Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025
Paper ID #48518

WIP: Developing an Onboarding Seminar Series for Non-traditional and Military Students in Engineering: A Design-based Research Approach

Hannah Wilkinson, Utah State University

Hannah Wilkinson is a PhD candidate in Engineering Education at Utah State University. She received a B.S. in Chemical Engineering in from the University of Utah and an M.S. in Engineering Education at Utah State University.

Dr. Angela Minichiello P.E., Utah State University

Angela (Angie) Minichiello, PhD is a military veteran, licensed mechanical engineer, and Associate Professor of Engineering Education at Utah State University.

WIP: Developing an Onboarding Seminar Series for Post-traditional and Military Students in Engineering: A Design-based Research Approach

Military students, defined for the purposes of this study as veterans and those currently serving in the military while attending college, are a population that deserve particular attention due to their unique identities and experiences transitioning from military service to higher education. Many higher education institutions have access to unique resources, such as private endowments or donations, military supportive communities, and/or campus proximity to military installations and Veteran Affairs (VA) centers, that make it possible to support and engage with military students in a plethora of ways. Other institutions have limited or no access to similar levels and variety of resources for military students. Still others experience difficulties justifying funding allocations to support military students, among competing priorities, considering their often comparatively low, and sometimes hidden, enrollment levels. For these latter types of institutions, our prior work suggests that one viable strategy for supporting military students across a range of higher education institutional contexts is to provide institutional-level and college-level (i.e., engineering college) programs that serve military students through their intersectional identities as post-traditional students [1]. For the purposes of this study, we define post-traditional students as encompassing standard definitions of non-traditional students, as well as military, first-generation college, and transfer students. Our decision to use the term *post-traditional* rather than *non-traditional* is discussed in a later section.

Purpose

This work-in-progress study is situated within an engineering college at a four-year, public, land-grant university in the western United States. As is common for U.S. western institutions, this engineering college has record of a comparatively small number of self-identified military students pursuing undergraduate engineering degrees; numbers have made it difficult for the engineering college leadership to justify allocating resources to provide targeted support for this student population. Therefore, to support military students within our institutional and college of engineering contexts, we are developing an onboarding seminar series purposed for first- and second-year *military and post-traditional students* in engineering. This biweekly seminar series addresses identified needs of post-traditional students entering higher engineering education and is based on documented success combining military and adult, post-traditional student support. The format of this intervention as a seminar was derived both from feedback from institutional agents who work with military students at the college and institutional levels [1], and from a similar transition course for veterans successfully introduced at the University of Wyoming [2]. While the seminar is open to all students, its focus is to be supportive of military students in particular. As such, this intervention *has an added focus on military student inclusion through integrated peer awareness training, peer mentorship, and allyship*.

Using design-based research (DBR), a multi-disciplinary design and development research methodology advanced by the learning sciences and modeled after engineering design principles [3], [4], we are developing the seminar series over multiple iterations with volunteer post-traditional and military student participants. During successive iterations, we are collaboratively developing the seminar curriculum, gathering student and partner/stakeholder feedback, and updating the curriculum based on recurrent data collection and analysis. Drawing from situated learning theory's Communities of Practice (CoP) [5], our project goal is to help students' navigate their undergraduate engineering degree and build a sense of belonging and self-efficacy in engineering by creating an integrated community of post-traditional and military students in engineering. To meet these goals, our study is guided by the following theory- and design-based research questions.

Theory

1. In what ways does an onboarding seminar series influence participants' navigation of their undergraduate engineering program?
2. In what ways does an onboarding seminar series influence participants' sense of belonging and self-efficacy in engineering?

Design

3. What aspects and elements of the design of the onboarding seminar series do participants find most beneficial to navigating their undergraduate engineering program?
4. What aspects and elements of the design of the onboarding seminar series do participants find to contribute to their sense of belonging and self-efficacy in engineering?

Background

Defining the Post-traditional Student Population

The first robust definition of non-traditional students was provided in the National Postsecondary Student Aid Study (NPSAS) and defined seven criteria for identifying non-traditional students [6]. These criteria included 1) delayed enrollment, 2) part-time enrollment, 3) being financially responsible for oneself, 4) being employed full-time while enrolled, 5) having dependents, 6) being a single parent, 7) not receiving a standard high school diploma. Importantly, these criteria, in truth, represented statistically derived risk factors for degree non-completion among students enrolled in higher education across the variety of institutional contexts that offer two- and four-year undergraduate degree programs.

In a recent systematic review of research, Brozina and colleagues [7] reported that the majority of research with non-traditional students in engineering uses select, but not all, of the NPSAS criteria, and/or uses additional criteria, including age, first-generation college status, and transfer student status to define non-traditional students in their studies. Given that the NPSAS categories were introduced in 1996, nearly 30 years ago, it may be that researchers are attempting to expand on the original definition of non-traditional students to better represent today's student population.

Additionally, while recognizing the challenges non-traditional students face when pursuing higher education, it is also important to recognize the strengths they bring with them to their education and future professions. By categorizing students simply by how they are "at risk" of failure, we curtail ourselves into deficit-thinking, which places blame on students for not completing their degrees, rather than on the institutional structures that are set up to primarily serve traditional students [8]. This tendency towards deficit-thinking, in conjunction with the fact that non-traditional students, depending on how they are defined, comprise as many as 50% or more of students in higher education today [9], suggests that the NPSAS non-traditional student definition may be inadequate for representing current non-traditional student populations.

However, as Brozina and colleagues [7] point out, the reality of not having a standardized definition of non-traditional students reduces our ability as researchers to replicate and connect studies with this student population and maintain research standards across the non-traditional student literature. Therefore, to help bridge the gap between a standardized definition and one that may more adequately represent today's student population, we chose to follow Soares and colleagues [9] by using a new term, *post-traditional student*, to identify the contemporary non-traditional student population that is the focus of this work.

As conceptualized by Soares and colleagues [9], the term *post-traditional student* not only includes the NPSAS's definition of common non-traditional student *characteristics*, but also adds an additional element of *intersectional identity* to the term. Post-traditional intersectional identities include first-generation college students, military students, and transfer students. While students with these identities may fall outside of the NPSAS criteria, it is more often true that students possessing these identities often experience many of the NPSAS characteristics, including delayed entry into college, attending college part-time, having dependents, and/or working full-time, simply due to the realities of these identities. Likewise, engineering education researchers more often report on student outcomes by identity-based groups, rather than by the deficit-based, at-risk characteristics proposed by the NPSAS. Thus, the definition of *post-traditional students* provided by Soares and colleagues [9] not only works with how researchers in engineering education define student groups by identities, but also recognizes how these identities help shape today's engineering student population.

Supporting the Military Student Population

Targeted support for military students in college at institutions with limited funding varies greatly [10]. Some institutions of higher education have access to resources that make it possible to support military students in more direct ways, such as through courses focused on military skills, well-funded veteran resource centers, and providing college credit for military experience [11], [12], [13]. Other institutions, however, may be limited by the layers of their institutional context in providing access to targeted resources and programs that can help military students not only survive but thrive in college [1].

One of the more well-known forms of targeted support for military students has come through Green Zone Awareness training. Green Zone training focuses on educating institutional faculty, staff, and administration on military students' experiences and the challenges they may face while attending school [14]. While Green Zone style training has shown some success in improving awareness of military students on campus, it has often fallen into the same "deficit-thinking" patterns that plague institutional awareness of post-traditional students [6], [10] by focusing more on how to mitigate the effects of PTSD and other mental health problems above other forms of support for social integration and educational success.

Notably, the University of Wyoming found success in supporting military students by providing a course to help returning veterans transition from military service to higher education [2]. The course included teaching financial and wellness skills, reviewing basic academic tools like writing and studying, providing information on institutional support for all students, and creating a community of veterans on campus. While no formal program evaluation was recorded, student feedback on the course was overwhelmingly positive [2].

While the University of Wyoming is located in the western United States, its institutional context is unique from other institutions in the area in that 1) the veteran resource office has a large amount of private funding and 2) there is a high level of community support for veterans, despite being located some distance from the nearest military installation [15]. This means that while results from the transition course are promising, they may be difficult to replicate at other institutions that do not have the same level of funding and community support.

Institutions with more limited dedicated funding for student support have met with success providing innovative programs for military students by creating programs that take advantage of the commonalities between military student and other adult or post-traditional student experiences [1]. These include resource centers for both adult and military students, free child-care options, and campus activities aimed at connecting military students with other post-traditional student groups [1]. These examples suggest that a viable avenue for supporting military students in higher education (particularly in engineering) may be to provide college-level programs (i.e., college of engineering) that serve post-traditional and military students together as an intersectionally interconnected group [1]. While we do not suggest that all post-traditional students are exactly alike and should be curtailed into "one-size-fits-all" support programs, we do recognize that many post-traditional students follow similar academic pathways in engineering. Considering that many institutions of higher learning may not have the resources available to support each group's needs, creating programming for all post-traditional students is one avenue to ensure military students receive support in engineering.

Theoretical Perspective

This study is situated within a transformative research perspective, which focuses research on positive societal change and recognizes the social structures that impact individuals as they participate in communities and institutions [16]. This perspective is well-suited to research with groups that are consistently under-supported in higher education, particularly research focused on developing support for these groups. The transformative perspective treats research as construction rather than discovery and focuses heavily on participatory research [16, p. 35].

Research Team Positionality

As a research team, we value transformative work that supports inclusion and accessibility in engineering education. The first author, a White, neurodivergent woman, has had experience navigating the social structures of higher education engineering programs that generate biases against women in STEM. As a math educator, she has worked with K-12 students to push against negative biases and encourage her students to succeed in math and STEM. The second author is a White woman and military veteran who is formally trained and has been professionally employed as an engineer. Today, as an engineering educator and researcher, she publicly advocates for military students in engineering and STEM degree programs. Her research in the field of engineering education draws directly from personal experiences serving in military, industry, and academic roles.

Theoretical Framework

This study draws on several educational theories as well as a conceptual framework purposefully developed for military students in engineering [1] and adapted for post-traditional students more generally. These theories and our conceptual framework are described in more detail below.

Communities of Practice

This study uses Communities of Practice (CoP), a theoretical framework based on situated learning theory and developed by Lave and Wenger [5]. According to Lave and Wenger [5] a CoP is a group of individuals who create a community centered around a specific practice or purpose where individuals participate to varying degrees to define knowledge and competence and where members negotiate and re-negotiate their identity as a participant of the community and as a member of society as a whole.

When run successfully, a CoP helps members who would normally exist on the periphery of a group, due to time constraints, feeling undervalued, or other factors, develop a strong identity with the community's domain of practice and move from low participation within the group to high participation [17], [18]. CoPs have been used with military students in other research to help them build camaraderie outside of military contexts [19]. In the case of our research, we are developing a CoP focused on the pursuit of an undergraduate engineering degree, for the purpose of supporting both post-traditional and military students in forming a strong engineering identity and sense of belonging within their community and the college of engineering.

Asset-Based Frameworks

To combat the deficit-based thinking that persists in research with military and post-traditional students, we are also framing our research within an asset-based framework. Asset-based frameworks have been developed as an alternative to deficit-thinking approaches used to study underserved students in education [8]. Asset-based frameworks focus on the strengths that students bring with them to education [8]. An asset-based frameworks was used to support this study to ensure that military and post-traditional students' various strengths and skills were taken into account when developing support for them.

Conceptual Framework

In our previous research with military students and faculty, staff, and administration that support them, it became clear that, for military student support to be successful long-term, it must be designed in context, that is, with the institution's context and limitations [1]. Institutional context includes location, size, community support, and limitations such as funding and other available resources.

In prior work, we developed a conceptual framework for military student support [1]. Since then, we have found other research that supports the idea that development of post-traditional student supports must factor in the same considerations of institutional context as in our original model [7], [9]. Thus, based on the work of Soares [9] and Brozina [7], we adapted our military student support framework to apply to post-traditional students. The resultant framework for post-traditional student support is shown in Figure 1.

Figure 1
Conceptual framework for institutional and college-level support for post-traditional students. Adapted with permission from Wilkinson [1].

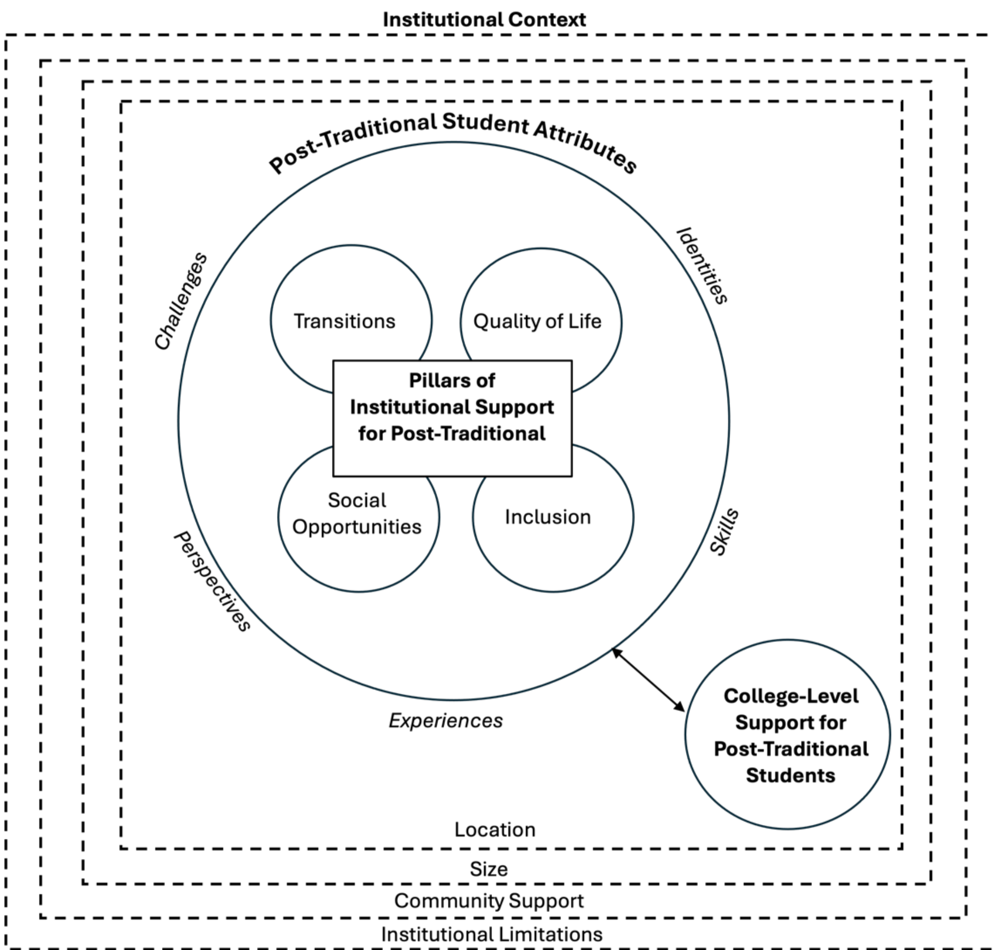


Figure 1 shows our conceptual framework for developing institutional and college support for post-traditional students. First, institutional support for post-traditional students can be placed into four *pillars of institutional support*: *transitioning* to higher education (be it from military service, full-time employment, or caretaker roles), *quality of life*, *social opportunities*, and *inclusion* on campus. Next, when support is developed within these pillars, our research suggests that institutional support should take into account *post-traditional students' attributes*, such as their various *identities*, lived *experiences,* and *perspectives,* as well as the *skills*/strengths they bring with them to their education and the *challenges* they face as post-traditional students in education.

In combination with institutional support, colleges, including the college of engineering, should work within their broader institution to build *college-level support for post-traditional students*. Finally, no matter the level, whether it be from the department, college, or university, all support lies within the overall *institution's context,* including its *location*, *size*, *community support*, and *other limitations*. In designing our seminar, we worked within the context of our college of engineering and institution, which is a public, land-grant university located in the western United States at least 50 miles from the nearest military installation and over 75 miles from the nearest VA hospital.

Methodology

This study uses a design-based research methodology approach that focuses on the development of educational interventions, support programs, and/or instructional practices while building educational theory [3], [20], [21]. Situated in pragmatic and transformative approaches to research [16], DBR is a flexible methodology that goes through an iterative cycle of design, implementation, analysis, and redesign, and can use multiple qualitative and quantitative methods throughout the research process [3]. It is particularly suited for developing support programs, as it is most often used in real education contexts and works to connect theory to practice (or design) [3], [4]. It is also particularly suited to research with a focus on institutional context, as working with participants and stakeholders through each iteration to solve an educational problem in context is an essential element of DBR [22].

In accordance with DBR methodology, this work will include the implementation of several iterations of the onboarding seminar. These iterations include a developmental phase, a practice phase, and a proof-of-concept phase. Each phase includes collecting data from stakeholders and/or participants, analyzing findings, and updating the seminar's structure and curriculum based on feedback.

Methods

The methods used to design and analyze the seminar are described below.

Stakeholder Perspectives

Before recruiting undergraduate student participants for the study, it was important to meet with stakeholders to get their input and backing for creating support for post-traditional students in engineering. Stakeholders included college of engineering deans, advisors, and faculty and veteran resource office directors and staff. The first author met several times with stakeholders, both in individual and group meetings and took detailed meeting notes.

Stakeholders primarily provided input on the seminar curriculum and structure based on their individual roles, backgrounds, and experiences. This input is described in more detail with the other preliminary findings.

Seminar Participant Recruitment

Undergraduate engineering student participants were recruited through IRB approved methods by distributing physical research flyers throughout the college of engineering building and veteran resource office, and going into engineering, math, and science courses that engineering undergraduates take to advertise the seminar. IRB required that only those who had completed informed consent could participate in the seminar, so we directed interested students to a Qualtrics survey where they could review informed consent documentation, sign up to participate, and be added to a class page where they learned more about the seminar. This class page, created in the Canvas learning management system [23], also included the seminar schedule, files from presentations, and other resources available to students.

To increase participation, we also developed a pre-seminar survey and had it sent, through approved IRB procedures, to all students in STEM-related colleges and the veteran resource office at our institution. Students who responded to the survey were compensated through the form of a $10 gift card and invited to provide contact information if they were interested in attending the seminar so that the research team could follow up with them.

Data Collection

Several sources of data are collected during each seminar iteration, including meeting notes, surveys, and focus group interviews. These are described in more detail below.

Meeting Notes. Every seminar session is audio-recorded using ZOOM software. The first author takes notes of participants' input throughout each session and then listens to the recordings to add any insights they might have missed during the session.

Pre-Seminar Survey. Participants are asked to provide feedback on eight different potential topics: math review, homework help, career prep, networking, writing review, computer literacy, programming, and mentoring. They were also provided an open-ended option for other topics they would wish to see covered in the seminar. The survey questions for each topic are included in the appendix and initial findings from the survey are described in more detail below.

Post-Seminar Survey. Once participants enter the study and attend their first seminar session, they are invited to take a survey focused on collecting feedback on the seminar and suggestions for improvement, as well as their self-efficacy and sense of belonging. The survey was developed using questions from our college's "Power Up" bootcamp for students [24] and from the General Engineering Self-Efficacy Scale [25].

Focus group Interviews. During the semester, participants who attend the seminar at least one time are invited to participate in a focus group interview. Focus group questions build on questions and responses from the post-seminar survey and meeting notes taken throughout the semester. Focus groups' audio are recorded using ZOOM's recording function.

Preliminary Findings

While only the first iteration of the developmental phase is complete, data collected from seminar sessions and surveys provide insight into how the seminar can be redesigned to build a CoP for military and post-traditional students. The initial findings have been organized into two areas to match with the study's research questions based on theory and those based on design.

Theoretical Findings

While only one participant attended the first seminar iteration, their feedback is still valuable and important to consider. This participant attended sessions remotely over ZOOM, and during sessions provided direct feedback on curriculum and resource accessibility, which will be implemented into future iterations.

They also discussed at length their desire to be able to have a community of engineering students to work with. As a post-traditional student attending classes remotely, they found it difficult to connect with other students and feel a sense of belonging in engineering. They expressed interest in the seminar both because of access to resources, as well as the chance to meet other post-traditional students in engineering. More data is needed from participants attending the seminar to determine if this motive is consistent across post-traditional students.

Design Findings

Participant Demographics. Most of the initial findings on the seminar design come from the pre-seminar survey. The survey was distributed to all the STEM colleges and through the veteran resource office at our university. As it was open to all students, the survey asked participants to self-identify as either a non-traditional, military, first-generation, or transfer student. While we define post-traditional students to include all of these groups, we chose to separate the survey question into these four groups to make it easier for students to respond, as they may be more familiar with the term *non-traditional* than *post-traditional.* Additionally, each post-traditional identity included a brief description to help students select the appropriate option. For example, next to the *non-traditional* option the survey said "such as older than 18 when starting college, working, or support dependents." Separating out the different post-traditional identities also ensures that military student data can be called out from other post-traditional student data as we develop support focused on military students. The survey also asked students to identify what college they are enrolled in. Fifty-eight students have participated in the survey so far. Table 1 provides a summary of the demographic data for these survey respondents based on reported STEM and non-STEM degree programs.

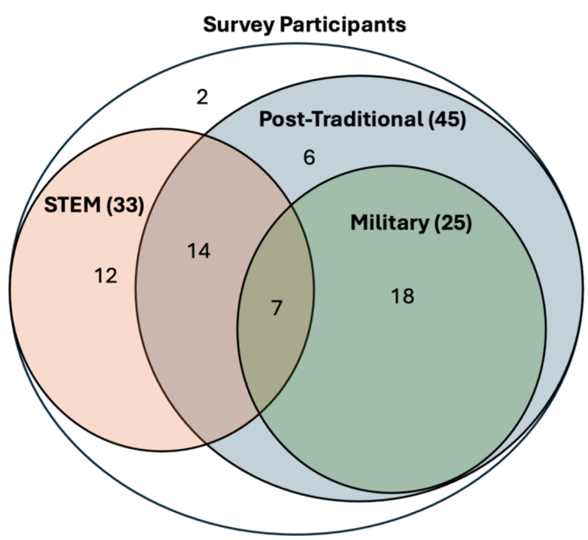
Table 1
Demographic data for pre-seminar survey.

	Post-Traditional Students				
Degree Program	*Non-traditional Student*	*Military Student*	*First Generation Student*	*Transfer Student*	Other
STEM	11	7	4	8	10
Non-STEM	21	18	13	13	2

Because participants can belong to more than one of the post-traditional categories, numbers within this table do not add up to the number of participants from the survey. However, data do give a good idea of the distribution of post-traditional students within STEM. Out of the 58 participants, 45 identified as being a post-traditional student, and 21 of those were in a STEM degree. Twenty-five survey participants identified as military students, with seven of those students pursuing a STEM degree. The "other" category in Table 1 represents students who did not identify as at least one of the post-traditional groups. Two of the 58 participants where neither post-traditional students nor pursuing a STEM degree.

Data from participants who are post-traditional but not military students or in STEM degrees (6) and from participants who are not a post-traditional student or in a STEM degree (2) is not included in our findings. Rather, we chose to focus on three subgroups within the survey participants that are of most interest to consider and compare in relation to our study's purpose: participants in STEM degrees (33), military students (25), and post-traditional students in STEM degrees (21). Figure 1 gives a visual representation of the overlap of these groups within the larger participant sample.

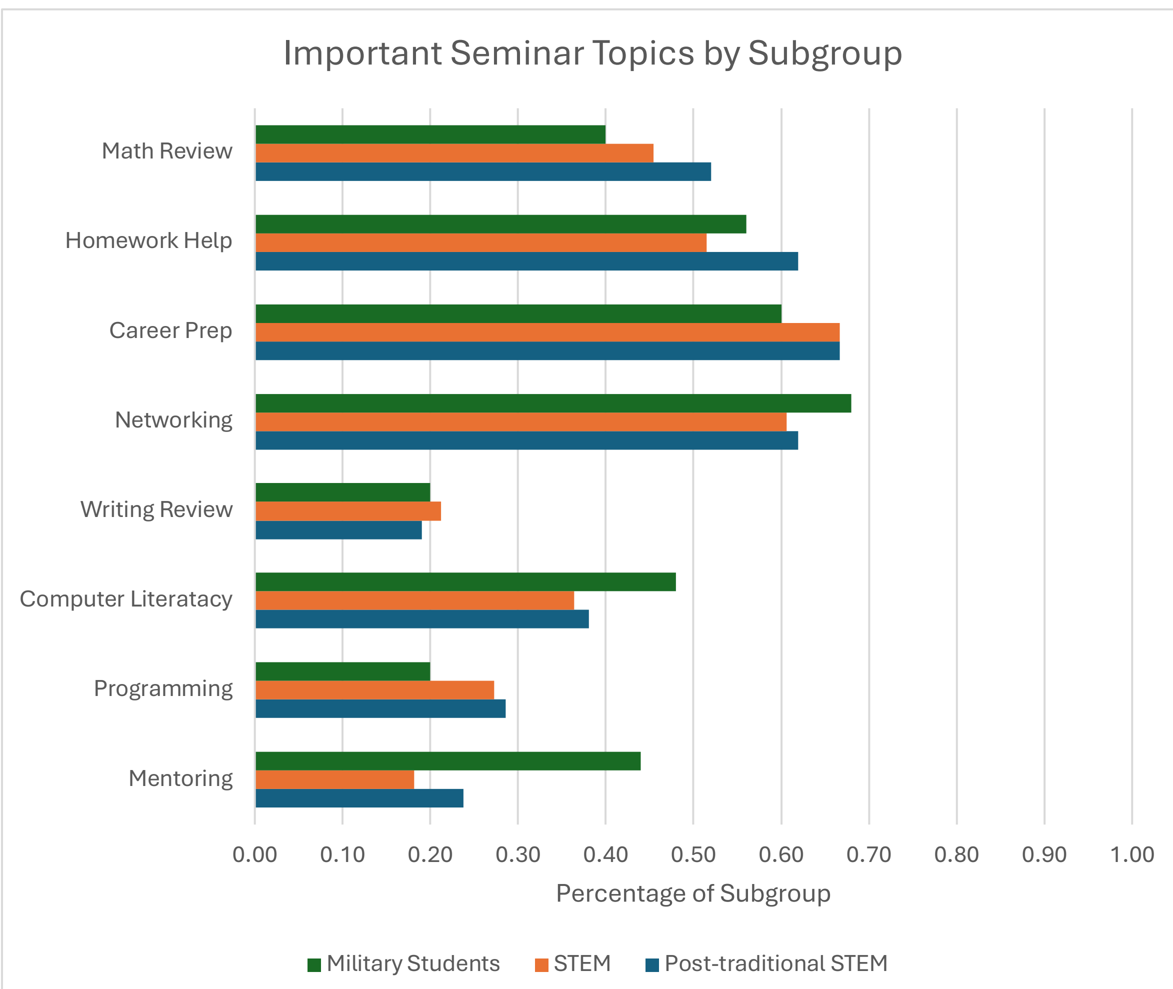
Figure 2
Overlap of subgroups within pre-seminar survey data.



Out of the 21 post-traditional students in STEM degrees, seven were military students. Despite recruiting heavily within the college of engineering, none of these military students are studying engineering specifically. This suggests that, in addition to further recruiting efforts to obtain feedback from military students studying engineering, support for military students in engineering may need to expand to be expanded to STEM to fit within our institution's context.

Pre-seminar Survey Findings. In the pre-seminar survey, participants were asked which topics out of eight (math review, homework help, career prep, networking, writing review, computer literacy, programming, and mentoring) would be most important to cover in an onboarding seminar for STEM. Survey participants were also provided an "other" category where they could provide any other topics they think are important. Figure 3 provides survey results for each of the subgroups mentioned above that are important to this research: military, STEM, and post-traditional STEM. The "other" category is not included in the chart, but significant write-ins from participants are described in the text.

Figure 3
Important seminar topics by group.

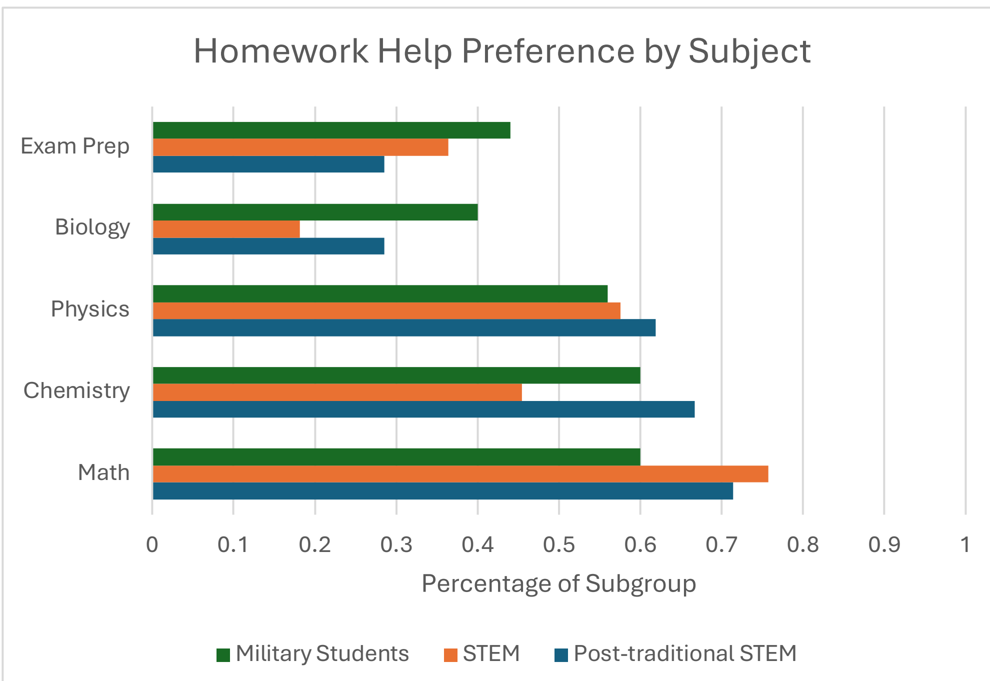


Overall, each participant subgroup selected important topics in similar proportions to one another. For example, for participants overall selected career preparation as an important topic while fewer overall selected writing review. The exception to this is Mentoring, which was selected by 44% of military students and only 24% of post-traditional STEM students and 18% of STEM students. Additionally, more military students chose computer literacy than math review, which contrasts with the other two subgroups. Homework Help, Career Preparation, and Networking were selected by over 50% of each subgroup and thus have strength to retain in future seminar iterations. More detailed results for these topics are discussed in the following sections.

Homework Help. Within the topic of Homework Help, participants were asked which specific subjects they would prefer help on out of math, chemistry, physics, biology, and general exam prep. They were also given the option to write in another subject they would like to receive homework help in. Figure 4 gives the breakdown of each subject for the three participant subgroups.

Figure 4

Homework help preference by subject.

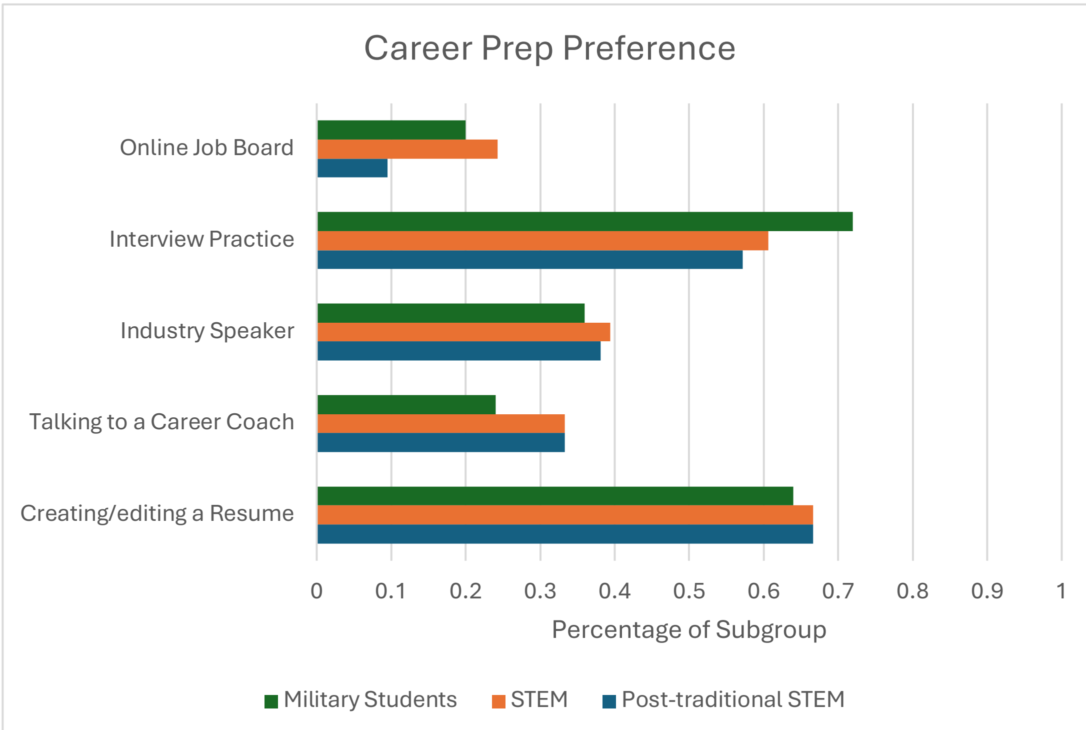


It should be noted that although less than 50% of participants selected Math Review as an important seminar topic, over 60% of each subgroup selected math as an important subject to cover in homework help. Additionally, one post-traditional STEM student suggested covering high-level engineering coursework during homework help sessions.

Career Preparation. Within the Career Preparation topic, participants were asked which forms of career preparation topics they would most want to participate in: creating/editing resumes, talking to a career coach, inviting industry speakers, interview practice, and learning how to use the university's online job board app. As with each other topic, participants were given the option to write in another type of career preparation they would be interested in. Figure 5 gives the breakdown of each career preparation form for the three participant subgroups.

Figure 5

Career preparation preference.

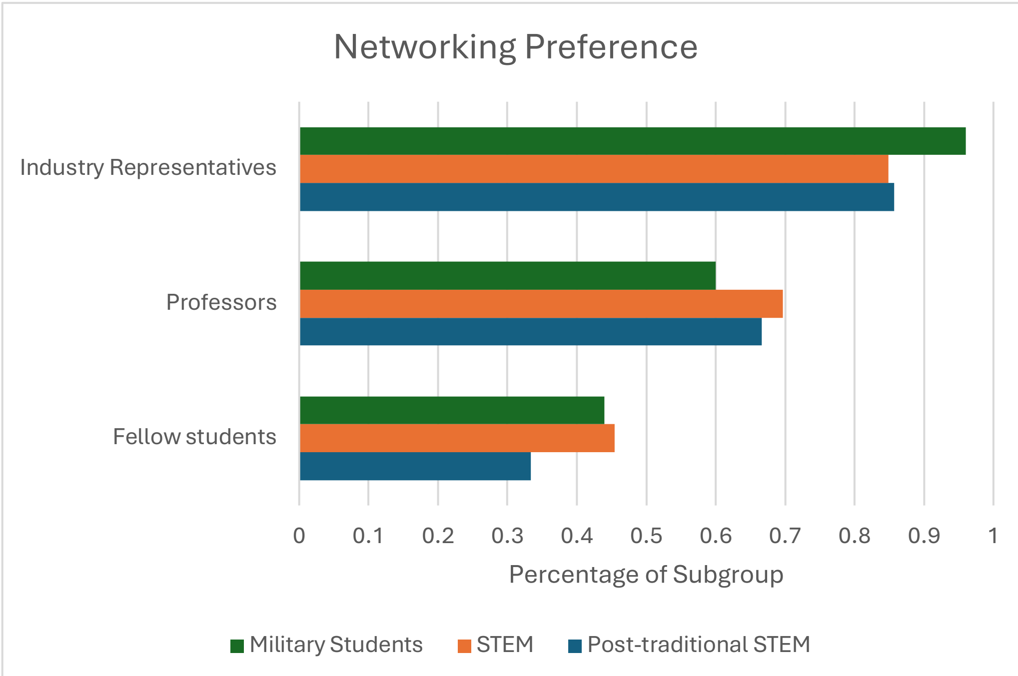


While results between subgroups were generally similar, a few key differences stand out. First, a higher proportion of military students chose interview practice as an important form of career preparation compared to post-traditional STEM and all STEM students. Second, military students differed from other post-traditional students in that more of them considered learning how to use the university's online job board app as important.

Reviewing the write-in option on the survey, one military student pursuing a STEM degree suggested having a session where they could learn more about a physics degree and what careers you can pursue with that degree.

Networking. Within the Networking topic, participants were asked if they would like opportunities to network with fellow students, professors, and/or industry representatives. Figure 6 gives the breakdown of networking preference for each subgroup.

Figure 6
Networking preference.



The results across all three subgroups are consistent for each type of networking preference. It is interesting to note that only one military student participant did not select networking with industry representatives. One military student pursuing a STEM degree suggested networking new students with students who are advanced within the same degree at a 3:1 or 5:1 ratio. This idea seems more like peer mentoring than networking, which is interesting given that military students in general favored mentoring more than the other subgroups.

Participant Interest. At the end of the pre-seminar survey, participants were asked to provide contact information if they were interested in attending the seminar. Of the 58 survey participants, 24 said they were interested in attending. Of those 24, 12 were military students, 16 were pursuing a degree in STEM, and 10 were post-traditional students in STEM. The pre-seminar survey was given towards the end of the first iteration of the developmental phase, meaning that students who expressed interest in the seminar will not be able to attend until the second seminar iteration occurs.

Seminar Attendee Feedback. In addition to contributions to the preliminary findings related to the theoretical research questions (RQ 1-2), the seminar participant also provided valuable input on the seminar design (RQ 3-4). For example, they asked questions about what kinds of careers different engineers can have, leading to a session covering the different engineering disciplines. As a post-traditional student, they mentioned frustrations with getting "up-to-date" on technology, leading to the inclusion of computer literacy as a topic on the pre-seminar survey.

Stakeholder Input. Stakeholders provided feedback based on their individual roles, backgrounds, and experiences. Some faculty, who had been post-traditional and/or military students themselves, provided topics they wished they had extra support on while completing their college and/or engineering undergraduate degree. Topics included where to find resources on campus, math help, building resumes, and connecting with engineering faculty. Stakeholders also provided input on the seminar name and structure. Originally, the seminar had been termed as an orientation. This was changed based on feedback from stakeholders in the college of engineering, who suggested that "orientation" might have a negative connotation for post-traditional students based on traditional freshman orientations. Stakeholders also suggested that participants should have the option to join seminar sessions remotely via ZOOM, an option that has been utilized in every seminar session to this date.

Summary of Key Findings. Out of all the data collected from student participants, both through the pre-seminar survey and seminar attendees, there are several key findings:

- All three participant subgroups (i.e., military students, STEM students, and post-traditional students in STEM) value homework help, career preparation, and networking as topics of support.
- All three participant groups value math homework help over other forms of math review.
- Military students chose mentoring support roughly twice as much as other subgroups.
- Military students chose interview practice support at higher proportions than the other subgroups.
- Half of pre-seminar survey participants who were interested in attending the survey were military students.

These key findings have implication for future seminar iterations that will be discussed in more detail below.

Discussion

While initial findings are limited to one seminar iteration, they point towards the need for this type of support for post-traditional students in engineering and STEM.

Theoretical Findings

Given the number of pre-seminar survey participants that showed interest in attending the seminar, we expect to see an increase in seminar attendees during the second iteration. As the number of participants attending the seminar increases, we plan to collect more data regarding students engineering self-efficacy and sense of belonging through the post-seminar survey. This data will be analyzed and included in future reports on this research. While we have only conducted a single seminar iteration at this time, initial findings, including the large proportion of survey participants interested in attending the seminar and the seminar participants high focus on connecting with other engineering students, suggest that there is both a want and need for community building support for post-traditional students in engineering and STEM.

Design Findings

The initial findings from participants show several areas where more consideration should be taken when designing the seminar. These include math reviews, career preparation, networking, and mentoring.

Math Review. Although math review was selected by less than half of participants, over 60% of each subgroup selected math as an important subject for homework help. These findings fit well with current research with post-traditional students in two ways. First, research shows math to be an important area of review for students returning to school after an extended break, fitting well with participants interest in math homework help. [2], [26]. Second, participants favored math homework help over other forms of math review. This finding suggests that post-traditional students may prefer math homework help over math instruction due to their perceived (or real) time constraints. Research shows that many post-traditional students have additional responsibilities that consume their time compared to "traditional" undergraduate students [7], [9]. Thus, post-traditional students look for support that is both useful as well as time efficient [27]. With these consideration in mind, we plan on providing math homework help for future seminar iterations.

Career Preparation and Networking. Career preparation and exploration was an important topic to both pre-seminar survey participants and the seminar attendee. Both a survey participant and the seminar attendee participant requested learning about their specific degree and related careers. Research with post-traditional students in general and military students in particular both show a student focus on career planning [9], [28], [29]. For first-generation college students and military students, education is often seen as a means to a better career and standard of living [30], [31], reflecting their strong focus on career planning.

Military students specifically also selected interview practice and networking with industry representatives at higher proportions than the other two subgroups. These findings suggests that military students are focused on learning how to better connect their military and education experience with their career trajectories. Current research with military students corroborates these findings, showing that many military students need help connecting their military experience to specific job market skills [29], [32]. Research also shows that many faculty, staff, and advisors who work with military students also have a hard time connecting military experience to future careers, especially in engineering [27]. While learning more about the different engineering disciplines was already part of the seminar curriculum, we plan to expand this session in the future to include learning about other STEM fields and careers as a whole. We also plan on including additional sessions for interview and networking practice.

Mentoring. While mentoring was selected by less than 25% of post-traditional students in STEM and STEM students as a whole, it was selected roughly twice as much by military students, with one military student explicitly requesting connections with other students in the same degree. This is likely connected to the fact that many military students are used to the structured community formed in the military, with explicit mentor/mentee roles [33], [34]. Additionally, camaraderie is an important concept to many individuals who serve in the military, and in fact one of the strengths military students bring with them to their education is the ability to work in leadership and team roles [13], [19]. Given these findings, we plan to implement changes to increase opportunities for peer mentoring and community building within the seminar.

Conclusions and Next Steps

As we move forward with the next iteration of our research, we plan to implement several changes to improve the quality of our seminar for both participants and college and university stakeholders.

Participant Recruitment

Despite a relatively large number of students showing interest in the seminar during recruitment efforts (i.e., taking flyers, verbally expressing interest at recruitment events) only two students completed informed consent and only one of those two participants attended multiple seminar sessions during the initial iteration. We expected to have a small number of participants due to the unique circumstances of post-traditional students that may not always give them time to participate in extra-curricular activities. However, it is possible that in working to ensure only research participants attended the seminar, our practices made it unnecessarily difficult to enter the study as a participant.

To address this difficulty and recruit more participants, we have made multiple changes to our recruitment process. First, participation has been opened to students in STEM, rather than just engineering. Second, we developed a separate, pre-seminar survey sent out to all students in STEM degrees and who access the veteran resource office. The purpose of this survey was to collect additional data about what topics students would want to cover in an onboarding seminar. At the end of the survey, students were given the option to provide contact information if they were interested in attending the seminar. Of the 58 responses received so far, 25 have said they would be interested in attending. We plan to contact these survey participants before our next seminar iteration and help them enter the study so we have more seminar attendees.

Seminar Curriculum and Structure

The initial design of the onboarding seminar included one to one-and-a-half hour-long sessions held every other week over the course of a semester. The first seminar session was designed to introduce participants to the overall goals of the seminar. Following sessions covered varying topics including an overview of engineering disciplines and related careers and homework help sessions.

Based on key findings, several changes are planned for future seminar iterations to improve support for post-traditional and military students in STEM. Table 2 shows the original seminar course layout (developmental phase), changes to be implemented based on current findings, and the seminar course layout for the next iteration (practice phase).

Table 2
Design changes to seminar course layout based on initial findings.

Developmental Phase	Changes from Findings	Practice Phase
Seminar Intro/CoP	Focus on math homework help	Seminar Intro/CoP
Engineering Career Exploration Session	Explore careers in engineering and STEM	Math Homework Help Session
Computer Literacy Session	Help students connect military experience to future careers	Engineering and STEM Career Exploration Session
Homework Help Session	Peer Mentoring and Community building	Interview and Industry Networking Practice Session
		Creating Study Groups and Peer Mentors Session
		Computer Literacy Session

While not shown in the table, we also plan to give time for participants to connect and build community with each other by providing refreshments and time to have informal conversations at the beginning and end of each session. Specific changes are discussed in more detail below.

Math Support. To address post-traditional students' math needs, we plan on collaborating with the college of engineering's math resource center to provide math tutoring and homework support specifically for seminar attendees.

Career Preparation and Networking. We plan to expand the curriculum on career preparation to include learning about different engineering disciplines and STEM fields and the careers available in both areas. We plan to collaborate with engineering and STEM advisors and the university's career center to ensure that information on each discipline and career is up-to-date. We will also work with the career center to provide interview practice and industry networking practice to seminar attendees.

Mentoring. Lastly, we plan to focus on mentoring and community building in STEM. Building connections with peers is an important aspect of developing a community [35]. We plan to provide time at the beginning and end of each seminar session for participants to build connections with peers in a more informal way. We will also dedicate a session to discussing mentorship, helping participants create study groups, and connecting them to faculty and peers.

These changes will be implemented before the next seminar iteration. We will collect both participant and stakeholder feedback during the next iteration, make a final round of changes, and then hold one more "proof-of-concept" iteration. Future work will report on findings from these iterations.

Acknowledgements. This material is based upon work supported by the National Science Foundation under Grant No.2045634. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of National Science Foundation. Data for this study were collected before January 20th, 2025.

References

[1] H. Wilkinson, "Understanding support for student veterans and servicemembers in public undergraduate engineering programs," Master's Thesis, Utah State University, Logan, UT, 2023. [Online]. Available: https://digitalcommons.usu.edu/etd2023/15

[2] S. F. Barrett, C. H. G. Wright, and M. Martinez, "Veteran's transition course at the University of Wyoming," presented at the 2017 ASEE Annual Conference & Exposition, Columbus, OH, 2017.

[3] T. Anderson and J. Shattuck, "Design-based research: A decade of progress in education research?," *Educ. Res.*, vol. 41, no. 1, pp. 16–25, 2012.

[4] A. Minichiello and L. Caldwell, "A narrative review of design-based research in engineering education: Opportunities and challenges," vol. 1, no. 2, Art. no. 2, Feb. 2021, doi: 10.21061/see.15.

[5] J. Lave and E. Wenger, *Situated learning: Legitimate peripheral participation*. Cambridge University Press, 1991.

[6] L. J. Horn and C. D. Carroll, "Nontraditional undergraduates: Trends in enrollment from 1986 to 1992 and persistence and attainment among 1989-90 beginning postsecondary students. Postsecondary Education Descriptive Analysis Reports. Statistical Analysis Report," U, Nov. 1996. Accessed: Dec. 30, 2024. [Online]. Available: https://eric.ed.gov/?id=ED402857

[7] C. Brozina, A. Johri, and A. Chew, "A systematic review of research on nontraditional students reveals inconsistent definitions and a need for clarity: focus on U.S. based studies," *Front. Educ.*, vol. 9, p. 1434494, Dec. 2024, doi: 10.3389/feduc.2024.1434494.

[8] S. R. Harper, "An anti-deficit achievement framework for research on students of color in STEM.," *New Dir. Institutional Res.*, vol. 2010, no. 148, pp. 63–74, Dec. 2010.

[9] L. Soares, J. S. Gagliardi, and C. J. Nellum, "The post-traditional learners manifesto revisited: aligning postsecondary education with real life for adult student success," American Council on Education, 2017. Accessed: Nov. 11, 2023. [Online]. Available: https://www.acenet.edu/Documents/The-Post-Traditional-Learners-Manifesto-Revisited.pdf

[10] R. J. Dillard and H. H. Yu, "Best practices in student veteran education: Making a 'veteran-friendly' institution," *J. Contin. High. Educ.*, vol. 64, no. 3, pp. 181–186, Sep. 2016, doi: 10.1080/07377363.2016.1229106.

[11] R. A. Cooper, M. Goldberg, M. Milleville, and R. Williams, "The experiential learning for veterans in assistive technology and engineering (ELeVATE) program," *J. Mil. Veteran Fam. Health*, vol. 2, no. 2, pp. 96–100, 2016.

[12] B. G. Crawford and J. B. Burke, "Student veterans: Tapping into a valuable resource," in *ASEE Annual Conference and Exposition*, New Orleans, LA: American Society of Engineering Education, Jun. 2016.

[13] N. Salzman, T. B. Welch, H. Subbaraman, and C. H. G. Wright, "Using veterans' technical skills in an engineering laboratory," presented at the 2018 ASEE Annual Conference & Exposition, Jun. 2018. Accessed: Apr. 07, 2022. [Online]. Available: https://peer.asee.org/using-veterans-technical-skills-in-an-engineering-laboratory

[14] R. J. Dillard and H. H. Yu, "Best practices in student veteran education: Faculty professional development and student veteran success," *J. Contin. High. Educ.*, vol. 66, no. 2, pp. 122–128, May 2018, doi: 10.1080/07377363.2018.1469072.

[15] "Veterans Services Center," UWYO Veterans Services Center. Accessed: Dec. 31, 2024. [Online]. Available: https://www.uwyo.edu/vetservices/index.html
[16] C. Kivunja and A. B. Kuyini, "Understanding and applying research paradigms in educational contexts," *Int. J. High. Educ.*, vol. 6, no. 5, p. 26, Sep. 2017, doi: 10.5430/ijhe.v6n5p26.
[17] V. Farnsworth, I. Kleanthous, and E. Wenger-Trayner, "Communities of practice as a social theory of learning: A conversation with Etienne Wenger," *Br. J. Educ. Stud.*, vol. 64, no. 2, pp. 139–160, Apr. 2016, doi: 10.1080/00071005.2015.1133799.
[18] K. Handley, A. Sturdy, R. Fincham, and T. Clark, "Within and beyond communities of practice: Making sense of learning through participation, identity and practice*," *J. Manag. Stud.*, vol. 43, no. 3, pp. 641–653, May 2006, doi: 10.1111/j.1467-6486.2006.00605.x.
[19] D. B. Kartchner, "Student veteran innovation workshop: Exploring purpose-driven camaraderie," Utah State University, Logan, UT, 2023.
[20] A. Bakker, *Design research in education: A practical guide for early career researchers*. London: Routledge, 2018. doi: 10.4324/9780203701010.
[21] P. Cobb, J. Confrey, A. diSessa, R. Lehrer, and L. Schauble, "Design experiments in educational research," *Educ. Res.*, vol. 32, no. 1, pp. 9–13, Jan. 2003, doi: 10.3102/0013189X032001009.
[22] A. Stockless and S. Brière, "How to encourage inclusion in a qualitative research project using a design-based research methodology," *Int. J. Qual. Methods*, vol. 23, p. 16094069241227852, Jan. 2024, doi: 10.1177/16094069241227852.
[23] "Canvas," Instructure. Accessed: Feb. 14, 2025. [Online]. Available: https://www.instructure.com/canvas
[24] "Power Up | College of Engineering," Utah State University College of Engineering. Accessed: Feb. 14, 2024. [Online]. Available: https://engineering.usu.edu/events/power-up/index
[25] N. A. Mamaril, E. L. Usher, C. R. Li, D. R. Economy, and M. S. Kennedy, "Measuring undergraduate students' engineering self-efficacy: A validation study," *J. Eng. Educ.*, vol. 105, no. 2, pp. 366–395, Apr. 2016, doi: 10.1002/jee.20121.
[26] S. E. Bamforth, C. L. Robinson, T. Croft, and A. Crawford, "Retention and progression of engineering students with diverse mathematical backgrounds," *Teach. Math. Its Appl.*, vol. 26, no. 4, pp. 156–166, Dec. 2007, doi: 10.1093/teamat/hrm004.
[27] C. Mobley, J. B. Main, S. M. Lord, C. E. Brawner, and M. M. Camacho, "Institutional agents' roles in serving student veterans and implications for student veterans in engineering," presented at the 2019 ASEE Annual Conference & Exposition, Tampa, FL: American Society for Engineering Education, 2019. doi: 10.18260/1-2--32971.
[28] C. E. Brawner, C. Mobley, J. Main, M. M. Camacho, and S. M. Lord, "Exploring the intersection of veteran status, age, and engineering study," presented at the 2016 ASEE/IEEE Frontiers in Education Annual Conference, Erie, PA, 2016.
[29] C. Mobley, C. E. Brawner, J. B. Main, S. M. Lord, and M. M. Camacho, "Entering the engineering pathway: student veterans' decision to major in engineering," presented at the 2017 ASEE Annual Conference and Exposition, Columbus, OH: American Society for Engineering Education, Jun. 2017. doi: 10.18260/1-2--28285.
[30] C. E. Brawner, C. Mobley, S. M. Lord, M. M. Camacho, and J. Main, "Transitioning from military service to engineering education," presented at the 2017 IEEE Global Engineering

Education Conference (EDUCON), Athens, Greece: IEEE, 2017. doi: 10.1109/EDUCON.2017.7942866.

[31] C. Mobley, J. B. Main, C. E. Brawner, S. M. Lord, and M. M. Camacho, "Pride and promise: the enactment and salience of identity among first-generation student veterans in engineering," *Int. J. Eng. Educ.*, vol. 35, no. 1A, pp. 35–49, 2019.

[32] C. E. Brawner, S. M. Lord, C. Mobley, J. B. Main, and M. M. Camacho, "How the 'needs of the force' impact navy and marine corps veterans' decision to major in engineering," presented at the 2019 ASEE Annual Conference and Exposition, Tampa, FL: American Society for Engineering Education, 2019.

[33] J. B. Main, M. M. Camacho, C. Mobley, C. E. Brawner, S. M. Lord, and H. Kesim, "Technically and tactically proficient: how military leadership training and experiences are enacted in engineering education," *Int. J. Eng. Educ.*, vol. 35, no. 2, pp. 446–457, 2019.

[34] D. B. Stringer and M. McFarland, "Veterans' contributions to enhancing the capstone learning experience of engineering cohorts," presented at the 2016 ASEE Annual Conference & Exposition Proceedings, New Orleans, LA: American Society for Engineering Education, 2016. doi: 10.18260/p.27180.

[35] M. Frierson, V. Hand, E. Mendoza, and J. Yoon, "Communities as fraught spaces," *AERA Open*, vol. 10, p. 23328584241260737, Jan. 2024, doi: 10.1177/23328584241260737.

Appendix A: Pre-Seminar Survey Questions

If you were attending a bi-monthly Onboarding Seminar for STEM, which topics do you feel would be important to cover? (Select all that apply)
- Math Review
- Homework Help
- Career Prep
- Networking
- Writing Review
- Computer Literation (using software/applications)
- Programming
- Mentoring
- Other (provide answer here)

Math Review: Which of the following subjects would be most beneficial to review? (Select all that apply)
- Calculus 2
- Algebra
- Trigonometry
- Exam Prep
- Other (provide answer here)

Homework Help: Which of the following subjects would be most important to get help in? (Select all that apply)
- Chemistry
- Physics
- Biology
- Exam Prep
- Other (provide answer here)

Career Prep: Which of the following would you most want to participate in? (Select all that apply)
- Talking to a Career Coach
- Industry Speaker
- Interview Practice
- Using Aggie Handshake (USU's online job board)
- Other (provide answer here)

Networking: Which of the following would be most beneficial to you? (Select all that apply)
- Networking with fellow students
- Networking with professors
- Networking with industry representatives
- Other (provide answer here)

Writing Review: Which of the following topics would be most helpful to cover? (Select all that apply)

- Editing Session with Writing Center Tutors
- Technical Writing Review
- Persuasive Writing Review
- Other (provide answer here)

Computer Literacy: Which of the following software/applications would be most helpful to get training on? (Select all that apply)

- Microsoft Word and Google Docs
- Microsoft Excel and Google Sheets
- Microsoft Powerpoint and Google Slides
- Campus Library Website
- Solidworks
- Adobe Creative Cloud
- Other (provide answer here)

Programming: Which of the following languages would be most helpful to cover? (Select all that apply)

- Python
- C++
- Matlab
- HTML
- Pseudo-coding
- Other (provide answer here)

Mentoring: Which of the following types of mentoring would be most useful to participate in? (Select all that apply)

- Forming Study Groups
- Peer Mentors
- Faculty Meet-and-Greet
- Other (provide answer here)

Would you benefit from participating in the seminar? If so, please provide contact information below and we will contact you for participation.