A Three-Year Study of Adult Undergraduate Engineering Students

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Abstract

Adult learners belong to a large group of individuals for whom lifelong learning is both a desire and a necessity and for whom career changes are or will be the norm. This topic is not exclusive to engineering, but impacts many STEM professionals. Adult learners also include those who may have significant family responsibilities, medical issues, work obligations, returning veterans/active service military people, or those who lack financial resources to commit to fulltime studies. While online education opportunities may fill some of the gaps, acquiring an identity as a professional in a field or discipline grows with personal connections. The work to date builds on prior research to understand multiple identities and professional identity development and design approach among undergraduate engineering students aged 25 and over.

During this three-year NSF funded study, qualitative and quantitative data were collected from three diverse sites including a large public university (UC Berkeley), a small private university (University of New Haven), and a community college (Cañada Community College). Semi-structured interviews, think-aloud protocols, and a large-scale survey have all contributed to a rich set of data. Results point to the construction of an identity as "other" among adult engineering students in institutions of various types. The data supports the need for engineering education systems to provide systems that support a broad range of students, as well as opportunities for students to work together across generational differences.

Adult engineering students

It is commonly thought that the college population as made up of those, typically 18-22 years of age, who continued directly from high school to higher education. However, an increasing percentage of college students is comprised of adult learners - those who opted for alternative paths and choose to return to college at a later point. The 2016 NCES report [1] reveals that nearly 30% of all students enrolled in undergraduate programs (public, private, 2-year, 4-year) in 2015 were 25 years of age or older. This demographic is now receiving increased attention for recruiting efforts. For instance, *BestColleges.com* [2] reports an increase in "degree programs, student associations or academic advisors specifically geared towards nontraditional students". It is important to mention that the terms *nontraditional student* [3] and *adult learner* are often used interchangeably, but the difference lies in defining characteristics versus age [4].

A desire to meet the needs for qualified engineering professionals has resulted in efforts to increase recruitment and retention. Research has looked at understanding the student experience and challenges in an effort to customize the different programs. Various studies have

looked at reasons students have for entering STEM programs [5, 6], while others have observed development of engineering identity as a reason for increased persistence [7]. The desire to have a diverse student population that leads to a diverse workforce has brought attention within engineering programs to the adult students. However, as discussed in prior papers [15, 16, 17], the literature shows that *adult learners* and *nontraditional students*, in general, face different challenges including different stressors, roles, and appraisal styles [8, 9,10].

Our study aims to understand the experiences, motivations, and identity development of the adult engineering undergraduate student. Specifically, we investigate the impact of prior engineering-related work experiences on how this population approaches engineering design, and their development of an engineering identity. The work parallels prior work in engineering design protocols [11, 12], and engineering identity development [7] in order to broaden the data pool as well as enable comparison of this target population versus the general engineering student population.

A study in three phases

Our study was carried out with the goal of identifying common themes related to engineering identity and college experience for adult undergraduate engineering students. Data was collected from a community college (Cañada Community College in Redwood City, CA), a small private university (University of New Haven in West Haven, CT), and a large public research university (U.C. Berkeley in Berkeley, CA). For the two first phases of the research, participants were engineering undergraduate students above the age of 25 with prior engineering work experience. Participants qualified for the study after completing an interest questionnaire that specifically asked them if they had had prior engineering-related work experience and if so to please describe. The descriptions showed clear linkage between engineering and their prior work experience (e.g., manufacturing line employee; or technician in the military). In situations where the relation to engineering was not explicit, the researchers followed up with the interested participant.

<u>Phase one: semistructured interviews</u>

Semistructured one hour interviews were conducted with participants at each separate location by trained research assistants. The research assistants involved both graduate and undergraduate students from psychology and engineering; their training was detailed in previous paper [13]. Students were asked questions involving identity, motivation, and whether they feel connected or disconnected to various aspects of student life. Participants were asked to generate a list of ten nouns or phrases that describe who they are and then to rank these nouns in order of importance. After each interview participants were asked to complete an option demographic

survey. Interviews were transcribed and analyzed using an open coding system and cross comparative inductive analysis to identify salient themes.

Analysis of the semistructured interviews and demographic data has revealed several important findings which has led to several publications [14, 15, 16, 17]. First, data revealed key differences in the identity trends of students at each academic institution. Community college students claimed multiple responsibilities in addition to their academic workloads. Public university students exhibited a schedule solely committed to their studies. Private college students were notably dedicated to their family roles and commitments and considered these more important than school. These social distinctions between student populations from each academic institution illustrate the diversity of nontraditional students and the challenges they face. Second, the concept of adult student "otherness" arose as a commonly reported theme from participants. Two kinds of adult student-traditional student relationships were described by participants; one where adult students saw themselves as more mature/committed than their younger peers and were thus less likely to have any meaningful relationships, and another where adult students admired their peers for their academic engagement. Last, participants commonly reported that their differences in prior life experience, their age, and their added life commitments were a major barrier to relating to traditional students and feeling socially included on campus. Analysis of the semistructured interviews continues and will seek to explore further trends in student goals, motivations, and engineering identity development.

Phase two: Think-aloud Design Protocols

Additional information about adult engineering students was collected using the design task from Atman [11, 12]. Observation of the design process can give us useful insight to differences between traditional students and adult engineering students on the way they approach and solve problems. Verbal protocol analysis was used in order to study the design behavior of each student. Each participant was asked to think out loud while solving the 3-hour design problem. In order to help prepare the students to think-aloud during the design problem, they were first given three short practice problems to solve out loud, including a multiplication problem and a short logical word problem. The participants were asked to speak all of their thoughts about solving the problem out loud. Each participant was recorded during the practice problems and design task, and their thoughts were later transcribed and coded for further analysis. The proctor of each study encouraged the participant to verbalize their thoughts anytime they fell silent for too long, and kept them on task. Once the design task was complete, the recordings were transcribed and each thought segment was coded into a category from the design process according to the CELT 06-02 report so that patterns in thought processes between adult engineering students and differences from traditional age students could be analyzed. To date, 10 have been transcribed and coded, and data collection and analysis continues.

Phase three: Large-scale survey deployment

In an effort to collect data from a larger array of institutions, a large-scale survey was designed to measure how the adult engineering learner views him/herself, how they perceive engineering, deal with stress, handle their multiple roles and their reasons for choosing to go to college respectively. The survey consisted of three key components: consent form, questionnaire and a demographics form; the survey collects data anonymously engineering students 18 years of age and older.

The large scale survey included six different measures based on previous research [8]: The Appraisal Scale [9], The Stressor Scale[18], the Work-Family-School Role Conflict Scale [19], the Academic Motivation Scale [20], and multiple questions included from the semistructured and design protocol phases; these questions were devised to measure how the adult learner identifies as engineer (e.g., do you, family members or peers see you as an engineering person).

The questionnaire aimed to quantitatively measure the differences and similarities between traditional engineering and adult engineering students. By employing already validated protocols, results of our engineering students will be compared to the large array of published data that includes traditional and adult students. Results will help to determine "what works" for adult learners and how we can make their learning environment more positive and thus likely to result in retention of the individuals in engineering.

Recommendations and Future Work

Our work contributes to the available data for both adult students and engineering students. Our current findings highlight this population to have similarities to the broader population of adult learners which sets them apart from the general engineering student populations. Engineering students in general face a rigorous academic program which combined with the additional challenges faced by adult learners may provide insight into the difficulties of their recruitment and retention. Engineering faculty and administrators will require a cognizant understanding of who these students are, -- the challenges they face, how they handle stress, their levels of self-efficacy, and their development of an engineering identity, -- if they are to successfully design and implement programs specifically targeted at this demographic.

The semistructure interview and design protocols have resulted in large amounts of data collected. Work continues to explore the intricacies of who these students are. The aim is to have large enough numbers that results can be generalized and broadly applied. Future work will dwell into adult learners' level of preparedness and their student-faculty relationship.

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