Enhancing Adult Learners' Sense of Community in Engineering Degrees: Preliminary Results

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The present gap in the current STEM workforce has led to an unmet need to increase the engagement of non-traditional college students who are joining engineering pathways from different entry points. Traditional college programs are not necessarily meeting the specific needs of various adult learners as this group comes from a plethora of different life paths. Adult learners have experiences and previous professional identities that do not necessarily fit the profile of a typical, straight-out-of-high-school engineering student -- nontraditional students identify more as employees rather than as students (Chen, 2017; Wirt et al., 2002). Adult learners often face lower levels of engagement than their traditional-aged peers and may have different levels of campus embeddedness than traditional students who did not have any other professional engagements prior to attending college (Exposito & Bernheimer, 2012; Gonclaves & Trunk, 2014). This pilot study focuses on the needs of a specific population of adult learners, namely, non-traditional engineering and engineering technology students who are pursuing engineering and engineering technology degrees and careers. This study questions whether students' participation in a specially designed targeted course experience results in increasing their sense of security regarding their academic and career pursuits.

Research Purpose and Questions

Prior studies have contributed to the exploration of learning communities (LCs) on student learning and retention as a function of social interaction (Jovanovic et al., 2019; Wenger et al., 2002); structure -- informal or formal (Anand et al., 2007; Brown & Duguid, 1991); and level of satisfaction (Bullington et al., 2021; Zhao & Kuh, 2004). Few, however, have examined the impact of LCs on the retention of adult learners, and in particular, of adult undergraduate engineering and engineering technology students. This study addresses this gap by exploring the development and impact of seminar course specifically designed to encourage to create a sense of community among adult engineering and engineering technology students. Under the framework of an andragogy model, the following three research questions guided this study:

1. What topics would adult undergraduate engineering and engineering technology students want addressed in a targeted course designed to foster the development of a sense of community while pursuing a degree and future career in engineering?
2. What topics would faculty include in a targeted course designed to foster the development of a sense of community while pursuing an engineering or engineering technology degree and future career in engineering?
3. Based on the responses to the two prior research questions, and *assuming areas of common interest are identified by the students and faculty*, how can a targeted pilot course be designed to successfully foster the sense of community for students' development of a sense of community while pursuing an engineering or engineering technology degree and future career in engineering?

Literature Review

The following literature review presents three areas related to this pilot study. It focuses on STEM-readiness in the United States, a brief explanation of andragogy and its use in understanding how adults learn, and an introduction to learning communities. Together, these areas lead to a greater understanding of how a specially targeted seminar course, designed for non-traditional, adult engineering and engineering technology students, can increase their sense of community while pursuing an engineering or engineering technology degree and future career in engineering.

Focus on STEM-Readiness in the United States

The US has a commitment to increasing STEM education to ensure global competitiveness. The goal is to "increase STEM literacy to increase diversity, equity, and inclusion in STEM fields, and to ensure a prepared STEM workforce in the future" (Committee on STEM Education, 2018, p. v) through four pathways: developing and enriching strategic partnerships, engaging students when disciplines converge, building computational literacy, and operating with transparency and accountability (Office of Science & Technology Policy, 2019).

There is a call to K-12 education to prepare students for STEM pathways earlier; in fact, it is recommended that students take Algebra I in 8th grade to be prepared for the rigors of college-level STEM education; however only 59% of schools offer Algebra I this early (U.S. Department of Education, 2018). Early and successful math from algebra to calculus by high school graduation creates more entries into STEM fields (Chen, 2009; Dou et al., 2019; Smith, 1996). If students are not math-ready when starting an engineering program, this results in increasing the average time-to-graduation rate among engineering and technology students and higher dropout rates due to the higher costs associated with enrolling into lower-level college math classes, which puts many underrepresented students at a disadvantage (Hamm, 2020). This becomes apparent when looking at four-year graduation rates for engineers, which are approximately 40% for Asians, 35% for Whites, 32% for Latinx, and 29% for African Americans (Yoder, 2016). Thus, if students are not ready for an engineering curriculum, they are more likely to fall behind early.

The need for STEM-readiness is also echoed for higher education. Many students change majors in their first two semesters if they do not feel able to adapt to the pace of the engineering and engineering technology curricula that often require extensive use of mathematics (Borrego, 2005). There have been calls to increase female and underrepresented minority graduates in STEM fields (Jelks & Crain, 2020; van den Hurk et al., 2019). Female and underrepresented minorities in engineering face further challenges including faculty and mentors not mirroring their diversity (Holmes et al., 2018; Russell, 2017); stereotype threats from peers, media, and in the curriculum (Redmond & Gutke, 2020); and different curricular needs and desires (e.g., more focus on societal needs/impacts in engineering for females, collaborative learning vs. group projects) (Brawner et al. 2012; Simmons & Lord, 2019).

While many agree that there is a STEM shortage in the workforce (Darwish & Darwish, 2019; New American Economy, 2017; Sahin et al., 2019), there are also indicators that there is confusion between a shortage and high demand in STEM occupations (Maiorca et al., 2019; Salzman & Benderly, 2019). STEM in general can be multi- and cross-disciplinary so there is ambiguity in the classification of STEM occupations (Landivar, 2013;

Salzman, 2015; Salzman & Benderly, 2019); and STEM graduates, though working, may not be working in STEM fields (Landivar, 2013; Salzman, 2015). Another argument, more in line with our research, suggests that while increasing the number of students with STEM degrees is important, it is also important to help students better prepare to enter the STEM-related workforce so that there is a more focused pathway to STEM careers (Cushing et al., 2019; Kendricks et al., 2019).

Andragogy

Understanding how and what motivates adults to learn is key to our research. Today's traditional college students do not look the same as they did in the past. Non-traditional or neo-traditional students – students who are older than 22 – are starting to be a prevalent group on some college campuses in the US. In fact, of the 19.9 million students enrolled in Fall 2019, 7.4 million were over the age of 25, and that number is projected to grow 12.6% by 2028 (National Center for Education Statistics, 2019).

Adult learners are motivated by the perceived level of value and significance of what they are learning and its impact on their careers. Thus, adult learners learn best in an environment where there is relatable self-directed learning. To learn most effectively, adult learners: a) must understand the why, what, and how they are learning; b) develop their self-concept based on autonomous and self-directed learning; c) may incorporate prior learning as a resource; d) are stimulated by life-related needs and task performance improvements; e) are orientated to contextual and problem-centered learning; and f) are motivated by intrinsic needs (Knowles et al., 1998). An andragogical model of learning centers on: "goals and purposes for learning", "individual and situation differences", and "core adult learning principles" (Knowles et al., 2015, p. 79), modeled in Figure 1. The andragogical model explains adult learner motivation and provides insight into how to structure the adult learning environment. As described in the next section, the development of a targeted learning community provides a way to specifically support adult learning and addresses the needs of adult learners in the andragogical sense.

Learning Communities (LCs)

Learning communities are "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger et al. 2002, p. 4). LCs can help members address common challenges through the cooperative learning generated from the combination of the group's social and intellectual capital (Nahapiet & Ghoshal, 1998; Wenger et al., 2002).

Wenger et al. (2002) identify a series of benefits of learning communities in an organizational sense. Short-term benefits include business improvements such as quick answers to questions; reduced time and costs; improved quality of decisions; more perspective on problems; and ability to take risks with support of the community. Other benefits include the development of organizational capabilities such as: the ability to execute a strategic plan, strengthen authority with others, increase retention of talent, increase knowledge capacity, create benchmarking studies, develop knowledge-based alliances, capitalize on the emergence of unplanned capabilities, increase capacity to develop new strategic options, foresee technological developments, and take advantage of emerging opportunities. Benefits to LC members include improved experiences on the job, help with challenges, access to expertise, improved learning experiences, enhanced confidence in solving problems, increased sense of collegiality and belonging, and enhanced career development opportunities, e.g., forum for enhancing skills, and networking for keeping up to date (Wenger et al., 2002).

Learning communities are rich social interactions where personal relationships are developed, ways of interacting and collaborating are established, and a common sense of members' identity is created (Wenger et al., 2002). This group identity holds LCs together while, at the same time, making LCs difficult to be copied or transported to other domains and locations different from the original LC. LCs are not a one-size-fit-all solution (Kolhbcher & Mukai, 2007). LCs have also been shown to have more positive effects on females and minorities (Russell, 2017). Being in a LC in postsecondary education can help prepare workers for engaging in organizational learning communities in the workforce (Bickford & Wright, 2006).

Self-directed, or targeted, learning communities empower participants to be involved in their own learning process (Xie, 2018). When collaborators are not a part of the decision-making process for their learning experiences, there can be less participation. However, when there is equal participation there is more buy-in from the participants (Carpenter, 2017). Students who are self-directed learners are more actively engaged and perform better (Geng et al. 2019; Yilmaz, 2016). Effective self-directed learners choose what, when, and how long to study (Tullis & Benjamin, 2011) and are task- and goal-oriented (Geng et al., 2019) which enhances their desire to be a part of the decision-making process in an LC agenda and facilitates the development of members' self-efficacy and buy-in.

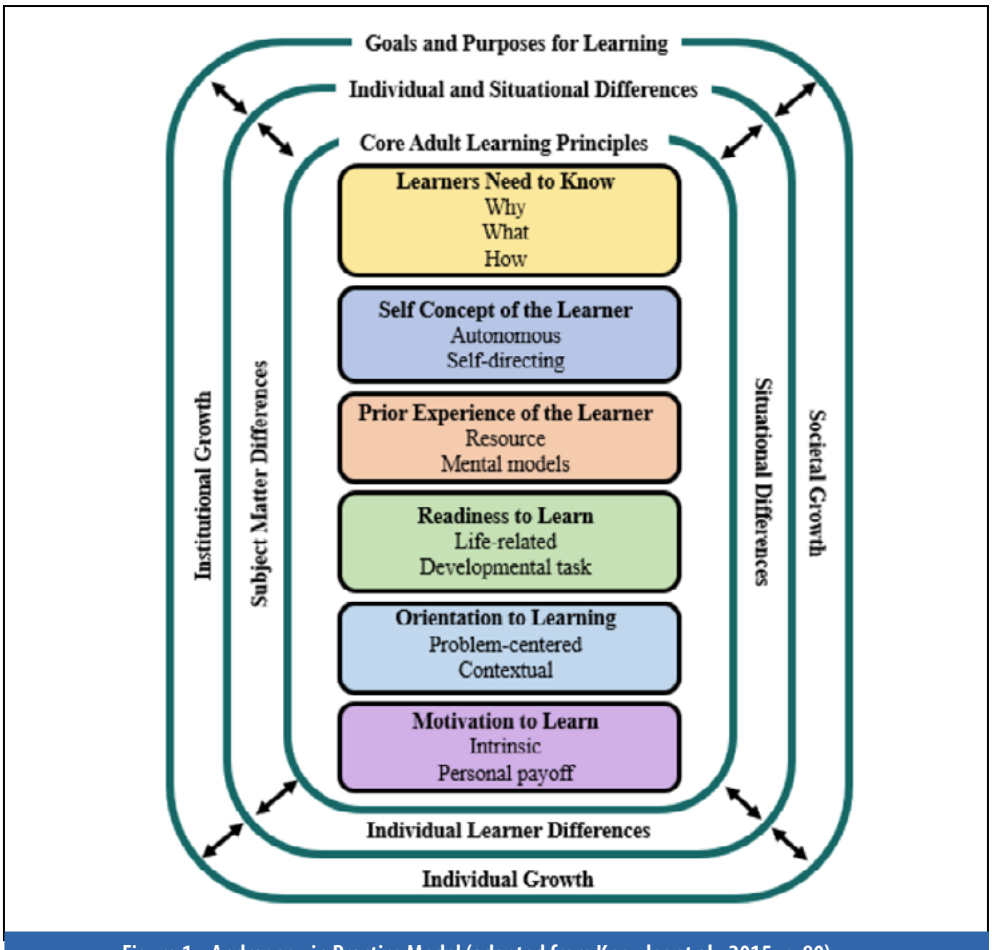

Figure 1. Andragogy in Practice Model (adapted from Knowles et al., 2015, p. 80)

Sense of Community

Sense of community is a result of belonging (Haar, 2018). Members of groups with a strong sense of community feel like they matter to their group members, and that working together will help them achieve goals and meet needs (McMillan, 1996). Learning communities create a sense of belonging because they have shared commitments and shared goals (McMillan, 1996). Zhang et al. (2016) describes four elements that are met with

strong communities: belonging, reciprocal mattering, attachment between members, and bonding with community members. These elements create a strong sense of belonging for community members.

In an academic sense, a strong sense of community leads to increased relationships between faculty and students (Kirk et al., 2016), especially when instruction occurs inside and outside of the classroom (de Borba et al., 2020), increased sense of belonging and connectedness Bullington et al., 2020; Jovanovic et al., 2019). And more satisfaction in general (Capone et al., 2018; Phrangee & Malec, 2017). Further, sense of community aids in the development of collective self-efficacy among students in the classroom (Capone et al, 2018; Chukwuorji et al., 2018) and increases students' academic engagement and socialization (Chukwouroji et al., 2018; Haar, 2017; Prati et al., 2018).

Connecting the Literature

After a thorough review of the literature, it is important to tie the concepts of andragogy with the benefits of learning community participation. Because LC participants tend to have increased interaction with like-minded peers, with similar learning interests, LCs can influence the needs of adult learners, particularly in an andragogical frame (Bullington et al., 2020). Discussions in LC sessions can center on helping to answer the *Need to Know* questions of why, what, and how. The feeling of connectedness in an LC can also help direct the *Self Concept of the Learner* by increasing participants' senses of autonomy and self-directedness (Bullington et al.,2020; Jovanovic et al., 2019;). For *Prior Experiences of the* Learner, LC participants' can take what they know and bring it to their LC partners and apply that knowledge to the tasks at hand. Being a member of an LC can enhance participants' *Readiness to Learn* by creating opportunities for learning and growth that are centered on tasks that directly deal with issues that will help them in their careers as well as developmentally. For *Orientation to Learning,* an LC can create opportunities where participants can directly use problem-centered and contextual concepts and apply those to what they are learning. Finally, having others around them with similar interests and goals can help adult learners increase their *Motivation to Learn* both on intrinsic and extrinsic levels.

Methodology

The research was conducted at Old Dominion University, a mid-size public university in the mid-Atlantic region of the US. The university has an annual enrollment of approximately 25,000 students dispersed among six academic colleges. The focus of this study was on the College of Engineering and Technology, which offers 10 undergraduate engineering and engineering technology degree programs. All qualified students (GPA of at least 3.0/4.0) who could demonstrate financial need were invited to apply to the NSF-funded Pathways to Completion program. The pool of applicants came largely from high achieving adult military veteran engineering and engineering technology students. All the participants in the current pool have served or are currently serving in the United States military. Thus, the focus of this pilot study is on this population.

Based on NSF funding over five years, it was determined that twelve scholarships of $5,000 could be allocated to each participant each fall and spring semester. Twelve veteran engineering and engineering technology students were identified to participate in a seminar course specifically designed to encourage the development of a LC among adult engineering and engineering technology students. For Fall semester 2018, there were 11 males (91.67%) and 1 female (8.33%) and for Spring semester 2019, there were 11 males (91.67%) and 1 female (8.33%). In Fall 2018, there were 1 (8.33%) African American/Black, 4 (33.33%) Latinx, and 7 White (58.33%) students. In Spring 2019, there were 4 (33.33%) Latinx, and 9 White (75.00%) students. In the Fall semester 2018, the ages of the participants ranged from between 22-39; mean = 28.75; and between 22-39; mean = 29.46 during Spring semester 2019. Students represented the following disciplines in Fall 2018: 8.33% - civil engineering, 25.00% – electrical engineering, 41.66% mechanical engineering, and 16.67% mechanical engineering technology; and Spring 2019: 8.33% civil engineering, 25% electrical engineering, 50% mechanical engineering, and 16.67% mechanical engineering technology. Table 1 presents the demographic data on the students who participated in the first year of the project.

The instructors came from different backgrounds. Three hold doctorates in engineering, one has a doctorate in STEM education, and one holds a doctorate in higher education. Racially and ethnically, there is a White male, two White females, an Asian female, and a Hispanic male. Overall, combined the instructors have over an average of 50 years working in higher education in fields related to engineering, engineering education, and veterans and underrepresented minority populations. One instructor is also a veteran of the US Navy.

Instrument Development and Administration

The seminar course is a required zero-credit, pass/fail course taken by the students in the Pathways program. Adhering to the six major precepts in the andragogy learning model discussed previously, the adult undergraduate veteran engineering and engineering technology students were included intentionally in the design of the seminar course. They specifically were asked to help identify topics of their interest that would help them feel more secure about their decision to pursue an engineering or engineering technology degree and future career in engineering. Along with the assistance of the researchers, who are familiar with the literature on engineering and engineering technology student success, and have over 50 years of combined experience in teaching, conducting research on, and advising engineering and engineering technology students. Topics were identified, discussed, refined, and grouped into six categories that formed the foundation for the seminar course. These same topics formed the categorical variables in the development of the pre-(retrospective) and post-seminar course assessment surveys. The six categorical seminar course topics, and survey variables were:

Age	Race	Gender	Major	Enrolled	
				Fall 2018	Spring 2019
26	Black	Male	Mechanical Engineering	X	
29	White	Male	Mechanical Engineering Technology	X	X
28	White	Male	Civil Engineering	X	X
28	White	Male	Mechanical Engineering	X	X
25	White	Male	Electrical Engineering	X	X
31	White	Male	Electrical Engineering	X	X
22	LatinX	Male	Mechanical Engineering	X	X
33	White	Male	Mechanical Engineering		X
26	Latinx	Male	Mechanical Engineering	X	X
31	White	Male	Mechanical Engineering		X
27	LatinX	Female	Mechanical Engineering	X	X
28	White	Male	Electrical Engineering	X	X
39	White	Male	Mechanical Engineering Technology	X	X

Table 1. Student Demographic Data

Camaraderie, Career Awareness, Engineering Identity, Professional Development, Financial Security, and Engineering Self-Efficacy, as shown in Table 2.

The assessment surveys were administered twice to each participant in both the first and second semesters, pre-course intervention (time 1) and post-course intervention (time 2). Students were asked to complete the survey retrospectively (Salkind, 2010) based on their pre-course experiences, meaning before they had been chosen as a participant in the Pathways to Completion program. Students were again asked to complete the survey after having participated in the seminar course. Items on the retrospective and post seminar surveys remained the same, though the stem changed. In the retrospective (pre) survey, for example, a stem read "Before being selected as a participant in the Pathways to Completion program, I felt that I had ample opportunities to. . .". In the post-seminar survey, the stem read "After having participated in the Pathways to Completion program, I feel that I had ample opportunities to. . .". All items were measured on a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). Multiple items, having strong face validity, were developed to measure each variable based on the researchers' familiarity with the literature, and prior experiences from working with this population: Camaraderie (6 items), Career Awareness (4 items), Engineering Identity (3 items), Professional Development (4 items), Financial Security (2 items), and Engineering Self-Efficacy (2 items), as shown in Table 3.

Topics/Variables	Description
Camaraderie	Friendship and encouragement to other like-minded military veteran students.
Career Awareness	Navigating internships, scholarships, and job applications; identifying suitable engineering careers; meeting working engineers (veterans).
Engineering Identity	Interacting with practicing engineers; attending field trips; listening to seminar guest speakers (veterans).
Professional Development	Developing resumes; preparing for interviews; developing follow-up contacts; and learning professional etiquette.
Financial Security	Acquiring resources to decrease anxiety due to financial constraints.
Engineering Self-Efficacy	Believing in one's ability to complete the degree and become a successful future engineer.

Table 2. Topics/Variables Pertaining to Engineering and Engineering Technology Connectedness and Community (Bullington et al., 2020; Jovanovic et al., 2019)

Topics/Variables	Items
Camaraderie	1. Meet other veterans 2. Voice opinions on academic topics 3. Meet successful veteran graduates 4. Voice opinions on challenges of academic/work/life balance 5. Voice self-motivation issues 6. Socialize with other veterans
Career Awareness	1. Become aware of various internships and scholarships 2. Become aware of how to evaluate internship and scholarship postings 3. Become aware of job postings on various websites 4. Become aware of how to evaluate job postings
Engineering Identity	1. Learn about what it is to be an engineer 2. Learn the importance of professional certifications 3. Identify with successful practicing engineers (veterans)
Professional Development	1. Learn how to prepare a resume 2. Learn how to prepare for interviews 3. Learn how to follow-up after interviews 4. Become aware of impact of social media on hiring process 5. Learn table etiquette
Financial Security	1. Can meet living expenses 2. Can meet academic expenses
Engineering Self-Efficacy	1. Believe that I belong in an engineering/engineering technology program 2. Believe that I will be a successful engineer in the future

Table 3. Topics/Variables and Items Pertaining to Engineering and Engineering Technology Connectedness (Bullington et al., 2020)

Data Analysis

The data set consisted of 12 valid responses for the retrospective pre-course (time 1) and post- course (time 2) surveys (Fall, 2018 and Spring, 2019 semesters); a total of 24 responses collectively for the first-year cohort. Given that who can qualify as a participant can change from semester to semester and year to year due to graduations, potentially being called to duty, or for other reasons for leaving, or because the same participants may not meet the Pathways selection criteria from semester to semester, and also because the researchers wanted to be consistent in their method of analysis from semester to semester and year to year, it was decided to consider the groups as independent. Because of this, their responses were not matched, though in the first year, most of the participants who participated, participated in both Fall 2018 and Spring 2019 semesters. Given the small number of participants in each semester (n = 12) and when combined formed the first-year cohort, also a small number of participants (n = 24), a Mann-Whitney U nonparametric test was conducted to analyze the differences in medians within and between, and in the combined semesters. The extent to which a concept is accurately measured in a quantitative study (validity) and the accuracy of an instrument (reliability) (Heale, 2015) were not determined at this time due to the small sample size. Hence, the researchers used the Mann-Whitney U test because it can be used on non-normal distributions, typical of small samples, and has greater efficiency than the *t*-test on non-normal distributions (Mann & Whitney, 1947) and when it is difficult to estimate reliability (Thiebaux & Zwiers, 1984). The researchers wanted to test whether two independent samples come from the same distribution (Nachar, 2008), in this case, the small samples that were different student populations in each one of the semesters. Also, due to the small number of participants, respondents were not categorized by age or type of engineering program. In addition to answering the quantitative survey questions, students were asked to write-in responses to open-ended qualitative questions in which they were asked how the seminar course could be improved to further the development of a learning community. Common themes were identified (Creswell, 2014; Patton, 2015).

Results

This section presents the results of the quantitative and qualitative analyses that were performed for the first-year cohort of the seminar course (Fall 2018 and Spring 2019).

Quantitative Analysis of Pre- and Post-Course Intervention Survey Data

Participants were assessed two times, pre-seminar course (time 1) and post-seminar course (time 2). The null hypothesis was that there would be no difference between the groups pre-seminar course (time 1) and post-seminar course (time 2) on all variables addressed in the seminar course: Camaraderie, Career Awareness, Engineering Identity, Professional Development, Financial Security, and Engineering Self-Efficacy. These are shown in Tables 4 and 5.

Based on the results of the Mann-Whitney U test, the null hypothesis of equal groups was rejected based on a comparison of the medians between pre-seminar course (time 1- Mdn_1) and post-seminar course intervention (time 2- Mdn_2) for each variable: Camaraderie, Career Awareness, Engineering Identity, Professional Development, Self-Efficacy, and Financial Security. Where z is greater than 1.96 or less than -1.96, the difference in the medians is significant. To determine the size of the effect of the course intervention, r was calculated where an above 0.1 is considered a weak effect, above 0.3 is considered a moderate effect, and above 0.5 is considered a strong effect (Ruland, 2018). Data were collected and analyzed for Fall 2018, Spring 2019, and then both semesters were combined.

The Mann-Whitney U test revealed that the Camaraderie scores were significantly lower in pre-course intervention (time 1) when compared to post-course intervention (time 2), with the intervention having a large effect size in Fall 2018, Spring, 2019, and when combined: Fall 2018 (Mdn1 = 2.00, Mdn2 = 5.00, U = 0.00, z =- 4.25, p = <0.001, r= 0.87); Spring 2019 (Mdn1 = 2.00, Mdn2 = 5.00, U = 0.00, z= -4.28, p = <0.001, r = 0.87); and combined (Mdn_1 = 2.00, Mdn_{C2} = 5.00, U = 0.00, z=-6.08, p = <0.001, r = 0.88).

The results of Mann-Whitney U test for Career Awareness revealed that the results were significantly lower in pre-course intervention (time 1) when compared to post-course intervention (time 2), with the intervention having a large effect size in Fall 2019, Spring 2019, and when combined: Fall 2018 (Mdn1 = 2.00, Mdn2 = 5.00, U = 0.50, z = -4.19, p = <0.001, r = 0.86); Spring 2019 (Mdn1 = 2.00, Md_2=5.00n, U = 2.50, z= -4.07, p = <0.001,r=0.83); Combined (Mdn_1 = 2.00, Mdn_2 = 5.00, U = 6.00, z= -5.88, p = <0.001, r = 0.85).

The Mann-Whitney U test for Engineering Identity revealed that scores were significantly lower in pre-course intervention (time 1) when compared to post-course intervention (time 2), with the intervention having a large effect size in Fall 2018, Spring 2019, and when Combined: Fall 2018 (Mdn_1 = 2.00, Mdn_2 = 5.00, U = 0.00, z = -4.28, p <0.0001, r = 0.87), Spring 2019 (Mdn_1 = 2.00, Mdn_2 = 5.00, U = 0.00, z = -4.23, p < 0.001, r = 0.86), combined (Mdn_1 = 2.00, Mdn_2 = 5.00, U =0.00, z = -6.05, p < 0.001, r =0.87).

The results of Mann-Whitney U test for Professional Development revealed that the results were significantly lower in pre-course intervention (time 1) when compared to post-course intervention (time 2), with the intervention having a large effect size in Fall 2019, Spring 2019, and when combined: Fall 2018 (Mdn_1 = 3.50. Mdn_2 = 5.00, U =0.00, z =- 4.19, p < 0.001, r = 0.86), Spring 2019 (Mdn_1 = 2.00, Mdn_2 = 5.00, U = 7.00, z = -3.67, p <0.001, r = 0.77), combined (Mdn_1 = 3.00, Mdn_2 = 5.00, U = 24.50, z = 5.46, p < 0.001, r = 0.79).

The Mann-Whitney U test for Self-Efficacy revealed that scores were significantly lower in pre-course intervention (time 1) when compared to post-course intervention (time 2), with the intervention having a large effect size in Fall 2018, Spring 2019, and when combined: Fall 2018 (Mdn_1 = 2.00, Mdn_2 = 5.00, U = 1.00, z = -4.27, p < 0.001, r = 0.87, Spring 2019 (Mdn_1 = 3.00, Mdn_2 = 5.00, U = 7.50, z = -3.83, p < 0.001, r = 0.78), combined (Mdn_1 = 2.00, Mdn_2 = 5.00, U = 14.00, z = -5.84, p < 0.001, r = 0.84).

The results of Mann-Whitney U test for Financial Security revealed that the results were significantly lower in pre-course intervention (time 1) when compared to post-course intervention (time 2), with the intervention having a large effect size in Fall 2019, Spring 2019, and when combined: Fall 2018 (Mdn_1 = 2.00, Mdn_2 = 5.00, U = 0.00 z = -4.38, p < 0.001, r = 0.89), Spring 2019 (Mdn_1 = 1.00, Mdn_2 = 5.00, U = 0.00, z = -4.40, p < 0.001, r = 0.90, combined (Mdn_1 = 2.00, Mdn_2 = 5.00, U =0.00, z = -6.25, p < 0.001, r = 0.90).

Qualitative Analysis: Themes

Based on a qualitative analysis of the open-ended question in which participants were asked for suggestions on how to improve the course, two themes emerged: 1) increase the number of field trips, and 2) increase opportunities to practice table etiquette. During both the Fall 2018 and Spring 2019 semesters, students indicated a desire for more field trips to see engineering practices in real time situations. During the Fall 2018 semester, one trip was planned to a local food processing plant. While students who attended found it interesting and educational, they indicated in Spring 2019 that they would like additional field trips to local manufacturing and civil engineering companies.

Another theme that emerged during the Fall 2018 semester was table etiquette. While on the surface, this may appear to be more frivolous than practical, this deals directly with their level of community, particularly in a job search. Several students suggested that they would like an opportunity to practice their table etiquette, rather than simply learn about its importance and impact on the hiring process. In response to this suggestion, in Spring 2019 arrangements were made for the students and guests, along with the faculty/researchers, to meet at a mid-priced restaurant in which a five-course meal was served. Students were asked to dress professionally (e.g., suit and tie) and to be responsible for covering the costs of their and their guest's meal. In this setting, students learned which utensils to use for which course, how to identify their drinking

	Fall 2018 (n = 24)							Spring 2019 (n = 24)						
	Pre (n = 12)		Post (n = 12)		Mann-Whitney U			Pre (n = 12)		Post (n = 12)		Mann-Whitney U		
	M	*Md*	*M*	*Md*	*U*	*z*	*r*	*M*	*Md*	*M*	*Md*	*U*	*z*	*r*
OVERALL ITEMS TOTAL	**2.34**	**2.00**	**4.77**	**5.00**	**2148.50**	**-19.48*****	**-0.85**	**2.33**	**2.00**	**4.62**	**5.00**	**3503.50**	**-18.45*****	**-0.80**
Camaraderie	**2.01**	**2.00**	**4.79**	**5.00**	**0.00**	**-4.25*****	**-0.87**	**2.01**	**2.00**	**4.81**	**5.00**	**0.00**	**-4.28*****	**-0.87**
1. Meet other veterans	2.42	2.00	4.92	5.00	2.00	-4.30***	-0.88	2.67	2.00	4.91	5.00	2.50	-4.14***	-0.86
2. Voice opinions on academic topics	1.75	1.50	4.83	5.00	1.00	-4.30***	-0.88	1.75	2.00	4.73	5.00	0.00	-4.29***	-0.90
3. Meet successful veteran graduates	1.67	2.00	4.92	5.00	0.00	-4.43***	-0.90	1.75	2.00	4.92	5.00	0.00	-4.44***	-0.91
4. Voice opinions on challenges of academic/work/life balance	1.75	1.50	4.75	5.00	1.50	-4.24***	-0.86	1.75	2.00	4.67	5.00	0.00	-4.40***	-0.90
5. Voice self-motivation issues	2.08	2.00	4.50	5.00	6.00	-3.92***	-0.80	1.83	2.00	4.75	5.00	1.00	-4.30***	-0.88
6. Socialize with other veterans	2.42	2.00	4.83	5.00	3.00	-4.17***	-0.85	2.33	2.00	4.92	5.00	1.50	-4.31***	-0.88
Career Awareness	**2.46**	**2.00**	**4.73**	**5.00**	**0.50**	**-4.19*****	-0.86	**2.50**	**2.00**	**4.52**	**5.00**	**2.50**	**-4.07*****	**-0.83**
1. Aware of various internships and scholarships	2.42	2.00	4.83	5.00	2.00	-4.26***	-0.87	2.58	3.00	4.67	5.00	6.00	-3.95***	-0.81
2. Know how to evaluate internship postings	2.50	2.00	4.75	5.00	3.00	-4.15***	-0.85	2.17	2.00	4.50	4.50	6.00	-3.93***	-0.80
3. Aware of job postings on various websites	2.33	2.00	4.67	5.00	8.00	-3.86***	-0.79	2.67	2.00	4.50	5.00	12.50	-3.58***	-0.73
4. Know how to evaluate job postings	2.58	2.00	4.67	5.00	6.00	-3.95***	-0.81	2.58	2.00	4.42	4.00	14.00	-3.56***	-0.73
Engineering Identity	**2.39**	**2.00**	**4.81**	**5.00**	**0.00**	**-4.28*****	**-0.87**	**2.36**	**2.00**	**4.67**	**5.00**	**0.00**	**-4.23*****	**-0.86**
1. Know what it is to be an engineer	2.92	3.00	4.58	5.00	12.50	-3.59***	-0.73	2.50	2.50	4.50	5.00	5.50	-3.95***	-0.81
2. Know importance of professional certifications	2.75	3.00	4.92	5.00	3.00	-4.26***	-0.87	2.83	3.00	4.58	5.00	12.50	-3.62***	-0.74
3. Identify with successful engineers	1.50	1.50	4.92	5.00	0.00	-4.45***	-0.91	1.75	2.00	4.92	5.00	0.00	-4.51***	-0.92
Professional Development	**2.97**	**3.50**	**4.65**	**5.00**	**0.00**	**-4.19*****	**-0.86**	**2.63**	**2.00**	**4.30**	**5.00**	**7.00**	**-3.76*****	**-0.77**
1. How to prepare a resume	3.08	3.50	4.67	5.00	13.00	-3.58***	-0.73	2.92	3.00	4.42	4.50	21.00	-3.05**	-0.62
2. How to prepare for interviews	3.25	4.00	4.75	5.00	10.50	-3.80***	-0.77	2.83	3.00	4.58	5.00	10.00	-3.74***	-0.76
3. How to follow-up after interviews	2.83	2.50	4.92	5.00	2.50	-4.28***	-0.87	2.33	2.00	4.58	5.00	7.50	-3.86***	-0.79
4. Aware of impact of social media on hiring	2.67	3.00	5.00	5.00	0.00	-4.49***	-0.92	2.83	2.50	4.67	5.00	16.00	-3.40***	-0.69
5. Aware of etiquette	3.00	3.50	3.92	4.00	42.00	-1.81	-0.37	2.25	2.00	3.25	3.00	41.50	-1.81	-0.37
Self-Efficacy	**2.17**	**2.00**	**4.83**	**5.00**	**1.00**	**-4.27*****	**-0.87**	**2.88**	**3.00**	**4.67**	**5.00**	**7.50**	**-3.83*****	**-0.78**
1. Belief they belong in an engineering or technology program	2.25	2.00	4.75	5.00	4.00	-4.11***	-0.84	2.83	3.00	4.67	5.00	8.00	-3.85***	-0.79
2. Belief they will be a successful engineer in the future	2.08	2.00	4.92	5.00	0.50	-4.38***	-0.89	2.92	3.00	4.67	5.00	12/00	-3.61***	-0.74
Financial Security	**1.67**	**2.00**	**4.92**	**5.00**	**0.00**	**-4.38*****	**-0.89**	**1.63**	**1.00**	**4.92**	**5.00**	**0.00**	**-4.40*****	**-0.90**
1. Can meet living expenses	1.67	2.00	5.00	5.00	0.00	-4.55***	-0.93	1.67	1.50	4.92	5.00	0.00	-4.42***	-0.90
2. Can meet academic expenses	1.67	2.00	4.83	5.00	0.00	-4.41***	-0.90	1.58	1.00	4.92	5.00	0.00	-4.47***	-0.91

Note. *** Significant at the $\alpha < 0.001$ level. ** Significant at the $p < 0.01$ level. * Significant at the $p < 0.05$ level.

Table 4. Comparison of First Year Semesters by Pre- and Post-Learning Community Intervention Constructs and Items

vessels; what to do with their napkin during and after the meal; how to pass the salt and pepper shaker, and how to introduce themselves and their guests, and to carry on a pleasant and appropriate dinner conversation.

For Spring 2019, students confirmed they would like to continue field trips to engineering-based firms and continue to refine their professional etiquette so they would be more comfortable in interview-type situations. The students also inquired about changing the format of

	Fall 2018 and Spring 2019 Combined (n = 48)								
	Pre (n = 24)		Post (n = 24)		Independent Samples t-test		Mann-Whitney U		
	M	*Md*	*M*	*Md*	*t*	*d*	*U*	z	*r*
OVERALL ITEMS TOTAL	**2.34**	**2.00**	**4.69**	**5.00**	**-43.79*****	**-2.70**	**-26.79**	**-26.79*****	**-0.83**
Camaraderie	**2.01**	**2.00**	**4.80**	**5.00**	**-18.65*****	**-5.38**	**0.00**	**-6.08*****	**-0.88**
1. Meet other veterans	2.54	2.00	4.91	5.00	-9.11***	-2.66	9.00	-6.03***	-0.87
2. Voice opinions on academic topics	1.75	2.00	4.78	5.00	-17.21***	-5.02	2.50	-6.09***	-0.88
3. Meet successful veteran graduates	1.71	2.00	4.92	5.00	-22.95***	-6.62	0.00	-6.34***	-0.92
4. Voice opinions on challenges of academic/work/life balance	1.75	2.00	4.71	5.00	-15.76***	-4.55	4.00	-6.11***	-0.88
5. Voice self-motivation issues	1.96	2.00	4.63	5.00	-11.72***	-3.38	12.00	-5.91***	-0.85
6. Socialize with other veterans	2.38	2.00	4.88	5.00	-10.04***	-2.90	9.00	-6.05***	-0.87
Career Awareness	**2.48**	**2.00**	**4.63**	**5.00**	**-11.42*****	**-3.30**	**6.00**	**-5.88*****	**-0.85**
1. Aware of various internships and scholarships	2.50	2.00	4.75	5.00	-9.90***	-2.86	15.00	-5.85***	-0.84
2. Know how to evaluate internship postings	2.33	2.00	4.63	5.00	-10.01***	-2.89	18.00	-5.75***	-0.83
3. Aware of job postings on various websites	2.50	2.00	4.58	5.00	-7.76***	-2.24	40.50	-5.31***	-0.77
4. Know how to evaluate job postings	2.58	2.00	4.54	5.00	-7.92***	-2.29	38.50	-5.36***	-0.77
Engineering Identity	**2.38**	**2.00**	**4.74**	**5.00**	**-15.97*****	**-4.61**	**0.00**	**-6.05*****	**-0.87**
1. Know what it is to be an engineer	2.71	3.00	4.54	5.00	-8.30***	-2.40	37.00	-5.37***	-0.78
2. Know importance of professional certifications	2.79	3.00	4.75	5.00	-7.23***	-2.54	33.00	-5.54***	-0.80
3. Identify with successful engineers	1.63	2.00	4.92	5.00	-28.32***	-8.18	0.00	-6.38***	-0.92
Professional Development	**2.80**	**3.00**	**4.48**	**5.00**	**-7.82*****	**-2.26**	**24.50**	**5.46*****	**0.79**
1. How to prepare a resume	3.00	3.00	4.54	5.00	-5.88***	-1.70	71.00	-4.67***	-0.67
2. How to prepare for interviews	3.04	3.00	4.67	5.00	-6.94***	-2.00	44.00	-5.31***	-0.77
3. How to follow-up after interviews	2.58	2.00	4.75	5.00	-8.69***	-2.51	24.00	-5.70***	-0.82
4. Aware of impact of social media on hiring	2.75	2.50	4.83	5.00	-7.23***	-2.09	34.00	-5.56***	-0.80
5. Aware of etiquette	2.63	2.50	3.58	4.00	-2.70*	-0.78	171.00	-2.48*	-0.36
Self-Efficacy	**2.52**	**2.00**	**4.75**	**5.00**	**-10.13*****	**-2.92**	**14.00**	**-5.84*****	**-0.84**
1. Belief that you belong in an engineering or technology program	2.54	2.00	4.71	5.00	-9.16***	-2.64	23.50	-5.69***	-0.82
2. Belief that you will be a successful engineer in the future	2.50	2.00	4.79	5.00	-10.18***	-2.94	22.00	-5.75***	-0.83
Financial Security	**1.65**	**2.00**	**4.92**	**5.00**	**-26.25*****	**-7.58**	**0.00**	**-6.25*****	**-0.90**
1. Can meet living expenses	1.71	2.00	4.96	5.00	-24.11***	-6.96	0.00	-6.38***	-0.92
2. Can meet academic expenses	1.63	1.50	4.88	5.00	-20.23***	-5.84	0.00	-6.28***	-0.91

Note. *** Significant at the $p < 0$ .001 level. ** Significant at the $p < 0.01$ level. * Significant at the $p < 0.05$ level.

Table 5. Comparison of First Year Semesters by Pre- and Post-Learning Community Intervention Constructs and Items

the course from a pass/fail to a graded one, but after a class discussion on requiring more oral and written course deliverables, they agreed that they did not want to add to their already heavy coursework requirements.

Discussion

During the initial open session with participants and faculty that focused on the design of the course, both the adult undergraduate engineering and engineering students and the faculty identified topics to be addressed in the targeted learning community that would help students to feel more secure about their decision to pursue an engineering or engineering technology degree and future career. After having thoroughly discussed the importance of each topic suggested, and after having collectively ranked ordered them, the suggestions morphed into topics that all (students and faculty) agreed to as being important to address in the course. These areas were: a) increasing camaraderie among themselves and other veterans; b) becoming more aware of professional websites on which internships and permanent job offers are posted, and learning how to evaluate them; c) developing a greater understanding of the various professional certifications, and better understanding what current practicing engineers do in the field; d) learning how to better prepare a professional resume, cover and follow-up letters, as well as learning to better prepare for interviews and business lunches and dinners; e) developing a greater sense of their ability to be a successful engineer in the future; and f) coming to terms with their being financially strapped that potentially affected their academic success.

Following the andragogy precepts previously discussed above, the research team highly recommends soliciting input from adult learners when designing courses, particularly structured sessions in a targeted seminar course. One of the most important points of andragogy is that adult learners are particularly sensitive to whether they perceive course content as being important and relevant to their careers. In this case, by including the participants in the initial design phase of the seminar course, with guidance from the faculty, each class session was tailored and directly addressed career-readiness topics that students themselves thought critical to their long-term success. Due to this, and possibly coupled with their prior experience in the military, the research team found participants highly engaged and attentive throughout the course, which was also reflected in their participation rate and the information participants shared in the open- and closed-questions on the survey.

Regarding whether the results of a pilot study could prove helpful when refining a course designed to help adult undergraduate engineering and engineering technology students feel more secure about their decision to pursue an engineering or engineering technology degree and future career, correlations between the variables in pre-course (time 1) and post-course (time 2) were not significant nor important since nearly all the participants who scored low pre-course scored high post-course. What is important, however, is that the variables and item medians between the pre-course intervention time 1 and post-course intervention time 2, the results of the surveys were significantly different, both within each semester, Fall 2018 and Spring 2019, and when semesters were combined for all variables.

It is reasonable to suggest that the course had a great

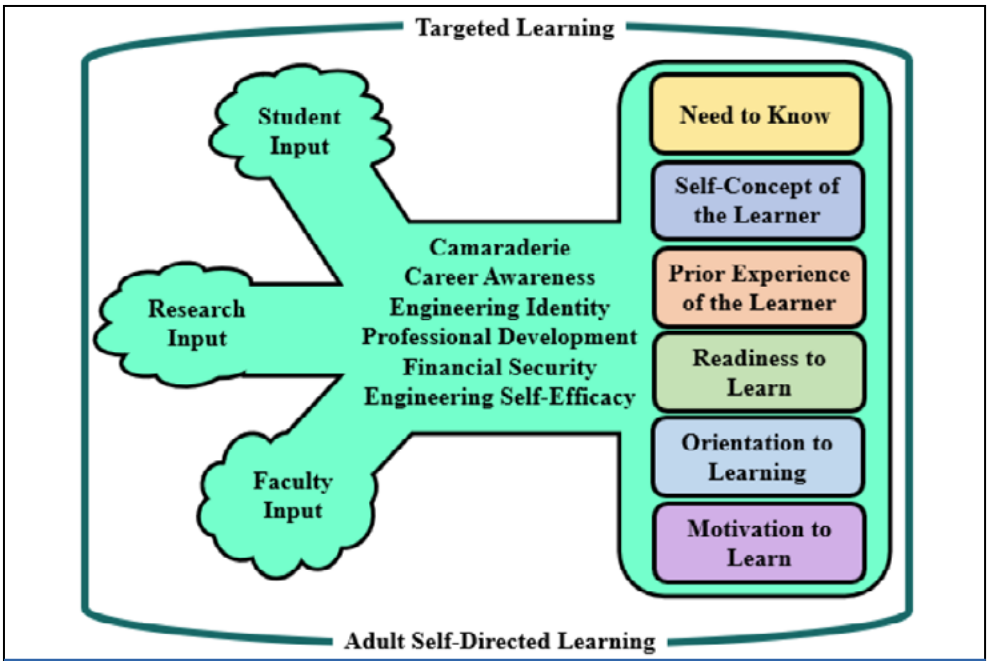

Figure 2. Targeted and Self-Directed Learning Based on Research Variables and Knowles et al.'s (2015) Andragogical Concepts

impact on enhancing adult undergraduate engineering and engineering technology students' sense of community with respect to their decision to pursue an engineering or engineering technology degree and future career, by increasing their sense of camaraderie, career awareness, engineering identity, professionalism, self-efficacy, and financial security. Reiterating, because the participants were involved in the design of the course itself, with faculty guidance, it is not surprising to see that the course had a significant impact on the participants. The targeted and focused direction of the self-directed learning communities from both faculty and adult learners allowed the class to pull on the adult learning principles of the andragogical model, as well faculty expertise. In addition, the mixed quantitative and qualitative approach implemented in this study allowed researchers to gain insight into the current course and opportunities for future improvements.

Figure 2 incorporates the variables studied in the Pathways to Completion project along with Knowles et al.'s (2015) andragogical concepts. Based on the input from students, faculty, and the existing research on STEM-readiness, learning concepts, and LCs, this figure depicts the connections between the variables and the andragogical concepts.

Conclusions and Future Research

Based on the results of the first-year cohort data, researchers suggest that the targeted course is an effective means in which to enhance the adult undergraduate engineering and engineering technology students' sense of community with their decision to pursue an engineering or engineering technology degree and future career. Further analysis will be conducted as each year of the project is implemented and data are collected, and course sessions will be refined based on the data analysis.

The learning community format allowed the students gain a better sense of community regarding their decision to pursue an engineering or engineering technology degree and to pursue a future career in engineering. The course helped the students learn to develop the skills to be successful in the workplace by enhancing communication, camaraderie, problem solving, idea exploration, and creating commonalities through knowledge, practice, and approaches (Wenger et al., 2002). Allowing the students to be a part of the decision-making processes and help direct the course components also allowed them to have more buy-in because they were learning about topics that they felt were important to be successful in their majors as well as later on in their careers.

Regarding the results of the qualitative analysis, table etiquette will continue to be addressed, but over both the fall and spring semesters in the future. For the remaining duration of the grant, in the fall semester, the finer things of dining will be discussed and practiced in the course. During the spring semester, students and their guests, along with the faculty/researchers will practice their table etiquette and table talk in a fine dining restaurant. Field trips will be continued to engineering firms for students to see engineering concepts in practice and network with engineers in the field.

There is a connection between the topics/variables identified in this study and andragogy. Further research will connect the topics/variables identified by the course participants in Table 3 and the six andragogical concepts. This will allow even further targeted learning strategies aimed at enhancing adult student success. Further study could examine whether this course would be successful without the added benefit of the semester scholarships. The Pathways to Completion NSF project is a five-year funded project led by P.I. Dr. Tony Dean. The data reported in this paper pertains to only the first year of the project, Fall 2018 and Spring 2019 semesters. Future research includes continued assessment of the impact of the course intervention, as well as further refinement of the survey instrument as more data are collected over the duration of the grant. In the future, a larger data set will allow the researchers to conduct an exploratory factor analysis to determine whether the variables used in the pre-course intervention (time 1) and post-course intervention (time 2) surveys offer more than face validity for the surveys used in this pilot study. Also, as more qualitative data are collected overtime, researchers will be able to identify whether new themes emerge and should be added to the current topics addressed in the Pathways to Completion course intervention which was designed to help engineering and engineering technology students enhance their sense of security with respect to their decision to pursue an engineering or engineering technology degree and future career.

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