Exploring nontraditional characteristics of students in a freshman engineering course

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Nontraditional undergraduate students face many additional obstacles in the completion of their degrees. Nontraditional student enrollment in postsecondary education is on the rise in the United States, and is beginning to reach the same enrollment level as with traditional students[1]. Students majoring in engineering are also in short supply[2,3]. Even with the increasing enrollment of nontraditional students, few of them decide to major in engineering. This population of students typically completes the same degree requirements as their traditional student counterparts, but complete these requirements with the addition of more responsibilities in their personal and/or professional lives[1]. Many nontraditional students go back to school with an increased motivation and focus, which can increase graduation rates and decrease attrition[4]. According to the National Center for Educational Statistics (NCES), characteristics of nontraditional students are one or more of the following[1]: financially independent, enrolled part-time, delayed enrollment after high school, full-time employment, having one or more dependents, single-parent classification, and not having a high school diploma. While defining all of the possible characteristics of nontraditional students may not be realistic, student-housing situation (i.e., on-campus or off-campus housing)[5,6] and age (i.e., being older than 24)[7] are also considered nontraditional characteristics.

Students can possess more than one of these nontraditional characteristics. Nontraditional students are categorized into minimally, moderately, and highly nontraditional students based on the number of characteristics possessed[1]. Across all three magnitudes of nontraditional students, the graduation rate of this population is significantly lower than that of traditional students[1]. These classifications can be an excellent way to compare students on the basis of these characteristics; however, the 'minimal' nontraditional student level could be a misleading representation of a nontraditional student. It is not uncommon to see undergraduates, even within the age range of the 'traditional' student classification, have a nontraditional characteristic while enrolled in a degree program (example: job, significant other/spouse, etc.). From the National Center of Educational Statistics (NCES), more nontraditional characteristics a student has, based on the number of characteristics alone, the less likely the student is to complete their degree[1]. Nontraditional engineering students have been found to complete their degrees at a higher rate than traditional students when comparing students by age[8].

The following review will cover research on nontraditional undergraduate students. Initially, the review will cover general literature of nontraditional students in higher education. Engineering-specific literature about nontraditional students will then be reviewed in detail. This will provide context between the nontraditional student population as a whole and nontraditional engineering students.

General literature. The nontraditional student demographic is rapidly expanding in institutions of higher education[9]. Some research shows that nontraditional students have a lower graduation rate, but nontraditional engineering students have a higher graduation rate[1,4]. Nontraditional students struggle with fitting into their institutions, particularly with student peers, partially because of their classification as 'nontraditional'[6]. By virtue of the word, nontraditional implies a lack-of-fit within the current environment[10-12]. Despite this label, nontraditional students have,

historically, been active members of academic communities since the 19th century[13]. With nontraditional students not actually being a new demographic and the stigma associated with the label, many researchers have begun referring to this population as "adult students or adult learners" along with "post-traditional students." [9]. Given this information, the term "nontraditional students" will be used to refer to this population throughout this paper.

Graduation rates. Many people in higher education assume that students with nontraditional characteristics detract time and energy that the student could devote to coursework. According to Choy[1], 53.9% of traditional students working on a bachelor's degree go on to graduate. According to the same report, students with two or more nontraditional characteristics graduate at rates of 16.9% (two to three nontraditional characteristics) and 11.2% (four or more nontraditional characteristics) respectively. Essentially, with each addition of a nontraditional characteristic, the likelihood of completing a degree is reduced. However, Choy[1] does not investigate how much each type of obligation reduces the likelihood of graduation in nontraditional students. The report does not take into account how much, for example, having dependents reduces the chances of graduation compared to being older than the age of 24 or working full-time.

Age-related differences. Despite the lower graduation rates among nontraditional students, there is mounting evidence that nontraditional students perform as well or better, academically, than do traditional students [4,14-16]. There is a stigma among older nontraditional students that they have a lower ability to learn new topics, such as math, compared to traditional students and younger nontraditional students [17]. There is wide variety of supported evidence of age-related cognitive decline among older adults, particularly for adults in middle age and beyond [18-19]. Unfortunately, this research also creates a decrement stereotype threat that leads older adults to believe that they are less capable of learning new information or skills as well as younger adults[16]. In their study, Johnson and Nussbaum[16] have demonstrated that older adults, even when they study for the same amount of time as younger adults, perform equally as well as younger adults on math tests. In the same study, older adults report significantly higher levels of test anxiety, social derogation, and other negative factors. These same adults reported significantly lower levels of math self-efficacy. Despite the similar math test performances between older and younger adults, graduation rates decline with the age of a nontraditional student [20].

Additional nontraditional characteristics. Beyond the age characteristic, other nontraditional factors do not have as much empirical support. Despite this lack of research, there are some studies that illustrate the benefits of being a nontraditional undergraduate student [21]. For example, female students with children tend to report higher levels of psychological well-being, despite having higher levels of stress than students without children [22]. For both traditional and nontraditional students, motivation varies by level and type [23]. Motivation is a particularly important predictor of college student success [24]. Intrinsic motivation, in particular, is predictive of student success and is seen more often in nontraditional students [23]. Accordingly, positive affect is significantly correlated with intrinsic motivation in all college students; regardless of whether they are classified as traditional or nontraditional [23].

Engineering-specific literature. On average, 60% of engineering students finish their degree [25-26]. Students with high levels of confidence in their ability to complete an engineering degree are

least likely to withdraw from their school or switch to another major [27]. Nontraditional students in engineering have a slightly higher rate of graduation than their traditional student counterparts [4,14]. Given the information that nontraditional engineering students graduate at higher rates than the average for nontraditional students across all disciplines [6], this supports the inquiry of investigation of what is happening in engineering that helps nontraditional students graduate whereas they may not be as successful in other programs. Not only is this understanding imperative to help universities learn how to better support their nontraditional students, it would also help researchers understand the specific characteristics of engineering programs that aid in nontraditional student success.

Student Support. Making students feel supported in their academic studies can help reduce attrition in engineering programs [28-29]. Universities have offered discipline-specific residential programs for some time now, with science and engineering programs being included in this service [30]. These programs house engineering students, with a particular emphasis on women and underrepresented minorities, in common residence halls with planned academic events and enroll students in the same courses together [30]. These programs appear to be conducive to academic success for students by providing an environment that is more immersive in their discipline. Additionally, living in a community like this would also appear to create an easier environment to seek help from peers and/or facilitate more opportunities for group study.

The transition into college can be a challenging experience for any traditional or nontraditional student [31]. These programs have incoming students arrive on campus several weeks before their fall classes start. Arriving to campus early gives the new students the opportunity to begin fostering relationships with peers from their discipline, and sometimes more advanced students serving as mentors, and allows them to get comfortable on campus before the Fall semester starts [32]. Since the inception of these programs, they have drastically improved retention rates and academic success among traditional undergraduate students [33]. More recent studies on bridge programs have found that, compared to groups of students that did not participate in the program, they had higher retention rates among female and underrepresented minority students [34]. The researchers found that social support and having a better sense-of-belonging yielded higher rates of persistence in STEM students.

Commuter students. Living off-campus can have implications in student success [35]. Off-campus housing requires students to keep track of additional expenses, such as rent, groceries, and utility bills. This living situation can also make access to student services more challenging because students must travel to campus to access the services. The commuter student demographic began to expand in the 1960's, and has yet to see a decline [36]. Access to course materials for commuter students have improved since the inception of learning management systems (e.g., BlackBoard) that provide electronic access to course materials, such as power points, lecture notes, recordings, and other materials [37].

Due to the various impacts of nontraditional student characteristics on success rates, universities may not know how to begin to implement programs for nontraditional students. This research has goals to show that nontraditional students are returning to universities to complete their degrees and an understanding of these students can help universities build programs to include

them, rather than deter these students. Higher education can use information from this research study to help re-organize their current programs to help nontraditional students.

Methods

Understanding the Prevalence and Magnitude Nontraditional Characteristics

This research will provide descriptive statistical information related to two research questions: (1) *What is the prevalence of nontraditional characteristics in engineering students?* and (2) *What is the prevalence of the different levels of nontraditional characteristics (i.e., minimal, moderate, or high) in engineering?*

The nontraditional student characteristic data was collected through an online survey created using Qualtrics. The survey was administered to students via an Internet link, through Qualtrics, to potential participants during the first week of classes in the fall semester of 2016 in an introductory engineering course for freshman and transfer students in their first semester on campus. There were 640 students enrolled in the fall introduction to engineering course during 2016, where 549 students responded to the survey. This provided nontraditional characteristics information about engineering students at this campus. The characteristics examined by the survey mimicked those mentioned previously, as cited in the Choy [1] report. The survey also included an examination of commuter students; breaking these students into groups based on distance travelled to campus and mode of transportation (e.g., walking, biking, public transportation, etc.).

Results

A sample of 549 undergraduates (426 male, 117 female, 6 other; M_{age} = 19.04) sent in responses from the survey. Participants' responses to several questions on the survey were coded as 'traditional' or 'nontraditional' when the questions were binary and referred to nontraditional student characteristics. Participants that did not report any characteristics were labelled as 'traditional students.' Nontraditional students were separated by the number of nontraditional characteristics they possessed. Participants with one characteristic were coded as 'minimally nontraditional,' two or three characteristics were coded as 'moderately nontraditional,' and four or more characteristics were coded as 'highly nontraditional.' Based on this coding system, we were able to determine the basic prevalence of nontraditional student characteristics from this one course offering. There were 328 traditional and 221 were nontraditional (NTS), of which 150 are minimally nontraditional, 36 are moderately nontraditional, and 35 are highly nontraditional).

Table 1: *Gender*

	Frequency	Percent	Valid Percent	Cumulative Percent
Male	426	77.6	77.6	77.6
Female	117	21.3	21.3	98.9
Other	6	1.1	1.1	100.0
Total	549	100.0	100.0	

Table 2: *NTS Magnitude*

	Frequency	Percent	Valid Percent	Cumulative Percent
Traditional	328	59.7	59.7	59.7
Minimal	150	27.3	27.3	87.1
Moderate	36	6.6	6.6	93.6
High	35	6.4	6.4	100.0
Total	549	100.0	100.0	

A principal components factor analysis (PCA) was conducted on each of the individual nontraditional student characteristics to determine which characteristics tended to co-occur. Components that loaded onto factors were only accepted if their loading value was +/- .4 or greater. All components loaded onto at least one factor and none were excluded. Varimax rotation was utilized. After the analysis, three factors emerged. For the first factor: marriage status, financial independence, full-time employment, taking a break while in college, and age loaded significantly. For the second factor: marriage status, having dependents, taking a break after high school, and age loaded significantly. For the third factor: living off-campus, taking a break while in college, and part-time status loaded significantly. This analysis indicates which characteristics are the most inter-correlated.

Table 3: *Rotated Component Matrix*

| | Component | | |
	1	2	3
Housing Status	.094	.224	.668
Marriage Status	.690	.463	.047
Has dependents	.203	.712	.096
Financial independence	.537	.399	.090
Work full-time	.778	-.080	.223
Break after high school	.047	.820	.223
Break while in college	.462	-.134	.683
Part-Time Student	.097	.216	.761
Age	.619	.423	.344

After the initial analyses, some of the variable were re-coded to allow for additional analyses. Age was re-coded into two groups, 'under 24' and '25+,' to facilitate a comparison on the basis of 'traditional' and 'nontraditional' ages. A 2 (under 24 vs. 25+) by 3 (male vs. female vs. other) ANOVA was conducted and was overall significant, $F(5,543) = 167.171$, $p = .000$. Simple effects analysis indicated a main effect for age, $F(1,548) = 104.602$, $p = .000$, such that student aged 25 and older ($M = 5.067$, $SEM = .424$) had significantly more nontraditional student characteristics than students aged 24 and younger ($M = .509$, $SEM = .137$).

A multiple linear regression was calculated to predict the number of nontraditional characteristics based on gender and number of dependents. A regression equation showing the relationship between nontraditional characteristics was found to be significant, $F(2,540) = 65.827$, $p < .000$, with an R^2 of .196. Participants' predicted number of nontraditional student characteristics is equal to 1.180 - .389 (GENDER) + 2.899 (DEPENDENTS), where sex is coded as 1 = male, 2 = female, and number of dependents measured as a continuous variable. Participants' number of characteristics by 2.899 characteristics for each dependent and males had .389 characteristics more than females.

A 2 (male vs. female) by 2 (married vs. non-married) between-subjects ANOVA was conducted on the number of nontraditional student characteristics and was overall statistically significant, ($F(3,539) = 140.661$, $p < .000$). The model detected a significant two-way interaction between gender and marriage status, such that married males ($M = 5.333$, $SEM = .230$) reported significantly more nontraditional student characteristics than did married females ($M = 2.00$, $SEM = .607$) and no difference between non-married males ($M = .627$, $SEM = .052$) and non-married females ($M = .386$, $SEM = .099$). To further examine the gender and marriage variables, the same model was run as a factorial ANCOVA controlling for age and was overall statistically significant, $F(4,538) = 379.775$, $p < .000$. The covariate, age, was statistically significant, $F(1,538) = 619.794$, $p < .000$. Age, being the most commonly examined NTS characteristic was

controlled to see how the other effects would appear in the absence of age effects. The two-way interaction persisted between marriage status and gender, such that married males ($M = 2.219$, $SEM = .201$) reported more nontraditional student characteristics than did married females ($M = 1.026$, $SEM = .417$) with no difference between non-married males ($M = .731$, $SEM = .036$) and non-married females ($M = .617$, $SEM = .068$).

A one-way between-subjects ANOVA, with dependents as the independent variable, was conducted on the number of nontraditional student characteristics and was statistically significant, $F(1,541) = 161.274$, $p < .000$, such that participants with dependents ($M = 6.250$, $SEM = .435$) reported more nontraditional student characteristics than did participants without dependents ($M = .684$, $SEM = .053$). To further examine this effect, the same model was run as an ANCOVA, controlling for age. The overall model was statistically significant, $F(2,540) = 683.164$, $p < .000$, as was the covariate, $F(1,540) = 928.547$, $p < .000$. With the covariate added to the statistical model, participants with dependents ($M = 1.700$, $SEM = .303$) continued to report more nontraditional student characteristics than did participants without dependents ($M = .752$, $SEM = .032$).

A one-way between-subjects ANOVA, with financial status as the independent variable, was conducted on the number of nontraditional student characteristics and was statistically significant, $F(1,541) = 349.421$, $p < .000$, such that financially independent participants ($M = 2.973$, $SEM = .127$) reported more nontraditional student characteristics than did financially dependent participants ($M = .418$, $SEM = .050$). To explore this effect further, the same model was run as an ANCOVA with age as the covariate. The model was statistically significant, $F(2,540) = 945.546$, $p < .000$, as was the covariate, $F(1,540) = 409.854$, $p < .000$. Controlling for age, financially independent participants ($M = 1.795$, $SEM = .086$) reported more nontraditional characteristics than did financially dependent participants ($M = .604$, $SEM = .031$).

A one-way between-subjects ANOVA, with part-time student status as the independent variable, was conducted on the number of nontraditional student characteristics and was statistically significant, $F(1,541) = 318.535$, $p < .000$, such that part-time students ($M = 3.600$, $SEM = .166$) reported more nontraditional student characteristics than did full-time students ($M = .510$, $SEM = .050$). To explore this effect further, the same model was run as an ANCOVA with age as the covariate. The model was statistically significant, $F(2,540) = 907.416$, $p < .000$, as was the covariate, $F(1,540) = 942.156$, $p < .000$. Controlling for age, part-time students ($M = 2.045$, $SEM = .112$) reported more nontraditional characteristics than did full-time students ($M = .651$, $SEM = .030$).

A 2 (post-high school break vs. no post-high school break) by 2 (break during college vs. no break during college) between-subjects factorial ANOVA was conducted on the number of nontraditional student characteristics and was overall statistically significant, $F(3,539) = 328.010$, $p < .000$. The model detected a main effect for post-high school break, such that participants who took a break after high school ($M = 5.426$, $SEM = .254$) reported more nontraditional characteristics than did participants who did not take a break after high school ($M = 2.420$, $SEM = .098$). The model also detected a main effect for taking a break during college enrollment, such that participants who took a break from their college enrollment ($M = 5.711$, $SEM = .260$) reported more nontraditional characteristics than did participants who did not take a

break from their college enrollment ($M = 2.135$, *SEM* = .083). The model did not detect a statistically significant interaction. To further examine the variables, the same model was run as a factorial ANCOVA controlling for age and was overall statistically significant, $F(4,538) = 575.539$, $p < .000$. The covariate, age, was statistically significant, $F(1,538) = 467.116$, $p < .000$. The ANCOVA model detected a main effect for post-high school break, such that those who took a break after high school ($M = 3.470$, *SEM* = .207) continued to report more nontraditional student characteristics than did those who did not take a break after high school ($M = 1.614$, *SEM* = .081). A main effect for break during college was also detected, such that participants who took a break from their college enrollment ($M = 3.629$, *SEM* = .213) reported more nontraditional student characteristics than did participants who did not take a break from their college enrollment ($M = 1.455$, *SEM* = .068). There continued to be a lack of interaction in this statistical model.

Discussion and Conclusion

General Summary

Upon examination of these initial findings, some trends appear in the data. Primary variables of interest following these exploratory analyses are number of dependents, marriage status, gender, and age. Overall, 40% of the undergraduate incoming freshman had at least one nontraditional characteristic, 27% had one or two nontraditional characteristics, 7% had three or four nontraditional characteristics, and 6% had more than four. This shows that nontraditional students with two or less NTS characteristics are not shying away from engineering because of their nontraditional characteristics, but are enrolling and embracing the challenge. The findings do show that students with three or more NTS characteristics are not enrolling at the same rate as students with less NTS characteristics.

The number of dependents reported by participants significantly mediated the additional number of NTS characteristics reported. It could be speculated that, by nature, having dependents while pursuing an undergraduate degree serves as a strong indicator that the individual likely has a high number of other NTS characteristics that they may be balancing. The term 'balancing' is used here because, while they are characteristics about a student, some of them can also be viewed as responsibilities (e.g., full-time work, dependents, marriage, etc.). Additionally, among the other NTS characteristics, having dependents is one of the more demanding characteristics. Dependents, of any age, usually require a significant amount of attention, finances, and other resources. Despite the effect of age, having dependents continued to be linked to more NTS characteristics (with less magnitude).

Marriage status was a particularly interesting variable in this study. Initial analyses indicated that married participants reported significantly more NTS characteristics than did their non-married counterparts. Interestingly, this effect was mediated by gender, showing that married males tended to report more NTS characteristics than married females. This study was within engineering, where there are less females than males (the incoming freshman class that was surveyed was 24% female), thus there were even less nontraditional females. This finding could support the result of relatively recent data that women tend to outperform men at all educational levels; indicating that there may simply be less NT females than males in the first place [38].

Effect of Age

When a layperson thinks of a NT undergraduate, they likely picture someone who decided to go back to college at a later age; failing to think about the many other characteristics that can describe a NTS. This paper indicates that these notions are incorrect. While being age 24 or older was linked to having more NTS characteristics, age was treated as a covariate in several of the analyses used for this study and was statistically significant each time. Despite its significance as a covariate, age did not significantly alter the results of the ANCOVA analyses; indicating that the NT characteristics persisted beyond the effects of age. These findings provide support for the notion that not all NTS are necessarily older than their peers. The phrase 'life happens' may be an appropriate sentiment for these findings, as some NTS may have continued into higher education immediately after high school or after a short break, but still accumulated a varying number of NT characteristics. As such, support for NTS should span beyond simply supporting older students and should focus on a more holistic support system for all students.

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