, three of the interview participants were serving in the National Guard. We selected 12 participants because previous research has suggested that data saturation can be reached with a sample of 12 participants [63]. Table 1 summarizes our sample's demographic characteristics. The participants come from a variety of majors, although mechanical and electrical engineering are well-represented, and ranged from first year to fourth year students. They also served in multiple military branches (Marine Corps, Navy, and Army) and ranged in number of years of service. Our participants also held different occupations while in the military, including materials technician, infantry rifleman, hospital foreman, signals intelligence, foreign language translator, electronic technician, staff instructor, mechanic, armored vehicle crewman, and sonar technician. The participants are generally older than traditional engineering students, with one-third married and one-third with dependents under 18 years old in the household.

Table 1. Demographic Characteristics of Study Participants

Demographic Characteristic		n
Engineering Major	Mechanical	5
	Electrical	4
	Construction Management	1
	Material Science	1
	Textiles	1
Year in Program	First Year	2
	Second Year	5
	Third Year	2
	Fourth Year	3
Military Branch	Army National Guard	3
	Marine Corps	4
	Navy	4
	Army Reserve	1
Years of Completed Service	1–5	6
	6–10	4
	>10	2
Sex	Male	10
	Female	2
Race	White	6
	Black	2
	Asian/Pacific Islander	2
	Hispanic/Latino	1
	Mixed	1
Age (years)	20–25	5
	26–30	3
	>30	4
Marital Status	Single	7
	Married	4
	Divorced	1
Total		12

4.2 Analytical approach

Our general approach for this study is thematic analysis. We first verified all of our transcripts by listening to the audio in comparison to the transcript. Once the transcripts were verified, we read them again to become more immersed in the narrative and to engage in familiarization. Thereafter, we developed episode profiles to highlight salient topics for each interview using the approach developed by Maietta, which included key quotes related to the influence of the military on the enactment of leadership in engineering education [64]. The episode profiles enabled us to focus on the leadership elements of the individual narratives more concretely while paying close attention to the full experience and embodiment of the participant. The episode profiles also provided key insights regarding leadership experiences and perspectives during military service and engineering study. We analyzed the data and episode profiles using co-analysis, where five members of our research team identified the relevant themes and associated evidence through iterative discussions for validity.

As described in a previous paper [65], our co-analysis comprised a five-stage framework analysis process to help ensure deep analysis of the emerging themes and the validity of our findings [66–69]. Framework analysis capitalizes on both inductive and deductive reasoning, such that both *a priori* and emergent coding are used in analysis [69, 70]. During stage 1, familiarization, we reviewed interview transcripts to become more immersed in our participants' stories. Thereafter, we analyzed the transcripts and generated episode profiles to identify relevant themes focusing on leadership in the military and engineering education using ATLAS.ti for stage 2 (identifying a thematic framework). In

stage 3 (indexing), we coded text to indicate the specific themes. In stage 4 (charting), we organized our codes into a separate document that categorized each quote by theme. And finally, in stage 5 (mapping and interpretation), we analyzed patterns, similarities, and differences across all responses in the sample. Once we completed our analyses, we checked our themes and findings against the remaining 48 interviews (outside of our 12 participants), and found that our findings were consistent across our larger sample.

5. Results

Our analysis generated three themes related to the translation of military leadership training and skills into engineering education: (1) how leadership skills are learned, (2) motivation to be a leader, and (3) translation and enactment of military leadership skills into engineering education. To preserve the anonymity of our participants, we present our participants' narratives using a three-character pseudonym, with the first character (a letter) indicating the academic institution and the remaining two characters (numbers) indicating the interview number. We also use the three-character pseudonym and masculine pronouns throughout to protect the identities of the female participants.

5.1 How leadership skills are learned

All the participants have unique experiences in the military and engineering education, and these experiences influence their perspectives on leadership, what leadership skills and traits they have developed, and how they define leadership. The veterans we interviewed tended to define leadership in terms of their personal experiences and/or in terms of the characteristics and traits of role model military leaders. Participants reported that they learned leadership skills (1) through experiences serving as a leader in the military, (2) through coursework and/or training offered through the military, and (3) by observing military leaders in action. Of these ways of obtaining leadership skills, our participants discussed observation and coursework/training more often than their experiences serving in leadership roles in the military.

Among those who had leadership experiences while in the military, they discussed their leadership experiences in terms of personal growth and responsibilities. For example, B09 indicated,

> "[The military] improves me a lot as a person, as a leader. There's a lot of opportunities to get better at leading people, especially as a second lieutenant. You're put in a leadership over a platoon, which is usually 50 people, and your responsibilities are to take care and plan ahead for these people. It's a very beneficial experience."

Likewise, A10 said,

> "From the military, you learned, obviously, discipline; how to be a leader; having responsibility not for yourself, but for other individuals; accountability; core values; integrity; honor."

Leadership training is particularly salient for those who participated in the Reserve Officer Training Corps (ROTC) program, as part of the enlisted-to-officer pathway. For example, D04, who is concurrently in the National Guard and ROTC, focused on the formal leadership training he received via the ROTC program. He discussed how these skills can translate into his future work and working with other people:

> "That's another thing ROTC helped with, is that you need to understand other people's backgrounds. So, they always tell us, if you can, put yourself in other people's shoes. What I did [for my engineering team project]—[in] the first week or two, my main focus wasn't the project . . . , I just focused on each person and figured out, okay, this is what he likes, this is what he doesn't like."

Similarly, A12 felt confident in his military leadership training. He explained that for other students, college was the "place to learn leadership, to learn teamwork, and that's what I've already learned while I was in the military."

In contrast, A04 felt that his military leadership training was difficult to translate into a course environment:

> "At first, it was kinda rough because you get some of the skills, like the leadership skills. They try to teach it, but that's not something that's easy to teach somebody, like how to deal with some of the attitudes people have."

Most of our participants indicated that what they learned regarding leadership while in the military was primarily experiential or from personal observations of positive and negative things that military leaders said or did, rather than through formal leadership training. For example, A10 indicated,

> "For myself, you take from other leaders. There's different leadership roles, different leadership characteristics. You take from other leaders their core values that you like, and you apply it to yourself. Your experience with training and working, and you apply that to your civilian life, either your civilian job or your education, or help dealing with yourself or family."

D04 talked about the servant leader mentality, where leaders see themselves as servants first. He recounted how one of his leaders instilled in him this way of leading:

> "One of the ones that he was very adamant about, as just an example, was the lowest ranks eat first. And the

reason he felt that was because the lowest ranks do the most work, and even in some of the campaigns the animals would've eaten before the humans did because they're the ones carrying everything. He did a lot of combat in South America in the jungle in a very harsh environment. And we still do that to this day . . . and the highest ranks serve the food and they eat very last. And the proper way to lead in the Marine Corps has a lot to do with that servant leader mentality.''

5.2 Motivation to be a leader

All of our SVE participants acquired leadership skills through their military experiences; however, motivation played a big part in their decision to exercise these skills in the engineering classroom. Their level of motivation to enact their leadership skills depended on the situation, such that they took on leadership roles when they deemed necessary. While many of our SVE participants tended to step up when their leadership skills were required in a given situation in engineering education, many also felt comfortable taking a minor role in group projects. For example, C02 shared,

> ''I'm completely content to take a back seat [in group projects], but you have to be able to . . . know when to grab your [voice] and use it. And if that's what I have to do, then that's fine. I'd rather do it than have somebody who's uncomfortable doing it try.''

Our participants recounted experiences when they enacted their military leadership skills in their engineering education endeavors. These leadership moments do not always conform to traditional visions of an authoritative figure leading a number of followers, but rather demonstrate individuals purposefully seeking out leadership roles in their academic environment to improve their own and others' education. These behaviors appear to be more in alignment with situational leadership and team leadership approaches. For example, in many engineering classes, SVEs work in teams. Our student veterans would often take a leadership position to help the group meet its goals. This leadership role took many forms, ranging from providing directives to facilitating conversations and communication between group members to ensuring that morale and rapport were high.

Our participants appeared to feel confident in their leadership abilities and seemed to bring that asset to the engineering teams in terms of completing deliverables and generating innovative solutions. Some of our participants indicated that because they had experienced so many complex and challenging situations while in the military, they were particularly well-equipped to handle the challenges of an engineering curriculum and were comfortable taking on leadership roles. C01 demonstrated this:

> ''I realized that a lot of things that I learned and a lot of things that I did [while in the military] really affected how I behave now. It affects my discipline, it affects how I manage people. It affects how I go about attacking things that I need to accomplish, interacting with teams. I mean, I don't know of many other college students that immediately were just like, 'Okay, I have to be the team leader and this is what we're going to do.' And, that's just who I am and it's based on what I've done.''

5.3 Translation and enactment of leadership skills into engineering education

Our SVE participants translated and enacted their leadership skills in the engineering classroom when they felt they were needed. Often, this was related to working in teams and to their own self-improvement. Again, these behaviors tended to reflect situational leadership and team leadership approaches. Many of the engineering problem-solving and design projects they encounter in the classroom are in a group environment, such that leadership skills they bring are particularly applicable. B09, for example, shared,

> ''[The military] has a lot of leadership training and experience along with it, which actually helps the engineering part of my education. We're working in groups, and I know how to be a group leader or project manager better and work efficiently with people.''

With their focus on getting the job done or the deliverable accomplished, our SVE participants used their leadership skills to facilitate group projects. This took the form of being a good role model or delegating tasks, as A10 indicated:

> ''You have to be a good role model for other people. Lead by example. That's what the military teaches. Also, developing a sense of responsibility among other people. Also, you have to delegate your authority, too. Sometimes, you can't do a task or a job by yourself in engineering, so you'll delegate the task out to several people. That way you all share the responsibility of getting a job done.''

Importantly, for these SVEs, leadership in the engineering classroom also takes the form of self-awareness and self-improvement. Part of stepping up as leader is to be prepared for the situation. As A10 described, ''Well, basically engineering or pursuing education, you have to have mastered the skill or the task that you're doing . . . before you can teach or lead someone else.'' And many SVEs feel prepared to tackle the complex challenges of engineering work and team dynamics. For example, D10 summarizes:

> ''Knowing yourself and seeking improvement was definitely one of the things that you understand in the military. Going through airman leadership school in order to become a tech sergeant, you have to understand the color of people's personalities. Understand your own weaknesses and what you're supposed to do,

> what you're best at, what are the best methods of learning. All those things I was taught in the military, but have applied to schooling as well. Technically and tactically proficient.''

This combination of being both ''technically and tactically proficient'' is relevant and beneficial to professional engineering practice, and constitutes one of the ways in which SVEs translate their military training into engineering education, as indicated by D08:

> ''The first [leadership principle of the 11 Timeless Principles of Leadership] speaks a lot to me. It says know yourself and seek self-improvement. Whether it's engineering or ROTC, in order to better anyone, you have to better yourself first. Self-improvement can go . . . with engineering, whether it's getting better in coding or understanding better thermodynamics or anything like that. Being technically and tactically proficient, that's also very important, because . . . you have a mission. You have a time set. Same thing with engineering. You have an assignment and you have a deadline. If you don't do your best and manage your time wisely, you're going to get a bad grade and you're going to have to take the class again.''

6. Discussion

The study results begin to address a gap in the literature on leadership development of engineering students. We found that SVEs gained a range of leadership skills from their experience in the military through formal training or coursework, by observing leaders in action, and through the experience of serving as a leader. Although classical texts on leadership and common images of leadership in the military promote the idea of leaders as ''warrior leaders'' [34] or ''charismatic heroes'' [33], the experiences of SVEs resonated more with ideas of situational leadership and team leadership [38]. That is, although military leadership is by design ''hierarchical,'' our participants tended to take more of a team-based approach in leadership in the engineering classroom, and hence, their leadership is more heterarchical. The SVEs' behaviors are in alignment with team leadership, in which diagnosing and taking action are prioritized, as well as situational leadership, which is enacted to develop the most salient steps toward the attainment of the team's objectives and goals. The SVEs also emphasized the importance of self-awareness, serving others, and helping ensure the good of the group through teamwork and thus contributing to shared goals. The participants' ideas of situational leadership extended into the academic setting in terms of their relative level of motivation to exercise their leadership skills. In particular, the SVEs were likely to take on leadership roles and responsibilities in situations where they felt it was warranted, but were also comfortable ''taking a back seat,'' as appropriate. Being a good teammate was seen to be just as important as taking the lead.

Although they acknowledged having leadership skills, the SVEs did not feel the need to demonstrate these skills at all times, but rather spent time observing others to develop camaraderie or to understand their teammates' or peers' perspectives, in line with team leadership. This finding confirms Aime, Humphrey, Derue, and Paul's more fluid and heterarchical approach to leadership [61]. In situations where they enacted their leadership skills, the SVEs tended to focus on self-improvement and/or serving as positive role models. For these SVEs, their goal was to become ''technically and tactically proficient'' in engineering. This extended from their engineering coursework to how they interacted with other engineering undergraduates. They described doing what was needed to complete the necessary engineering class deliverables, which sometimes involved delegating tasks and other times involved other methods, such as motivating team members to complete aspects of the engineering class work.

7. Limitations

Research on the leadership skills that student veterans bring to the context of engineering education is still emerging. In this study, we used an inductive and deductive approach to understand student veterans' meanings of leadership in relation to the 11 ''Timeless Principles of Leadership.'' The goal was to elicit an emic understanding (from their own perspectives and experiences). A limitation of this study, therefore, is that an etic perspective (outsider knowledge) about leadership is less prominent. We also focused on SVE leadership in the classroom; however, there are opportunities to enact leadership skills in multiple contexts, such as in student organizations and other co-curricular activities. Focusing on students veterans' leadership in the senior capstone course, as well as in other academic contexts, would contribute to extending the literature. Finally, we did not probe our participants about ineffective leadership nor did these themes arise prominently in our findings. However, McCall and Lombardo identified the following traits of ineffective leaders: ''intimidating and bullying subordinates, laziness, an inability to think critically, and insufficient management skills'' [71]. Further research opportunities exist to study ineffective leadership practices, as well as how specific military-acquired practices translate or fail to translate into levels of SVE success in engineering. There are also opportunities for future research on leadership to consider how SVEs continue to hone their leadership skill sets as they graduate from engineering

education and transition into professional engineering practice.

8. Conclusion and implications

This study highlights the ways SVEs gain leadership skills and how these skills are enacted in engineering education. Most of our SVE participants reported gaining leadership skills in the military by observing military leaders in action and from coursework and other types of leadership training, more than from the practice of holding leadership positions. This is consistent with them being enlisted rather than officers. The SVEs applied their leadership skills in engineering education in ways that promoted team effectiveness and positive academic outcomes. While all of the SVE participants valued their military leadership skills, many chose to enact these skills in the engineering classroom when they felt it was needed. Many assumed more of a team-based or situational leadership approach, rather than a hierarchical approach. By focusing on understanding their peers' perspectives and serving as role models, SVEs not only help strengthen the bonds between team members, but they also contribute to the overall quality of their classmates' education. Insofar as their non-SVE classmates and team members also learn leadership skills from observing others, SVEs provide engineering undergraduates with positive models for servant leadership and achieving "technical and tactical" proficiency.

Our research highlights how student veterans transfer and enact skills between different domains—from the military to engineering. Academic administrators and key stakeholders could potentially use these findings to contribute to the design of student services or support programs across academic institutions for military veterans transitioning into engineering study by highlighting narratives that illuminate the skills SVEs bring to engineering learning spaces. Course instructors may be able to leverage SVE leadership skills in the development of their curriculum toward the benefit of SVEs and other engineering undergraduates; for example, by promoting more team-based projects.

Using an asset-based framework in designing and planning education programs and policies could help support SVEs and other groups of potentially marginalized students. By focusing on the skills and talents that diverse students bring into higher education, such as leadership skills, stakeholders could better engage students in the classroom to increase success for all students. Our research findings highlight the transferability of military leadership skills in engineering education and suggest possibilities for future research on transferability across multiple domains.

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