2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #34212

Developing Two-Year College Student Engineering Technology Career Profiles

Dr. Kristin Kelly Frady, Clemson University

Kristin Frady is an Assistant Professor at Clemson University jointly appointed between the Educational and Organizational Leadership Development and Engineering and Science Education Departments. Her research focuses on innovations in workforce and career development in educational, community, and industry contexts, specifically focusing on middle skills, STEM, and community college applications.

Dr. Christy Brown, Clemson University

Dr. Christy Brown is a Clinical Assistant Professor of Quantitative Methodology in the Department of Education and Human Development (EHD) at Clemson University. She is the director of the EHD Quantitative Clinic, which provides statistical support to educational researchers.

Dr. Karen A. High, Clemson University

Dr. Karen High holds an academic appointment in the Engineering Science and Education Department (ESED) at Clemson University. Prior to this Dr. Karen was at Oklahoma State University where she was a professor for 24 years in Chemical Engineering. She received her B.S. in chemical engineering from University of Michigan in 1985 and her M.S. in 1988 and Ph.D. in 1991 in chemical engineering both from Pennsylvania State University. Dr. Karen's educational research emphasis includes faculty development and mentoring, graduate student development, critical thinking and communication skills, enhancing mathematical student success in Calculus (including Impact of COVID-19), and promoting women in STEM. Her technical research focuses on sustainable chemical process design, computer aided design, and multicriteria decision making. She also has extensive experience in K-12 STEM education and program evaluation and assessment. She has held a variety of administrative positions: 1) Director of STEM Faculty Development Initiatives-Clemson, 2) Associate Dean for Undergraduate Studies in the College of Engineering, Computing and Applied Sciences-Clemson, 3) Interim Director of Student Services-Oklahoma State University, 4) Coordinator of the Women in Engineering Program-Oklahoma State University, and 5) Director of the Oklahoma State University Measurement and Control Engineering Center-Oklahoma State University.

Prof. Claretha Hughes Ph.D., University of Arkansas, Fayetteville

Dr. Claretha Hughes is Professor of Human Resource and Workforce Development at the University of Arkansas (UA. Her research interests include valuing people and technology in the workplace, technology development, diversity intelligence, learning technologies, and ethical and legal issues. She has published numerous articles and chapters in peer-reviewed journals, books, and conferences and has 13 books. She serves as a book proposal reviewer for SAGE, Emerald, IGI Global, Palgrave Macmillan, and CyberTech Publishing. She is currently involved in a National Science Foundation Research in Formation of Engineers project as a Co-PI. She has served in manufacturing leadership roles for Coca-Cola Bottling Company Consolidated, Abbott Laboratories, and Burlington Industries. She is a national member of ATD and has twice presented at the ATD International Conference and Exposition. Dr. Hughes is a Langevin Certified Master Trainer, Harvard Management Development Fellow, and a Darden School of Business Minority Executive Education Scholar. She has a PhD in Career and Technical Education from Virginia Tech, Master of Textiles in Textile Technology Management from NC State University, B.A. in Chemistry from Clemson University, and MBA in Management from University of Arkansas.

Mr. Robert M O'Hara, Clemson University

Robert is a doctoral candidate in the learning sciences program at Clemson University. His research interests lie at the intersection of structured learning environments, sense of belonging, and academic confidence in undergraduate engineering students. A focus is placed on the reciprocal interaction between psychological processes and behaviors in these students and how they change over time based on

classroom environments and lived experiences. Prior to starting the Learning Sciences program, Robert, worked as a student affairs professional in higher education focusing on residential curriculum, social justice advocacy and awareness, and Intergroup Dialogue.

Mr. Shuyu Huang

Developing Two-Year College Student Engineering Technology Career Profiles

1. Introduction

There is little research on curricular differences between two- and four-year programs, career development of engineering technology (ET) students, and professional preparation for ET early career professionals [1]. Yet, ET credentials (including certificates, two-, and four-year degrees) represent over half of all engineering credentials awarded in the U.S. [2]. ET professionals are important hands-on members of engineering teams who have specialized knowledge of components and engineering systems. This research study focuses on how career orientations affect engineering formation of ET students educated at two-year colleges.

The purpose of this quantitative research study is to identify dimensions of career orientations and anchors at various educational stages to map to ET career pathways. The research question this study aims to answer is: For students educated in two-year college ET programs, how do the different dimensions of career orientations, at various phases of professional preparation, impact experiences and development of professional profiles and pathways? First, literature on the context of ET and connected career development theories which provide framing for the study are presented. Next, the methods and analyses used to answer the research question are described. Then this paper presents the results of this approach, and finally it provides conclusions and implications for the research findings.

2. Literature

2.1 Engineering Technology

ET plays an important role in supporting the engineering workforce. In some instances a distinction is made between engineering technicians and engineering technologists but, in general, ET professionals are those who are the "hands-on" members of an engineering team who have specialized knowledge of equipment, applications, components, operating characteristics, and limitations of engineering systems and processes in a specific area of expertise [3]. While there are several different definitions of ET, the most common element among all definitions is the focus of ET professionals on practical and applied engineering applications [3]. ET professionals earn a postsecondary credential which may range from industry-recognized certification, to an academic certificate, to an associate degree, to a bachelor's degree. Given that over half of all engineering credentials awarded in the U.S. (53 percent) were in ET certificate and two-year degrees, focusing on two-year college ET programs is appropriate [2]. However, despite the large number of ET graduates, research focusing on ET (not engineering) is sparse [1]. In fact, the National Academies of Sciences, the U.S. Department of Education, and Congress have recommended increasing funding and research in ET education [1,4]. The lack of research leaves engineering education faculty, staff, and administrators without adequate resources to educate and support this unique group of students.

Learning more about how to improve ET education and career development is important because ET represents a large sector of the American workforce. A current search of ET related occupations in the Occupational Information Network (O*NET) reveals 433 related occupations with approximately 185 of those jobs identified as "bright outlook" (occupations that are expected to grow rapidly) [5]. ET professionals are significant members of the 17 million

workers in the U.S. skilled technical workforce [6]. While this is a large and robust workforce, more attention to career development within this field is needed given that by 2022 there is predicted shortage of nearly 3.4 million skilled technical workers [6]. More research needs to be done to better understand the field of ET, the labor market, and the fields impact on the technical workforce [7]. Developing a deeper understanding of ET students and the role of ET education will support engineering technology education and career development across a variety of applications including, but not limited to, two-year college certificate and degree programs, four-year engineering transfer programs, workforce development programs, and industry.

2.2 Theoretical Frameworks

To better understand the career orientations of ET students, two leading career development theories have been used to guide this study, Social Cognitive Career Theory (SCCT) and Schein's Career Anchors Theory.

2.2.2 Social Cognitive Career Theory (SCCT)

Social Cognitive Career Theory (SCCT) is a theory which links students' attitudes, interests, experiences, self-efficacy beliefs, outcome expectations, and personal goals to educational and career decisions and outcomes [9]. SCCT aims to "understand the processes through which people form interests, make choices, and achieve varying levels of success in educational and occupational pursuits" [10] (p. 36). This theory has undergone several iterations but is foundationally built upon Bandura's concept of self-efficacy with interest development, choice-making, performance and persistence, and satisfaction and well-being all building on this core concept [11,12]. Self-efficacy, a social cognitive theory, helps to explain a person's perception or belief about their capability to produce effects [13]. Self-efficacy is also related to outcome expectancy which describes a person's expectations about outcomes based on action taken. Lent, Brown, and Hacket believed that the combination of these factors, plus the person, and their environment were intricately linked and have great impact on career development and success [14]. Further, the combination of these frameworks, in the context of STEM education, have been shown to influence motivation and persistence [8].

2.2.3 Schein's Career Anchors Theory

Prior studies have demonstrated that student knowledge of, attitudes toward, and motivation to pursue STEM can not only positively impact academic performance but can also indicate future career interests of participation in the STEM workforce [8]. Knowledge of these attitudes and motivations may be measured through career orientations or career anchors. A career anchor is a combination of self-concept characteristics which includes talents, abilities, motives, needs, attitudes, and values. Career anchors can develop over time and aid in shaping personal and career identity [15]. One of the leading career development theories which has been developed into a variety of career development tools, is Schein's Career Anchor's Theory. Since its development in the 1970s, it has been one of the most popular and influential career development tools [16]. Schein's theory aligns well with SCCT because in it, Schein defines a career as a combination of individual identity and self-concept, self-perceived talents and abilities, values and interests, and individual motivation [17]. In this theory, Schein identified eight career anchors: [15,18, 19]

- **Autonomy and Independence (AU).** People with this anchor desire career opportunities which provide independence and autonomy. Interestingly, it has been found that

autonomy needs increase as people age. Also, some with this anchor are more willing to trade status and income for freedom of lifestyle. Of all of the anchors, Schein believes that people with this anchor will have the most ease in the occupational world because they are typically the most adaptable to future changes.

- **Security and Stability (SE).** Individuals in this anchor value careers that provide security, good benefits, and a stable and decent income. Workers in this anchor are typically trusting of the organization and give little efforts towards personal career development. As a result, people in this anchor typically experience the most severe shift as a result of changes in the workforce and/or organization policies.
- **Technical and Functional (TF).** Individuals with this anchor have a strong identity tied to their specific area of expertise, knowledge, and skill. These individuals desire to apply and develop technical competencies and be known as experts.
- **General Management (GM).** Individuals with this career anchor desire to assume positions of managerial responsibility. Aptitudes and skills most closely associated with this anchor include high levels of motivation, interpersonal competence, analytical and financial skills, and emotional competence. This career anchor is also the most often espoused career anchor because of positive public perceptions of management.
- **Entrepreneurial Creativity (EC).** Creativity is at the core of this anchor and people with this anchor desire to build or create something original. The number of people in this career anchor is growing as a result of technological advancements of society and increasing mobility.
- **Service and Dedication to a Cause (SV).** People in this anchor pursue work that is meaningful that they perceive will enhance the greater good. As technology has increased visibility and connection to world problems and grand challenges, this career anchor has grown. Workers in this anchor may pursue activities that lead them away from traditional organizations and promotions in order to support valued activities.
- **Pure Challenge (CH).** Individuals with this career anchor enjoy solving complex, difficult problems and tasks. This is a growing career anchor. People in this anchor engage intellectual, strategic, and interpersonal skills and competencies to meet a variety of challenges.
- **Lifestyle (LS).** Individuals with this anchor seek to find balance between personal, family, and career requirements. These workers tend to define success in the context of its relation to life as a whole. This career anchor has also increased as dual career households, working to integrate two careers, have increased. For many people in this anchor, family can take priority over work and careers. Also, this anchor has grown to include individuals who wish to stay put or not relocate for a job.

To provide more insight into the working of career anchors, Wils, Wils, and Tremblay suggested a circular model of career anchor structure where the career anchors were organized into four quadrants or motivational domains to aid in identifying complementary and conflictual anchors [20]. The identified domains were self-transcendence (TF and SV), openness to change (CH, EC, and AU), self-enhancement (GM), and conservation (SE and LS) [20]. Career anchors are important in providing self-awareness throughout an individual's career which can lead to increased job satisfaction, job stability, and work quality [21]. These anchors also aid researchers and practitioners in identifying new areas for improving career development in educational and organizational settings [15,22].

3. Methods

3.1 Participants

In order to investigate career orientations at various phases of professional preparation, the study participants (n = 289) were recruited from three different groups: (1) students in engineering technology related programs from a medium rural-serving technical college (n = 137), (2) students in engineering technology related programs from a large urban-serving technical college (n = 52), and (3) engineering students at a medium Research 1 university who transferred from a two-year college (n = 120). The participants predominantly identified themselves as male (78%), 18-24 years old (84%), White (77%), and coming from two-year programs in either General Engineering Technology (38%) or Engineering Transfer (23%). The only statistically significant difference in the distributions of these demographic variables across the three participating institutions was in age group (χ^2 = 22.3, empirical p-value ≈ .0008), with the urban-serving technical college having a much larger percentage of students in nontraditional age categories of 25 years and older (36%) than the other two institutions (8% for the rural-serving technical college and 17% for the four-year university).

3.2 Instrumentation

All participants completed Schein's Career Anchor Inventory [18]. This instrument contains 40 six-point Likert-scale items with eight subscales of five items each corresponding to the eight different career anchors. Typically, subscale scores are calculated by summing responses to the component items and then a respondent's top career anchor is identified as the subscale with the greatest sum. If the maximum sum occurs in two subscales, the respondent is classified as having tied career anchors, and if the maximum sum occurs in more than two subscales, the respondent is classified as having flat career anchors.

Two items related to the development of professional profiles and pathways were also included. One item asked students to identify the two greatest influences on their choice of a career with response options of father, mother, other family, classes, teacher, counselor, coach, manager, friend, social media, other media, and own interests/experiences. The second of these items asked students to identify the services or experiences that were most beneficial in supporting their career choices (check all that apply) with response options of academic advising, counseling services, career services, apprenticeship, internship, undergraduate research, mentoring, summer bridge and/or first-year experiences, and veteran's affairs services.

Additional demographic information was also requested. Respondents were asked to identify their sex (male or female), age group (all respondents selected either 18-24, 25-34, 35-44, or 45-54), ethnicity (White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, or Other), whether they were a full-time or part-time student, and whether they were employed full-time, part-time, or not employed. Students at the technical colleges were asked to identify the two-year program they were currently enrolled in and students at the four-year university were asked to identify the two-year program they completed prior to transferring.

3.3 Data Collection

Electronic surveys in Qualtrics were distributed to students via email. In the technical colleges, students were invited to participate by instructors and college research administrators. In the four-year university, students were invited via email directly from the research team.

3.4 Data Analysis

Of the 289 respondents, 23 answered fewer than eight questions on Schein's Career Inventory. As these students did not respond to at least one question from each career anchor, a determination of their top anchor was not possible and they were removed from the analysis, reducing the sample size to 266 students (132 from the rural-serving technical college, 48 from the urban-serving technical college, and 86 from the four-year university). Of these 266 respondents, 50 skipped at least one question on Schein's Career Inventory. For this reason, each anchor subscale score was converted to a mean score (the sum of the item responses divided by the number of items answered for a particular anchor) before a determination of the top anchor was made. This would avoid a scenario where a student had one particular anchor identified as their top anchor simply because they answered more of the items for that anchor than for any other. For the 266 respondents, the rate of students who skipped at least one question did not differ significantly by institution or by top career anchor, and the psychometric properties of the inventory were nearly identical with and without these cases included.

The analysis of these data was done using the SAS statistical software package Version 9.4 and included three main components: (1) an exploratory data analysis to summarize the career anchors of the respondents and examine differences across groups by institution, major, demographics, types of educational experiences, and types of work experiences, (2) a latent class analysis to identify clusters of similar students based on their career anchor, educational experiences, work experiences, and other demographics, and (3) a comparison of career choice influences and supports by identified latent class. This cross-group analysis aids in the development of profiles of values, talents, abilities, and motives to support customized career development tailored specifically for ET students.

4. Findings

4.1 Career Anchors Distribution

The distribution of top career anchors among the 266 students responding to at least one item per anchor in the career inventory is displayed in Figure 1. Lifestyle was the most common

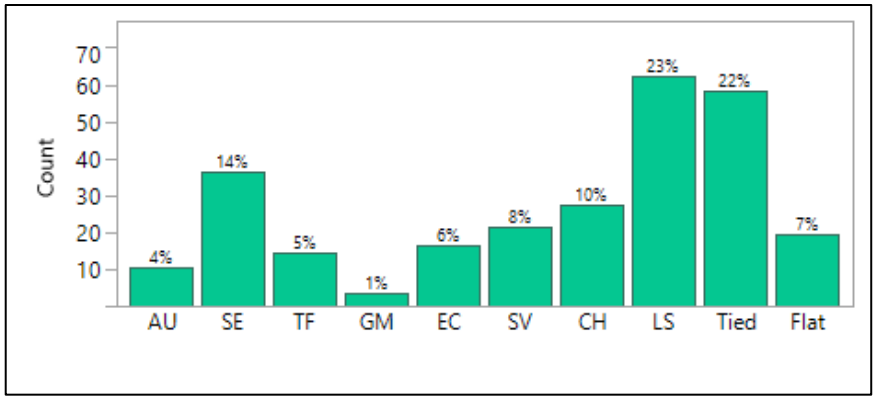

Figure 1. The distribution of top career anchors for the engineering technology students who responded to the survey, with the percentage of respondents classified as having a particular career anchor displayed above the corresponding bar in the bar graph.

top anchor among the respondents with 62 (or 23.3%) of the students in this category. This was followed by tied anchors with 58 students (or 21.8%), then Security and Stability with 36 students (or 13.5%), and then Pure Challenge with 27 students (or 10.2%). Each of the remaining career anchors was identified as the top anchor for less than 10% of the students, including Service and Dedication to a Cause (7.9%), flat anchors (7.1%), Entrepreneurial Creativity (6.0%), Technical and Functional (5.3%), Autonomy and Independence (3.8%), and General Management (1.1%). There was not a statistically significant difference in the distribution of top anchor across institutions (p-value = .1093), two-year programs (p-value = .1305), sexes (p-value = .3358), age groups (p-value = .8789), ethnicities (p-value = .1195), whether or not a student was full-time (p-value = .9632), or whether or not a student was employed full-time (p-value = .7990). In each case, a Monte Carlo approximation of Fisher's exact test was carried out, as the usual χ^2 test of association was not appropriate given the sparseness of the two-way tables.

To determine if the students with tied and flat anchors tended to have similar career orientations as those with one top anchor, the various combinations of either tied or flat anchors was explored. Among the 77 students with tied or flat anchors, Pure Challenge appeared as one of the top anchors for 37 (or 48%) of these students, Lifestyle for 34 (or 44%) of these students, Service and Dedication to a Cause for 30 (or 39%) of these students, and Security and Stability for 26 (or 34%) of these students. Thus, Pure Challenge made up a much greater share of the responses among students with tied and flat anchors than among students with one unique top anchor, and Lifestyle made up a much smaller share among students with tied and flat anchors than among students with one unique top anchor.

The most common combinations of tied or flat anchors included LS/SE, LS/CH, LS/SV, and CH/SV with 6 students in each combination. Note that this is the most common top anchor of LS paired with the 2nd, 3rd, and 4th most common top anchors (SE, CH, and SV, respectively) and then the 3rd and 4th most common top anchors paired together (CH and SV).

4.2 Latent Class Analysis

To identify clusters of similar students based on the multiple observed categorical variables, a latent class analysis [23] was performed. Latent class analysis assumes there is an unobserved categorical latent variable whose levels define different groups, or latent classes, within the data. The Latent Class Analysis platform in the JMP Pro statistical software package Version 14.3 was used to fit a latent class model and determine the most likely cluster or latent class for each student. The observed categorical variables included in the analysis were institution, top anchor, sex, age group, ethnicity, and full-time employment status. Latent class models with 2 through 8 clusters were considered, and the best fitting model based on both AIC and BIC was the model with just two clusters. The composition of each cluster in the 2-class solution is summarized in Figure 2. There were 177 students classified as most likely belonging to cluster 1 and 55 students classified as most likely belonging to cluster 2. The remaining 38 students in the sample could not be classified because they did not respond to all of the demographic items.

Parameter Estimates

		School			Sex		Age Group				Ethnicity						Employed Full Time	
Cluster	Overall	2YR Rural	2YR Urban	4YR	Female	Male	18-24	25-34	35-44	45-54	AI/AN	Asian	Black	NH/PI	Other	White	No	Yes
Cluster 1	0.72866	0.6113	0.0853	0.3034	0.2127	0.7873	0.9839	0.0021	0.0099	0.0041	0.0011	0.0568	0.0715	0.0184	0.0935	0.7588	0.9918	0.0082
Cluster 2	0.27134	0.2480	0.4509	0.3011	0.2413	0.7587	0.4540	0.3669	0.1059	0.0732	0.0160	0.0756	0.1001	0.0016	0.0416	0.7651	0.5970	0.4030

Figure 2. The composition of each cluster in the 2-class latent class model solution. For each cluster, the proportion of students in each category of the institution, sex, age group, ethnicity, and full-time employment variables is given.

The first cluster, labeled here as traditional students, is estimated to account for 73% of the students in the population. This cluster was predominantly White males aged 18-24 who were not employed full time. Approximately 60% of these students were from the rural-serving technical college and 30% from the four-year university. The primary career anchors for these students were Lifestyle and Security/Stability.

The second cluster, labeled here as nontraditional students, is estimated to account for the remaining 23% of the students in the population. They differed from cluster 1 in that 40% were employed full time and only 45.5% were aged 18-24. In fact, as shown in Figure 3, only four students classified as belonging to the second cluster were neither more than 25 years old nor employed full time. These four students

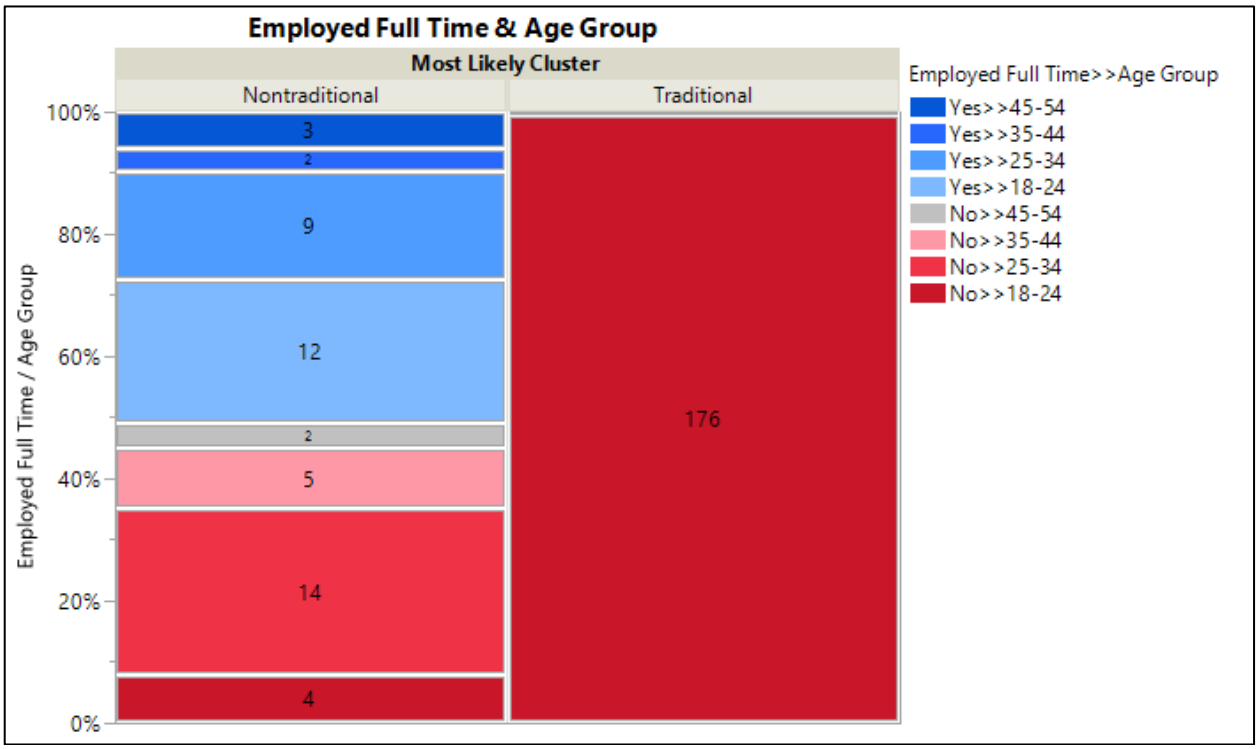

Figure 3. A segmented bar graph displaying the number of students at each combination of full-time employment status and age group within the two latent classes, labeled as nontraditional and traditional students.

included the only student who identified their ethnicity as American Indian or Alaskan Native, an Asian female, an Asian male whose top anchor was Pure Challenge, and a White female

whose top anchor was Pure Challenge. Thus, cluster 2 appears to be comprised of nontraditional students whereas cluster 1 was comprised of traditional students. Among the nontraditional student cluster, 45% of the students were from the urban-serving technical college, 30% were again from the four-year university, but only 25% were from the rural-serving technical college.

As seen in Figure 4, the nontraditional student cluster again had a very high rate of students whose top anchors were either Lifestyle or Security/Stability, but they had a much higher rate of students whose top anchor was Pure Challenge than did the cluster of traditional students (23.5% compared to 7.3%). A Monte Carlo approximation of Fisher's exact test provided moderate evidence (p-value = .099) of an association between all top anchors and cluster (traditional versus nontraditional).

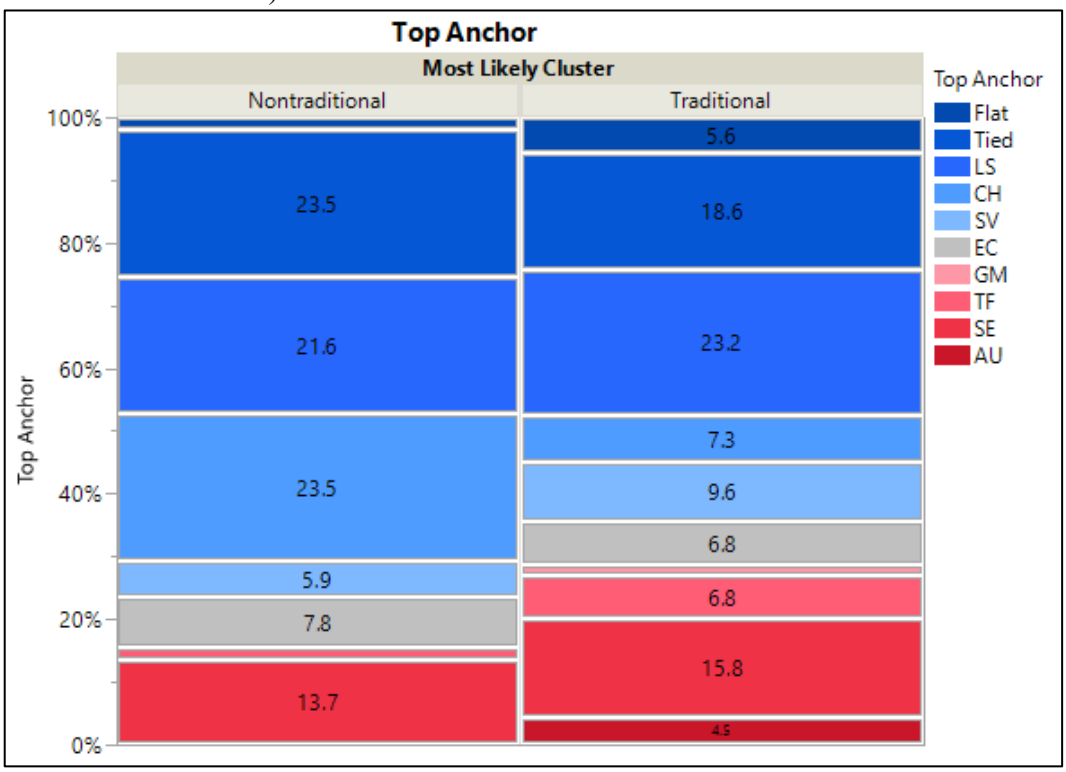

Figure 4. A segmented bar graph displaying the distribution of top career anchor within the two latent classes, labeled as nontraditional and traditional students.

4.3 Career Choice Influences and Supports by Latent Class

To explore possible differences in the development of professional profiles and pathways between the two identified latent classes (nontraditional and traditional students), responses to the survey items on career choice influences and supports were compared across the two groups. The first of these items asked students to identify the two greatest influences on their choice of a career. Figure 5 compares the responses for students in the traditional and nontraditional clusters.

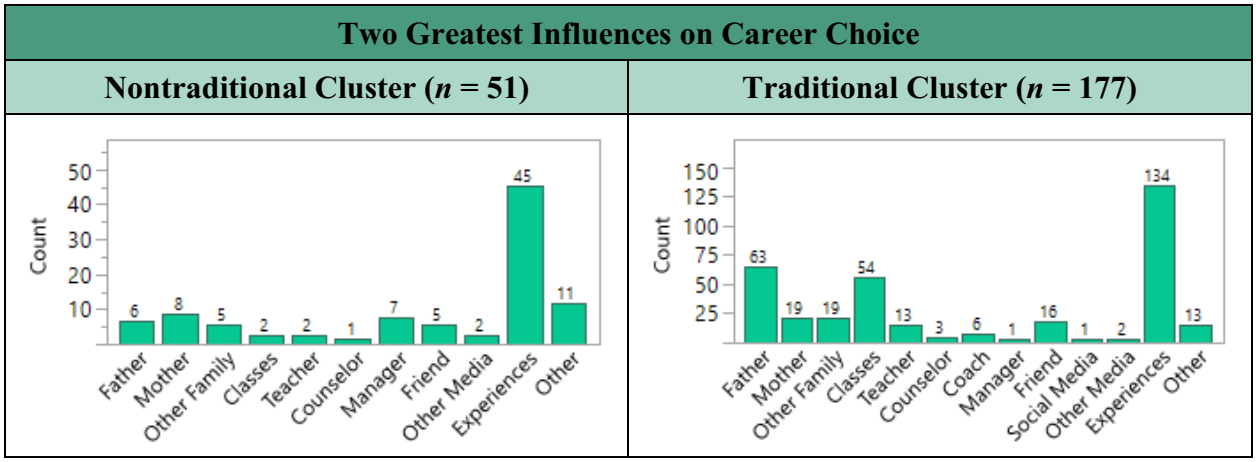

Figure 5. Bar graphs comparing the number of students in the nontraditional and traditional clusters who selected each option from the survey item that asked students to identify the two greatest influences on their choice of a career.

Note that because students were asked to select two influences, the total counts across all options exceed the group sizes. For both groups, own interests/experiences was the most frequently selected influence, selected by 45 out of 51 (or 88%) of students in the nontraditional cluster and 134 out of 177 (or 76%) of students in the traditional cluster. Some differences between the two groups are that father was selected as one of the greatest influences by a much higher percentage of traditional students (36%) than nontraditional students (12%), and classes was also selected by a much higher percentage of traditional students (31%) than nontraditional students (4%). Conversely, manager was selected as one of the greatest influences by a much higher percentage of nontraditional students (14%) than traditional students (1%). According to Fisher's exact test, used here because of the small observed counts in some categories, there was a statistically significant difference between the proportion of traditional and nontraditional students selecting father, (p-value = .0009), classes (p-value < .0001), and manager (p-value < .0001).

The second survey item which focused on student career choices asked students to identify the services or experiences that were most beneficial in supporting their career choices. Figure 6 compares the responses for students in the nontraditional and traditional clusters. Because this was a "check all that apply" item, the total counts across all options again exceed the group sizes.

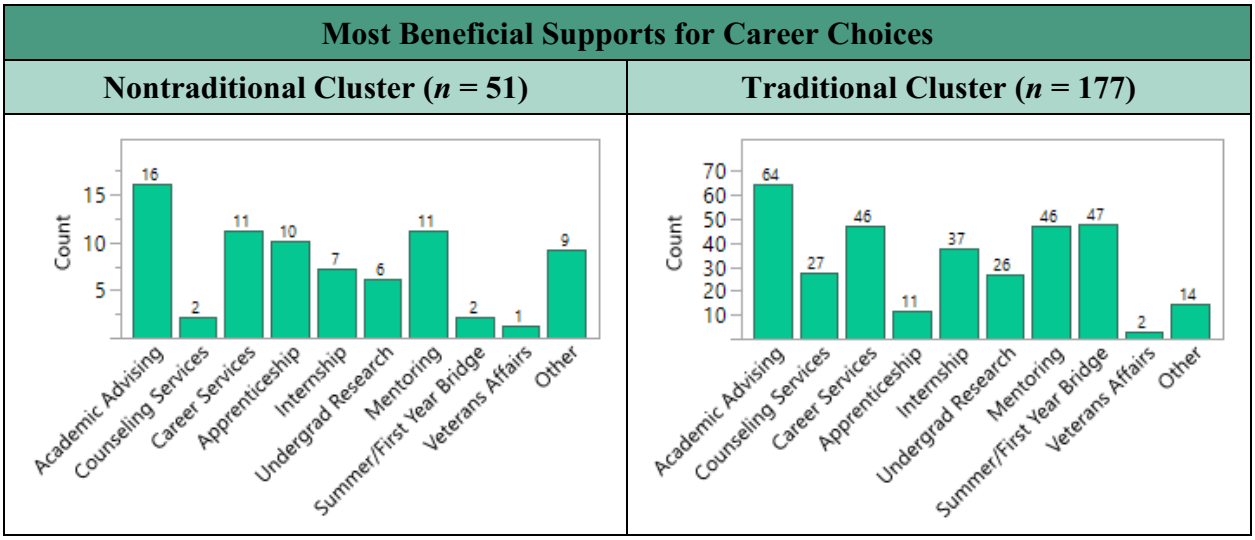

Figure 6. Bar graphs comparing the number of students in the nontraditional and traditional clusters on career choice supporting services or experiences

In both groups, academic advising, career services, and mentoring were among the most frequently selected services or experiences. However, summer/first year bridge experiences were selected by a much higher percentage of traditional students (26.6%) than nontraditional students (3.9%), whereas apprenticeship was selected by a much higher percentage of nontraditional students (19.6%) than traditional students (6.2%). According to Fisher's exact test, there was a statistically significant difference between the proportion of traditional and nontraditional students selecting summer/first year bridge experiences (p-value < .0001) and apprenticeship (p-value = .0102).

5. Discussion and Conclusion

5.1 Discussion and Implications

The findings from this research provide insight into the career orientations (anchors) of ET students at two different institutional phases of their professional preparation, two-year college and post transfer at a four-year college. The discussion of these results will begin with overall ET career orientation and anchor results since differences between the groups (program of study, institution, sex, ethnicity, or employment status) were not found to be significant. Next, the discussion will focus on career development differences for two distinct groups of ET students: traditional students (predominantly White males aged 18-24 who were not employed full time) and nontraditional students (more likely to be older than age 18-24 and more likely to be working full time). The discussion of differences between these groups will highlight information on ET career pathway experiences that impact career choice and the career services supporting development of ET pathways.

Examination of the career orientations of the ET students participating in this study revealed that the primary career orientations, or anchors, were lifestyle (23.3%), tied anchors were mostly mixing lifestyle and security and stability (21.8%), and security and stability (13.5%). The high presence of tied anchors was at first concerning since Schein contends that students may have

only one career anchor [19]. However, more recent research suggests that as many as 46% of individuals are influenced by multiple career anchors [21]. Career anchor plurality may in fact be useful in understanding, describing, and counseling complimentary and exclusive career development decisions [20, 24]. In the Wils, Wils, and Tremblay circular model of career anchors, interestingly the top career anchors resulting in this study lifestyle and security and stability, were both in the conservation quadrant which is characterized by motivations related to tradition, conformity, and security [20]. These motivations may also be viewed as work values and provide important insight into the professional expectations of ET students. A risk however for students with these two career anchors is becoming stagnant or obsolete in today's dynamic marketplace. To reduce this risk, ET students need support and to learn active learning skills which will allow them to better adapt to rapidly changing workplace situations [15]. Specifically considering the security and stability anchor, ET students need more training in how to develop skills to become more self-reliant and self-managing in these career areas. Development of professional pathways for these students should focus on teaching them how to create their own internal and external structures to create security and stability in their careers. [15,16].

Recognizing that the majority of this sample was of ages 18-24 (84%) (Generation Z) emerging research suggests that these career orientations of ET students align with the generational expectations of this population. For example, Generation Zers, who grew up during the Great Recession and witnessed their parents' work experiences wane and flow due to economic disruptions, crave security and expect to have to work harder to be successful [25]. In addition, this generation also values flexibility and work-life balance [26] which both the lifestyle and security and stability anchors confirm in this population. A similar career anchors study conducted on Generation Z students and early career professionals also found that there were strong preferences for the lifestyle and security and stability anchors with the remaining anchors being selected much less frequently [27]. These findings suggest that development of future professional profiles and pathways for these Generation Z, ET students should focus on horizontal (not vertical) career growth. Horizontal career growth focuses on creating value through expanding knowledge and career trajectories and is often portrayed as a career lattice with more opportunities than a narrow career ladder. The ability to leverage and expand existing skills as well as adopting a perpetual learner mindset is invaluable in strengthening and creating more sustainable career pathways [15]. In today's rapidly changing and adapting labor market, workers need to become more self-reliant and adept at self-analysis to determine where their career anchors or orientations best fit in the emerging occupational structure and identify areas where they need to evolve to develop new sets of crucial skills [15].

The latent class analysis identified two different clusters or groups: traditional ET students and nontraditional ET students. Traditional student anchors aligned with the overall results of this study and were primarily lifestyle and security and stability, but nontraditional anchors had a much higher prevalence of pure challenge. The addition of pure challenge for nontraditional students provides opportunities to engage these students more deeply in ET by including more complex and difficult problems, development of strategic thinking skills, and opportunities for academic competition in the curriculum [15]. Given that pure challenge individuals tend to define their career as overcoming impossible odds and winning [15], career development resources might also focus on ways to support and provide resources for nontraditional students when they encounter these "impossible odds."

The latent class analysis also revealed that the experiences of traditional versus nontraditional students impacted the development of professional pathways differently for these groups of ET students. Both groups responded that experiences were the most common career choice influence. This reinforces the notion that creating, facilitating, and integrating career development experiences into curriculum is important in development of professional profiles and career interests [28]. Throughout a student's K20 academic career, integration of positive experiences and decisional support will help them to approach career decision-making in a more organized manner [29]. Specifically, for traditional students the influence of father and classes was significant. Prior research also citing the importance of parental influences on career development has suggested leveraging these influences to form new relationships to support finding jobs and strong career pathways [30]. It is however important to also recognize that students from depressed economic backgrounds have less access to financial and social capital (parental influences on careers are less strong) and less access to particular types of learning experiences [31]. Development of professional profiles and career pathways should also consider these important factors. For nontraditional students, the influence of managers was significant. Increasingly, managers are playing more significant roles in organizational career development although there is little research to examine the nature of this role or its implications for employees [32]. Similar to the prior research suggesting leveraging the influential role of parents in career development, the role of managers in career development may be leveraged to establish more formal career networks and pathways.

Next, examination of career services that were perceived as beneficial provided insight into the formation of professional identity and ET pathways. All students felt that academic advising, career services, and mentoring were beneficial. As career services in higher education have evolved, a major focus has become building relationships with stakeholders to establish communities capable of supporting career and professional needs [33]. This links the importance of these career service findings with the findings on career influences and reinforces the importance of leveraging career influences to develop more formal networks. Additionally, traditional students reported that summer/first year bridge experiences were important. Embedded first-year career exploration experiences such as this, learning communities, and internships have been recognized as a high-impact practice for career development and are especially important for two-year college transfer students who are less likely to use career services [34]. This study also found that for nontraditional students there was a significant relationship between apprenticeship and support of career choices. Apprenticeship pathways and experiences have been found to increase student achievement, employability, and retention and create expanded career opportunities [35]. There are however questions remaining to be answered by research about how to integrate apprenticeships into postsecondary education, how to use social supports, school, and work during the apprenticeship to support career development, and the integration of internships into early career employment opportunities [36]. Integration of these experiences and career influences will be important in the development of ET professional profiles and pathways.

A surprising finding was the low selection of the entrepreneurial creativity anchor. Generation Z research suggests that students of this age are entrepreneurial, creative, and innovative [25], yet the entrepreneurial creativity anchor yielded a low response. The entrepreneurial anchor is

important because new companies created by this group will be a major source of new jobs for the other anchor groups thus encouraging and growing entrepreneurship is a vitally important component of economic development [15]. Educational institutions need to train students for both entrepreneurship and more autonomous careers [15]. Future research might focus on examination of how entrepreneurial orientations and experiences may be integrated into ET professional images and pathways. Additionally, future research examining which experiences, specific ways to broaden career influences, and explicit efficacious factors and characteristics of supporting career services would provide more information and context for ET professional profile and pathway development.

5.2 Research Limitations

This study has potential limitations. First, the field of ET is vast and dynamic. Often ET jobs, skills, and competencies are strongly influenced by regional industry. The participants in this study were from two- and four-year institutions preparing students for ET and engineering related positions primarily in the southeastern U.S. Also, this study had a moderately small sample size with 289 students. ET students in other geographic locations may have different results. However, many of the results from this study confirm prior research on students of this population [27]. Second, in order to increase the number of participants in this study, surveys were administered across two semesters. The research team took care to ensure that participants were not duplicated; however, COVID-19 interrupted the second semester of data collection. Some results were collected in the semester prior to students being moved from face-to-face to online learning, but it is possible that participation may have been increased if not for this disruption.

5.3 Conclusions and Future Work

In conclusion, the present research explored the utility of social cognitive career theory and career anchors as theoretical framework for understanding different dimensions of career orientations, at various phases of professional preparation, and how they impact experiences and development of professional profiles and pathways. These findings contribute research to a gap in ET and two-year college engineering education research. Findings suggest that lifestyle and security and stability are leading career anchors with the addition of pure challenge for nontraditional students. Further, career interests are primarily developed through experiences for all students, the father and classes for traditional students, and managers for nontraditional students. Beneficial services important in shaping career development for ET students were academic advising, career services, and mentoring, summer/first year bridge experiences for traditional students, and apprenticeships for nontraditional students. The extent to which these orientations, interests and experiences, and career services may be integrated into ET curriculum and programs of study may have important consequences for ET students' ability to meet the challenges today's rapidly changing workplace. Use of these perspectives can also aid in creation of professional profiles and pathways capable of creating more sustainable and resilient careers in ET.

This study is part of a larger National Science Foundation funded grant project aiming to develop a greater understanding of the professional identity, institutional culture, and formation of engineer technicians and technologists who are prepared at two-year colleges. These findings are being integrated with other qualitative data sets collected by the research team. The blending of

these quantitative findings with other qualitative data will serve to provide greater insight into ET professional identity formation, the effect of educational institution culture on ET formation, and ET career development. The findings from these integrated data sets are being used to develop an empirical framework incorporating individual career anchors and effect of institutional culture, for understanding ET professional formation. This framework is guiding creation of a career development intervention which will be piloted Summer-Fall 2021. Other practical implications of this work include use of findings to create career pathways mapped to career anchors, integration of career development tools into two-year college curricula and programs, greater support for career development in ET programs, and creation of alternate and more diverse pathways into engineering.

Acknowledgement
This material is based upon work support by the National Science Foundation under Grant No. EEC 1825126.

References

[1] National Academy of Engineering, "Engineering technology education in the United States," Washington, DC: The National Academies Press. 2016.

[2] The Integrated Postsecondary Education Data System, (IPEDS), "Data on engineering technology degrees," Washington, DC, 2014.

[3] *About Us*. National Institute for Certification in Engineering Technologies, Sept 2017. [Online]. Available: https://www.nicet.org/about-us/

[4] Strada Education Network (US) Lumina Foundation for Education, "Certified value: when do adults without degrees benefit from earning certificates and certifications?" 2019.

[5] *O'NET online quick search for engineering technology.* O'NET, Feb 2021. [Online]. Available: https://www.onetonline.org/find/result?s=%22engineering%20technology%22&a=1

[6] National Science Board, "The skilled technical workforce: Crafting America's science & engineering enterprise," Washington, DC, 2019.

[7] Bureau of Labor Statistics, "Occupational projections and worker characteristics", Washington, DC, 2020. [Online]. Available: https://www.bls.gov/emp/tables/occupational-projections-and-characteristics.htm

[8] Unfried, A., Faber, M., Stanhope, D.S., & Wiebe, E., "The development and validation of a measure of student attitudes toward science, technology, engineering, and math (S-STEM)," *Journal of Psychoeducational Assessment,* vol. 33, no. 7, pp. 622-639, 2015.

[9] Lent, R.W., & Brown, S.B., "Social cognitive approach to career development: An overview," *Career Development Quarterly,* vol. 44, pp. 310-321, 1996.

[10] Lent, R.W., & Brown, S.B., "Contextual supports and barriers to career choice: A social cognitive analysis," *Journal of Counseling Psychology,* vol. 47, no.1, pp. 36-49, 2000.

[11] Bandura, A., "Self-efficacy: Toward a unifying theory of behavioral change," *Psychological Review*, vol 84, pp. 191–215, 1977.

[12] Lent, R.W., & Brown, S.D., "Social cognitive model of career self-management: Toward a unifying view of adaptive career behavior across the life span," *Journal of Counseling Psychology,* vol. 60, no. 4, pp. 557-568, 2013.

[13] Bandura, A., *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall, 1986.

[14] Lent, R.W., Brown, S.D., & Hackett, G., "Toward a unifying social cognitive theory of career and academic interest, choice, and performance," *Journal of Vocational Behavior,* vol 45, pp. 79-122, 1994.

[15] Schein, E., "Career anchors revisited: Implications for career development in the 21st century," *Academy of Management Executive,* vol. 10, no. 4, pp. 80-88, 1996.

[16] McGuire, D., *Human resource development (2nd ed.).* Thousand Oaks, CA: Sage, 2014.

[17] Egan, T. M., Upton, M. G., & Lynham, S. A., "Career development: Load-bearing wall or window dressing? Exploring definitions, theories, and prospects for HRD-related theory building," *Human Resource Development Review,* vol. 5, no. 4, pp. 442-477, 2006.

[18] Schein, E.H., & Van Maanen, J., *Career Anchors, 4th ed.* San Francisco: Wiley, 2013.

[19] Schein, E. H., "Developing your career: Know your career anchors and develop your options," Sloan Working Papers, Sloan School of Management, MIT, 1980

[20] Wils, L., Wils, T. & Tremblay, M., "Toward a Career Anchor Structure: An Empirical Investigation of Engineers," *Relations industrielles / Industrial Relations,* vol. 65, no. 2, pp. 236–256, 2010.
[21] Chapman, J., "An empirically derived framework for conceptualizing Schein's career orientation theory," *Journal of Career Assessment,* vol. 24, no. 4, pp. 669-684, 2016.
[22] Singh, M.K., Bhattacharjee, V., & Kodwani, A.D., "Mapping career anchors in a large engineering company: a study," *Paradigm,* vol. 13, no. 2, pp. 50-56, 2009.
[23] Lazarsfeld, P. F., & Henry, N. W., *Latent structure analysis.* Boston: Houghton Mifflin, 1968.
[24] Wils, T., Wils, L., & Tremblay, M., "Revisiting the career anchor model: A proposition and an empirical investigation of a new model of career value structure," *Relations Industrielles / Industrial Relations,* vol. 69, no.4, pp. 813-838, 2014.
[25] Iorgulescu, M., "Generation Z and its perception of work," *Cross-Cultural Management Journal,* vol. 18, no. 1, 47-54, 2016.
[26] Agar, T., & Öneren, M., "Role of talent management in career development of generation Z: A case study of a telecommunication firm," *International Academic Journal of Social Sciences,* vol. 5, no. 1, pp. 28-44, 2018.
[27] Bohdziewicz, P. "Career anchors of representatives of generation Z: some conclusions for managing the younger generation of employees," *Managing Diversity in the Context of International HRM*, vol. 6, no. 113, pp. 57-74, 2016.
[28] Buschor, C.B., Berweger, S., Frei, A.K., & Kappler, C., "Majoring in STEM – What accounts for women's career decision making? A mixed methods study," *The Journal of Educational Research*, vol. 107, no. 3, pp. 167-176, 2014.
[29] Ireland, G. W., & Lent, R. W., "Career exploration and decision-making learning experiences: A test of the career self-management model," *Journal of Vocational Behavior,* vol. 106, pp. 37-47, 2018.
[30] Kenny, M.E., Blustein, D.L., & Meerkins, T.M., "Integrating relational perspectives in career counseling practice," *The Career Development Quarterly*, vol. 66, no. 2, pp. 135-148, 2017.
[31] Flores, L.Y., Navarro, R.L., & Ali, S.R., "The state of SCCT research in relation to social class: Future directions," *Journal of Career Assessment,* vol. 25, no. 1, 6-23, 2017.
[32] Crawshaw, J. R., & Game, A., "The role of line managers in employee career management: An attachment theory perspective," *The International Journal of Human Resource Management,* vol. 26, no. 9, pp. 1182-1203, 2015.
[33] Dey, F., & Cruzvergara, C. Y., "Evolution of career services in higher education," *New Directions for Student Services,* vol. 148, pp. 5-18, 2014.
[34] Stebleton, M. J., & Diamond, K. K., "Advocating for career development and exploration as a high-impact practice for first-year students," *Journal of College and Character,* vol. 19, no. 2, pp. 160-166, 2018.
[35] Shaw, S., Gordon, H. R. D., Xing, X., & Carroll, M. C., "Why apprenticeship programs matter to 21st century postsecondary education," *The CTE Journal,* vol. 7, no. 2, pp. 1-11, 2019.
[36] Hofman, C., Stalder, B. E., Tschan, F., & Häfeli, K., "Support from teachers and trainers in vocational education and training: The pathways to career aspirations and further career development," *International Journal for Research in Vocational Education and Training,* vol. 1, no. 1, pp. 1-20, 2014.