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Departures from the "norm": How nontraditional undergraduates defined their success in an alternative engineering transfer program

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Departures from the "norm": How nontraditional undergraduates experienced success in an alternative engineering transfer program

This research paper presents findings from a narrative qualitative research study conducted with 14 nontraditional undergraduates (14 white; 13 male 1 female) enrolled in a 2-year engineering transfer program. The engineering transfer program was offered by a four-year, public land grant institution, located in the western United States, to provide an alternative pathway to engineering degrees for geographically dispersed students located throughout the state. Nontraditional undergraduates comprise a growing population within U.S. higher education who, based on age-, education-, and socioeconomic-related factors, do not fit within the grand narrative of the "traditional" college undergraduate. Nontraditional undergraduates include those who delay college entry, attend college part-time, work full-time, financially support themselves and/or dependents, are single parents, and/or become eligible to attend college via credentials considered equivalent to earning a high school diploma (i.e., General Education Development or GED). In addition, many nontraditional students share intersecting identities with other gender, racial, and ethnic groups that are underrepresented in science, technology, engineering, and mathematics (STEM) education.

Based upon national recognition that nontraditional students possess untapped potential to strengthen and diversify the engineering workforce, the purpose of this qualitative research study was to examine the lived experience of nontraditional students engaged along alternative pathways to engineering degrees. Providing new understandings of how nontraditional students made sense of their engineering education experiences, this work reports on the ways nontraditional engineering students narratively described their success in the context of the two-year transfer program. Findings revealed that participants' views of success included common measures of academic success in engineering; they also reflected participants' longer-term career goals and financial plans. Findings have implications for the development of robust engineering pathways at both 2- and 4- year institutions.

Departures from the "norm": How nontraditional undergraduates experienced success in an alternative engineering transfer program

The idea/ideal of the traditional college undergraduate as "one who earns a high school diploma, enrolls full time immediately after finishing high school, depends on parents for financial support, and either does not work during the school year or works part time" is giving way in 21st century America [1]. As early as 2002, researchers noted that only 27% of U.S. college undergraduates met all of these "criteria," and that truly traditional college students were becoming the "exception rather than the rule" [1].

Who are nontraditional undergraduates?

Several scholars have theorized the differences between traditional and other, so-called "nontraditional," undergraduates. In fact, the term "nontraditional undergraduate" has proved difficult to define clearly due to the multi-faceted ways in which contemporary students differ. Early theorists critically questioned the notion of the traditional/nontraditional binary and suggested that being nontraditional a) intersects with other gender, racial, ethnic, and socioeconomic identities and, therefore, cannot be defined solely by membership within these recognized minoritized groups, and b) is more a "matter of extent" than being one-half of a dichotomous category [2].

Horn [3] proposed a framework comprising seven age- and socioeconomic statistical risk factors for undergraduate attrition for characterizing the degree to which an undergraduate differs from the traditional "norm." These nontraditional student characteristics include:

- Delaying enrollment (does not enter postsecondary education in the same calendar year that high school graduation);
- Attending part-time for at least part of the academic year;
- Working full-time (35 hours or more per week) while enrolled;
- Being considered "financially independent" (i.e., is not a dependent of a parent or guardian) for the determination of eligibility for financial aid;
- Having dependents other than a spouse (usually children, but may also be caregivers of sick or elderly family members);
- Being a single parent (either not married or married but separated and has dependents); or
- Not earning a high school diploma (completing high school with a GED or other high school completion certificate or did not finish high school).

Using this model, students are categorized as "minimally nontraditional" if they possess only one characteristic, "moderately nontraditional" if they possess two or three characteristics, and "highly nontraditional" if they possess four or more characteristics [3]. Applying this framework, Horn [3] found that nontraditional students were 1) more than twice as likely as traditional students to leave school in their first year; 1) much less likely to earn a degree within five years; 2) far more likely to have leave school without returning than their traditional counterparts.

Why we need to examine nontraditional student experiences in STEM

In the United States, STEM education at all levels remains a significant national priority based upon concerns ranging from global competitiveness, national security, 21st century workforce needs, and equal access. In 2018, U.S. science and engineering (S&E) bachelor's degrees comprised only 10% of the global total, while India and China together produced almost half of the world's S&E bachelor degrees during the same time period. The U.S. demand for graduates with STEM degrees continues to grow at a faster rate than the demand for qualified graduates in other occupations. Despite the value and increasing necessity of STEM skills within today's society and the 21st century workforce, substantial numbers of Americans still do not have equal access to postsecondary STEM education and, thus, have limited opportunities for STEM-related employment and careers [4].

Along with unequal access to STEM degree programs, researchers report stark differences between traditional and nontraditional undergraduate enrollment and degree attainment in STEM, wherein nontraditional students consistently fare worse. Chen and Weko [5] found it was atypical for students who were older, financially self-supporting, or from low socio-economic backgrounds to enroll in four-year STEM bachelor's degree programs. Similarly, significantly lower percentages of older or financially self-supporting students earned STEM degrees [5]. Differences in the ways that undergraduate students leave STEM bachelor's degree programs were also found: A greater number of younger and financially dependent students left by changing to a non-STEM major, while more older and financially self-supporting students left by leaving postsecondary education altogether.

In the context of the growing nontraditional undergraduate population [1, 3], the persistent conflict between national STEM priorities and flagging nontraditional student STEM enrollment and degree attainment draws attention. While evidence suggests that being nontraditional does, in fact, put undergraduates at risk for STEM non-enrollment and degree non-completion, little is known about the mechanisms by which these unfavorable outcomes occur. Because students' personal views of success may influence the decisions they make about persisting in STEM degree programs, the purpose of this study was to explore how nontraditional students narratively described experiences of success in the context of a STEM degree pathway. This research narratively examined the lived experiences of 14 nontraditional engineering students enrolled in an alternative engineering transfer program. Findings from this study can be used to inform changes to educational structures and policies and curricular and extracurricular support programs needed to make STEM education a viable option for all of today's postsecondary learners.

Literature Review

Engineering Student Success

Developing deeper understandings of the ways that nontraditional students conceptualize success in STEM is essential for improving their persistence in STEM degree programs. In their literature review, van den Bogaard [6] reported that " student success is a broad concept that can be operationalized in many different ways" [6]. van den Bogaard [6] discussed multiple approaches for defining student success/failure applied in the STEM education literature: student attrition characterized as “dropouts” or “switchers” [7-10], degree attainment [11-13], student intentions to persist in STEM or progress within a set period of time [14-16], course completion, course grade achievement or overall grade point average [13, 17, 18], and continued re-enrollment [19].

Moreover, since the construct of academic success is highly contextual [6], several researchers have operationalized the construct of student success as combinations of factors. For example, Haemmerlie and Montgomery [20] operationalized student success in a freshman engineering class using combined measures of student academic achievement (end of second semester grade point average) and re-enrollment in engineering majors during the fall of the following academic year. Suresh [21] investigated the link between two common measures of student success, course grades and the number of course repeats, by exploring how student academic achievement in engineering “barrier” courses (e.g., calculus, physics, and statics) affected student intentions to persist in engineering after their first two years of study.

As van den Bogaard [6] discussed, the ethnographic work of Seymour and Hewitt [9] helped to uncover the contextual, multi-faceted nature of student success in STEM education. Seymour and Hewitt [9] reported that students who persisted in STEM disciplines (i.e., non-switchers) were not inherently different than students who changed majors (i.e., switchers). Rather, both groups shared common attributes and abilities. Moreover, these groups also shared complaints about STEM education, including inadequate teaching practices and support from STEM faculty and advisors, a pervasive weed-out culture, and an overwhelming curricular pace and workload. Similar to the non-switchers, the majority of switchers were found to have spent considerable, time, money and effort on their STEM education prior to leaving STEM.

Seymour and Hewitt [9] concluded that what appeared to separate these two groups was the ability of non-switchers to develop effective attitudes or coping strategies and, in many cases, instances of chance that positively affected students at a critical juncture in their education. Similarly, Pierrakos, et al. [10] found that undergraduates who persisted in engineering after their first year had engaged in engineering–related activities and formed a social/professional network within engineering, while the students who switched out of engineering during their first year had not. Together, these studies suggest that student persistence in STEM may be a strong function of student satisfaction related to STEM education processes, support structures, and culture.

Nontraditional Student Success

The literature further indicates that nontraditional students often use more personalized and broad-minded measures to consider and evaluate their own educational success. For example, Wirth and Padilla [12] found that community college students took a wider view of their success and used goal realization and course completion (rather than degree completion) as indicators of their personal achievement. Johnson and Berge [22] emphasized that goal realization may include attainment of specific skill sets or knowledge needed to progress at the workplace, regardless of whether the student chooses to complete the specific course or degree. Hagedorn [23] reported that, while getting a degree was the strongest reason for adult community college students (ages 22 to 45) to enroll, the relative importance of degree attainment decreased as the age of the student respondents increased. As the age group increased, the importance of other factors in the decision to enroll, including lack of employment, proximity of college to work, encouragement of an employer, and pursuing a credential needed for work, grew. In fact, for the oldest students (age 46 and above), getting a degree was no longer the primary impetus for enrollment.

As a group, women have been found to hold alternative views of success concerning their experiences in college. Researchers [24] found that views of success for female students grouped around several themes: success is internal; success is subjectively defined; success involves a balance between work and family; and success involves contributing to a community. The authors recommended that factors of balance, relationships, community contribution, and goal orientation should be taken into account when assessing success for female college students.

Purpose and Research Question

In support of national priorities to improve access and outcomes within STEM education for nontraditional undergraduates, this work reports on the findings of a study that qualitatively examined the lived experiences of nontraditional students engaged in an alternative engineering pathway. Data generation and analysis were guided by the following research question: *How do participants describe success based on their experiences within the alternative engineering transfer program?*

Theoretical Framework

Because many if not most nontraditional students can be characterized as adult learners, adult learning theory was used as the theoretical framework for this study. Adult learning theory [25] proposes that there are fundamental differences between the ways that adults approach learning and the ways in which learning experiences are often provided by the pedagogical practices prevalent in higher education. Adult learners are considered to be different from traditional college students because they are "self-directing" and possess "[self-concepts] of being responsible for [their] own lives" [25]. It is theorized that young people become adult learners upon leaving school or college, seeking full-time employment, getting married, and starting a family [25]. Thus, many of the qualities used to characterize nontraditional students (i.e., working full time, being financially self-supporting, having dependents other than a spouse, etc.) also serve to differentiate adult from non-adult learners. In other words, students become adult learners as a result of many of the same experiences that mark them as "nontraditional" college students.

In Knowles' "Andragogical Model" [25] of adult learning, life experience and self-concept play important roles in the attitudes, perceptions, and motivations that adults bring to their learning and education. Other key elements of this model include the importance of a) an adult learners' "need to know" [25] related to the topics and concepts presented, b) realistic learning experiences that provide for the individual and personal discovery, and c) the level of control that adult learners can exert over their own, individual learning experiences. By providing theoretical insights into the ways that nontraditional students value and prioritize their educational experiences, the tenets of adult learning theory helped to scaffold researcher interpretations of the experiences described by the participants in this study.

Research Context

The engineering transfer program was offered at a western, public university from 2009 - 2015. In keeping with the university's land grant mission, the transfer program employed distance-delivery (i.e., synchronous broadcast) to provide the first 2-years of its bachelor of science in engineering curricula to geographically dispersed, rural, and working adults who resided within the large, western state. The program was administered within a regional campus network via evening classes conducted synchronously through interactive video conferencing (IVC). A cadre of teaching faculty taught courses within the program and coordinated with engineering faculty within the college of engineering to ensure that courses taught in the transfer programs met the standards of each engineering department. Graduates of the program earned an Associate's Degree in Preengineering and were eligible to physically transfer to the university's main campus to complete their engineering bachelor's degree.

Methodology

Because one-half of U.S. students who receive bachelor's degree in science or engineering enroll in a 2-yr program at some point in their education [26] and, increasingly, students are entering community colleges with the goal of attaining bachelor's degrees [27], this study focused on the experiences of nontraditional students enrolled in a 2-yr engineering transfer program to ensure broad transferability of its findings. To develop understandings of the multiple, lived realities of the participants, I (the researcher) adopted an interpretivist theoretical perspective [28-31] and openly assumed that participants "…experience the world around them in different ways" [28]. Within the interpretivist paradigm, "reality is socially constructed" and "variables are complex, interwoven, and difficult to measure" [31]. In order to explore nontraditional student experience, I employed a narrative research methodology [32, 33]. Polkinghorne [34] described narrative research as "a subset of qualitative research designs in which stories are used to describe human action" [34]. Chase [35] explained, "Narrative inquiry[1] is a particular type… of qualitative inquiry…. [that] revolves around an interest in life experiences as narrated by those who live them" [35].

Participant Selection

During the summer of 2015, I recruited volunteers via email from the population of 55 students who had either a) graduated from the transfer program or b) completed the Engineering Statics course within the program following procedures approved by our university's institutional review board. Because Statics is the first engineering course engineering students take, completion of Statics ensured that all volunteers had experienced actual engineering instruction within the transfer program. The 25 volunteers who responded were asked to complete an online screening survey about the nontraditional student characteristics they possessed while enrolled in the transfer program. Screening survey data were used to characterize volunteers as traditional, minimally nontraditional, moderately nontraditional, or highly nontraditional [3]. I used a

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[1] Here, Chase [35] uses the term "narrative inquiry" as a synonym for narrative research more generally, and is not referring to the specific research methodology known as Narrative Inquiry developed by Dr. Jean Clandinin and colleagues.

purposive sampling strategy known as “intensity sampling” [36] to select 14 participants (Table 1) who had between three and six characteristics in order to include those that “manifest sufficient intensity to illuminate the nature …” of being a nontraditional student and exclude “extreme or deviant cases [that] may be so unusual as to distort” the experiences of interest to the study [36].

Table 1. Characteristics of Study Participants

Participant self-selected identifier	Gender	Nontraditional Category	Age at start	Years spent in transfer program to associate’s degree
Connor	M	Moderate (3)	20	4
Cade	M	Moderate (3)	21	2
Mike	M	Moderate (3)	22	2
Clair	M	Moderate (3)	22	2.5
Tom	M	High (5)	22	2.5
Jaxon	M	Moderate (3)	22	3
Skyler	M	High (5)	23	5
Cooper	M	Moderate (3)	24	4.5 (expected)
Joe	M	High (5)	29	6
Brad	M	Moderate (4)	31	5
Daniel	M	High (5)	33	3.5
Tommy	M	High (5)	41	7
Thomas	M	High (5)	44	3
Kay	F	High (5)	48	NA[2]

Note 1. In keeping with the racial/ethnic makeup of the student population at this institution, all participants were white and not of Hispanic or Latinx ethnicity.

Note 2. Kay, who was attempting to reenter the engineering workforce after raising a family as a single parent, never officially enrolled in the transfer program since she already had a bachelor’s degree in civil engineering.

Methods

I generated qualitative data individually with each participant over a seven-month period using a dialogic, in-depth, interview process. Interviews were conversational in tone, semi-structured, recorded, and transcribed for analysis. The purpose of the semi-structured interviews was to engage participants in sharing personal stories related to their experiences in the transfer program. Initial interview protocols included questions that helped focus participant story-telling on the topic of the research question, including: 1) Describe how you came to participate in the transfer program? 2) What are/were your goals? 3) What obstacles do/did you face? and 4) What successes have you achieved?

The multi-interview process required both participant and researcher to complete specific activities prior to each meeting. Participant activities included completing the screening survey, preparing a journey map of experiences in the program [37], and reviewing and providing comments on drafts of their narratives I was developing using generated data. Researcher activities included developing the initial and follow on interview protocols, completing a reflective memo after each meeting, preparing an “annal” or “chronicle” [38] to synthesize each participant’s narrative description of their experiences into a time-based account and then co-develop and refine a longitudinal narrative of experience with each participant.

Analysis

In keeping with qualitative scholars who urge integration of data generation and analysis so that each informs the other [39-42], I embedded "narrative analysis" directly within data generation processes (Figure 1). Narrative analysis is the process by which researchers organize data elements (i.e., discrete stories) into a coherent developmental account [34]. In effect, narrative analysis is a synthesis of data rather than its separation into constituent parts (i.e., coding). I used narrative analysis to create representative, experiential narratives in collaboration with each participant. Later, I analyzed the data across the narratives, looking for outcomes related to the research questions, to provide transferable conclusions and recommendations for practice. To further ensure research quality, I engaged in regular debriefings with two research advisors: a senior researcher and associate professor in the field of engineering education and a professor of qualitative research in the field of education.

Limitations

A sample size of 14 may be considered as one limitation of this study. However, smaller (i.e., less than 20) sample sizes are characteristic of qualitative research since they allow for in-depth, detailed data collection and interpretation and findings from qualitative research do not purport to be representative of the population of interest. Rather, qualitative researchers employ purposeful selection in order to select an appropriate number of participants that "…will best help the researcher understand the problem and answer the research questions" [43]. Therefore, the richly detailed and descriptive nature of the narrative data collected from the participants in this qualitative study is seen to mitigate any limitations associated with sample size.

A second limitation of this study is the lack of cultural, ethnic, and gender diversity within the participant population. The student population at our university is strongly influenced by its location in the western United States; the majority of students who participated in the engineering transfer program are white and male. The use of Horn's [3] model to characterize student participants based on age-, education- and socioeconomic-related nontraditional student factors— rather than on race, ethnicity, or gender— helped mitigate this limitation by providing a framework for categorizing participant diversity in ways that are transferrable across contexts.

A third limitation of this study is the reflective nature of the data. Because the participants retrospectively described their experiences, there is uncertainty whether these descriptions closely match the descriptions the participants would have provided if interviewed while in the program. It may be true that the participants, at the time of the interviews, possessed a more holistic opinion of the program that affected their memories of their experiences. Methodological emphasis on data triangulation, member checking of co-created narratives, and the prolonged field time of the researcher (six years teaching in the program) helped to mitigate this limitation.

Findings and Discussion

Findings highlight participants' views of their success in engineering education, as well as how these views related to their goal of becoming engineers. Analysis showed that participant views of success were contextual, relational, and reflective of participant's long-term goals that often evolved or solidified during the educational process. While many participants held views of success previously reported in the engineering education, community college, and nontraditional student literature, this study also uncovered other views of success not previously reported.

Participant Success Measures Reflect Those Reported in Engineering Education Literature

In analyzing the data, the multi-faceted nature of the construct of student success [6, 9] became evident. Most participants described having more than one view of success. As shown in Table 2, many of the varied ways in which student success has been operationalized among traditional student populations within the engineering education literature (e.g., degree attainment, grade achievement, persistence or intentions to persist in a degree major over time, and re-enrollment) were also reflected in the participants' personal views of success. Specifically, eleven participants considered that earning an engineering bachelor's degree was a summative or cumulative measure of their overall educational success. Several (six) participants considered grades in engineering, especially in the transfer program, to be formative indicators of their success. Many participants indicated that earning good grades in the transfer program increased their confidence and engineering self-efficacy. Persistence in a chosen engineering disciplinary major and re-enrollment on a semester-by-semester basis were other ways that participants assessed their success. All of these success measures have been previously reported in the engineering education literature (Table 2).

Table 2. *Participant Success Measures Previously Reported in Engineering Education Literature*

Success Measure	Participants (# participants)	Used as Success Measure in Engineering Education Literature
Earn engineering bachelor's degree	Skyler, Tom, Clair, Daniel, Connor, Tommy, Brad, Joe, Mike, Jaxon, Thomas (11)	Moller-Wong and Eide [11]
Get good grades in engineering program	Cade, Mike, Tom, Kay, Clair (5)	Baldwin [18], Haemmerlie and Montgomery [20], Suresh [21]
Persist in engineering major	Clair, Cooper, Brad (3)	Lent, et al. [14], Cech, et al. [15], Litzler and Young [16], Suresh [21]
Re-enroll in engineering programs at other universities	Cooper (1)	Ohland, et al. [19], Haemmerlie and Montgomery [20]

Contextual nature of common success measures. In addition, we found that many of these common views of success that were previously reported in the engineering education literature carried contextual undertones among the participants. One example was seen in the participants' considerations of using grades to indicate success. Four students (Cade, Mike, Tom, Kay) who listed grades as a measure of success had been high achieving students in high school. Based on their high school experience, they easily connected high grades with success. These students considered good grades to be "mostly A's" (Mike), especially during the transfer program. Each of these students expressed the idea that getting "good" grades improved their confidence and helped them feel that they could do (or, in Kay's case, could still do) engineering.

Yet, the meaning of the word "good" in "good grades" was seen as mutable among the participants. Brad, who had been a hard working—but not an exceptionally high achieving—student in high school, considered "good" grades in engineering to be "no D's and no repeats." Grades below Brad's level of "good" would be insufficient to keep clear of administrative actions related to the number of courses failures and repeats. Clair, who admitted that he had not tried very hard in high school (except in automotive class), came to view grades as a personal measure of success only after he earned high marks during his first semester in the transfer program. Prior to completing that first semester, Clair considered "doing as well as he could" and "trying hard" as being successful. After achieving high marks in all of his classes for the first time in his life that first semester, Clair began to base his personal success in engineering on his grades.

For Cooper, who had struggled substantially while moving in and out of several high schools, success was experienced simply as "survival" in engineering and persistence within the major — regardless of the grades he achieved. In fact, Cooper's fierce determination to continue in engineering education led him to search for other nearby engineering programs that would allow him unfettered re-enrollment with unlimited course retakes.. In the event that he was unsuccessful in the transfer program (due to an excessive number of course failures), Cooper was determined to re-enroll in engineering at another institution. Thus, Cooper saw dogged persistence toward his goal of becoming an engineer, rather than his grades, as a measure of his success.

Participant Success Measures Reflect those Attributed to Nontraditional Students

The ways participants' experienced success also supported the broader representations of success attributed to nontraditional students in the community college literature (Table 3). These views of success include a more generalized goal orientation [12], the attainment of recognized career skills [13, 22, 25], and maintaining balance between competing life demands [22, 24].

Table 3. *Participant Success Measures Attributed to Nontraditional Students in the Literature*

Success Measure	Participants (# participants)	Literature
Get an engineering job after college /Improve earning potential /Get a better life	Clair, Skyler, Cooper, Daniel, Thomas, Jaxon (6)	Wirth and Padilla [12]
Understand engineering /Learn to relate engineering to real world /Gain engineering skills /Learn how to learn engineering	Cade, Tom, Connor, Brad, Joe, Mike, Kay (7)	Boswell and Passmore [13], Johnson and Berge [22], Knowles, et al. [25]
Maintain job performance and/or family life during school	Tom, Joe, Mike, Brad, Kay, Thomas (6)	Johnson and Berge [22], Enke and Ropers-Huilman [24]

Several participants equated success in engineering education with a social mobility goal of becoming an engineer. Others equated success to learning the material well and being able to apply engineering concepts to real world problems. Four participants (i.e., Tom, Joe, Mike, and Brad) who were concurrently employed in engineering–related roles (e.g., technician, engineering apprentice, engineering intern) considered that maintaining their job performance while earning their degree was an important facet of their success. It was clear that these participants viewed current employment as a pathway to a career as an engineer. Therefore, they strongly desired to maintain their level performance and supervisor/mentor relationships. In other words, these participants would not have considered themselves successful if they earned the engineering bachelor's degree but lost or performed poorly in their current job in the process. Others (Tom, Joe, Mike, and Kay) further discussed how important it was to them to balance school with work and family life. Thomas described the strain that going to school placed on his marriage and his need to stop-out when faced with a personal family tragedy.

Contextual interplay between degree attainment and social mobility goals. The relationship between more traditional success measures, such as degree attainment, and nontraditional success measures, such as goal realization, is important to consider. In contrast to more academic majors in higher education, engineering is a professional major (i.e., engineering bachelor's degree programs prepare students for careers in the engineering profession; an engineering bachelor's degree is prerequisite for gaining employment as an engineer). With this understanding of the professional nature of engineering study, the traditional success marker of degree attainment was conflated with the participants' social mobility/career goal in this study. Based on the co-created narratives, it is clear that all participants desired to work as engineers. Moreover, 11 of 14 participants indicated that degree attainment was a personal marker for success. Therefore, degree attainment as a marker for success cannot be wholly separated from the social mobility career goal. In other words, it was likely that the participants' view of degree attainment as a success measure was more related to their desire to gain employment as an engineer than to getting an academic degree in engineering. As Thomas explained, " …In your forties, you go to school because you want a better job… not because Mom's making you go to college." This finding supports those of Hagedorn [23] who reported that older community college students were less likely to return to college to earn a degree than younger students, but more likely than younger students to return to school because a degree or certification was required for work or because their employer encouraged them to go.

Stackable credentialing in engineering. The potential for offering stackable credentials as incentives to nontraditional students in engineering is also of importance. In conversations with the participants, many communicated that they did not place substantial value in earning an associate's degree in Preengineering. None of the participants suggested that they had a goal of earning an associate's degree when they entered the transfer program. All participants (except for Kay, who already had an engineer bachelor's degree) pursued an engineering bachelor's degree as prerequisite for engineering employment. Notably, Jaxon was unaware that he had earned an associate's degree after completing the transfer program; Tom described how he was "embarrassed to walk at graduation" for an "just and associate's degree." It was clear from the narratives that the participants valued the bachelor's degree, and devalued the associate's degree, based on the perceptions of the employment potential each degree represented.

Alternatively, a few participants did see value in earning an associate's degree in Preengineering for other reasons. Cade and Skyler noted that an associate's degree might help facilitate college credit transfer to another institution, since credit for awarded degrees may be easier to transfer than individual courses. Others (Tom, Tommy) suggested that earning the associate's degree served as a personal and professional milestone on the way to earning a bachelor's degree and provided them a measureable stake in the ground. Tom and Cade envisioned that the associate's degree could as potentially serve as "employment insurance" (Tom) or a "backup plan" (Cade) in the event that completion of the full engineering bachelor's degree didn't work out. Tommy saw tangible evidence of this potential in the form of job postings for civil engineering technician jobs that required an Associate's Degree in Preengineering. Some participants (Tommy, Joe, Brad, Mike, Thomas) discussed how earning the associate's degree helped them prove to their current employers that that they were serious about—and capable of—completing their engineering bachelor's degree program improved their chances of getting a full time engineering position with the same employer once they graduated with their bachelor's degree.

Participant Success Measures Not Previously Reported in the Literature

As shown in Table 4, participants also experienced success in ways not previously reported in the literature. Nine participants qualified the traditional success measure of degree attainment. These qualifiers included a) attaining the bachelor's degree in the minimal time possible, b) limiting or abstaining from student loans while in school, and c) maintaining a level of employment that provided retirement and/or medical health benefits while pursuing their degree.

Table 4. *Participant Success Measures Not Previously Reported in the Literature*

Success Measure	Participants (#)
Minimize time to bachelor's degree	Daniel, Mike, Skyler (3)
Limit / abstain from student loans while attending school	Cade, Clair, Daniel (3)
Maintain retirement or medical benefits while attending school	Mike, Tom, Kay (3)

Minimize time to engineering bachelors' degree. Mullin [44] discussed that time was a critical factor for low-income students who attend 2-year institutions primarily because their time is often limited due to work responsibilities. Mullin [44] and Fry [45] pointed out that these students may "stop-out" of school during time of financial or personal hardship. Clearly, participants in this study experienced severe and often conflicting demands. They were required to effectively prioritize activities and manage their time in order to simultaneously progress in the program, maintain employment, and care for their families. Yet, despite these demands, three participants (Daniel, Mike, and Skyler) qualified their success in terms of the time it took them to earn their bachelor's degree. For these participants, setbacks that delayed their degree completion were particularly distressing. Daniel, who was a self-employed entrepreneur prior to starting in the transfer program, was determined to beat the national average time for bachelor's degree completion. Mike was determined to stay on track in the transfer program, even while suffering a near-fatal rupture of his appendix. Instead of taking another setback, Skyler— who lost nearly a year when he broke his wrist in an automobile accident during the transfer program—chose to change majors from mechanical engineering to civil engineering in order to stay on track for graduation. For these participants, there was the sense of their urgency to get out of school and on with life—in terms of earnings and family life—as quickly as possible. This result contradicts the community college literature that indicates that nontraditional students often stop-out in times of personal emergency and potentially points to ways in which nontraditional students in professional majors, such as engineering, may view success as time-dependent.

Limit / abstain from student loans. Spellman [46] and Bailey [47] argued for increased financial assistance for non-traditional students. Bailey [47] claimed that the federal student loan program, which is currently based on need, is biased toward younger, full-time students and against working students. McKinney, et al. [48] found that, while they often considered federal loans as a last resort, community college students reported feeling that the loans had ultimately contributed to their academic success. These authors warned that while an "aversion to borrowing" can protect students from accruing "unmanageable debt," it can also act as a "barrier to [educational] access and persistence" [48, Student and Familial Characteristics, para. 2].

Eleven of the 14 participants in this study were considered financially self-supporting ("financially independent" for student loan determination); all were responsible for paying for their own education. Three of the participants (Clair, Daniel, and Cade) made conscious decisions to either heavily limit or altogether abstain from taking out student loans to pay for their engineering education (Table 4). These participants went as far as to consider limiting /abstaining from student loans as a condition of success: the less money they borrowed to finance their engineering degree, the more successful they judged themselves to be. This potentially unprecedented view of success may have been an artifact of upbringing within the dominant local culture (Latter-Day Saints), a particular characteristic of nontraditional students who study engineering, or underpinned by the participants' personal abilities to secure alternative funding for school (Clair and Daniel were able to fund transfer program costs using scholarships; Cade was able to fund his education by working and living at home with this parents). It may also be true that nontraditional students who are employed and support spouses (Clair) or families (Daniel) have more developed financial sense and, thus, are more wary of incurring student loan debt than traditional students are. This area is ripe for further research.

Maintain retirement or medical benefits while attending school. There were participants who indicated that maintaining medical and retirement benefits while attending school was an important or necessary part of their success. Tom, Mike, and Kay each discussed the importance of maintaining the health and retirement benefits they were earning prior to entering the transfer program while they were going to school. The desire to maintain his current level of retirement benefits made it unattractive for Tom, who had been receiving 401K retirement benefits since he started working at the Wal-Mart Distribution Center at 19, to look for other jobs that may have better accommodated his school schedule. Tom kept the same benefitted job throughout his engineering education even though it meant he was never able to do course work or study during the weekend (because he worked thirty-six hours on the graveyard shift Fridays - Sundays). For Kay, a degreed civil engineer who left the profession to raise her family as a single parent, the need to maintain medical benefits for her three children effectively tied her to a low skilled, seasonal job for the IRS and made it impossible to attend school on a consistent basis. Mike found the health benefits he received on the job to be invaluable when he got married after completing the transfer program. The desire/need of nontraditional students to receive/maintain medical and retirement benefits as part of their employment during school, which has implications for nontraditional student academic and employment decisions, has not been previously reported in the literature.

Conclusion and Implications

This study explored how nontraditional student participants experienced success while participating in 2-yr engineering transfer program. The focus on nontraditional students is timely and in tune with national STEM education priorities. The aim of this study was go “beneath the surface” [32] to find deeper meaning in ways in which nontraditional students make sense of their experiences within engineering education.

In sum, study findings suggest that nontraditional students in engineering view success differently than traditional engineering students do. Findings illustrate how nontraditional engineering students conceptualize success as a blend of academic measures commonly used to operationalize student success in the engineering education literature (i.e., progression towards a degree, grade performance, persistence in intended major, and re-enrollment) and the relational and goal-oriented views more common among students attending community and two-year colleges (i.e., social mobility, learning how to apply knowledge and skills in the workforce, and maintaining an appropriate balance of school, work, and family responsibilities). Additionally, this study uncovered previously unreported ways that nontraditional students in engineering qualified their success in terms of time and financial considerations, including minimizing time to bachelor’s degree, and abstaining from student loans and maintaining employer’s health and retirement benefits while in school.

The findings of this study have three potential implications for engineering education practice. First, instructors, advisors, and administrators may benefit nontraditional students in engineering simply through greater awareness of the ways that nontraditional engineering students conceptualize their educational success differently than the ways documented in the engineering education literature (I.e., grade and persistence in major). With greater awareness, instructors can tune the types and timing of course assignments and assessments to align with the other life demands faced by nontraditional students, who may be integrating college, work, and families responsibilities. Instructors may choose to place greater emphasis on conducting career mentoring with nontraditional students, who are more likely to be employed, at some level, in the STEM workforce while pursuing their degree. Advisors and administrators can consider how current academic policies and procedures, such as limits on course repeats and withdrawals, may disproportionally limit or curb nontraditional student persistence. Advisors and administrators may also look for ways to adjust or augment current student recognition/award structures, which are typically grade-based (i.e., dean’s lists, honor societies) or require student participation in extracurricular activities (i.e., undergraduate research, club and council leadership). Finding ways to recognize the efforts, achievements, and contributions made by nontraditional students in engineering may further improve their persistence.

Second, findings of this study suggest that one of the most profound ways that academic institutions can promote nontraditional student success is by supporting their employment while in school. Rather than limiting engineering academics and employment to be an either-or proposition, academic institutions might actively partner with local engineering industries to help place nontraditional engineering students who require employment into part- or full- time engineering-related (e.g., technician, drafting, apprentice) jobs. Job placements would help nontraditional financially support themselves and dependents while also providing them professional experience and opportunities for applying engineering-related concepts in practical situations. Partnerships may also benefit local engineering employers by providing a vetted source of employees who are simultaneously instructed and mentored in engineering.

Last, the findings from this study suggest that institutions should carefully consider the implementation of stackable credentials along engineering pathways. While some study participants viewed an Associates Degree in Preengineering as a backup plan or potential employment insurance in case of degree non-completion, participants generally did not value the associate's degree. While providing stackable credentials in engineering should carry substantial benefits for students who may have to stop-out and re-enter school at a later date, what, when, and how many credentials are the most beneficial for nontraditional students in engineering is an important area for further study. This study suggests that institutions should closely coordinate with local engineering employers to ensure these employers value the stackable credential and use it as a hiring criterion. Generally, this study suggests that if local employers recognize and value the stackable credential, student will also.

References

[1] (2002). *Findings from the Condition of Education, 2002. Nontraditonal undergraduates (NCES 2002-012)*.

[2] J. P. Bean and B. S. Metzner, "A conceptual model of nontraditional undergraduate student attrition," *Review of Educational Research,* vol. 55, no. 4, pp. 485-540, 1985.

[3] (1996). *Nontraditional undergraduates: Trends in enrollment for 1986 to 1992 and persistence and attainment among 1989-1990 beginning postsecondary students (NCES 97-578)*.

[4] Committee on STEM Education of the National Science and Technology Council (NSTC), "Charting a course for success: America's Strategy for STEM Education," December 2018. Accessed: January 26. [Online]. Available: https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

[5] (2009). *Stats in Brief: Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education (NCES 2009-161)*.

[6] M. van den Bogaard, "Explaining student success in engineering education at Delft University of Technology: A literature synthesis," *European Journal of Engineering Education,* vol. 37, no. 1, pp. 59-82, 2012.

[7] V. Tinto, *Leaving College. Rethinking the Causes and Cures of Student Attrition.* London: University of Chicago Press, 1987.

[8] M. A. Beasley and M. J. Fischer, "Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math, and engineering majors," *Social Psychology of Education,* vol. 15, no. 427-488, 2012.

[9] E. Seymour and N. M. Hewitt, *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press, 1997.

[10] O. Pierrakos, T. K. Beam, J. Constantz, A. Johri, and R. Anderson, "On the development of a professional identity: Engineering persisters vs engineering switchers," in *39th ASEE/IEEE Frontiers in Education Conference*, San Antonio, TX, 2009.

[11] C. Moller-Wong and A. Eide, "An engineering student retention study," *Journal of Engineering Education,* vol. 86, no. 1, pp. 7-15, 1997.

[12] R. M. Wirth and R. V. Padilla, "College student success: A qualitative modeling approach," *Community College Journal of Research and Practice,* vol. 32, pp. 688-711, 2008.

[13] R. A. Boswell and D. L. Passmore. (2013) Role of early family configuration and hours worked on student success in two-year colleges. *The Community College Enterprise*. 9-18.

[14] R. W. Lent *et al.*, "Social cognitive predictors of adjustment to engineering major across gender and race/ethnicity," *Journal of Vocational Behavior,* vol. 83, pp. 22-30, 2013.

[15] E. Cech, B. Rubineau, S. Silbey, and C. Seron, "Professional role confidence and gendered persistence in engineering," *American Sociological Review,* vol. 76, no. 5, pp. 641-666, 2011.

[16] E. Litzler and J. Young, "Understanding the risk of attrition in undergradiate engineering: Results from the Project to Assess Climate in Engineering," *Journal of Engineering Education,* vol. 101, no. 2, pp. 391-345, 2012.

[17] M. Bruinsma and E. P. W. A. Jansen, "Educational productivity in higher education: An examination of part of the Walberg Educational Productivity Model," *School Effectiveness and School Improvement,* vol. 18, no. 1, pp. 45-65, 2007.

[18] A. Baldwin, "Indicators of success for University of Miami-Dade Community College graduates in business/management, computer sciences and engineering," Miami-Dade Community College, Florida. Office of Institutional Research, 1993. [Online]. Available: http://files.eric.ed.gov/fulltext/ED366395.pdf

[19] M. W. Ohland, S. D. Sheppard, G. Lichtenstein, O. Eris, D. Chachra, and R. A. Layton, "Persistence, engagement, and migration in engineering programs," *Journal of Engineering Education,* vol. 97, no. 3, pp. 259-278, 2008.

[20] F. M. Haemmerlie and R. L. Montgomery, "Gender differences in the academic performance and retention of undergraduate engineering majors," *College Student Journal,* vol. 46, no. 1, pp. 40-45, 2012.

[21] R. Suresh, "The relationship between barrier courses and persistence in engineering," *Journal of College Student Retention,* vol. 8, no. 2, pp. 215-239, 2006.

[22] S. G. Johnson and Z. Berge, "Online eductaion in the community colllege," *Community College Journal of Research and Practice,* vol. 36, pp. 897-902, 2012.

[23] L. S. Hagedorn, "Adult students and their "fit" in postsecondary institutions," *Change,* vol. 37, no. 1, pp. 22-29, 2005.

[24] K. A. E. Enke and R. Ropers-Huilman, "Defining and achieving success: Students at catholic women's colleges," *Higher Education in Review,* vol. 7, pp. 1-22, 2010.

[25] M. S. Knowles, E. F. Holton, and R. A. Swanson, *The adult learner: The definitive classic in adult education and human resource development*, 6th ed. Burlington, MA.: Elsevier., 2005.
[26] S. Olson and J. B. Labov, *Community College in the Evolving STEM Education Landscape: Summary of a Summit.* Washington DC: National Academies Press, 2012.
[27] (2012). *Community college student outcomes 1994-2009 (NCES Report 2012-253)*. [Online] Available: http://nces.ed.gov/pubs2012/2012253.pdf
[28] J. Jawitz and J. Case, "Communicating your findings in engineering education: The value of making your theoretical perspective explicit," *European Journal of Engineering Education,* vol. 34, no. 2, pp. 149-154, 2009.
[29] M. Koro-Ljungberg and E. P. Douglas, "State of qualitative research in engineering education: Meta-analysis of JEE articles, 2005-2006," *Journal of Engineering Education,* vol. 97, no. 2, pp. 163-176, 2008.
[30] Y. S. Lincoln, S. A. Lynham, and E. G. Guba, "Paradigmatic controversies, contradictions, and emerging confluences, revisited," in *The Sage handbook of qualitative research*, N. K. Denzin and Y. S. Lincoln Eds., 4th ed. Thousand Oaks, CA: Sage Publications, Inc., 2011, ch. 6, pp. 97-128.
[31] C. Glesne, P. Smith, Ed. *Becoming qualitative researchers: An introduction*, 4th ed. Boston, MA: Pearson, 2011.
[32] J. M. Case and G. Light, "Emerging methodologies in engineering education research," *Journal of Engineering Education,* vol. 100, no. 1, pp. 186-210, 2011.
[33] J. W. Creswell, *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage, 2013.
[34] D. E. Polkinghorne, "Narrative configuration in qualitative analysis," *International Journal of Qualitative Studies in Education,* vol. 8, no. 1, pp. 5-23, 1995.
[35] S. E. Chase, "Narrative inquiry: Still a field in the making," in *The Sage Handbook of Qualitative Research*, N. K. Denzin and Y. S. Lincoln Eds., 4 ed. Thousand Oaks, CA: Sage, 2011, ch. 25, pp. 421-434.
[36] M. Patton, *Qualitative research and evaluation methods*, 3rd ed. Thousand Oaks, CA.: Sage Publications, 2002.
[37] J. D. Nyquist *et al.*, "On the road to becoming a professor," *Change,* vol. 31, no. 3, pp. 18-27, 1999.
[38] D. J. Clandinin, *Engaging in Narrative Inquiry* (Developing Qualitative Inquiry). Walnut Creek, CA: Left Coast Press, 2013.
[39] Y. S. Lincoln and E. Guba, *Naturalistic inquiry*. Beverly Hills, CA: Sage, 1985.
[40] J. A. Maxwell, *Qualitative research design: An interpretive approach*. Thousand Oaks, CA: Sage, 1996.
[41] M. B. Miles and A. M. Huberman, *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage, 1994.
[42] I. E. Seidman, *Interviewing as qualitative research*. New York: Teacher's College Press, 1991.
[43] J. W. Creswell, *Research design: Quantitative, qualitative, and mixed methods approaches*, 4th ed. Thousand Oaks, CA: Sage Publications Inc., 2014.
[44] C. M. Mullin, *It's a matter of time: Low-income students and community colleges (Policy Brief 2012-02PBL)*. Washington, DC: American Association of Community Colleges., April 2012.

[45] R. Fry, *Latinos in higher education: Many enroll, too few graduate*. Washington, DC: Pew Hispanic Center, 2002.

[46] N. Spellman, "Enrollment and retention barriers adult students encounter," *The Community College Enterprise,* vol. 13, pp. 63-79, 2007.

[47] T. Bailey, "Student success: Challenges & opportunities," *Community College Journal,* vol. 76, no. 1, pp. 16-19, 2005.

[48] L. McKinney, M. Mukherjee, J. Wade, P. Shefman, and R. Breed, "Community college students' assessments of the costs and benefits of borrowing to finance high education," *Community College Review,* vol. 43, no. 4, 2015.