

Work-in-Progress: Student Experience and Pathways to Success of "Non-Traditional" Students in Chemical Engineering

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Introduction

This work-in-progress paper presents the initial phase of a two-year NSF-supported project focused on understanding the experiences of non-traditional students enrolled in a traditional Chemical Engineering (ChE) undergraduate program.

Most engineering curricula in US universities were designed based on the assumption that students would enter a four-year college immediately after high school and then progress linearly through a sequential set of courses to complete a bachelor's degree. This has resulted in curricula that can present both challenges and opportunities for non-traditional students. The curriculum in Chemical Engineering (ChE) and related engineering disciplines is typically highly sequential, with the timing and order of courses enforced by specific pre- and co-requisite requirements. [1] The sequential nature of the courses means that there are multiple possible bottlenecks and barriers that can make it difficult for students to progress through the program. Anecdotally, we have observed that a missing pre-requisite or failed course can delay student graduation by a full year, leading to increased student costs and a higher chance that a student will not complete their degree program. [1] This is true for traditional engineering students, and these problems could be exacerbated for non-traditional students such as transfer and part-time students.

There is a lack of data and insight regarding the experiences of both traditional and non-traditional undergraduate students in ChE and related programs. This information is critically important to understand the effectiveness of any curricular changes and the implementation of initiatives aimed at improving student experience. Herein we describe the literature review and instrument design stages of a longitudinal, mixed-methods study that will track student experiences through their first three semesters (18 months) in a ChE degree program (i.e., after enrollment in the introductory ChE Mass & Energy Balances course).

The purpose of this WIP is twofold: (1) identify common characteristics of different groups of students considered as non-traditional; and (2) identify existing instruments and/or key concepts to build or adapt survey and interview instruments appropriate to capture the experiences of non-traditional students enrolled in traditional Chemical Engineering undergraduate programs.

Literature Review

This work does not aim to enumerate all possible categories of non-traditional students. Rather, it concentrates on three groups that reflect the primary characteristics of interest for this study: veterans, transfer students, and returning mature students. These subgroups of students have received attention from previous literature and are a large representation of non-traditional students. We aim to uncover the complexities experienced by Chemical Engineering students from diverse backgrounds, such as those in the aforementioned non-traditional pathways, to

understand what factors can have a distinct impact on their educational experience. From this expansive body of literature, we identified eight constructs that encompass major factors common across those different non-traditional populations. These constructs are focused on (1) transition and identity shifts, (2) institutional complexities, (3) academic adjustments, (4) personal life outside of the academic setting, (5) social acceptance, (6) costs or additional resources needed, (7) development of personal connections with people within the academic world, and (8) a focus on an asset over deficit mindset.

Regarding transitions and identity shifts, existing literature highlights Schlossberg's Transition Theory and the applications of the 4 S's—situation, support, self, and strategies [2], [3]. In the veteran space, this could be seen along a continuum of starting the educational journey, being deployed, serving in combat, and beginning school again [2]. A similar notion coined “transfer shock” is found in transfer students who experience some dip in academic performance after they have matriculated into a new school [4]. Within returning students, individuals were labeled as “frustrated participants” due to their difficulty acclimating to educational environments that were not always inclusive of different backgrounds [5]. A frustrated participant could be further defined as someone who was motivated by educational outcomes but not always able to gain educational support [5].

Differing institutional environments come with differing institutional complexities. For veteran students, this could be related to GI Bill issues or VA health benefits. [6]. For instance, being unable to produce proof of funding or health insurance could negatively impact academic enrollment [7]. Returning students who might need loans for their education can feel that the increasing amount of debt is not designed for someone who has other non-academic financial obligations [5]. This can make these students feel that the system, in its entirety, was not designed for someone like them. Lack of guidance within higher education can be seen within all student groupings, with returning students claiming it is an environment “not for the likes of them” and transfer students noting additional constraints such as weak articulation policies (e.g., unclear requirements to transfer credits) and a lack of transfer advising or preparation regarding the higher level of academic performance expected [4], [5].

Within academia, the emphasis on learning “how to learn” can be a challenge upon reintegration for students balancing other personal activities or experiencing various amounts of stigmatization which can be different from traditional first-time in college students [8]. Based on enrollment as a full- or part-time student, additional barriers relating to time management and assignment completion need to be accounted for [5]. This can be additionally seen in the support systems a student has. For example, for a veteran transitioning back into academia, having a strong familial pillar or support system was found to be extremely important for overall student success [8]. Having strong on-campus support for students with similar experiences, such as being a returning student, promotes an environment in which certain events, like orientation sessions, do not seem exclusionary.

When it comes to serving non-traditional students, identifying them early and crafting holistic support solutions can foster their success. From a veteran's perspective, identifying those students and providing them with mentorship or transition coaching/counseling can promote their overall success and trajectory [8]. Similarly, in supporting transfer students, avoiding a view that considers them as a monolithic block is important, as each individual student needs their own academic tailoring from an institutional resource perspective [9].

Extensive work has shown that transfer students bring forms of social capital—such as established academic and peer networks—that are associated with positive student outcomes [10]. However, veteran students found social aspects such as finding mentorship or navigating leadership more difficult. Military leadership comes with a clear chain of command; however, within academia this form of structure is not always explicit, and it is often incumbent upon the student to discover [8]. Students whose parents did not have any educational experience in the country in which they are attending college, revealed additional difficulties due to overall unfamiliarity with university structuring and lack of guidance [5].

Our last construct, asset over deficit mindset, will entail a set of questions highlighting the assets that a non-traditional student can bring to a chemical engineering undergraduate program rather than focusing on deficits. More importantly, this asset over deficit approach will guide the wording of the questions across all eight constructs. The notion of deficit thinking, a stigma unfortunately common in the study of transfer students, insinuates a damaging stereotype that a student might not be intellectually capable of progressing through a given set of academic curricula [10]. However, non-traditional students can possess distinct advantages when compared to first-time-in-college (FTIC) students. An example found in veteran students is a high-level of leadership and maturation; similarly, returning students bring a wealth of lived experiences [11].

Research Methods

While the previous section addressed the first purpose of this work (i.e., identify common characteristics of different groups of students considered as non-traditional) it also enabled the identification of existing research instruments that could be adapted for the purpose of this study. Our study will be guided by an explanatory mixed methods approach [12]. The first strand of data will be collected through the longitudinal application of a survey (three instances over an 18-month period), followed by a second strand consisting of qualitative interviews. The repeated application of the survey aims to capture evolutions and changes in students' experience. We have chosen the follow-up explanations variant of the explanatory design process that uses the qualitative strand to provide greater depth and insights that would not be captured by a survey [12]. Ongoing work includes defining criteria to decide how students will be selected to participate in the interview process.

The Laanan-Transfer Students' Questionnaire (L-TSQ) emerged as the most suitable candidate. The L-TSQ is a 304-item survey focused on transfer students' non-cognitive traits, interests, and attitudes through a series of Likert-scale questions ranging from "agree strongly" to "disagree

strongly” [13]. The original development and validation of the Laanan Transfer Student Questionnaire (L-TSQ) reports evidence of reliability and validity through multiple procedures, including the calculation of coefficient alpha values for each factor, stability testing, an extensive review of relevant literature, pilot testing with a representative sample, and the establishment of face validity to ensure alignment between survey items and their intended constructs [13]. However, due to the perceived impracticality of administering such a long questionnaire as the L-TSQ, we decided to explore the development of our own instrument grounded in the eight constructs identified through the literature review.

Based on the factors proposed within the L-TSQ and their associated components, Table 1 illustrates how the constructs identified through the literature review can be conceptually aligned with L-TSQ factors [13]. Although there is not a one-to-one mapping—and it was not expected—four of our constructs exhibit direct alignment with different components of the three L-TSQ factors. The remaining constructs identified through the literature review are conceptually related to additional L-TSQ components, with the exception of (6) costs or additional resources needed.

Table 1. Alignment of Study Constructs with L-TSQ Factors [13]

Factor Name from L-TSQ	Associated Component from L-TSQ	Directly Aligned Constructs	Conceptually Related Constructs
Quality of effort	• Experiences with faculty	(7) Connections with people in academia	
	• Clubs and organizations		(7) Connections with people in academia
	• Course learning		(3) Academic adjustment
	• Experience with academic counseling		(2) Institutional complexities
General perceptions	• Overall satisfaction at four-year institution		(2) Institutional complexities
	• Perceptions of faculty		(7) Connections with people in academia
	• Stigma as transfer student		(8) Asset over deficit mindset
	• Competition and survival culture		(1) Transition and identity shifts
Adjustment Process	• Psychological adjustment	(1) Transition and identity shifts	
	• Academic adjustment	(3) Academic adjustment	
	• Social adjustment	(5) Social acceptance	(4) Life outside academic setting

Unlike components of the L-TSQ instrument, the constructs we identified are not organized into higher-level categories based on the type or timing of students' experiences. Instead, our intent is to capture experiences associated with each construct across multiple points before and during the study period. This distinction in conceptualization, together with the inclusion of constructs related to financial and resource constraints, supports the decision to develop a new instrument. Moreover, the substantive alignment summarized in Table 1 provides preliminary evidence of content validity for the selected constructs.

Given the page constraints of this work-in-progress paper, this manuscript presents only a high-level overview of the construct-to-instrument mapping. A more detailed discussion will be shared during the conference presentation.

Next Steps

Building on the same literature-informed process, we developed survey items designed to explore each of the eight constructs. We aimed to have at least four items per construct to support initial validity assessment while maintaining a reasonable survey completion time. In parallel, we followed established methodological guidance to inform the overall survey design, including the checklist proposed by Creswell and Creswell, which addresses participant selection, planned statistical analyses, potential threats to internal and external validity, and approaches to data interpretation [14]. Appendix A presents the survey instrument to support transparency and facilitate feedback. Preliminary results from the Spring 2026 pilot will be shared at the 2026 conference.

Participants in the study will include students enrolled in a Mass and Energy Balances course at three institutions in the U.S. Mid-Atlantic region with undergraduate Chemical Engineering programs. The work described in this WIP paper was conducted under interim approval by the Institutional Review Board (IRB); the full protocol has been revised and is currently under review. Following the receipt of IRB approval, the survey will be piloted during the late Spring 2026 semester at one participating institution. Findings from the pilot will be used to refine the instrument for administration to one cohort at each institution in Fall 2026 and to inform the development of a complementary semi-structured interview protocol as part of the mixed-methods research design. Students from the Fall 2026 cohorts will subsequently be tracked for up to two subsequent administrations of the survey instrument over an 18-month period.

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Appendix A. Survey Instrument

Non-traditional students experience items (blocks 1 through 8) are rated on a five-point Likert Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither disagree nor agree, 4 = Agree, 5 = Strongly agree

Header: Thank you for taking the time to complete this survey. Your participation will remain confidential. Any data collected will be analyzed and reported only in terms of overall trends; no names or personal information will be linked to your responses. While we value your honest perspective, feel free to skip any question or stop the survey at any point.

Please provide your institutional email address. This information will only be used to contact you in the event you are selected in the random draw for a gift card and/or for a follow-up survey at a later date.

Block 1. Transitional Challenges & Identity Shifts

Underlying construct: Difficulty renegotiating identity and role expectations during educational transition.

Items:

1. I experienced a significant personal adjustment when transitioning into my current academic program. (reverse code)
2. My previous life experiences align well with expectations for students in the four-year college or university environment.
3. I felt prepared for the cultural differences between my prior environment and the four-year college or university.
4. Adjusting to the role of “student” required more effort than I expected. (reverse code)
5. I felt that my transition into college involved more than just academic adjustments.

Block 2. Navigational Capital & Institutional Complexity

Underlying construct: Ability to navigate institutional systems, policies, and administrative processes.

Items:

1. I understood the administrative steps required to enroll and remain in my academic program. (for example, submitting transcripts, vaccine/medical requirements)
2. Institutional policies (for example, credit transfer, benefits, requirements) were clearly explained to me.
3. I knew where to go on campus to get help with administrative issues (for example, course registration, tuition payment).

4. Navigating institutional processes took time away from my academic focus. (reverse code)
5. I felt supported when dealing with institutional paperwork and procedures.

Block 3. Academic Adjustment

Underlying construct: Adjusting to academic behaviors, expectations, and skills.

Items:

1. I felt confident in my academic skills when I started my program.
2. Adjusting to academic expectations was challenging for me. (reverse code)
3. I needed time to relearn effective study or learning strategies. (reverse code)
4. I understood what professors expected of me academically. (for example, syllabus, assignments, exams)
5. My previous educational experiences prepared me well for my current coursework.

Block 4. Competing Life Roles & Time/Flexibility Constraints

Underlying construct: Impact of nonacademic responsibilities on academic engagement.

Items:

1. Responsibilities outside of school affect how much time I can devote to my studies. (reverse code)
2. I often must balance school with work, family, or other obligations. (reverse code)
3. My academic schedule is flexible enough to accommodate my life responsibilities
4. Time constraints due to non-academic duties make academic success more difficult for me. (reverse code)
5. My university recognizes that students may have responsibilities beyond school.

Block 5. Social Belonging, Peer Connection, & Stigma

Underlying construct: Sense of belonging and perceived acceptance within the campus community. (Focus on belonging in ChE and general experiences on campus)

Items:

1. I feel that I belong in the campus community.
2. I feel comfortable interacting with other students in my college classes.
3. I feel comfortable interacting with other chemical engineering students.
4. I feel misunderstood or out of place among my peers. (reverse code)
5. My background or pathway to college is respected by others.

6. I feel accepted by students who do not share my background.
7. I feel integrated into the chemical engineering community at my university.
8. My chemical engineering instructors made me feel appreciated.

Block 6. Financial Strain & Resource Adequacy

Underlying construct: Financial stress and access to necessary resources.

Items:

1. Financial concerns affect my ability to focus on my coursework. (reverse code)
2. I have reliable access to financial resources needed to attend college.
3. Delays or uncertainty in funding create stress for me. (reverse code)
4. I understand the financial obligations associated with my enrollment.
5. My institution provides adequate financial guidance or support.

Block 7. Support Networks

Underlying construct: Availability and quality of social and institutional support.

Items:

1. I have someone on campus I can turn to for academic guidance.
2. Faculty and/or staff take an interest in my success.
3. I feel supported by people who understand my background.
4. I have access to mentoring or advising when I need it.
5. I feel isolated when navigating college challenges. (reverse code)

Block 8. Asset-Based Recognition vs. Deficit Framing

Underlying construct: Perception that prior experiences are valued as strengths rather than deficits.

Items:

1. My prior experiences are seen as valuable in my academic environment.
2. I feel that my background gives me strengths that help me succeed.
3. I feel judged based on assumptions about students like me. (reverse code)
4. My university recognizes the value of the diverse educational pathways of students.
5. I am encouraged to apply my previous skills and experiences to my coursework.

Block 9. Demographic Questions

1. What is your age? [numeric]
2. What is your gender? [multiple choice]
3. How would you describe your ethnicity? [multiple choice]
4. Are you of Hispanic, Latino, or Spanish origin? [yes/no]
5. Which of the following best describes you? Veteran (student entering college or university after military service); Returning student (student returning to college or university after one or more years outside of educational environment); Transfer from community college; Transfer from another 4-year institution; First Time in College (student entering a college or university without prior higher education experience); other (please specify) a combination (please specify) [multiple choice]
6. Do you consider yourself a part-time student? [yes/no]
7. Are you a first-generation college student? (i.e., neither of your parents or guardians completed a four-year college degree) [yes/no]
8. How much time was spent between your most recent formal education and enrollment at your current institution? (examples include the summer between high school graduation and college enrollment the following fall, served in the military for 5 years, took a gap year between high school and college, worked in industry for 10 years before entering college, etc.) [multiple choice]