

Thinking Critically about Critical Research with Military Undergraduates in Engineering Education

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Abstract

This theory paper considers prominent critical social theories from the education research literature to conceptualize a critical theoretical space to understand individual theory affordances, gaps and potential ways moving forward to examine military student experience in engineering education.

In this work, *military undergraduates* are understood to be those who comprise a heterogeneous group of prior enlisted military veterans (i.e., those who have served in the enlisted ranks in the U.S. military but no longer serve) and those who concurrently serve as enlisted members of the U.S. military, such as in the Armed Forces Reserves or National Guard, while attending college. Two commonalities help to characterize this group: a shared military culture that is voluntarily adopted and deeply ingrained through military service, and the near ubiquitous presence of racial, ethnic, gender, socio-cultural, and/or socio-economic diversity. Thus, while military students share a collective military culture, they embody the multiplicity of race, ethnicity, gender, orientation, and ability that interweaves U.S. citizenry and represent the disparate socio-economic sectors and geographic and cultural regions that comprise the nation. As such, increasing military student participation in engineering may help realize a socio-culturally/economically inclusive workforce that engineers for the common good while drawing on a pooled wealth of life experiences, practices, and perspectives.

Despite the affordances that military students present to the engineering workforce, the unprecedented levels of military educational benefits available and the potential for enlisted servicemembers to develop STEM career interests while engaged in the technologically advanced U.S. military enterprise, participation, and persistence of military undergraduates in engineering programs remain dishearteningly low. While research with military undergraduates in higher education continues to increase and expand in focus, scholars agree that this research remains reactive, deficit-based, and overly attuned to veterans' needs and services, including mental health, disability, and academic support. This historic focus on needs and services has resulted in a literature base wherein military students have been essentialized and written, (nearly) exclusively by civilians, as deficient—oftentimes to the point of deviance.

To conduct research and engage in praxis and reflection that actively counter socio-educational injustices imposed on military undergraduates in engineering, this paper explores theoretical, conceptual, and methodological dimensions of prominent critical social theories and social-justice educational approaches—Bourdieuian Analysis of Capital (BAC), Funds of Knowledge (FoK), Community Cultural Wealth (CCW), and an emerging Veteran Critical Theory (VCT)—in light of military culture and military student experience in engineering. Mutual consideration of each approach, seeking points of similarity and difference, results in an integrated social critical theory space tuned to the unique tensions experienced by military students in engineering. The current work will help add a critical focus to the examination of military student experience in institutions of higher education and help address calls for asset-based, liberative approaches to research and practice for the purpose of transformation in engineering education.

Introduction

Recent historical events such as the 2008 enactment of the Post 9/11 Veterans Educational Assistance Act, which authorized historic levels of education benefits for military veterans, current service members, and military dependents, and the proposed ending of the 20+ year Global War on Terror (2001-?) have catalyzed an extraordinary influx of military student into U.S. systems of higher education. A similar influx of military veterans and service members into college has not been seen since WWII; it is estimated that the number of Post-9/11 veterans surpassed five million in 2021 [2]. Yet, despite unprecedented use of education benefits and strong potential to develop interests in STEM careers because of their military experience, military undergraduates continue to engage and persist in engineering degree programs at dishearteningly low levels. Very few (1 in 12) military veterans who enroll in college go on to study engineering [3]; even fewer complete entry level engineering degrees and become engineers in the workforce.

In this work, *military undergraduates* are understood to be a heterogeneous group comprising prior enlisted *military veterans* (i.e., those who have served in the enlisted ranks of the U.S. military but no longer serve) and those who concurrently serve as enlisted service members of the U.S. military, such as in the Armed Forces Reserves or National Guard, while attending college. Two commonalities help to characterize current and former military members as a group: a deeply ingrained, shared military culture and the presence and acknowledgement of racial, ethnic, cultural, gender, and socio-economic diversity within that culture. As a cultural group, military undergraduates are unique in the ways they a) embody the multiplicity of race, ethnicity, gender, orientation, and ability within the U.S. citizenry and b) represent, or come from, the varied and disparate socio-economic sectors and geographic and cultural regions that comprise the nation. As such, increasing military undergraduate participation in engineering can help to realize a socio-culturally and socio-economically inclusive workforce that engineers for the common good while drawing on a pooled wealth of life experiences, practices, and perspectives.

Purpose

The historical dominance of the affluent, abled-bodied White male as the socio-economic, socio-cultural, racial, and gendered norm in engineering is well-documented within the educational research literature. The profound inertia of this classed, embodied, raced, and gendered status quo has endured over 200+ years and has resulted in its institutionalization as the “default” in engineering education and the engineering profession [see e.g., 1]. The slow rate of change in tracked measures of diversity (i.e., race, ethnicity, binary gender) in science and engineering [see e.g., 2] confirms the deep need to attend to, support, and advocate for diversity and the inclusion of marginalized groups in engineering.

Toward this end, scholars are increasingly calling for and employing critical approaches to engineering education research [3-10]. Critical approaches are unique in their focus on transformative praxis using the knowledge developed in the research process. In this theory paper, I work to identify and develop a critical social theoretical space tailored for the purpose of reframing perceptions of deficit that may surround military undergraduates in engineering, as well as identifying and dismantling oppressive policies, procedures, and structures that work against their “success” (i.e., participation, persistence, and thriving) as undergraduates in engineering. In doing so, this work adds to a growing body of literature that uses of asset-based and liberative approaches in research and practice for the ultimate purposes of transformation in engineering education.

Background

The U.S. Military and Engineering Education: A Shared and Interdependent History

The U.S. military and the U.S. system of engineering education share a uniquely intertwined history. Beginning in antebellum America, the U.S. military played a pivotable role in the establishment and development of an American system of engineering education [11]. At the outset of the Industrial Revolution, America desperately needed engineers to design and construct its national infrastructure, including roads, canals, and railroads. Meanwhile, antebellum American colleges, which focused on a classical college curriculum comprising courses in philosophy, mathematics, Greek and Latin, and classical literatures, were suffering mounting criticism for being elitist and disconnected from national needs. However, in pluralistic and decentralized 19th century America, neither public consensus nor public agencies existed that could organize and oversee development of a national system of engineering education.

As antebellum American colleges weathered these criticisms, the first formalized system of post-secondary engineering education in the United States developed within French-inspired military schools that materialized apart from the existing collegiate system. Founded in 1802, the United States Military Academy at West Point became the first American institution to offer (in 1817) a four-year engineering curriculum. Interestingly, while the primary purpose of West Point's education was to train military officers as engineers for service in the Army Corps of Engineers, West Point's engineering curriculum was judiciously designed to support both military engineering and civilian (civil) engineering needs. Thus, in 1817, West Point became the nation's first undergraduate *civil* engineering school [11]. The West Point dual-purpose engineering model spread quickly to other U.S. military schools, including Norwich University (1826), Virginia Military Institute (1839), The Citadel (1843), and The U.S. Naval Academy (1845).

Military schools did not remain the sole or main providers of formalized engineering education in the United States, however. Soon after the establishment of the engineering curriculum at West Point, British inspired U.S. polytechnic schools began offering programs of study in civil engineering, while certain antebellum colleges began experimenting with offering engineering partial courses, full courses, and multi-course programs of study. During the next 100 years, the number of U.S. engineers trained in military schools became the minority as polytechnics and antebellum colleges laid the groundwork for what would be the tremendous expansion of U.S. engineering education programs within land grant institutions funded through the Morrill Act of 1862 [11].

The reciprocal relationship that developed between the U.S. system of engineering education and the U.S. military during the antebellum period once again came to the forefront immediately after WWII. Prior to WWII, the U.S. government owned its own shipyards and manufacturing facilities and relied on civilian industries to arm the military only during times of declared war. During WWII, however, the U.S. government changed how it armed its military, moving to contracting the services of private industries, known as defense contractors, to develop and manufacture military weapons and technologies. Correspondingly, the dramatic rise in defense funding for university engineering research and development projects and private industry (defense contractor) engineering jobs ushered in a new era of engineering education. Combined with a mandate for engineering curricular changes emphasizing mathematics and science that was set in motion by the Grinter Report (1955), the prestige and funding associated with winning federal funding competitions quickly took precedence over in-house collaborations with local industry. Thus, the U.S. military-engineering education relationship was re-

established and, in many ways, remains in place today. This time, however, civilian institutions became providers of trained engineers to military funded organizations, whether as students in graduate-level engineering programs working on defense sponsored projects or as degreed engineers working at defense contracting companies, for the purposes of doing military engineering work [12].

The Critical Research Paradigm

Critical Social Theories

With increasing fervor, frequency, and directness, researchers in engineering education call for the use of and employ critical social theories and closely related assets-based approaches to frame empirical research in the field. The aim of critical inquiry is to examine structures of social power to find “truth” as it relates to social power struggles. According to Lincoln, et al. [13],

Critical theorists...locate the foundations of truth in specific historical, economic, racial, gendered, and social infrastructures of oppression, injustice, and marginalization. ... Knowers ... may be cast as unaware actors in such historical realities (‘false consciousness’) or as aware of historical forms of oppression but unable or unwilling, because of conflicts, to act on those historical forms to alter specific conditions in this historical moment (‘divided consciousness’).

While critical researchers examine institutionalized oppression from varying (singular and/or intersectional) perspectives, the “foundation” of all critical social theory is this social critique inexorably linked with conscious raising and a potential for “positive and liberating social change” [13]. Thus, all critical researchers similarly pursue the identification, critique, and active dismantling of structures and relations of power that impede the thriving of any/all people in society.

Social-Justice Educational Frameworks

Social-justice educational frameworks are *assets-based*, or anti-deficit, approaches to education that are grounded in critical social theories [8, 14]. Deficit thinking emerged in the 1960s to theorize U.S. K-12 school failure. Deficit thinking, tantamount to “blaming the victim” [15], situates the reasons for school failure within the “minds, bodies, communities and cultures of students” [16]. Historically, deficit thinking has been used to explain school failure among low-income and minority students and is considered to be a form of racial, ethnic, and socioeconomic oppression [15]. In higher education, deficit thinking is particularly acute within STEM majors, wherein marginalized students face harsh critiques based on ingrained beliefs about who can succeed, such as the “mythical norm ...of the high-achieving, elite, white male” [5]. Assets-based approaches are needed in engineering education to “fundamentally change the way the field views and acts on issues of diversity and inclusion” [14] and recast narratives of marginalized groups from stories of deficit, despair, and risk into stories of asset, hope, and “promise” [17].

The Precedence for Critical Research in Education Engineering

In light of a seemingly intractable lack of diversity problem in engineering [18], engineering education scholars are increasingly engaging critical social theories across a variety of anti-oppressive stances [4, 7, 8, 19], including those that examine race, ethnicity and culture, gender, socio-economic status, sexuality and sexual orientation, and ability, as well as a mix of these interlocking oppressions for purposes of

achieving structural critique and institutional change in engineering. Table 1 presents and describes a (non-exhaustive) list of critical social theories used to critique institutional oppression in engineering.

Table 1. List (non-exhaustive) of critical social theories used to identify and transform oppressive structures in engineering education

Critical Social Theory or Framework	Example EER Works	Focus	Theoretical Contributors
Processes of Education			
Critical Pedagogy	[9, 20, 21]	Identifies and disrupts power imbalances present in educational settings, especially those connected to race and class	Paulo Freire [22] bell hooks [23]
Hidden Curriculum	[24-26]	Critiques hidden processes of recurring hierarchical socialization within education	Henry Giroux [27]
Race			
Critical Race Theory (CRT)	[4, 28-30]	Race as social construct and signifier; Racism is normal within society; Institutions are designed to reinforce whiteness; Racism exists at an institutional level (such as in educational institutions) to privilege White people to the exclusion of People of Color; Stories are a means of psychic preservation for outgroup members; Stories can affect oppressors who often rationalize the oppression	Delgado and Stefaniec [31] G. Ladson-Billings [32]
Color Blind Racism	[7]	Race; Critiques arguments made to de-center issues of institutionalized racism and whiteness based on four tenets: abstract liberalism, cultural racism, naturalism, and the minimization of racism	Eduardo Bonilla-Silva [33]
Critical Whiteness	[4]	White privilege; The set of societal assumptions, privileges, and benefits that accompany the status of being White [34]	Cheryl Harris [34]
Community Cultural Wealth (CCW)	[28, 35-37]	Race; Assets-based; Derived from Critical Race Theory and in response to Bourdieuan Analysis of Capital which describes how societal power selects codes of capital; Identifies six unique types of dynamic and interactive capitals (wealths) that Students of Color possess and employ to resist oppression and navigate and succeed in socially unjust educational environments	Tara J. Yosso [33]
Ethnicity and Culture			
Funds of Knowledge (FoK)	[38-41]	Socio-cultural; Assets-based; Critiques educational practices that are disjointed from the lives of culturally and socio-economically diverse students; Calls for instructional approaches that bridge the historically accumulated, culturally developed, and socially distributed resources knowledge, skills, and practices that are essential for well-being in households and to function within communities [40]	Luis Moll [42] Velez-Ibáñez and Greenberg [43] L.S. Vygotsky [44]

Critical Social Theory or Framework	Example EER Works	Focus	Theoretical Contributors
Ethnicity and Culture			
Funds of Identity (Fol)	[41]	Socio-cultural; Assets-based; Inspired by Funds of Knowledge framework; Theory of human identity in which identity is built from sociodemographic conditions, social institutions, artifacts, significant others, practices, and activities that become essential to a person's self-definition, self-expression, and self-understanding. Funds of knowledge become funds of identity when people actively use them to define themselves [45]	Esteban-Guitart and Luis Moll [45]
Gender			
Critical Feminisms	[20, 30, 46]	Women and Gender Studies; Masculinity Studies; Critiques gender constructions and interactions within cultural and societal power relations	bell hooks [47] Dorothy Smith [48, 49]
Sexuality and Orientation			
Queer Theory, trans studies	[50-52]	Sexuality as socially constructed, fluid, and continually negotiated; Critiques heteronormativity, homophobia, and transphobia; Gender performativity	Michel Foucault [53] R. R. Troiden [54] Judith Butler [55]
Disability			
Critical Disability	[56, 57]	Disability as social constructed; Critiques ableness; Conceptualizes impairment vs. disability	Susan Wendell [58] Michael Oliver [59]
Co-existing Oppressions			
Intersectionality	[5, 28, 30]	Interlocking oppressions (race, ethnicity, gender, orientation, ability, etc.); Identifies and critiques how social inequalities are compounded for those who embody multiple marginalized identities [28]	Kimberle Crenshaw [60]

As the data in Table 1 depict, engineering education researchers are engaging in critical research across several anti-oppressive stances and by employing a variety of critical theoretical framings. The fact that research review articles have been published in the engineering education literature for four of these frameworks—Funds of Knowledge [61], Community Cultural Wealth [14], Critical Feminisms [19] and Intersectionality (i.e., Women of Color) [35]—signals an increasing visibility of and interest in critical research in the field.

Signs of increasing visibility and interest, however, do not suggest that critical engineering education research is, itself, without or above critique. On the contrary, critical research in engineering education is itself critiqued in several ways. Borrego and Beddoes [19], for example, point to underutilization of available critical feminist theories, particularly intersectional, interactional, and masculinity studies approaches, that are considered to have substantial potential to benefit the gendered field of engineering. Denton and Borrego [61] suggest that, despite a relative abundance of FoK research in STEM education, FoK work remains focused on K-12 curriculum development and lacks a broader implementation and assessment of its effects on student learning outcomes related to identity, self-efficacy, and belonging. Holley Jr. and Masta [4] critique the “invisibility of whiteness” within critical race research in engineering

education, contrasting the numerous studies designed to “examine the experiences of racially excluded students navigating the system of whiteness” with the small number designed to analyze the origins and persistence of racial stratification in engineering.

Conducting Critical Research with Military Undergraduates in Engineering Education

There have been increasing calls for social-educational justice for military students across U.S. systems of higher education [see e.g., 62]; engineering education is becoming a prominent contributor of assets-based research with military students among STEM education fields [63]. The engineering education community recognizes that today’s military undergraduates 1) are demographically and socio-economically diverse along several axes (i.e., race, ethnicity, gender, orientation, and ability) deemed critical for the future of the U.S. engineering innovation, and 2) often have knowledge, experiences or know-how, such as employing and/or maintaining advanced technological tools and devices in real world scenarios, that come from military service that can act as entry points into engineering. It has even been suggested that military undergraduates are an untapped human resource in engineering [64].

There are several reasons why critical social research with military undergraduates is needed to ensure them equitable and just opportunities to participate in higher engineering education:

1. Generous educational benefits make military undergraduates exploitable. Current Post 9/11 GI Bill benefits afforded to military undergraduates are more generous and numerous than ever before in history. The amount and extent of benefits offered to military undergraduates and their dependents can, however, make them a target for exploitation by unvetted “military friendly” programs and for-profit institutions [62]. Many military undergraduates today come to college with full tuition and housing benefits, which can mean that universities often do not have to provide scholarships or find other funding sources to recruit them into programs of study or retain them. In times of declining undergraduate enrollment, there is the potential for institutions to prey on military students lack of information about higher education [62] through aggressive advertising and recruitment practices, even to the point of pursuing military friendly school designations without having clear intentions to live up to the promise of what that designation means and requires [65].

2. Unknowable culture. All military members, past and present, are connected through a deeply ingrained military culture. This culture is not well understood and is often falsely interpreted and represented among civilians [62, 66]. Moreover, like other invisible or latent forms of diversity, membership within the military culture can easily be hidden from others and military undergraduates are said to occupy a third or liminal space located between civilian student and military service member [62, 67]. While military culture often provides a positive framework for life outside of the military, the general lack of understanding, and misunderstanding, that civilians have about military culture can be an isolating force within the lives of military undergraduates. In other ways, military enculturation may lead military undergraduates to have a false sense of consciousness about their status as learners, since military training environments are, in many ways, more equitable (go/no go mastery training and recycling) than typical learning environments in civilian academic institutions [68] and particularly environments within STEM programs like engineering. In this way, military undergraduates may be naïve to or surprised by the existence of potentially oppressive structures within academic programs at civilian institutions of higher education.

3. Exposure to implicit bias in higher education. It is known that military students face implicit bias in educational settings. This bias comes in many forms. Bias may be deficit-based coming from ideas about military anti-intellectualism and perceptions about the abilities or desires of military personnel to perform academically and intellectually [68, 69]. Other deficit bias, particularly within STEM fields such as engineering, may come from concerns about military undergraduates as nontraditional, adult learners and the long and arduous academic path they must follow to complete a degree [70]. Bias may also focus on stereotypes of military personnel presented in the media and movies that tell us that military veterans are deviant, angry and volatile people to be feared [62]. Still other bias casts military undergraduates as broken combat veterans who suffer from PTSD and other mental health issues and are constantly in need of help [62]. Moreover, there is potential for upfront knowledge of these biases about military service persons to lead military students to experience stereotype threat syndrome within civilian academic environments.

4. Co-existing and continuing oppressions. The demographic, socio-cultural, and socio-economic diversity represented within today's U.S. enlisted service member population [71] strongly suggests that military undergraduates are likely to experience more than oppression that co-exist along more than one axis of diversity/oppression. (The experience of co-existing oppressions is even more certain we consider military status as its own axis of diversity/oppression.) Importantly, while the U.S. military is considered diverse, as a social organization it is itself not free of implicit bias (i.e., based on racial, gender, orientation, ability) within its ranks [72]. Thus, student service members may come into higher education having already experienced bias-based oppression along singular or multiple axes. Due to the high likelihood of diverse military undergraduates experiencing multiple, co-existing oppressions in military and higher education settings, an intersectional approach to research with military undergraduates is needed to draw meaning from their transitional and educational experiences and to advocate for their fair and just treatment in higher education.

Current Theoretical Approaches to Research with Military Undergraduates in Engineering Education

In a recent review of the current state of the empirical literature related to military undergraduates in engineering education [63] it was reported that, of 22 articles published since 2016, 15 used non-critical social theories, including identity-based theories (6), transition theories (7), learning theories (2), and leadership theories (2), to frame research with military students in undergraduate engineering. Two other articles employed Grounded Theory Methodology and three others did not articulate a theoretical framework guiding their work. A single paper in this study, which is a methods-based paper published in the *International Journal of Qualitative Studies in Education*, employed critical theory as a guiding framework. In this work, Mobley et. al. [73] employed Veteran Critical Theory [62] as an “organizing framework” to describe qualitative methods (key event timeline and the identity circle) used in research with military undergraduates in engineering to elicit rich narratives and counter narratives of experience.

At the time of writing this manuscript, only one other publication, a doctoral dissertation in the field of engineering education written by Sheppard [41], that employed critical theory could be found. In this paper, Sheppard [41] employed the socio-educational justice framework FoK to support a “strengths-based” analysis of the engineering-related assets that military veteran participants (i.e., engineering undergraduates, engineering graduate students, or engineers employed in industry) experientially learned during military service. These two works [41, 73] provide precedence for the acceptance and continued use of critical social theory to frame research with military students in engineering education.

A Critical Theory Space for Research with Military Undergraduates in Engineering Education

Following [74], this section explores critical social theories and social-justice oriented educational approaches used in engineering education research and places them “into dialogue” to develop a theory space for designing and conducting critical research with military undergraduates in engineering. The integrated theory space, which is presented in Figure 4, synthesizes and highlights the potential convergences, divergences, overlaps and gaps of available critical social theories for research with military undergraduates in engineering. This critical theory space is then used to locate places from which to move forward, while maintaining a spatial awareness and connection to the convergences and divergences of existing critical social theories and the purposes which they serve.

Veteran Critical Theory in Education

Phillips and Lincoln [62] conceptualized Veteran Critical Theory (VCT) as a space for theorizing oppression in civilian institutions of higher education from the perspective of military veterans. As the “next in an important tradition of emancipatory paradigms,” VCT draws from five critical theoretical paradigms including critical feminisms, critical race theory, queer theory, disability theory, and border theory. VCT comprises 11 tenets (Table 2) and is envisioned as a research tool for expanding, organizing, and linking research on student veterans; as a sensitivity- and awareness-training tool for faculty, administrators, and student affairs staff; and as a communication tool for student veterans and non-veterans to better express and understand military-related experiences.

Table 2. Eleven Tenets of Veteran Critical Theory in Education [62]

1. Civilian Privilege	Structures, policies, and processes privilege civilians over veterans
2. Oppression, Marginalization, and Microaggressions	Veterans experience various forms of oppression and marginalization including microaggressions <ul style="list-style-type: none">• Denial of privacy (military stories are freely open to all)• Spread effect (one dis/ability implies more)• Secondary gain (emotional/social gain of showing respect to someone with disability)• Assumptions of helplessness (disability related)
3. Victims of Deficit Thinking	Veterans are victims of deficit thinking in higher education
4. Occupy Third Space	Veterans occupy a third space (country) on the border of multiple conflicting and interacting power structures, languages, and systems
5. Narrative and Counter-Narrative	Veteran Critical Theory values veterans’ narratives and counter narratives
6. Multiple (shifting) Identities	Veterans experience multiple identities at once
7. Constructed by Civilians	Veterans are constructed (written) by civilians, often as deviant characters or caricatures
8. Unknowable by Civilians	Veterans are more appropriately positioned to inform policy and practice regarding veterans
9. Interest Convergence	Some services advertised to serve veterans are ultimately serving civilian interests
10. Non-Essential Nature	Veterans cannot be essentialized

11. Shared Culture	Veteran culture is built on a culture of respect, honor, and trust
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Strengths and gaps associated with use of VCT to research with military undergraduates in engineering are discussed in the following sections.

Strengths of VCT for Research with Military Undergraduates in Engineering

VCT’s focus on higher education enables its wide application within and across academic disciplines. Whereas CRT does not explicitly name Whiteness and White Privilege among its tenets [4], VCT enables a strong critique of civilian power through conceptualization of civilian privilege and the civilian construction of veterans. Similar to CRT, VCT tents engage with narrative and counternarrative to contextualize veterans experiences as means for healing and exposing oppression [32]. Narrative and counternarrative may be particularly important for helping faculty, administrators and support personnel better understand the “unknowable” military culture. Clear linkages are provided as stepping off points to engage with critical social theory (e.g., CRT, critical feminism, Queer Theory, critical disability theory) and intersectionality theory through its tenets of Oppressions, Marginalizations, and Microaggressions and Victims of Deficit Thinking. Clear linkages are provided to engage with identity theories through its tenets of Multiple (shifting) Identities and Third Space. Clear linkages are provided to engage with social-cultural theory (e.g., FoK, Fol) through its tenet of Shared Culture. Linkages are also provided to engineering faculty and the academic support community by the tenets of VCT serving as a guiding framework for sensitivity and awareness training, primarily for student serving personnel.

Gaps within VCT for Research with Military Undergraduates in Engineering

VCT presents gaps through its focus on veteran only students instead of all military (i.e., non-veterans who are currently serving) students in higher education. The theoretical grounding for its focus on veterans only is not made clear; theorizing the distinction as well as satisfying for any potential need for new tenets to encompass current military students is needed. While conceptualizations of the mechanisms of marginalization of veteran students are mostly focused on dis/ability-based microaggressions, there are limited linkages within VCT to critical disability studies and the critique of ableness in veteran culture. VCT also lacks focus on the transformations of perceived veteran deficits into assets and linkages of these critiques to higher education curriculum and education praxis.

Community Cultural Wealth

Informed by the tenets and traditions of CRT, Community Cultural Wealth (CCW) [33] is a social justice educational framework that uses counter-narrative to transform deficit assumptions, narratives, and marginalization of diverse groups. Specifically, “CCW reveals accumulated resources that Communities of Color utilize, as assets, to navigate, and interrupt oppressive institutions” [74]. Identifying (at least) six categories of unacknowledged “capitals” (i.e., “wealths” that take form as knowledge, abilities, skills, strategies, and networks) (Table 3), CCW describes how Students of Color dynamically and interactively combine and build these assets to collectively form their community cultural wealth, which becomes “embodied and used ... to survive and resist macro- and micro-forms of oppression” [74]. In linking concepts of “wealth” and “capital,” Yosso [33] challenges how (White) power exclusively selects which assets are viewed as “capital” in society, such as in Bourdieu’s Analysis of Capital (ala Marx). [74]

Table 3. Six Capitals of Community Cultural Wealth [33]

1. Aspirational Capital	Ability to maintain hopes and dreams for the future, even in the face of real and perceived barrier; culture of possibility; future focused resiliency
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2. Familial Capital	Cultural knowledges nurtured among <i>familia</i> (kin) that carry a sense of community history, memory, and cultural intuition
3. Linguistic Capital	Intellectual and social skills attained through communication experiences in more than one language and/or style; traditions of storytelling
4. Navigational Capital	Skills of maneuvering through social institutions, particularly institutions not created with Communities of Color in mind
5. Resistant Capital	Knowledges and skills fostered through oppositional behavior that challenges inequality
6. Social Capital	Networks of people and community resources

Strengths and gaps associated with use of CCW to research with military undergraduates in engineering are discussed in the following sections.

Strengths of CCW or Research with Military Undergraduates in Engineering

CCW is underpinned by a strong critique of race, racism, and White middleclass power. CCW's emphasis on the critique of power and privilege may be extended to other power asymmetries in higher education that directly affect military students (military/civilian, abled/disabled). CCW is rich in its ability to transform perceived cultural deficits into assets and to provide mechanisms for resistance and change at a community level. Identified capitals provide a basis for unique military capitals. For example, Linguistic capital may be re/defined to include military experiences with detailed, direct, remote, and/or urgent communication about technical issues and military member comfort using acronyms and jargon, all of which may be seen as assets in technical disciplines and career fields. Additional opportunities to also define or re/define currently identified capitals in the military student context (i.e., Aspirational capital-aspiring to serve, to go for college; Familial capital-"military family"; buddies, camaraderie; Navigational capital-navigating bureaucracy, complex social processes; and social capital-military culture, extended military family, veterans resource services and associations) or to develop new military-based capitals applicable within engineering education and the engineering profession exist.

Gaps within CCW for Research with Military Undergraduates in Engineering

While CCW provides strong linkages to communities (local and academic) and rich approaches for transforming perceptions of veteran deficits into assets as capitals (i.e., wealths), it lacks linkages directly to higher education curriculum and educational praxis. Thus, beyond the discovery and description of capitals (i.e., wealths), CCW presents no clear mechanism for applying them to curricular design or teaching generally or in STEM/engineering specifically.

Funds of Knowledge (FoK)

FoK [42] is an assets-based social justice educational framework that was conceptualized to describe how Mexican Americans in "economically vulnerable" areas of the U.S. southwest developed strategic and "use-value" (i.e., as contrasted with market value) bodies (funds) of knowledge within their homes and local communities. [74] FoK was originally developed as a research-to-practice methodology wherein researcher and teachers ethnographically co-inquire within homes and at community sites and then build FoK findings into school curricula. [42] Vygotskian framing of "use-value" knowledge ensures that "both life-based and discipline-based knowledge are valued for curriculum" and supports an "inclusive, fair-world justice" ethic. [74] Strengths and gaps associated with use of FoK to research with military undergraduates in engineering are discussed in the following sections.

Strengths of FoK for Research with Military Undergraduates in Engineering

FoK is an assets-based approach to educational praxis. Using the FoK approach, research and teachers collaboratively reveal and define diverse assets of oppressed groups and transform deficit assumptions into use-value categories of knowledge. [42]

Gaps within FoK for Research with Military Undergraduates in Engineering

FoK has seen greatest use in K-12 classrooms and its application in higher education is not as established. FoK may overemphasize “celebratory” FoK and ignore FoK that derives from difficult life experiences and contexts. [74] Given the stressful, dangerous, and complex nature of military experience and particularly combat experience, non-celebratory FoK (e.g., dark FoK) may be important for revealing some of the potential ways that military experience can be used as a knowledge fund in engineering education. FoK lacks critique of socio-cultural power relations (use value vs market value) and does not provide mechanisms for continuing links with research communities after data collection is complete. To be used with military students, FoK must be recontextualized to operate with additional forms of cultural and intersectional identity. [74]

Bourdieuian Analysis of Capital (BAC)

Bourdieuian Analysis of Capital (BAC) employs Marxian logic (market driven or exchange-value capital selection) to explain how the restriction of the accumulation of cultural capital (objectified, institutionalized, and embodied) to the few is the key dynamic by which fields reproduce social-structural inequality [74]. Of these, institutionalized and embodied capital are of greatest importance for education. Educational institutions are mass markets inhabited by diverse students possessing varying “cultural uses” and literacies. Institutions invest in some uses and literacies over others and, in doing so, select for and reproduce the social structural power of those cultural groups [74]. Embodied capital comprises dispositions for “perceiving and responding” to situations that are learned and “tacitly embodied” during immersion in social habitats, particularly early in life (primary habitus). Interactional styles associated with social-structural positions are not well explained to students who do not culturally inherit them (hidden curriculum). In this way schooling unfairly selects for codes of cultural power and reproduces social structural inequality [74]. Strengths and gaps associated with use of BAC to research with military undergraduates in engineering are discussed in the following sections.

Strengths of BAC for Research with Military Undergraduates in Engineering

BAC exposes and critiques the selection of (exchange value) capital selection and restrictions of the power accumulation of capital within society. BAC strengths lie in its provision of rich conceptual tools (forms of capital, habitus, and field) for theorizing how social structural stratification is reproduced within systems that structure social positions within the system based on power relationships, for example, as in professions such as engineering. Scholars [75] have conceptualized “military habitus” as “unconscious thoughts and behaviors acquired through military training and service.” Others [76] found that military habitus can contain useful attributes and dispositions such as going with the flow, being comfortable with discomfort, calm assertiveness, and situational awareness, among others. Along with professionally useful attributes and dispositions, military habitus can also contain “thoughts and behaviors that can impair a veteran’s ability to be successful in life,” such as extreme vigilance, an inability to manage emotions, and drinking alcohol, often to excess. Thus, theoretical concept of habitus can be very useful for understanding and describing the ways that attributes, behaviors, and dispositions that are learned during military service can both support and inhibit success within the engineering profession, which has its own habitus.

Table 4. Critical Theory Space for Research with Military Undergraduates in Engineering Education

Theory	Strengths	Gaps	Ways Forward
Veteran Critical Theory (VCT)	<p>Enables strong critique of power through conceptualization of civilian privilege and civilian construction of veterans</p> <p>Emphasis on contextualized narrative and counternarrative provides for opportunities for healing for the oppressed and mechanisms for affecting oppressors</p> <p>Provides robust linkages to, Intersectionality Theory, and other emancipatory paradigms such as CRT, Critical Feminisms, Queer Theory, Disability Theory (Oppression, Marginalization, and Microaggressions; Victims of deficit Thinking)</p> <p>Enables linkages to Identity Theories (Multiple Shifting Identities)</p> <p>Enables linkages to Third Space and Boundary Theories (Third Space)</p> <p>Enables linkages to socio-cultural praxis frameworks such as FoK, FoI (Shared Culture)</p> <p>Provides a framework for community (e.g., faculty, staff, and peer) mobilization through sensitivity and awareness training</p>	<p>Lacks mechanisms to critique educational structures from the viewpoint of higher education students who are current military service members (non-veterans)</p> <p>Current conceptualizations of marginalization largely focused on dis/ability-based microaggressions</p> <p>Lacks mechanisms to critique deficit thinking by transforming deficit assumptions into assets</p> <p>Lacks mechanisms for practical application in higher education curriculum</p>	<p>Theorize which tenets apply to currently serving military students and whether new tenets are needed</p> <p>Theorize marginalization and microaggressions apart from those linked to dis/ability</p> <p>Uncover linkages to assets-based , social-justice educational frameworks</p>
Community Cultural Wealth (CCW)	<p>Strong critique of race, racism, and racialized power which may be extended to other power asymmetries [74] (i.e., civilian /military, abled/disabled, female/male, binary/nonbinary).</p> <p>Reveals diverse assets/ transforms deficit assumptions [74]</p>	<p>Lacks linkages for practical application in higher education curriculum [74]</p>	<p>Use term “wealths” rather than “capitals” maintains explanatory power of “capital” as selective, mainstream, and market driven and “wealths” as cultural [74]</p> <p>Theorize the application of CCW to power asymmetries other than race.</p>

Table 4. Critical Theory Space for Research with Military Undergraduates in Engineering Education

Theory	Strengths	Gaps	Ways Forward
	Provides links to community and, thus, community mobilization and action [74]		<p>Theorize the re/definition of CCW capitals (for Student of Color) into capitals for military students</p> <p>Uncover new capitals based on military student experience in engineering</p> <p>Uncover approaches for linking CCW with engineering curriculum and educational praxis</p>
Funds of Knowledge (FoK)	<p>Research-to-practice approach; supports Praxis [74]</p> <p>Reveals diverse assets/ transforms deficit assumptions [74]</p> <p>Linkages to Existential and Dark Funds of Identity [77] which may be important funds for military students</p>	<p>Lacks a critique of socio-cultural power and privilege [74]</p> <p>Lacks linkages to communities for mobilization [74]</p> <p>Potential for overemphasis on “celebratory” or FoK when there is rich knowledge in difficult lived experience [74]</p>	<p>Mobilize FoK to contest “market value” capital selection and to redistribute codes of “market value” capital selection [74]</p> <p>Recontextualize use for other forms of cultural or intersectional diversity [74] (military/civilian abled/disabled)</p> <p>Recontextualize use in post -secondary educational contexts</p> <p>Theorize use of non-celebratory FoK that come from difficult, intense, or challenging life experiences for military students.</p>
Bourdieuian Analysis of Capital (BAC)	<p>Provides rich conceptual tools (forms of capital, habitus, and field) for theorizing the reproduction of social structural stratification using Marxian logic [74]</p> <p>Conceptual linkages to Hidden Curriculum</p> <p>Implicit Linkages to Critical Pedagogy</p>	<p>Exposes but does not provide tools for opposing capital-selection injustice [74]</p> <p>Lacks conceptual tools for proactive approach for pursuing justice (educational or community praxis) [74]</p> <p>Lacks explicit linkages to intersectional approaches [74]</p>	<p>Clarify how BAC conceptual tools do/don’t apply to intersectionality with racialized and other power asymmetries [74] (military/civilian, abled/disabled)</p> <p>Clarify how BAC conceptual tools do/don’t apply to higher education settings (different from mass market “schooling”?)</p> <p>Provide explicit linkages to Critical Pedagogy</p>

Table 4. Critical Theory Space for Research with Military Undergraduates in Engineering Education

Theory	Strengths	Gaps	Ways Forward
			<p>Uncover engineering habitus and compare/contrast with military habitus to develop ways to oppose and interrupt capital selection injustice</p> <p>Extend BAC to understand how capital selection and restrictions on powerful accumulation can be contested within institutional fields [74] such as engineering</p>

Note: Way forward shown in bold text are specific to engineering education.

Gaps within BAC for Research with Military Undergraduates in Engineering

BAC is critiqued for providing tools that expose but not actively oppose capital-selection injustice, and because it lacks explicit linkages between intersectional oppressions due to racial oppression and other power asymmetries (e.g., gender, orientation, dis/ability, military/civilian).

Ways Forward

The comparative analysis of critical social theories (as shown in Figure 4) highlights ways forward for research with military undergraduates in engineering. These ways forward are described in the following section.

1. VCT, which provides strong links to existing critical social theories and socio-cultural educational frameworks, presents substantial possibilities for identifying military student oppression and addressing this oppression within engineering educational support communities of faculty, staff, and peers (i.e., through sensitivity and awareness training). Moving forward, researchers should:

- a. Theorize if/how current VCT tenets apply to students who are current service members (i.e., not veterans) and if any new tenets for students currently serving are needed. Alternatively, consider whether VCT applies only to veteran students.

- b. Uncover additional types of microaggression and mechanisms of marginalization of military students in engineering beyond those already identified in VCT (which are largely linked to veteran dis/abilities).

- c. Uncover new linkages between VCT and social justice educational frameworks wherein military student oppression uncovered and communicated using VCT can be directly and actively opposed within the formal engineering curriculum and classrooms.

2. CCW presents a strong critique of race, racism, and racialized power by revealing diverse assets and supports the transformation of deficit assumptions through narrative. Moving forward, researchers should:

- a. Theorize the application of CCW to power asymmetries other than race.

- a. Re/define existing CCW capitals (which were originally defined for Students of Color) considering military student experience in engineering.

- b. Uncover new capitals based on military student experience in engineering.

- d. Uncover approaches for applying CCW within engineering curriculum for the purpose of educational praxis.

3. FoK is a socio-cultural educational framework that supports praxis and transforms deficit assumptions by revealing diverse assets and creating curriculum and educational experiences that make use of those assets. Moving forward, researchers should:

- a. Recontextualize FoK methodology for other forms of cultural or intersectional diversity (i.e., military culture) and for use in post-secondary contexts

- b. Theorize and uncover dark/existential fund based on military student experience.
4. BAC provides conceptual tools for theorizing the reproduction of social structural stratification using market-based (i.e., Marxian) logic. As such, BAC tools have largely been applied to capital selection within systems of structural stratification based on social classes, and not on other power asymmetries (i.e., race, disability, gender, etc.). Moving forward, researchers should:
- a. Uncover engineering habitus and compare/contrast with military habitus to develop ways to oppose and interrupt capital selection injustice
 - b. Extend BAC theory o understand how capital selection and restrictions on capital accumulation can be contested within other institutional fields [74] such as the military and the engineering profession

In Conclusion

In this work, critical social theories, and social justice oriented educational approaches, most of which have precedence for use in engineering education, were placed “into dialogue” to develop a critical theoretical space (Figure 4) that can be used to guide research designs, questions, and decisions about critical research with military undergraduates in engineering. The theory space results from thinking critically about appropriate and potentially transformative approaches for bringing critical focus to the examination of military student experience in institutions of higher education and serves to catalyze, locate, and document ongoing debate and critique within engineering education research.

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