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UNDERSTANDING THE IMPACT OF A FIRST-YEAR ENGINEERING PROGRAM ON UNDERGRADUATE STUDENT PERSISTENCE IN ENGINEERING

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DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Education
at the University of Kentucky

By

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ABSTRACT OF DISSERTATION

UNDERSTANDING THE IMPACT OF A FIRST-YEAR ENGINEERING PROGRAM ON UNDERGRADUATE STUDENT PERSISTENCE IN ENGINEERING

The goal of this research study was to understand the impact first-year engineering programs have on undergraduate student persistence in engineering. First-year engineering programs feature a uniform first year curriculum for undergraduate engineering students and are designed to strengthen retention and increase graduation rates. This study sought to understand which factors present in first-year engineering programs influence student persistence in engineering. This study took place in the local context and examined the experience of engineering undergraduate students enrolled in a first-year engineering (FYEng) program at a state-level flagship land grant research institution in the southern region of the United States, Bluegrass University (BU). With the goal to understand which factors present in the BU-FYEng program influence student persistence in engineering, a confidential survey was utilized to gather information about student experiences and was administered to engineering students in early 2019. Students provided both quantitative and qualitative survey responses which were analyzed to understand student perceptions of the benefits of the BU-FYEng program, as well as the factors that contributed to their continued persistence in an undergraduate engineering major. The theoretical foundations of this study are rooted in Tinto's Theory of Student Departure (1975) and Astin's Theory of Student Involvement (1994). Adapted from Reason's (2009) Comprehensive Model of Influences on Student Learning and Persistence, Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College was used to guide study design. Together, these theoretical frameworks and models underscore the importance of student involvement with both the academic and social aspects of college during the first year, both of which are key design features of the BU-FYEng program.

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08/05/2022

Date

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DEDICATION

This paper is dedicated to my family. To my wife Victoria, I love you. Your support through this challenging process has been everything to me, and without it, none of this would have been possible. Thank you. To my son Alex, I love you. This paper is the reason why I missed so many weekend days playing with you and your brother. By the time you are reading this you will be old enough to understand the benefits of that hard work and time spent, and we will look back on this experience together knowing it was challenging, but worth it. To my son Matthew, I love you. Your happiness is contagious as is your laughter, your curiosity limitless. I cannot wait to see you and your broth grow into young men with families of your own. To my mother-in-law Karina, I love you. You are a true matriarch, the glue that holds this family together. I am so happy that you are here with us, forever.

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CHAPTER 1. INTRODUCTION

Earning a bachelor's degree is the key to financial self-sufficiency and has replaced the high school diploma as the credential to earn to begin a career (Carnevale et al., 2013; Kuh et al., 2008). Regarding earning potential, individuals that earn a bachelor's degree earn significantly more than those who do not. According to the Bureau of Labor Statistics, in 2020 the median weekly earnings for individuals with a bachelor's degree were 60% higher than those with only a high school diploma (Torpey, 2020). Additionally, by 2020 65% of jobs in the economy will require some postsecondary education and training beyond high school, with 35% of those jobs requiring a bachelor's degree (Carnevale et al., 2013).

Individuals that earn a bachelor's degree in an engineering or computer science discipline earn significantly more than other bachelor's degree earners. The median annual salary is over $90,000 for engineering and computer science occupations (Statista, 2021), which is more than twice that of all occupations (Torpey, 2018). Engineers and computer scientists are among the top 5 highest paying occupations (Statista, 2021).

The desire to major in engineering or computer science has many influences, but among those influences, no doubt, is future earning potential. The allure of a high paying career in engineering or computer science makes these undergraduate majors enticing. Many undergraduate students begin college with the goal to become an engineer or computer scientist but do not finish college on that same path. Engineering is an academically rigorous major requiring more time and academic commitment than other majors (Lichtenstein et al., 2010), resulting in many students beginning college pursuing an engineering or computer science major but not completing the degree.

National Graduation Rates

Even with decades of persistence research to lean on, resulting in innumerable program interventions (Mayhew et al., 2016; Pascarella & Terenzini, 2005), national graduation rates have not improved over time (Reason, 2009). According to the National Center for Education Statistics' Digest for Education Statistics, for first-time full-time undergraduate students who began seeking a bachelor's degree at 4-year degree-granting institutions in fall 2012, the overall 4-year graduation rate was 43.7%, and the overall 6-year graduation rate was 62.4% (Department of Education, 2019). White and Asian students, as well as women, had 4-year and 6-year graduation rates that were above the national average, while all other racial categories had 4-year and 6-year graduation rates below the national average. In looking at the span of graduation rate data over the last 10 years, the data indicates that students in smaller racial and ethnic groups graduate at a lower rate than their peers in larger racial and ethnic groups, and the same is true for women who graduate at a higher overall rate than men (Department of Education, 2019).

A similar trend holds true for undergraduate engineering students: the 4- and 6-year graduation rates for Asian and female students are higher than the national average, white students graduate at a rate that mirrors the national average, while the graduation rates for students in smaller racial/ethnic categories are sometimes higher and sometimes lower than the national average due to their low numbers (American Society for Engineering Education [ASEE], 2016).

National Graduation Rates in Engineering

In the ASEE (2016) report, *Engineering by the Numbers*, national undergraduate engineering student retention and time to graduation benchmarks are provided. The ASEE report is produced annually using data provided by higher education institutions

that have engineering degrees that also provide this data on an annual basis to ASEE (note, ASEE is only able to report data from institutions that choose to share data with ASEE). While retention and graduation rates of undergraduate engineering students have increased over the past ten years (2007 - 2017), the national 4-year and 6-year graduation rates for undergraduate engineering students are still lower than the national average. According to the most recent report, in 2015, the overall national 4-year graduation rate for engineering students was 33% compared to 43.7% for all majors, and the 6-year graduation rate was 59% compared to 62.4% for all majors (ASEE, 2016). Additionally, between 2006 and 2015, white, Asian, and female undergraduate engineering students have 4- and 6-year graduation rates that are at or above the national average for all engineering students. For the same time frame, for smaller racial and ethnic groups, the graduation rates tend to "bounce around" the national average, sometimes being lower or higher depending on the racial or ethnic group (ASEE, 2016).

Engineering is an academically rigorous undergraduate major, in which the first year is designed to be foundational, with students taking a set of challenging and time-consuming courses that include calculus, chemistry, physics, and engineering computing. Many undergraduate engineering students do not perform well in their first year due to various factors including the transition from high school to college, academic rigor, insufficient academic preparation, and the significant amount of time engineering students need to spend to be successful. Thus, many engineering undergraduates do not persist, and decide to change majors or drop out.

Retention vs. Persistence

Retention is an institutional phenomenon in that postsecondary educational institutions seek to retain students from the point of initial enrollment through to

graduation. Persistence, on the other hand, is an individual phenomenon, in that students themselves persist through to graduation (Reason, 2009). This study focuses on between-year persistence, specifically first- to second-year persistence. Utilization of the terms retention and persistence will proceed as described, with retention referring to institutional or programmatic retention, and persistence referring to individual student decisions.

Persistence Research

The amount and depth of research that exists surrounding undergraduate student persistence and retention is quite extensive, dating back several decades. Tinto's (1975) interactionalist theory, better known as the theory of student departure, sought to map the various factors impacting academic and social integration of students, and how they influence students to either persist or drop out. Astin's (1994) theory of student involvement places an overall emphasis on students actively engaging with the various aspects of college, which then influences whether they persist. These two theories are considered foundational to higher education persistence research.

Subsequent research has taken into consideration gaps found in these frameworks and has given rise to more comprehensive frameworks that take into consideration factors that these foundational frameworks overlook. Reason's (2009) Comprehensive Model of Influences on Student Learning and Persistence builds upon the work of Astin (1994) and Tinto (1975, 1993) and includes various factors, both before entering college, and during college, that influence students' persistence decision in various ways. Reason's (2009) model serves as a comprehensive guide to understanding these factors and expands on prior theoretical models by including the interactions and interconnectedness of the organizational context, the peer environment, and the classroom, curricular, and out-of-

class experiences that comprise individual students' experiences. Reason's comprehensive model has laid the foundation for many studies on persistence. Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College adapts Reason's (2009) framework to focus on the factors impacting more specifically first year persistence among engineering students.

Together, these foundational and comprehensive theoretical frameworks informed this study and its purpose: to understand the impact a first-year engineering program has, at a specific institution, on undergraduate student persistence in engineering. In the next chapter, a more in-depth overview of these foundational and comprehensive theoretical frameworks is explored.

Persistence in Engineering

First-Year Experience and First-Year Engineering Programs

The freshman year is a critical time for institutions of higher education to maximize the opportunity for students to discover who they are, and where they plan to go in life. Student success in higher education is largely determined by the experience's students have during their freshman year (Noel et al., 1985). Higher education administrators began exploring the use of First Year Experience (FYE) programs decades ago and showed great success in strengthening retention and persistence into the 2nd year (Pascarella & Terenzini, 2005). Examples of FYE programs include, but are not limited to, orientation programs, mentoring programs, academic support programs, residential living/learning programs, clubs and organizations, and the freshman seminar (Upcraft et al., 2005). These campus initiatives are especially useful in connecting first year students to the institution and its culture.

Building on the success and proliferation of FYE programs, engineering educators began experimenting with redesigning the first year for undergraduate engineering students, with the combined goal to both integrate the academic and social experience and mitigate student departure among engineering undergraduates. Beginning in the early 1990's, engineering educators began experimenting with using a common first year engineering curriculum with additional integrated academics and social components, which later became known as First-Year Engineering Programs (FYEng) (Al-Holou et al., 1999; Corleto et al., 1996; Friar, 1994; Froyd & Rogers, 1997). Some of the institutions which showed success, to name a few, included the Rose-Hulman Institute of Technology, the University of Alabama, Texas A&M, Drexel University, The Ohio State University, North Carolina State University, the University of Florida, and the University of Detroit Mercy (Al-Holou et al., 1999; Corleto et al., 1996; Friar, 1994; Froyd & Rogers, 1997).

Engineering programs with an integrated first year curriculum, referred to as FYEng, have reported success in retaining students beyond the first year of college (Hoit & Ohland, 1998; Kee & Al Akkad, 2000; Knight et al., 2003; Willson et al., 1995), increasing the likelihood that they will pursue and complete an engineering degree. Research has also shown that there were positive results for women, Hispanic, and African American students as well (Hoit & Ohland, 1998; Willson et al., 1995). FYEng programs feature a uniform first year curriculum for undergraduate engineering students and are designed to strengthen retention and increase graduation rates (Hubbard, 2017b). FYEng programs incorporate faculty interaction, peer mentoring, a uniform curriculum, and for residential institutions, many also include or require a living learning component,

such that students are living together as first year engineering students. The success of FYEng programs at retaining students is not surprising. Findings from higher education research focusing on academic performance indicates that "comprehensive strategies for promoting student success that combine student services (such as academic advising, tutoring, mentoring) with curricular interventions (such as first year seminars, learning communities, supplemental instruction, shorter-term developmental courses), financial aid, or other strategies have the potential to dramatically improve retention and graduation" (Mayhew et al., 2016, p. 552).

Local Context

Bluegrass University (BU) is a pseudonym for a state-level flagship land grant research institution located in the southern region of the United States. At BU, recent 4-year graduation rates (fall 2014 cohort) are just over 47%, and 6-year graduation rates (fall 2012 cohort) are just under 66%. In the same time frame, undergraduate students in the BU College of Engineering had a 4-year graduation rate of 35.4% and 6-year graduation rate of 68.9% (BU-Graduation-Website). It takes many students longer than 4 years to complete an engineering major, thus the 4-year graduation rate is lower when compared to BU graduates. Over the course of 6 years, however, undergraduate engineering students at BU graduate at a slightly higher rate than the rest of the university students.

In fall 2016, the BU College of Engineering embarked on the ambitious task of implementing a common curriculum for all incoming engineering students. Across the first 2 semesters of study, undergraduate engineering students completed the Bluegrass First Year Engineering (BU-FYEng) program, a typically 5-credit hour common curriculum that is spread over 2 semesters. First-time first semester freshmen complete a

5-credit hour sequence: EGR 101 “Engineering Exploration I” (1cr) and EGR 102 “Engineering Exploration II” (2cr) in their first semester, then EGR 103 “Fundamentals of Engineering Computing” (2cr) in their second semester. Transfer students complete EGR 112 “Engineering Exploration for Transfer Students” (1cr) in their first semester and EGR 103 “Engineering Exploration II” (2cr) in the second semester; or complete just EGR 215 “Introduction to the Practice of Engineering for Transfer Students” (3cr). Most transfer students complete a programming course prior to transfer and can waive EGR 102 “Fundamentals of Engineering Computing”. The variation in which courses a transfer student will complete for the BU-FYEng program depends on their academic preparation and timing of entry.

Through the common curriculum model, the BU-FYEng program exposes all undergraduate engineering students to the various engineering majors and career paths offered in the college so they can make an informed major/career choice. The BU-FYEng program includes engineering design coursework that emphasizes teamwork as well as engineering computing coursework that exposes all engineering students to computer programming. Students enter the college as an undeclared engineering major, then declare their engineering major later while completing the second semester of the BU-FYEng program in preparation for registration the following semester.

With the primary institutional goal of improving engineering student retention, all incoming engineering freshman and transfer students are required to complete the common curriculum, which features hands-on design team projects that provide students with an understanding of what it is like to be an engineer working on a cross-functional team (Hubbard, 2017a). The program also introduces students to all engineering major

disciplines offered at BU so that they can make an informed choice of major (BU-FYEng-Website). The BU-FYEng program features include optional on-campus housing in which engineering students live and study together (residential living-learning program), co-curricular programming (learning about majors and career paths, career panels, guest speakers), peer mentoring, cross-functional team-based assignments, real world engineering problem solving, connection with faculty, connection with fellow students (friends/cohort), and open and supported lab space (Innovation Center Lab and FYE Open Lab).

Perhaps the most defining feature of the BU-FYE program is that it offers the option of living in a residential Living Learning Program (LLP) specifically for Engineering students, enabling them to live with their engineering peers. During the 2018-2019 academic year when the survey was conducted, BU-FYEng students had the option of living in the residential LLP, and many first year and transfer students chose to live on campus in the BU Engineering LLP. In Fall 2018, 411 of 899 engineering students (45.7%) that entered BU's College of Engineering as either a first-time freshman or transfer student chose to live in the engineering residential LLP. This feature enables BU-FYE students to live together and study together, interweaving the social and academic experiences of students. Decades of higher education research support the notion that academic programs designed to promote learning, adjustment, and retention, like living-learning communities, are positively associated with student persistence and completion. Further, living on campus, as opposed to off campus, was perhaps the most consistent contributor to a range of positive college outcomes (Mayhew et al., 2016; Pascarella & Terenzini, 2005).

Local environments play a very important role in student persistence decisions (Pascarella & Terenzini, 2005; Reason, 2009). Therefore, when studying the impact of a program designed to support student persistence, one must do so in the local context. This research study sought to understand the factors present in the BU-FYEng program that influence and support undergraduate student persistence engineering, specifically, first- to second-year persistence. Further, this study sought to understand what BU-FYEng students think will be the most and least helpful features of the BU-FYEng program they completed as they progress through their engineering degree.

The survey utilized was administered in the 2018-2019 academic year. The Fall 2018 cohort of BU-FYE students included a total of 899 students: 753 first-time freshman (83.8%) and 146 transfer students (16.2%). Among the 899 students in this cohort, 719 are male (80%) and 180 are female (20%), 167 are non-white (18.6%), and 184 First Generation (20.4%), and 411 (45.7%) chose to live on the Engineering LLP for Fall 2018. Data regarding the number of commuter students among this groups was not able to be obtained due to limitations on institutional demographic data collection methods.

Study Design

With the goal to understand which factors present in FYEng influence student persistence in the BU-FYEng program, this study was designed utilizing Hayden's (2017) framework to guide study design. As stated previously, the BU First Year Engineering program started in fall 2016. With the goal to understand student perception about the program, BU-FYE program administrators sought outside assistance in designing a confidential student survey which was administered to 2018-2019 cohort BU-FYEng students in the 2nd semester of program progression. Students provided both quantitative

and qualitative survey responses which were analyzed to understand their perceptions of the benefits of the BU-FYEng program, as well as the factors in Hayden's model that contributed to their continued persistence in engineering.

Quantitative and qualitative responses from the survey were analyzed to understand overall student perception of the BU-FYE program, and Hayden's framework was utilized to understand which factors present in the BU-FYEng program impacted student persistence decisions. Survey data was analyzed to understand overall student perception (primary research question), and additional data analysis was conducted to separate and understand the perceptions and experiences of various subgroups (secondary research questions), including commuter students, transfer students, and first-generation students; and to also understand the perceptions and experiences of women and students of color (non-white).

Research Questions

This research study focuses on persistence among undergraduate first year engineering students at BU and sought to understand student perceptions of the factors present in the BU First Year Engineering program that strengthen retention, and support persistence to the second year in an engineering major. To that end, the primary research question for this study is:

Which factors present in the first-year engineering program influence student persistence in engineering?

Additional secondary research questions include:

1. *How do students perceive the BU-FYEng program?*
2. *How does commuter status impact the experience of BU-FYEng students?*
3. *How does transfer status impact the experience of BU-FYEng students?*

4. *How does first generation status impact the experience of BU-FYEng students?*
5. *How does gender identity impact the experience of BU-FYEng students?*
6. *How does race/ethnicity impact the experience of BU-FYEng students?*

Alignment of Research Questions with Theoretical Framework

Utilizing Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College, this study aligns data collected from the confidential survey administered in 2018 with specific factors in Hayden's framework. An analysis of the data within the comprehensive framework Hayden provides, informed our understanding of the factors present in the BU-FYEng program that influence and strengthen student persistence decisions.

Purpose and Significance of the Study

This study adds to the body of literature that focuses on between-year persistence, specifically first- to second-year persistence. The student response data from the confidential survey illuminated which factors present in FYEng that contributed to the continued enrollment of students beyond their first year, and which factors did not. The organizational environment and the peer environment are different at each educational institution. Therefore, performing research in the local context is necessary. While many studies exist that focus on student persistence, fewer studies exist that focus on persistence among engineering students, and even fewer studies focus on understanding which factors present in FYEng influence student persistence in engineering. This study, therefore, lends valuable knowledge to the field.

For FYEng to be successful in their goal to support undergraduate engineering student persistence, it is critical to understand the factors present in these programs that

positively impact persistence in the first year. Understanding student perceptions about which factors positively impact persistence among BU-FYEng students provided valuable insights that will serve to strengthen institutional retention, and mitigate student departure at that institution, and others.

This study was done in the local context but can be of benefit to other FYEng, even those that do not share that same or similar institutional and student body characteristics. Additionally, insights learned from the results of this study add to the overall body of knowledge surrounding this topic. Overall, understanding student perceptions and insights helps engineering educators and program administrators to enhance and improve program features that ensure the supportive academic and social environment necessary for first year engineering students to flourish. While this study adds to the existing literature, more research beyond this study is needed that seeks to understand which factors present in FYEng influence student persistence in engineering.

CHAPTER 2. LITERATURE REVIEW

As discussed, earning a bachelor's degree is the key to financial self-sufficiency and has replaced the high school diploma as the credential to earn to begin a career (Carnevale et al., 2013; Kuh et al., 2008). Earning a bachelor's degree has benefits beyond the student, and degree completion positively impacts student families, their communities, and society (Kuh et al., 2008). The first year of college is a critically important time for students and many factors influence their desire to continue attending school, to persist in their goal of earning a college degree. A better understanding of student persistence in college, particularly first-to-second year persistence, is needed for engineering educators who seek to retain students pursuing academically rigorous and time-consuming majors.

In this chapter, programs designed to strengthen and support first-to-second year retention among engineering and computer science students are examined in detail, as well as the theoretical models that laid the foundation for their creation.

Persistence Research

Tinto's Theory of Student Departure

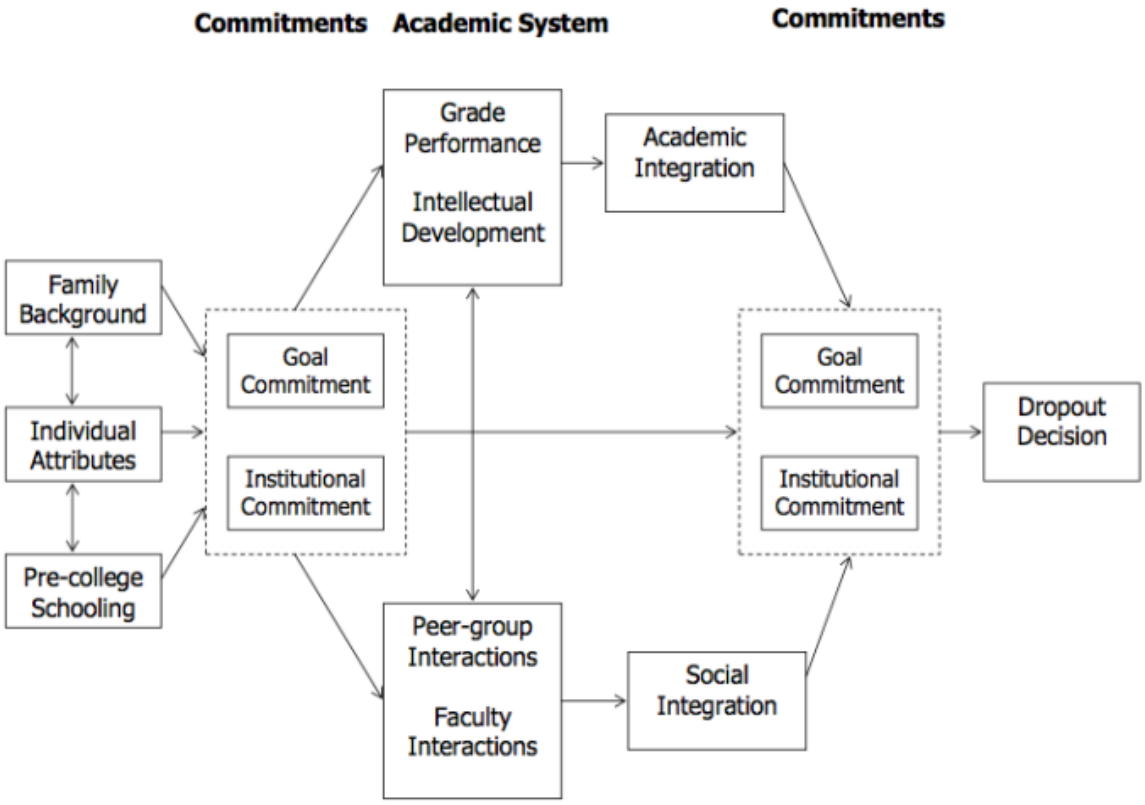
Theories of student retention and persistence in higher education began in the 1970's with the work of Tinto (1975), who put forth his interactionalist theory, better known as the theory of student departure. Essentially, according to Tinto's (1975) model, students have different levels of academic and social integration as they interact with peers, faculty members, and other institutional personnel, which all interact to influence a student's decision to drop out or persist. A more simplified explanation of Tinto's (1975) interactionalist theory is that if a student's goal commitment (his/her desire to graduate

from college) and institutional commitment (his/her integration into the institution's academic and social structures) are high they are less likely to dropout. Regarding institutional commitment, Tinto (1975) indicates dropout occurs when there are "insufficient interactions with others in the college and insufficient congruency with the prevailing value patterns of the college collectively" (p. 92). Tinto also distinguishes between different types of student attrition: voluntary withdrawal, academic dismissal, and transferring out, placing voluntary withdrawal in the context of a given institution rather than from higher education (Hubbard, 2017b).

Tinto's (1975) theory also introduced the concepts of normative integration and collective affiliation, as seen in Figure 1. Normative integration manifests itself in student intellectual development (via earning good grades and being happy with their academic environment), and collective affiliation manifests itself via social integration, which is simply how well the student integrates into the social culture of the institution (Tinto, 1975, pp. 104-107). Higher education institutions include both academic and social structures. Therefore, academic and social integration is essentially the level in which the individual student interacts with, and integrates with, the institution and its social structures. As a student progresses through college, they interact with the academic and social systems of the institution in many ways, both formally and informally. Tinto's concepts of academic and social integration have subsequently influenced higher education administrators to implement policies and programs designed to assimilate students into the academic and social culture, especially incoming freshman, to increase the likelihood that they will stay in school and graduate from college.

Figure 1

Tinto's (1975) Interactionalist Theoretical Framework



In his later work, Tinto (1993) refined his original 1975 theoretical framework by adding additional financial resources as a pre-college entering component, as well as acknowledging that external communities play a role in student dropout decision-making. Further, Tinto (1993) strived to explain the student dropout process as specific to a given higher education institution. Tinto (1993) believed that institutional factors were critical to understanding why student's dropout, indicating that his theoretical model is not a systems model of departure (p. 112). Alignment, or fit, between the student and the institution is a critical component to student success (Hubbard, 2017a).

Criticism of Tinto's Theory of Student Departure

According to Braxton et al. (1997), Tinto's interactionalist theory lacks empirical support, and tests of it have shown mixed results (from Braxton et al., 2011). Braxton et al. (1997) conducted a thorough analysis of Tinto's theory and found thirteen testable propositions, which, if Tinto's theory were supported empirically, would show that his theory was correct. Braxton et al. (1997) conducted empirical research that tested these propositions using a box score method to assess the amount of empirical testing conducted on each of the thirteen propositions. Overall findings indicated strong empirical support for 5 of the 13 testable propositions, and only 2 of 13 and 1 of 13 testable propositions at commuter and 2-year institutions respectively (Braxton et al., 1997, 2011). There seems to be a lack of agreement on how to measure Tinto's concept of academic integration (Braxton & Lien, 2000). Tinto's theory also does not apply evenly to all student types (non-traditional students, commuter students), nor does it apply evenly to all types of higher education institutions (residential institutions, commuter institutions, 2-year colleges).

More recent criticism (Rendón et al., 2000) indicates that Tinto's theory is based on a flawed model, in which the need exists for students to separate from their previous community and assimilate into the dominant college community. Further, Tinto's description of the stages of student departure should be modified to include more diverse populations (Rendón et al., 2000). In Tinto's (1993) subsequent theoretical revision, he indicated his theory is "not a systems model of departure" (p. 112), and further acknowledged that different student groups possess different circumstances and, thus, institutions should utilize different policies and programs for various student types. While Tinto's theory does a great job of attempting to explain the complex mechanisms that

influence the overall student experience in college, his theory is overly complex, with so many factors impacting the overall student experience that it makes the theory itself difficult to test empirically. Still, Tinto's theory of student departure has laid the theoretical foundation for innumerable studies and has become the foundational theory in higher education persistence research.

Beginning with their 1991 book *How College Affects Students*, Pascarella and Terenzini examined dozens of persistence research studies of noted that future studies should focus on the interrelationship between social and academic integration, investigating how these factors influence retention, persistence, and goal attainment among students. Additionally, they noted future studies should include race and ethnicity as variables and should include student perceptions about the quality of instruction (Pascarella & Terenzini, 1991). Pascarella and Terenzini (1991) further concluded that future studies on involvement theories like Tinto's and Astin's should be expanded to include the role of financial aid, the role of the college major, and the influence of peer, faculty, and advisor relationships on student persistence.

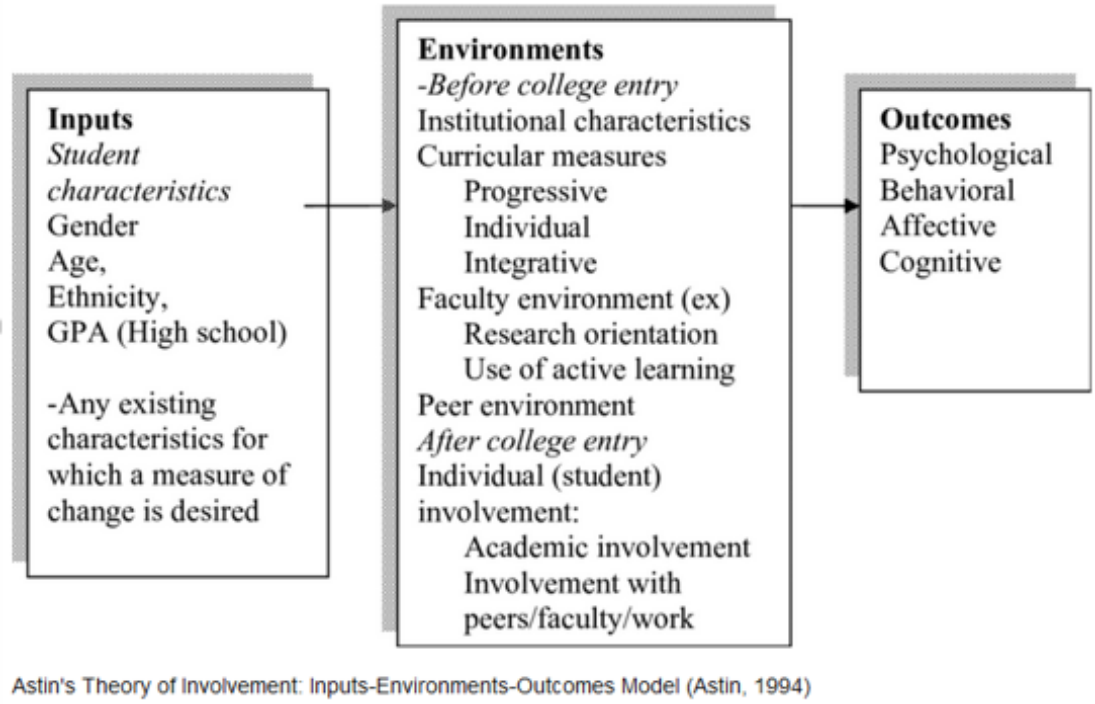
Astin's Theory of Student Involvement

The Theory of Student Involvement, put forth by Alexander Astin (1994), indicates that the "amount of student learning and personal development associated with any educational program is directly proportional to the quality and quantity of student involvement in that program" (p. 519). Astin's (1994) theory was based on findings from his earlier work in 1975 and 1977 attempting to understand why student's drop out from college. Astin (1975) defines a highly involved student as one who "devotes considerable energy to studying, spends much time on campus, participates actively in student organizations, and interacts frequently with faculty members and other students" (p. 1).

Astin's (1994) Input-Environment-Outcomes model, as shown in Figure 2, displays the student entry characteristics, the before- and after-college entry environments that student will be exposed to, and the outcomes that result from the college experience.

Figure 2

Astin's (1994) Inputs-Environments-Outcomes Model



Astin's Theory of Involvement: Inputs-Environments-Outcomes Model (Astin, 1994)

Astin's (1994) Input-Environment-Outcomes model shows that students enter college with various student characteristics that he calls inputs (which include gender, age, ethnicity, and any other characteristic for which a measure of change is desired). Students are then exposed to various environments within college (which include environments related to peers, faculty, and the institution) and students are individually involved academically with their peers, faculty, and the college environment. This results in psychological, behavioral, affective, and cognitive outcomes for each student that completes college.

Astin's (1994) theory of student involvement defines involvement as essentially the behavioral manifestation of motivation (p. 522). He later tested his theory empirically as he embarked on the largest nationwide study of student development: a ten-year research study utilizing longitudinal data from over 200,000 students at over 300 higher education institutions and employing measures for over 80 different student outcomes. Astin's (1994) study sought to identify factors in the college environment that positively influenced student persistence, and he found that the three most important forms of student involvement were (a) academic involvement, (b) student peer group involvement, and (c) involvement with faculty. Additionally, Astin (1994) found that the student's peer group is "the single most important source of growth and development during their undergraduate years" (p. 398). Student involvement, according to Astin (1994), essentially

> refers to the quantity and quality of the physical and psychological energy that students invest in the college experience. Such involvement takes many forms, such as absorption in academic work, participation in extracurricular activities, and interaction with faculty and other institutional personnel. (p. 528)

If student involvement is more substantial, both academically and socially, student development increases. Astin's (1994) theory serves to articulate and summarize what decades of research have shown, that the more students are involved the more they develop, the more they learn, and the more likely they are to remain enrolled in college and persist to graduation (Hubbard, 2016b).

Commenting on his longitudinal study conducted in 1994, Astin (1999) states, "every positive factor was likely to increase student involvement in the undergraduate experience, whereas every negative factor was likely to reduce involvement" (p. 523). This indicates that the factors contributing to retention and persistence suggest active

student involvement, whereas the factors contributing to a student dropping out suggested a lack of student involvement. Student involvement influences learning and engagement. Students develop both socially and intellectually through these experiences, and persistence is the result. According to Astin (1999), "from the standpoint of the educator, the most important hypothesis in the theory is that the effectiveness of any educational policy or practice is directly related to the capacity of that policy or practice to increase student involvement" (p. 529). Institutional policies should focus on whether a campus program increases student involvement. This includes things like extracurricular activities, student clubs and organizations, campus recreation options, residence halls, sororities and fraternities, honors programs, sports teams, among many other things (Astin, 1999).

Astin's theory was seemingly born out of frustration with the tendency for academics to view higher education institutions as a sort of "black box" in which there are inputs (e.g., higher education policies, and programs) and outputs (e.g., good grades, degree completion) but with no adequate explanation for the student learning and development that occurs. Astin (1994) states, "the theory of involvement, in other words, provides a conceptual substitute for the black box… [and] emphasizes active participation of the student in the learning process" (p. 522). The simple concept that the more a student is involved, academically and socially, the more likely they are to persist to graduation is a concept that higher education administrators can easily support.

Astin's (1994) theoretical model does have limitations. Specifically, it is undergraduate student centric, focusing almost exclusively on the traditional college undergraduate that enters college right after high school, and, like Tinto's theory, does

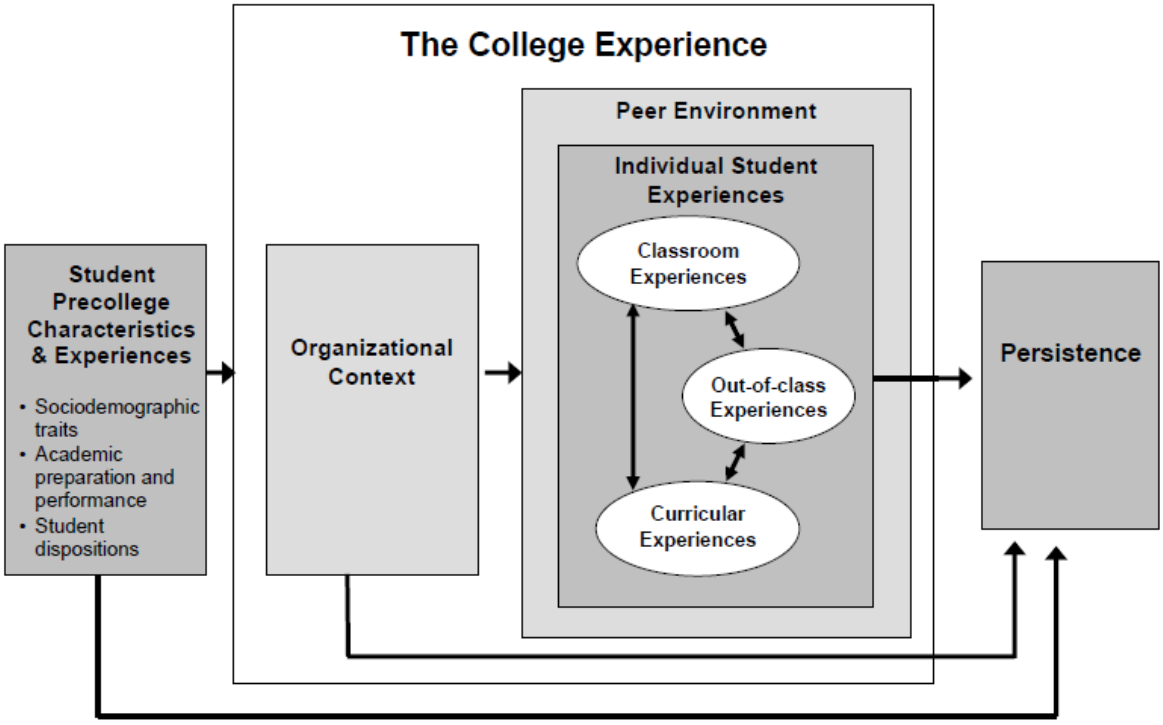
not apply to all student types (e.g., non-traditional students, students attending 2-year colleges then transferring). The prevalent underpinnings of theoretical frameworks of persistence, retention, and student success focus heavily on the broader constructs of academic and social engagement, and essentially, the extent to which a student is "involved" as Astin indicates, or "integrated" as Tinto indicates. Indeed, as Pascarella and Terenzini (2005) point out "individual effort or engagement is the critical determinant of the impact of college" (p. 602).

Comprehensive Conceptual Models of Persistence

Decades of higher education research conclude that there are multiple forces operating in multiple settings to influence both student learning and persistence (Pascarella & Terenzini, 1991, 2005). Higher education researchers focusing on persistence have attempted to create conceptual models of student persistence that go beyond the confines of both Astin's and Tinto's theoretical models (Berger & Milem, 2000; Pascarella, 1985). In 2005 Terenzini and Reason put forth a model that synthesizes and extends the models proposed by Tinto (1975, 1993) and Astin (1985, 1994), and further incorporates other models that focus on the organizational effects on student outcomes (Berger & Milem, 2000). Originally proposed as a conceptual framework to guide student outcomes research, specific to outcomes like persistence, the model incorporates four sets of constructs, and takes into consideration "the multiple and interrelated student, faculty, and institutional forces that influence college success" (Reason, 2009). Reason (2009) subsequently used this framework to organize and create a comprehensive conceptual model of student persistence, as seen in Figure 3.

Figure 3

Comprehensive Model of Influences on Student Learning and Persistence



Adapted from *Parsing the first year of college: Rethinking the effects of college on students* [Paper presentation], by Terenzini and Reason, 2005, Annual Conference of the Association for the Study of Higher Education, Philadelphia, PA, USA.

Reason's (2009) model takes into consideration the multiple interrelated forces that a student experiences in college, which include student precollege characteristics and experiences and the college experience, which includes the organizational context, the peer environment, and individual student experiences. Individual student experiences include classroom experiences, out-of-class experiences, and curriculum experiences that all interact and interrelate together within the peer environment. The peer environment and the organizational context; which includes things like policies, the culture of the institution, and institutional type; all interact together to form the college experience. Precollege characteristics and experiences include socio-demographic traits, academic

preparation and performance, and student dispositions (Reason, 2009). All these factors work together in different ways for each student, influencing the students desire to continue to persist in their goal.

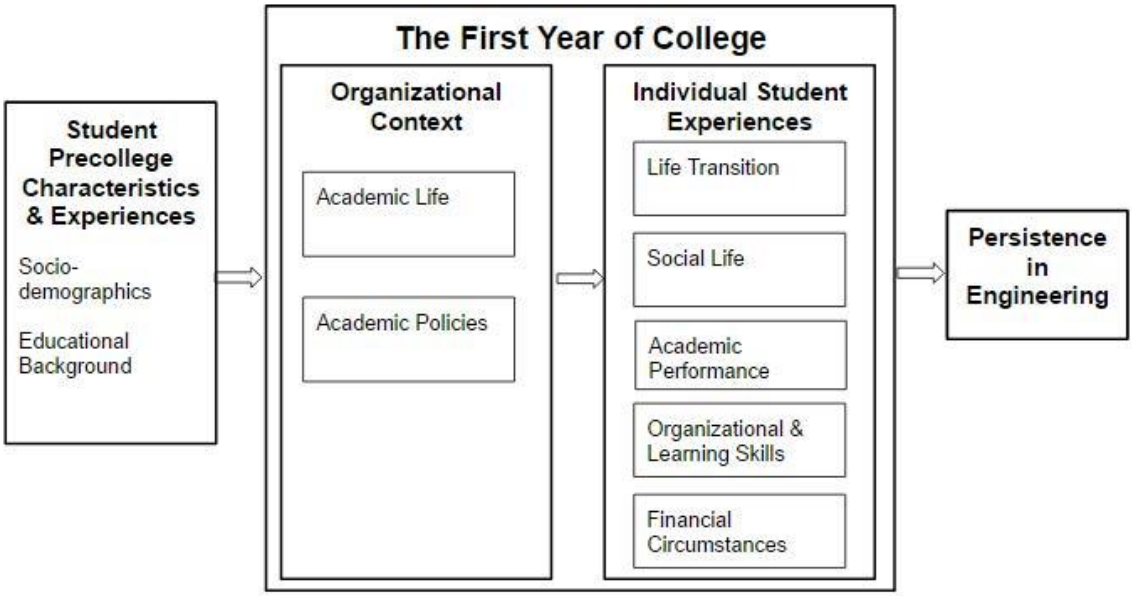
Reason's (2009) model takes into consideration the multiple factors that influence persistence and organizes it into a conceptual framework with four interrelated domains. Reason's paper introducing this framework has been cited hundreds of times since its introduction and has provided higher education persistence researchers with a comprehensive model that has been long sought after. Reason's comprehensive framework has been utilized to understand student persistence from a variety of perspectives and has also been further adapted to understand more nuanced areas of persistence research (Hayden, 2017).

Higher education researchers have asserted that persistence research be done at the local level, in the local context (Ohland et al., 2008; Reason, 2009). Given that institutions vary in many ways (e.g., size, location, demographics, spread of majors offered, residential vs. commuter, etc.) conducting research in the local context is a logical approach to understanding the nuances present at each institution, and within each academic program, that constantly impact a student's desire to continue their education in that major, or at that higher education institution. To better distinguish between the different features impacting a student's first year of college, Hayden (2017) adapted Reason's (2009) comprehensive model specifically to understand the factors that influence persistence in the first year of college, among engineering students at a specific institution. By adapting Reason's model for the local context in Hayden's study, the

Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College was created, as seen in Figure 4.

Figure 4

The Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College



Adapted from "An Examination of Persistence Research through the Lens of a Comprehensive Conceptual Framework," by R. D. Reason, 2009, *Journal of College Student Development*, *50*(6).

Hayden adapts Reason's model for the local context by looking specifically at persistence in the first year, rather than persistence to degree completion, and specifically at persistence among engineering students, an academically rigorous major with a larger time commitment than other majors (Lichtenstein et al., 2010). Within the Organizational Context domain of Reason's (2009) model, Hayden (2017) has included Academic Policies and Academic Life as subfactors, both are particularly impactful at influencing persistence for engineering students in the first year. Reason's (2009) Peer Environment and Individual Student Experiences domains were combined and further defined to

reflect the specific experiences of engineering students in their first year. In Hayden's (2017) model, Academic Performance, Organizational & Learning Skills, and Financial Circumstances were added as sub factors, and Life Transition and Social Life were added as subfactors. Again, these adaptations were made to align the framework with the local context in which the study was conducted: first year engineering students. Within the Individual Student Experiences domain, Hayden (2017) adapts Reason's (2009) model by including five factors that research has shown are particularly impactful to students in their first year: life transition, social life, academic performance, organizational and learning skills, and financial circumstances.

Research on Persistence in First Year of College

The experiences students have in their first year of college largely determines their desire to continue to their second year of college, and ultimately persist to earn a bachelor's degree. For students in an engineering or computer science major, the overall student experience is further impacted by the academic rigor and time commitment needed to be successful in an engineering major (Lichtenstein et al., 2010). The experience students have in their first year of college has been found to be more impactful on persistence to the second year than pre-college characteristics (Kuh et al., 2008). According to a study conducted across 18 institutions and over six thousand students, although precollege characteristics influence persistence and grades in the first year, the most significant effect on persistence in the first year is student engagement, regardless of precollege characteristics. Engagement was found to have a compensatory effect on first year grades and persistence, meaning that the exposure to effective educational practices had a greater effect on students of color and lower ability students (Kuh et al., 2008).

The first year is critically important to the success of all students, and particularly important for engineering or computer science students. Engagement has shown to be effective in strengthening student persistence, and engagement in the first year is bolstered by programs that are designed to connect students with individuals like themselves, both personally and academically. FYE programs are designed to enhance engagement and interactions among peers and faculty.

Background: First Year Experience Programs

Higher education policies and programs designed to enhance the first-year experience of students are focused on strengthening student retention and persistence. According to Pascarella and Terenzini (2005) "the impact of college is largely determined by the individual effort and involvement in the academic, interpersonal, and extracurricular offerings on campus" (p. 602). As theories of student development, retention, and success have gained traction with higher education administrators since the 1980's, programs designed to enhance, and support first-year students have become much more prevalent. Research studies

> consistently show the effectiveness of several academic programs and experiences specifically designed to promote student academic performance and persistence, includ[ing] first year seminars, supplemental instruction, academic advising, summer 'bridge' programs, undergraduate research programs, living-learning centers, learning communities, and active and collaborative pedagogies. (Pascarella & Terenzini, 2005, p. 612)

The best way for students to succeed in college is by challenging them and supporting them. Students need to be challenged by providing them with educational experiences designed to nurture learning and personal development, and they need to be supported by providing them with campus programs and services that help them learn and develop. According to Upcraft et al. (2005) "when a proper balance is maintained

between challenge and support, students are positioned to succeed in college. When that balance is not maintained, students are more likely to fail" (p. xii). Programs designed to support first-year students, commonly referred to as FYE programs, are prevalent on most college campuses today. FYE programs are essentially interventions – an intentional effort taken to improve a situation. In higher education, these interventions come in the form of both required and optional student programs and services designed to support students during a vulnerable time in their life when they are transitioning into college (Upcraft & Gardner, 1989).

Driven by the desire for higher education institutions to retain and graduate as many students as possible from each entering freshman cohort, FYE programs are designed to help students connect to the institution and to their fellow students. As stated previously, examples of FYE programs include, but are not limited to, orientation programs, mentoring programs, academic support programs, residential living/learning programs, clubs and organizations, and the freshman seminar (Upcraft et al., 2005). These campus initiatives are especially useful in connecting first-year students to the institution and its culture.

With the primary goal of supporting student retention, FYE programs were born out of theoretical models of student development, persistence, and student success that focus on a student's intellectual development, and academic and social engagement. Student success in higher education is largely determined by the experience's students have during their freshman year (Noel et al., 1985). In their 1989 book titled *The Freshman Year Experience: Helping Students Survive and Succeed in College*, authors Upcraft and Gardner indicated that to enhance student success among freshman,

institutions of higher education "must (1) develop a clear and broader definition of it, (2) commit to a set of beliefs that create maximum opportunities, and (3) know and understand the variables that affect it" (p. 1). Once institutions do those three things, they can then develop policies, programs and services that give freshmen the maximum opportunity to succeed. Students go through an enormous amount of personal change and development while in college including academic and intellectual competence, identity formation, career and life-style decisions, cultural awareness, and development of a personal philosophy of life (Upcraft & Gardner, 1989).

As Upcraft et al. (2005) states, "if institutions are to develop an educational environment for first-year student success, they must understand that preparation, ability, and motivation are only part of the persistence puzzle" (p. 45). FYE programs are essential to ensuring that students can thrive and are an important component to the overall set of programs and services that higher education institutions need to provide. The goal of every institution of higher education should be to challenge and support students, and to provide an educational environment that is both diverse and inclusive.

Background: First Year Engineering Programs

A study conducted by Astin (1999) indicated that majoring in engineering correlated negatively with student satisfaction, and engineering students felt more depressed and overwhelmed than their non-engineering peers. Astin (1999) painted a relatively grim picture of the situation in higher education for engineering students, stating "these findings indicate that the climate characterizing a typical institution with a strong emphasis on engineering is not ideal for student learning and personal development" (pp. 360-361). Astin's research findings were supported by findings from other studies, confirming that engineering students are not satisfied with their learning

environment (Doolen & Biddlecombe, 2014; Hubbard, 2017b; Pascarella & Terenzini, 2005; Rompelman, 2000).

Through National Science Foundation funded Engineering Education Coalitions (1990 – 2005), integrated first-year curriculum models for engineering students were tested and implemented at over 40 universities. Many of the coalition universities that implemented integrated first-year engineering curriculum models were successful in showing improvement in retention and graduation rates (Al-Holou et al., 1999; Corleto et al., 1996; Friar, 1994; Froyd & Rogers, 1997). Increases in graduation rates among women and minorities were also found (Corleto et al., 1996). One longitudinal study, conducted on *Connections* program participants from the 1994 and 1995 cohorts at Colorado School of Mines, showed significant long-term benefits, indicating "students who participated in the *Connections* program graduated at a significantly higher rate than their peers and reported retrospectively that the program had a strong positive effect on their college careers" (Olds & Miller, 2004). Exposure to first-year engineering integrated curriculum models were indeed beneficial during these early curricular experiments (Hubbard, 2016a).

The success of the earlier NSF-sponsored curricular experiments led to the proliferation of integrated first-year engineering curriculum models nationwide. Since then, many ABET accredited institutions have implemented integrated curriculum models in engineering, with many research studies showing positive results specifically for engineering student retention in the first year (Hoit & Ohland, 1998; Kee & Al Akkad, 2000; Knight et al., 2003; Willson et al., 1995). Research showed that there were positive results for women, Hispanic, and African American students as well (Hoit &

Ohland, 1998; Willson et al., 1995). Given that FYEng are designed to enhance the educational experience in the first year, it is understandable that research studies regarding the impact of these programs are focused on retention outcomes in the first year.

Many of the NSF-funded programs were able to demonstrate success via improved retention and graduation rates. Utilization of a common integrated first year curriculum for both freshman and transfer students is now much more commonplace and growing in popularity (Hubbard, 2016a).

Conclusion

Astin's (1994) theory of student involvement placed an overall emphasis on students actively engaging with the various aspects of college, which influences student persistence. Tinto's (1975) theory of student departure focused on the academic and social integration of students, and how these integrations influenced students to either persist or drop out. Both theoretical frameworks are foundational to higher education persistence research. Both foundational frameworks have their merits, but also have their weaknesses, as discussed previously.

Given the complex matrix of characteristics, interactions, and influences that impact a student's desire to persist, utilizing a comprehensive framework is better suited for understanding how these things interact and influence student persistence. Reason's (2009) Comprehensive Model of Influences on Student Learning and Persistence, and Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College were explored. Reason's (2009) comprehensive model has laid the foundation for many studies on persistence, with Hayden adapting Reason's framework specifically for persistence among first year

engineering students, a population that faces different obstacles than typical college students.

In this chapter we explored foundational theoretical frameworks for student persistence and retention (Astin, 1994; Tinto, 1975), as well as more recently developed comprehensive frameworks (Hayden, 2017; Reason, 2009). These foundational and comprehensive theoretical frameworks all inform this study and its purpose: to understand the impact FYEng have on undergraduate student persistence in engineering.

CHAPTER 3. RESEARCH METHODOLOGY

As discussed in Chapter 1, the purpose of this research study is to explore and understand the experience of engineering undergraduate students enrolled in a first-year engineering (FYEng) program at a state-level flagship land grant research institution in the southern region of the United States, BU. This study sought to understand which factors present in the BU-FYEng program influence first- to second-year student persistence in engineering. With the goal to understand which factors present in the BU-FYEng program influence student persistence in engineering, a confidential survey was utilized to gather information about student experiences and was administered to BU engineering students in early 2019. Students provided both quantitative and qualitative survey responses which were analyzed to understand their perceptions of the benefits of the BU-FYEng program, as well as the factors that contributed to their continued persistence in an undergraduate engineering major.

Chapter 2 included a discussion regarding the decades of persistence research with findings indicating multiple interactions take place within the college experience that influence a student's desire to persist (Astin, 1994; Reason, 2009; Tinto, 1975, 1993), and the experience students have in their first year greatly shapes persistence decisions (Hayden, 2017; Kuh et al., 2008). Further, because local environments play an important role in student persistence decisions (Pascarella & Terenzini, 2005; Reason, 2009), research should be done in the local context (Ohland et al., 2008; Reason, 2009) to better understand how the features of that unique setting impact student persistence decisions.

In this chapter, the research methods used for this study are discussed in detail.

Research Questions

This research study focused on persistence among undergraduate first-year engineering students at BU and sought to understand student perceptions of the factors present in the BU-FYEng program that support first- to second-year persistence in an engineering or computer science major. The primary research question for this study was:

Which factors present in the first-year engineering program influence student persistence in engineering?

Additional secondary research questions include:

1. *How do students perceive the BU-FYEng program?*
2. *How does commuter status impact the experience of BU-FYEng students?*
3. *How does transfer status impact the experience of BU-FYEng students?*
4. *How does first generation status impact the experience of BU-FYEng students?*
5. *How does gender identity impact the experience of BU-FYEng students?*
6. *How does race/ethnicity impact the experience of BU-FYEng students?*

The primary research question sought to understand the factors present in BU's FYEng program that influence student persistence in engineering. The six secondary research questions provided additional insight into overall student perceptions and experiences, as well as the specific perceptions and experiences of subpopulations of engineering students. Secondary question 1 provided valuable insights into how BU-FYEng students perceive the program, and secondary questions 2-6 explored the experiences of various subpopulations. Together, the answers to these research questions helped to provide an understanding of how the BU-FYEng program was perceived, and the program features that influenced student persistence decisions among these students.

Conceptual Framework

As stated, prior, Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College was adapted from Reason's (2009) Comprehensive Model of Influences on Student Learning and Persistence. Utilizing Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College to guide study design, survey questions were aligned with the factors present in the model, as shown in Figure 4 (p. 25).

Hayden's (2017) model provides a comprehensive framework to understand the interrelated factors impacting an engineering student's decision to persist. All 7 factors included in Hayden's model (academic life, academic policies, life transition, social life, academic performance, organizational & learning skills, and financial circumstances) align with specific survey questions and response options.

Instrument

A confidential survey was administered to all BU college of engineering students March 19th, 2019, through April 22nd, 2019, and asked a set of questions specifically for students that were actively enrolled in the BU-FYEng program. Survey data was collected over an approximately 1-month period with 147 total responses recorded. The survey population size is approximately 800-900 students, which is the approximate size of the 2018 incoming cohort of FYE students. The survey was administered by BU-FYEng program administrators via an email that included a link to the survey. The instrument was designed for internal use, and therefore, face validity is the highest form of validity that the instrument possesses. Face validity, as it relates to this instrument, is discussed in more detail later in a subsequent section of this chapter.

Data Collection

The study was designed by first aligning the research questions with survey questions. Table 1 displays the primary and secondary research questions aligned with the survey questions.

Table 1

Alignment of Research Questions with Survey Questions

Research Question	Survey Question
Which factors present in the BU-FYEng Program influence student persistence in engineering?	Q20-Are you planning on continuing your enrollment at BU-EGR next semester? Q21-What factors contributed to your continued enrollment?
How do students perceive the BU-FYEng program?	Q10-What part of BU-FYEng do you think will be MOST HELPFUL to you as you progress through your degree? Q11-What part of BU-FYEng do you think will be LEAST HELPFUL to you as you progress through your degree? Q12-Is there anything else you would like to share with us about your BU-FYEng experience? Q6-Please indicate your agreement with the following statements: (My introductory engineering course(s) helped me with…
How does commuter status impact the experience of BU-FYEng students?	Q16-Are you a commuter?
How does transfer status impact the experience of BU-FYEng students?	Q2 or Q3-Which introductory course completed or completing?
How does first generation status impact the experience of BU-FYEng students?	Q23-Did one or both of your parents attend college?
How does biological sex or gender identity impact the experience of BU-FYEng students?	Q17-I identify as…
How does race/ethnicity impact the experience of BU-FYEng students?	Q18/Q19-Race/ethnicity and Hispanic/Latino

Once alignment of the research questions with survey questions was complete, a secondary process of alignment occurred to map the response options and factors to the existing question alignment. As mentioned, survey questions and response options align with all 7 factors included in Hayden's model: academic life, academic policies, life transition, social life, academic performance, organizational & learning skills, and

financial circumstances. Additionally, the primary research question aligns directly with the primary desired outcome: persistence in engineering. Table 2 displays the alignment of the primary research question with the corresponding survey questions, response options, and factors present in Hayden's (2017) model.

This study utilizes a mixed methods approach in that both quantitative and qualitative data were obtained via survey administration. Questions with open-ended responses specifically asked for student opinions of what they perceive to be the most and least helpful aspects of the BU-FYEng program (Q10 and Q11), as well a question that allows students to respond with "anything else they would like to share" about the BU-FYEng program (Q12). All other questions were quantitative in nature in that multiple response options were provided, which were used for basic descriptive statistical analysis (rate, frequency, distribution).

Data Analysis

The population of this study is 899 engineering students who attended BU in the 2018-2019 academic year. All 899 students were sent a link to the survey resulting in 126 complete survey responses (response rate 14%), and both qualitative and quantitative survey responses were collected. The survey was administered to all BU engineering students enrolled in March 2019, with survey responses gathered between March 19, 2019 and April 22, 2019. The survey response data was provided by actively enrolled BU-FYEng students. Quantitative data were analyzed using descriptive statistical analysis, and qualitative data were coded for themes and incorporated into the overall analysis. Table 2 lists each research question, the corresponding survey question, response options, and the factors aligned with Hayden's (2017) Model.

Table 2

Alignment of Primary Research Question with Survey Questions, Response Options, and Factors in Hayden's (2017) Model

Research Question	Survey Question	Response Option	Factors in Hayden's (2017) Model
Which factors present in the BU-FYEng program influence student persistence in engineering?	Q20-Are you planning on continuing your enrollment at BU-EGR next semester?	yes/no	persistence in engineering
	Q21-What factors contributed to your continued enrollment?	financial aid	financial circumstances
		peer mentoring	organizational & learning skills
		connection w/faculty	academic life
		friends/cohort	life transition academic life social life
		campus resources	academic life
		innovation center lab	academic life
		FYE open lab	academic life
		my academic program	academic life
		living learning program	life transition academic life social life
		my experience in FYE	ALL 7 factors
How do students perceive the BU-FYEng program?	Q10-What part of FYE do you think will be MOST HELPFUL to you as you progress through your degree?	open-ended	Academic Life Social Life
	Q11-What part of FYE do you think will be LEAST HELPFUL to you as you progress through your degree?	open-ended	Academic Life Social Life
	Q12-Is there anything else you would like to share with us about your FYE experience?	open-ended	Academic Life Social Life
	Q6 Please indicate your agreement with the following statements: (My introductory engineering course(s) helped me with…) Q6-1 Making an informed major choice	Likert Scale Matrix (SD,D, Neither, A, SA)	Academic Life
	Q6-2 Learning about EGR and CS MAJORS at BU	Likert Scale Matrix (SD, D, Neither, A, SA)	Academic Life

(table continues)

Table 2

(continued)

	Q6-3 Learning about EGR and CS CAREER OPTIONS at BU	Likert Scale Matrix (SD, D, Neither, A, SA)	Academic Life
	Q6-4 Developing teamwork skills	Likert Scale Matrix (SD, D, Neither, A, SA)	Academic Life Organizational & Learning Skills
	Q6-5 Developing real-world problem-solving skills	Likert Scale Matrix (SD, D, Neither, A, SA)	Academic Life Organizational & Learning Skills
	Q6-6 Understanding the PRACTICE of Engineering	Likert Scale Matrix (SD, D, Neither, A, SA)	Academic Life
	Q6-7 Understanding being a licensed Professional Engineer (PE)	Likert Scale Matrix (SD, D, Neither, A, SA)	Academic Life
	Q6-8 Developing skills useful to my engineering major coursework	Likert Scale Matrix (SD, D, Neither, A, SA)	Academic Life Organizational & Learning Skills
How does commuter status impact the experience of BU-FYEng students?	Q16-Are you a commuter?	Yes/No	Financial Circumstances Social Life
How does transfer status impact the experience of BU-FYEng students?	Q2 or Q3-Which introductory course completed or completing?	EGR 215 chosen	Financial Circumstances Social Life
How does first generation status impact the experience of BU-FYEng students?	Q23-Did one or both of your parents attend college?	Yes/No	Socio - Demographics
How does biological sex or gender identity impact the experience of BU-FYEng students?	Q17-I identify as…	Man, Woman, Something Else	Socio - Demographics
How does race/ethnicity impact the experience of BU-FYEng students?	Q18-I identify as… (race/ethnicity)	White, Black or African American, American Indian or Alaskan Native, Asian, Native Hawaiian or Pacific Islander, Middle/Near Eastern, Bi/Multi-Racial,	Socio - Demographics
How does race/ethnicity impact the experience of BU-FYEng students?	Q19-Are you Spanish, Hispanic, or Latinx, or none of these?	Yes/None of these	Socio - Demographics

Coding Open-Ended Responses for Themes

The survey utilized 3 open-ended survey items that enabled survey respondents to provide a text response. Utilizing open-ended survey items allows respondents to provide feedback not bound by rating scales or response options and allows respondents to provide commentary about specific issues they view as important (Alkin & Vo, 2011). The open-ended survey responses above were coded for themes and incorporated into the overall analysis.

Descriptive Statistical Analysis

A univariate descriptive statistical analysis was used to first understand the survey response patterns of students. Frequency tables were used to understand the number and percentage of respondents for each question. "A frequency table shows how often each response (a value) was given by the respondents to each item (a variable)" (Nardi, 2014). Frequency tables will help us to understand who the respondents are with respect to gender/sex, race/ethnicity, and other categories linked to secondary research questions like commuter status or first-generation status. Additionally, understanding how the responses are distributed across response options is important, therefore data visualization was also performed, and included bar charts, pie charts, or other data visualizations where appropriate. While data visualization was important in the exploration and analysis of the data, data tables were produced for each research question, and charts and other data visualizations were not included in the results.

Cross Tabulation

The univariate statistical analysis preceded a more in-depth bivariate statistical analysis, which included running a cross-tabulation of both quantitative and thematically coded qualitative survey responses, which was performed for self-reported demographic

factors including gender, race/ethnicity, first generation, and commuter students. Running a cross tabulation analysis illustrated whether there was some relationship occurring with variables in the data (Nardi, 2014).

Reliability and Validity in Study Design

Acquiring data for analysis can be done by utilizing new instruments or existing instruments. Reliability deals with the repeatability of findings. If a study were conducted more than once it would be considered reliable if the same or similar results occurred each time the study was conducted (Colorado State University, 2022). As DeVellis (2012) states "a reliable instrument is one that performs in consistent, predictable ways" (p. 31). Utilizing existing instruments to answer stated research questions when conducting an evaluation study is advantageous, since the evaluator can select an instrument that has demonstrated consistent results and is considered reliable (from Hubbard, 2017b). Reliability and validity are independent of each other. In addition to concerns regarding reliability, threats related to validity also exist in this study. Validity deals with the credibility or believability of the research. The internal validity, external validity, and face validity this study was examined to determine the threats inherent in the study's design. This study is unique. Therefore, before the survey instrument in this study can be said to be reliable it must demonstrate consistency. The tool was designed for internal use and has not been replicated. Therefore, overall, the reliability of the data collected for research questions utilizing a newly developed data collection tool is low.

Internal validity is the "approximate truth about inferences regarding cause-effect or causal relationships" (Trochim, 2006). When trying to determine if a program like the BU-FYEng program is impactful, conducting a survey of students in the program to get

their direct feedback is wise, and is a typical means to assess and measure the program features that support persistence, and to assess student perceptions of the program overall. Doing so assists program directors to understand whether specific program features, that are linked to program goals, are strengthening student persistence in the program. For example, one of the primary goals of the BU-FYEng program is to raise retention and graduation rates for engineering students. For each student who chooses to pursue an engineering major, there may be many reasons why they persist and graduate that have nothing at all to do with their exposure to the BU-FYEng program. Nonetheless, gaining an understanding of the program features that contribute to their continued persistence assists engineering educators in understanding this under studied field, and adds valuable information to the existing body of literature.

External validity deals with the generalizability of findings. As it relates to the BU-FYEng program, external validity is whether the results of the study can be applied to other FYEng programs, or participants of other FYEng programs. Given that study design in the local context was intentional, it is difficult to say that the results of the evaluation study are generalizable outside of the BU-FYEng program. While it may be difficult to generalize the overall results of the evaluation study to populations outside of BU, given that the study utilizes a research method (student survey) that can be easily replicated at other institutions or with other FYEng populations, it may be possible for other institutions to use the same survey or modify the tool to study their FYEng population (from Hubbard, 2017a). However, given the differences between BU-FYE programs at different institutions (e.g., institutional type, selectivity, differences among

students, timing of BU-FYE program implementation, etc.) it is difficult to say that the results of this study are generalizable to other programs or populations.

Face validity refers to whether the assessments or instruments used in the evaluation study measured what they were supposed to measure. While a legitimate, but not mathematical, way of measuring validity, face validity essentially asks, "if the measure seems to be getting the desired result" (Nardi, 2014, p. 62). Face validity is the weakest form of validity because you are making a "face value" judgment (from Hubbard, 2017b). The face value judgment may be correct, but it is not backed-up by anything measurable, just perception. As it relates to this study, the study design measures the factors present in the BU-FYEng program that influence student persistence in engineering. The methodology proposed to assess and measure persistence in engineering is appropriate and logical given that the survey was administered prior to alignment with the comprehensive framework. However, because there are many factors impacting persistence decisions among BU-FYEng program participants, there are far too many variables present that are not able to be measured and accounted for in this study, or by this instrument. Face validity, therefore, is the strongest evidence of validity that this study possesses.

Limitations

While the survey does utilize a mixed methods approach, more student perception data should be collected in the form of interviews with students who completed the first-year engineering program, as well as those who did not complete the program and/or changed majors. Qualitative research like focus groups and interviews would serve to provide a better understanding of student perceptions in their first year, and can guide decision-making in academic and social programming, living arrangements, policies and

procedures, and more. Additional research in this area would benefit this body of knowledge tremendously.

This study focused on the factors present in the BU-FYEng program that influenced persistence positively, and the survey instrument was likely designed with that goal in mind. However, with this survey instrument and study design, attention is not being paid to the factors that do not influence persistence. For example, question 20 asked "Are you planning on continuing your enrollment in UK's College of Engineering next semester?" and "Yes/No" are the response options. When a student chooses "No", ideally, there should be supplemental questions that ask why they are not planning to continue their enrollment. This is an improvement that can be made with future iterations of this survey, if administered. Only 1 question is negatively worded and asks, "What part of FYE do you think will be LEAST HELPFUL to you as you progress through your degree?". While this open-ended question yielded interesting results, it does not directly ask students to identify the factors that lead to their decision not to persist.

CHAPTER 4. RESULTS

This research study sought to understand the impact FYEng have on undergraduate student persistence in engineering. As described in Chapter 3, the data for this study was collected via a survey instrument that utilized both quantitative and qualitative survey response options. The confidential online survey was administered March 19th through April 22nd, 2019 to students attending BU First Year Engineering (BU-FYEng) program. Survey data was collected over an approximately 1-month period in which 126 complete responses were recorded (among 147 total responses). The survey population size was approximately 899 students, which is the size of the fall 2018 incoming cohort of engineering freshman and transfer students in BU-FYE program. Incomplete responses were removed before formal analysis since they lacked critical information needed to understand the demographics and/or status (first generation, transfer, commuter) of the individual providing the response, or failed to include a full set of responses to quantitative questions.

Research Questions

As stated in Chapter 3, this research study focused on persistence among undergraduate first-year engineering students at BU and sought to understand student perceptions of the factors present in the BU-FYEng program that support first- to second-year persistence in an engineering or computer science major. The primary research question for this study was:

Which factors present in the first-year engineering program influence student persistence in engineering?

Additional secondary research questions include:

1. *How do students perceive the BU-FYEng program?*

2. *How does commuter status impact the experience of BU-FYEng students?*
3. *How does transfer status impact the experience of BU-FYEng students?*
4. *How does first generation status impact the experience of BU-FYEng students?*
5. *How does gender identity impact the experience of BU-FYEng students?*
6. *How does race/ethnicity impact the experience of BU-FYEng students?*

The primary research question sought to understand the factors present in BU's FYEng program that influence student persistence in engineering. The six secondary research questions provided additional insight into overall student perceptions and experiences, as well as the specific perceptions and experiences of subpopulations of engineering students. Secondary question 1 provided valuable insights into how BU-FYEng students perceived the program, and secondary questions 2-6 explored the experiences of various subpopulations. Together, the answers to these research questions helped to provide an understanding of how the BU-FYEng program is perceived by these students, and the program features that influenced student persistence decisions.

Recoding of Variables

To ensure accuracy during the analysis of data, recoding of some survey data responses was needed. Several variables were recoded prior to data analysis.

First, to identify transfer students, Questions 2 and 3 asked students to indicate which BU-FYEng courses they had completed the prior semester (Q2) and the current semester (Q3). Response options for both questions included all first and second term BU-FYEng courses EGR 101, EGR 102, EGR 103, EGR 103/112 (for transfer students), EGR 199, and EGR 215 (for transfer students). The purpose of these two questions was to determine which students were completing EGR 103/112 or EGR 215, which are

designed specifically for transfer students. The variable "TRANSFER" was created, and responses from questions 2 and 3 were recoded such that EGR 103/112 or EGR 215 responses were coded "Yes", and all other responses coded as "No" for analysis: Yes, to identify transfer students, and "No" to identify non-transfer students.

Second, Question 17 asked students to provide their gender identity, and students were given 3 response options: "A Man, a Woman, or Something Else". For the third response option "Something Else", an additional text box was provided so that students could indicate what they identify as, if not a man or woman. For analysis, the variable "GENDER" was created. The one response indicating "Something Else ", was recoded as "unknown" since no additional information was provided. Categories for variable GENDER include "male", "female", and "unknown".

Third, Questions 18 and 19 asked students to identify their race and ethnicity. Question 18 asked "I identify as…" and several response options were provided across race categories aligned with pre-existing BU admissions demographic areas. Question 19 asked "Are you Spanish, Hispanic, Latinx, or none of these?" with response options provided as "Yes" and "None of these". Recent guidance surrounding the reporting of race and ethnicity information indicates that, for various reasons including fairness, equity, and consistency, the categories of race and ethnicity should be combined for analysis, with the terms "race" and "ethnicity" unified into an aggregate, mutually exclusive set of categories "race/ethnicity" (Flanagin et al., 2021). For analysis, the variable" RACE_ETHN" was created, and responses from questions 18 and 19 were combined. "Yes" responses from Question 19 "Are you Spanish, Hispanic, Latinx, or none of these?" were coded "Hispanic", even if the respondent provided a race with their

response to Question 18. The category "Hispanic" was then utilized for analysis in the data set alongside other race/ethnicity response options.

Fourth, to facilitate further analysis of race/ethnicity data as it relates to other demographic and subpopulation variables, the variable "BIPOC" was created. BIPOC is an acronym that stands for "Black, Indigenous, and People of Color" and is used to describe all individuals that are considered "non-white" (Garcia, 2020). Race/ethnicity data was further categorized as BIPOC yes/no, and race/ethnicity response data was coded as "yes" for BIPOC (non-white) students, and "no" for white students. This provided another variable to utilize in data analysis.

Data Analysis

A descriptive statistical analysis of the data was performed utilizing SPSS Version 28. Content analysis of open-ended survey response data was performed in Microsoft Excel for Windows 10. A more thorough explanation of how content analysis of open-ended responses was performed is explained in a subsequent section of this chapter. Results from both analyses are utilized in the Chapter 5 Discussion to enhance the overall understanding of student perceptions of, and experiences in, the BU-FYEng program.

Student Demographics

Before a discussion of the distribution of survey responses can be conducted, a brief understanding of the demographics of survey respondents is needed. As stated, there were 126 complete responses utilized for analysis. Table 3 displays the gender identity breakdown as indicated by the responses to Question 17.

Table 3

Gender Identity of Survey Respondents

Q17 "I Identify as…"	Frequency (%)
A Man	92 (73%)
A Woman	33 (26.2%)
Something Else	1 (.8%)
Total	**126 (100%)**

Of the 126 respondents, 92 respondents identified as "a man", 33 identified as "a woman", and 1 respondent indicating they identify as "something else" other than a man or woman. Individuals identifying as "a man" and "a woman" may be referred to as "male" and "female" respectively in subsequent sections for discussion. For the 1 respondent indicating they identified as "something else" the response for gender identity was coded as "unknown".

Respondents were asked to indicate their race and ethnicity via responses to Questions 18 and 19. As stated prior, race and ethnicity response data were combined into one variable "race/ethnicity" for analysis. Question 19 asked "Are you Spanish, Hispanic, Latinx, or none of these?" with response options provided as "Yes" and "None of these". As stated, prior, and to remain consistent with recent guidance, the categories of race and ethnicity were combined into 1 category for analysis (Flanagin et al., 2021). Therefore, respondents coded as Hispanic do not share an additional race/ethnicity category and are not categorized as Bi/Multi-racial. "Yes" responses were coded "Hispanic", even if the respondent provided a response to Question 18 regarding race. All other race/ethnicity response options are considered non-Hispanic, and race/ethnicity data in subsequent tables are displayed in that manner. Table 4 displays the race/ethnicity breakdown of the 126 complete responses included in the analysis.

Table 4

Race/Ethnicity of Survey Respondents

Q18 "I Identify as…"	Female Frequency (%)	Male Frequency (%)	Unknown Frequency (%)	Total (%)
American Indian or Alaskan Native	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Asian	6 (4.8%)	7 (5.6%)	0 (0%)	13 (10.3%)
Bi/Multi-racial	0 (0%)	5 (4%)	0 (0%)	5 (4%)
Black or African American	3 (2.4%)	0 (0%)	0 (0%)	3 (2.4%)
Hispanic	1 (.8%)	6 (4.8%)	1 (.8%)	8 (6.3%)
Native Hawaiian or Pacific Islander	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Near/Middle Eastern	0 (0%)	0 (0%)	0 (0%)	0 (0%)
White	23 (18.3%)	74 (58.7%)	0 (0%)	97 (77%)
Total	**33 (26.2%)**	**92 (73%)**	**1 (.8%)**	**126 (100%)**

Over 75% of the 126 survey respondents are white students, with 74 white males (58.7%), and 23 white females (18.3%). Asian students comprise the second largest percentage of survey respondents with 13 Asian respondents (10.3%), which includes 7 male (5.6%) and 6 female (4.8%) respondents. All other race/ethnicities comprise less than 10% of the respondent population each, with 8 (6.3%) Hispanic respondents (1 female, 6 males, and 1 unknown), 5 (4%) Bi-Racial male students, and 3 (2.4%) female Black or African American respondents.

To gain an understanding of how subpopulations of students experience and perceive the BU-FYEng program, students were asked questions that served to align them with statuses common in higher education research, specifically first-generation, commuter, and transfer status. Table 5 displays the demographic breakdown of subpopulations among the survey respondents and includes a breakdown of BIPOC respondents as well (Garcia, 2020).

Table 5

Subpopulation Demographics of Survey Respondents

Subpopulation	Female Frequency (%)	Male Frequency (%)	Unknown Frequency (%)	Total Frequency (%)
Commuter Students (Q16)	1 (.8%)	15 (11.9%)	0 (0%)	16 (12.7%)
First Generation Students (Q23)	2 (1.6%)	18 (14.3%)	0 (0%)	20 (15.9%)
Transfer Students (Q2/Q3)	3 (2.4%)	6 (4.8%)	0 (0%)	9 (7.2%)
BIPOC (Q18/Q19)	10 (7.9%)	18 (14.3%)	1 (.8%)	29 (23%)

Of the 126 complete responses provided, 16 students (12.7% of total responses) indicated they were commuters (living more than a 30-minute drive away), 20 students (15.9%) indicated they were first generation college students (neither of their parents completed college), and 9 students (7.2%) indicated they were transfer students. A breakdown of BIPOC respondents was also included, with 23% of respondents indicating they were a person of color (Garcia, 2020).

Some students provided responses that were positively aligned with 2 or even 3 of the statuses. Among this subpopulation of survey respondents, it was noted that no individual respondent aligned with all 4 subpopulation categories, but 3 respondents (all white males) aligned with 3 subpopulation categories (first generation, commuter, and transfer student). Several other students share 2 of the 3 statuses, such that 5 respondents indicated they are both first generation and commuter (all white males), 3 respondents are non-white (BIPOC) and transfer, and 3 respondents are both transfer and commuter status.

Representative Sample

A representative sample is one where the individuals in the sample proportionally reflect the attributes of the population (Nardi, 2014). As mentioned in the introduction, the survey utilized was administered in the 2018-2019 academic year. The Fall 2018

cohort of BU-FYE students included a total of 899 students: 753 first-time freshman (83.8%) and 146 transfer students (16.2%). Among the 899 students in this cohort, 719 are male (80%) and 180 are female (20%), 167 are non-white (18.6%), and 184 First Generation (20.4%), and 411 (45.7%) chose to live on the Engineering LLP for Fall 2018. Data regarding the number of commuter students among this groups was not able to be obtained due to limitations on institutional demographic data collection methods. Table 6 displays the subpopulation demographics of the survey respondents and the Fall 2018 BU-FYEng students.

Table 6

Subpopulation Demographics of Survey Respondents and Fall 2018 BU-FYEng Cohort Student

Subpopulation	Survey Responses Frequency (%)	Fall 2018 BU-FYEng Cohort Frequency (%)
Male	92 (73%)	719 (80%)
Female	33 (26.2%)	180 (20%)
1st Generation	20 (15.9%)	184 (20%)
Transfer	9 (7.2%)	146 (16%)
BIPOC	29 (23%)	167 (19%)

NOTE: Commuter data was not available for the Fall 2018 BU-FYEng cohort.

The students from each demographic subpopulation in Table 6 is proportional when comparing the percentage of students that responded to the survey with the percentage of students from the BU-FYEng cohort. Apart from commuter students, the survey responses from this study are representative of the population being studied.

Primary Research Question Results

The primary research question in this study was "Which factors present in the BU-FYEng program influence student persistence in engineering?". Question 20 on the survey asked, "Are you planning on continuing your enrollment in the BU-FYEng program next semester?" and students were provided with Yes/No response options. Of

the 126 complete responses, 115 (91.3%) indicated there were planning on continuing in the BU-FYEng program, and 11 respondents indicated "no" they were not planning to continue next term. As a supplement to Question 20, Question 21 asked "What factors contributed to your continued enrollment?" in which students were provided ten response options. The response prompt for this item was to "check all that apply". Table 7 displays the alignment of Question 21 responses with the frequency counts and percentages of the 115 Question 20 "Yes" responses, and the corresponding factors in Hayden's (2017) model.

Table 7

Frequency and Percent of Factors Contributing to Continued Enrollment and Corresponding Factors in Hayden's (2017) Model for 115 CONTINUING Respondents

Q21 "What factors contributed to your continued enrollment?"	Frequency	Percent of "Yes" Respondents Choosing Factor	Corresponding Factors in Hayden's (2017) Model
Financial Aid	49	42.6%	financial circumstances
Peer Mentoring	7	6%	organizational & learning skills
Connection with Faculty	21	18.3%	academic life
Friends/cohort	66	57.4%	life transition academic life social life
Campus resources	22	19.1%	academic life
Innovation Center Lab	15	13%	academic life
FYE Open Lab	10	8.7%	academic life
My academic program	70	60.8%	academic life
Living Learning Program	20	17.4%	life transition academic life social life
My experience in BU-FYE	27	23.4%	ALL 7 factors

While response data was not included for the 11 "No" respondents to Question 21 "What factors contributed to your continued enrollment?", response data from these 11 "No" respondents (NOT CONTINUING) is both important and valuable and was included in the analysis of response data for other survey items included in the study. An

analysis of response data for the 11 respondents answering “No” to Question 20 (“Are you planning on continuing your enrollment in the BU-FYEng program next semester?”) is included in this chapter after the analysis of all 6 secondary research questions.

As Table 7 indicates, among the 115 complete “Yes" responses, BU-FYEng students indicated their academic program (60.8%), their friends/cohort (57.4%), and financial aid (42.6%) were the three most important factors that contributed to their continued enrollment in the BU-FYEng program. Additional factors that students indicated contributed to their continued enrollment include their experience in BU-FYEng (23.4%), campus resources (19.1%), connection with faculty (18.3%), and the LLP (17.4%).

Finding 1: For all respondents continuing in the BU-FYEng program, their academic program (their major), their friends/cohort, and financial aid were the three most important factors that contributed to continued enrollment, with respondents indicating these 3 factors contributed the most to their planned continued enrollment in the BU-FYEng program. This finding aligns with and supports the academic life, social life, financial circumstances, and life transition factors in Hayden’s (2017) model.

Finding 2: For all respondents continuing in the BU-FYEng program, their experience in the BU-FYEng program, campus resources, connection with faculty, and the LLP were additional factors that contributed to their continued enrollment in the BU-FYEng program. This finding aligns with and supports the academic life, social life, life transition, and all 7 factors in Hayden’s (2017) model.

Secondary Research Question Results

The six secondary research questions listed below provided additional insight into overall student perceptions and experiences, as well as the specific perceptions and experiences of subpopulations of engineering students:

1. *How do students perceive the BU-FYEng program?*
2. *How does commuter status impact the experience of BU-FYEng students?*
3. *How does transfer status impact the experience of BU-FYEng students?*
4. *How does first generation status impact the experience of BU-FYEng students?*
5. *How does gender identity impact the experience of BU-FYEng students?*
6. *How does race/ethnicity impact the experience of BU-FYEng students?*

Secondary research question 1 utilized open-ended response data and provided valuable insight into how all BU-FYEng students perceive the program. Secondary research questions 2-6 explored the experiences of various subpopulations of survey respondents, specifically commuter, transfer, first generation, and BIPOC students (Garcia, 2020), as well as the experiences of respondents based on their reported gender identity.

Secondary Research Question 1

Secondary research question 1 "*How do students perceive the BU-FYEng program?*" is aligned with 4 survey items:

- Question 10 "What part of BU-FYEng do you think will be the MOST HELPFUL to you as you progress through your degree?"
- Question 11 "What part of BU-FYEng do you think will be the LEAST HELPFUL to you as you progress through your degree?"

- Question 12 “Is there anything else you would like to share with us about your BU-FYEng experience?”
- Question 6 “Please indicate your agreement with the following statements: ‘My introductory engineering course(s) helped me with…’”

Understanding how BU-FYEng students perceive their experience in the program is fundamental to this study. To understand the perceptions of all BU-FYEng respondents, the analysis included all responses to Questions 6, 10, 11, and 12, including any open-ended responses from individuals indicating that they were not planning to continue in the BU-FYEng program next term (“No” to Question 20). Data from subpopulations of these respondents were separated for analysis, with quantitative responses analyzed via the cross-tabulation function in SPSS, and qualitative response data to Questions 10, 11, and 12 were analyzed via Microsoft Excel.

Questions 10, 11, and 12 are open-ended response items designed to elicit candid feedback from students about their perceptions of the BU-FYEng program, both favorable and unfavorable. Open-ended response data were separated and coded for themes using Microsoft Excel. All open-ended responses were coded in two ways: (a) as either positive, negative, or neutral; and (b) for themes based on the content of the response (e.g., connection to faculty, teamwork, resources, etc.). In some instances, students gave mixed responses in which they indicated something was positive and then indicated something else was negative. In such instances the codes for these responses were separated so that positive and negative responses can be aggregated to better understand overall student perceptions. Where appropriate, responses that were coded

both positively and negatively remained combined as response examples from specific student subpopulations.

Question 10 states "*What part of BU-FYEng do you think will be the MOST HELPFUL to you as you progress through your degree?*". The results for question 10 were mixed, in that even though the question was asking for student perceptions of the MOST HELPFUL part of the program, many students responded negatively. Of the 86 qualitative responses to Question 10, 67 (78%) responses were positive, and 19 (22%) responses were negative. Of the positive responses with themes relating to the most helpful part of the BU-FYEng program, basic engineering skills learned, resources, information sessions, MATLAB, teamwork, and professor interaction all were mentioned multiple times across open-ended responses to this item. Additional themes mentioned included ethics, major and career exploration, and friends. Most of the negative responses were overwhelmingly negative, indicating that the entire BU-FYEng program was not helpful or a waste of time, while some negative responses were more specific, indicating that unbalanced student teamwork was a problem, or that the program is not helpful for Chemical Engineering students. One student specifically indicated they dropped engineering because of the BU-FYEng program.

Finding 3: For all respondents, the MOST HELPFUL features of the BU-FYEng program included teamwork, professor interaction, learning basic engineering skills, and information sessions (to learn about other engineering majors). This finding aligns with and supports both the academic life and organizational & learning skills factors in Hayden's (2017) model.

Question 11 states "*What part of BU-FYEng do you think will be the LEAST HELPFUL to you as you progress through your degree?*". The results for Question 11 were mixed as well but overwhelmingly negative given the question is asking respondents to identify the LEAST HELPFUL aspects of the BU-FYEng program. Among the 84 qualitative responses to Question 11, 79 (94%) were negative and 5 (6%) were positive. The positive responses were not specific, indicating overall that nothing is unhelpful. Among the themes for negative responses to question 11, the EGR 101 course was mentioned overwhelmingly as the least helpful part of the BU-FYEng program. EGR 101 was characterized as a busy-work course that is "a waste of time", and "pointless for those who have chosen a major". Many students also indicated that "all of it" or "all" was the least helpful, with specific commentary revolving around it being a "waste of time" and "all of the stress" added being unhelpful. Learning MATLAB or coding was also cited as a least helpful feature, often with the feedback indicating that coding is not required for their chosen major. Additional themes regarding the least helpful parts of the BU-FYEng program included projects that are off-topic or unrelated to the chosen major, additional stress, unnecessary busy work, and learning Arduino.

Finding 4: Overwhelmingly, all respondents perceived EGR 101 as the LEAST HELPFUL feature of the BU-FYEng program, specifically characterizing it as a busy work course, that it is a waste of time, and useless for those that have chosen a major. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Finding 5: Students' view of learning MATLAB was mixed and was cited often in open-ended feedback as both a MOST HELPFUL and LEAST HELPFUL aspect of the BU-FYEng program. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Question 12 states "*Is there anything else you would like to share with us about your BU-FYEng experience?*". Of the 56 open-ended responses provided to Question 12, about half of the responses were negative (31 negative responses, 55%), about a quarter were neutral or mixed positive-negative responses (16 responses, 29%), and the rest were positive responses (9 responses, 16%). Among the negative responses, students described the workload as being too heavy, some feel the program needs restructuring, and others feel that the program favors Electrical and Computer Science Engineering majors. In some cases, respondents were very candid with what they shared and some also provided specific suggestions for program improvement. One student indicated:

> *I felt as though the FYE was not very effective to introduce students into their intended engineering majors. CPE, CS, and EE majors were not given good introductory classes, and EGR 102 did not provide a good introduction to coding and wiring. EGR 102 and 101 did not really encompass [the] curriculum which pertained to many of the other engineers.*

Neutral responses generally provided constructive feedback for program improvement. One student indicated:

> *Working in groups sounds like a good idea, but the execution was really poor. I think we should have a basic understanding in all the concepts used for projects like the ones assigned in 103. It's difficult to implement subjects and concepts that we haven't learned about in other classes, so the projects often felt impossible and only frustrated many students including myself. I would like to learn a lot of the basic material first (physics, chemistry, programming) before we are forced to combine many of them into an assignment.*

Positive responses were mostly general in nature, indicating the whole program is helpful or the respondent is satisfied overall with the BU-FYEng program, with "amazing faculty" being cited three times as a positive aspect of the program. Positive responses tended to be more general in nature, whereas negative responses included more specific information regarding why the perception is negative.

Finding 6: Across all responses, students perceive the workload associated with the BU-FYEng program as too heavy and too stressful for the number of units earned. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Finding 7: Across all responses, students view the BU-FYEng program as providing inadequate academic preparation for all engineering majors offered. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Overall, open-ended responses were very informative, providing valuable insight into student perceptions regarding the BU-FYEng program. Further disaggregation of the open-ended response data is done via analysis of the remaining secondary research questions, which focused on the experiences of subpopulations with the BU-FYEng program.

Question 6 asked respondents to indicate their level of agreement (Likert scale) with several statements aligned with BU-FYEng program learning objectives. Question 6 statements include:

- Making an informed major choice
- Learning about the Engineering and Computer Science majors at BU
- Learning about Engineering and Computer Science career options
- Developing teamwork skills
- Developing real-world problem-solving skills
- Understanding the practice of engineering
- Understanding being a licensed Professional Engineer (PE)
- Developing skills useful to my engineering major coursework

Students were asked to indicate their level of agreement with the above statements using 5-point Likert scale response options (Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, and Strongly Disagree). Understanding the nuances between similar responses like strongly agree and agree are incorporated into Question 6 data tables to see the distribution of responses across each statement. For Question 6 findings, however, understanding whether respondents agree, disagree, or neither agree nor disagree with the statements are reported. Therefore, when reporting findings associated with Question 6 throughout this study, the two agree responses (agree and strongly agree) are combined, and the two disagree statements (disagree and strongly disagree) are combined into one result. Table 8 displays the distribution of responses for Question 6 across all 126 respondents.

Table 8

Frequency and Percent of Question 6 Responses and Corresponding Factors in Hayden's (2017) Model for ALL 126 Respondents

Q6 "My introductory engineering course(s) helped me with…"	Frequency and Percent of Likert Scale Responses						Corresponding Factors in Hayden's (2017) Model
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Total	
Making an informed major choice	19 (15.1%)	16 (12.7%)	26 (20.6%)	47 (37.3%)	18 (14.3%)	126 (100%)	Academic Life
Learning about the Engineering and Computer Science majors at BU	12 (9.5%)	16 (12.7%)	21 (16.7)	61 (48.4%)	16 (12.7%)	126 (100%)	Academic Life
Learning about Engineering and Computer Science career options	11 (8.7%)	18 (14.3%)	33 (26.2%)	51 (40.5%)	13 (10.3%)	126 (100%)	Academic Life
Developing teamwork skills	7 (5.6%)	7 (5.6%)	25 (19.8%)	68 (54%)	19 (15.1%)	126 (100%)	Academic Life
Developing real-world problem-solving skills	10 (7.9%)	9 (7.1%)	31 (24.6%)	61 (48.4%)	15 (11.9%)	126 (100%)	Academic Life Organizational & Learning Skills
Understanding the practice of engineering	11 (8.7%)	8 (6.3%)	25 (19.8%)	69 (54.8%)	13 (10.3%)	126 (100%)	Academic Life
Understanding being a licensed Professional Engineer (PE)	17 (13.5%)	18 (14.3%)	31 (24.6%)	48 (38.1%)	12 (9.5%)	126 (100%)	Academic Life
Developing skills useful to my engineering major coursework	16 (12.7%)	22 (17.5%)	28 (22.2%)	44 (34.9%)	16 (12.7%)	126 (100%)	Academic Life Organizational & Learning Skills

As Table 8 indicates, across all Question 6 responses, the largest percentage of responses indicate that respondents agree that the BU-FYEng program helps them across all program learning objectives listed.

Finding 7: Across all BU-FYEng program learning objectives listed (Q6 statements), most students agree that the BU-FYEng program helps them with all

program learning objectives listed. This finding aligns with and supports both the academic life and organizational & learning skills factors in Hayden's (2017) model.

Secondary Research Questions 2 - 6

Secondary research questions 2 through 6 focus on understanding the perceptions of subpopulations of respondents within the BU-FYEng program. The alignment of research questions and survey items provided in the primary research question and secondary research question 1 are also used in the analysis of response data for these subpopulations. Table 2 in Chapter 3 displays the complete alignment of secondary research questions with survey items in specific detail. To understand their perceptions, response data from Questions 20, 21, 6, 10, 11, and 12 were analyzed for each subpopulation of students aligned with a secondary research question.

Secondary Research Question 2

Secondary research question 2 "*How does commuter status impact the experience of BU-FYEng students?*" explored the experience of this subpopulation of students. To understand the experiences and perceptions of commuter students in the BU-FYEng program, a cross tabulation analysis was conducted in SPSS to understand the relationship between Question 16 "*Are you a commuter? (Living more than a 30-minute drive away)*" and all other variables within the data set included in this study. Of the 126 complete responses, 16 students indicated "Yes" to Question 16. The responses from these 16 students were analyzed separately to gain an understanding of the perceptions and experiences of this BU-FYEng subpopulation of students.

Question 20 asked "Are you planning on continuing your enrollment in the BU-FYEng program next semester?" and students were provided with Yes/No response options. Of the 16 Commuter students that provided complete responses to the survey, 15

indicated “Yes” and were planning to continue enrollment in the BU-FYEng program next semester, 1 indicated they were not planning to continue. Question 21 asked “What factors contributed to your continued enrollment?” in which students were provided ten response options. The response prompt for this item was to “check all that apply”. Given that Question 21 asked about factors contributing to their continued enrollment, only the 15 “Yes” responses were analyzed, the 1 “No” response was excluded in the analysis. Table 9 displays the Question 21 frequency counts and percentages of each response option aligned with the 15 Question 20 “Yes” responses.

Table 9

Frequency and Percent of Factors Contributing to Continued Enrollment and Corresponding Factors in Hayden’s (2017) Model for 15 CONTINUING COMMUTER Respondents

Q21 “What factors contributed to your continued enrollment?”	Frequency	Percent of “Yes” Respondents Choosing Factor	Corresponding Factors in Hayden’s (2017) Model
Financial Aid	7	43.8%	financial circumstances
Peer Mentoring	0	0%	academic life
Connection with Faculty	1	6.2%	academic life
Friends/cohort	5	31.3%	life transition academic life social life
Campus resources	2	12.5%	academic life
Innovation Center Lab	2	12.5%	academic life
FYE Open Lab	2	12.5%	academic life
My academic program	9	56.3%	academic life
Living Learning Program	0	0%	life transition academic life social life
My experience in BU-FYE	4	25%	ALL 7 factors

While response data was not included for the 1 “No” respondent to Question 21 “What factors contributed to your continued enrollment?”, response data from the 1 “No”

respondent is valuable and was included in the analysis of response data for other survey items included in the study.

Finding 8: For commuter students, their academic program (their major), financial aid, and their friends/cohort were the three most important factors that contributed to continued enrollment in the BU-FYEng program. This finding aligns with and supports the financial circumstances, academic life, social life, and life transition factors in Hayden's (2017) model.

Finding 9: For commuter students, their experience in the BU-FYEng program was an additional important factor that contributed to continued enrollment. This finding aligns with and supports all 7 factors in Hayden's (2017) model.

Question 6 "My introductory engineering course(s) helped me with…" asked respondents to indicate their level of agreement (using a 5-point Likert scale) with several statements aligned with BU-FYEng program learning objectives. Table 10 displays the distribution of the 16 commuter student responses for Question 6.

Finding 10: Most commuter students agree, across all BU-FYEng program learning objectives listed (Question 6 statements), that the BU-FYEng program helps them with all program learning objectives listed. This finding aligns with and supports both the academic life and organizational & learning skills factors in Hayden's (2017) model.

Open-ended feedback from commuter student respondents was minimal but informative. Open-ended responses derived from Questions 10, 11, and 12 were designed to elicit candid feedback from students about their perceptions of the BU-FYEng program. Open-ended response data were separated and coded for themes using

Table 10

Frequency and Percent of Question 6 Responses and Corresponding Factors in Hayden's (2017) Model for 16 COMMUTER Respondents

Q6 "My introductory engineering course(s) helped me with…"	Frequency and Percent of Likert Scale Responses						Corresponding Factors in Hayden's (2017) Model
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Total	
Making an informed major choice	2 (12.5%)	1 (6.3%)	3 (18.8%)	9 (56.3%)	1 (6.3%)	16 (100%)	Academic Life
Learning about the Engineering and Computer Science majors at BU	2 (12.5%)	1 (6.3%)	3 (18.8%)	9 (56.3%)	1 (6.3%)	16 (100%)	Academic Life
Learning about Engineering and Computer Science career options	2 (12.5%)	2 (12.5%)	2 (12.5%)	9 (56.3%)	1 (6.3%)	16 (100%)	Academic Life
Developing teamwork skills	2 (12.5%)	1 (6.3%)	3 (18.8%)	9 (56.3%)	1 (6.3%)	16 (100%)	Academic Life Organizational & Learning Skills
Developing real-world problem-solving skills	2 (12.5%)	1 (6.3%)	4 (25%)	5 (31.3%)	4 (25%)	16 (100%)	Academic Life Organizational & Learning Skills
Understanding the practice of engineering	2 (12.5%)	0 (0%)	4 (25%)	7 (43.8%)	3 (18.8%)	16 (100%)	Academic Life
Understanding being a licensed Professional Engineer (PE)	2 (12.5%)	0 (0%)	5 (31.3%	7 (43.8%)	2 (12.5%)	16 (100%)	Academic Life
Developing skills useful to my engineering major coursework	2 (12.5%)	2 (12.5%)	3 (18.8%)	6 (37.5%)	3 (18.8%)	16 (100%)	Academic Life Organizational & Learning Skills

Microsoft Excel. All open-ended responses were coded in two ways: (a) as either positive, negative, or neutral; and (b) coded for themes based on the content of the response (e.g., connection to faculty, teamwork, resources, etc.). In some instances, students gave mixed responses in which they indicated something was positive and then indicated something else was negative. In such instances the codes for these responses

were separated so that positive and negative responses can be aggregated to better understand overall student perceptions.

Question 10 states "*What part of BU-FYEng do you think will be the MOST HELPFUL to you as you progress through your degree?*". Among commuter students, 10 of 16 students provided an open-ended response to Question 10. Of the 10 responses provided, 7 were positive (70%) and 3 were negative (30%). Overall, commuter students view the BU-FYEng program positively, citing a wide range of program features and learning outcomes as MOST BENEFICIAL. The 7 positively coded responses provided a range of positive themes, with responses indicating learning MATLAB (and circuitry) was the most beneficial, as well as teamwork, engineering skills, resources, faculty interaction, and the confirmation of engineering major choice. Among the 10 positively coded responses was 1 from a student who also indicated they were not continuing in the program the next term. This individual indicated the "*problem solving skills and time management learned through this [program]*" were the MOST HELPFUL, also indicating that these skills "*are just good universal skills to have*". The 3 negative responses were pervasively negative, with 2 of the 3 responses describing the BU-FYEng program as a program motivated by financial gain from students, with 1 respondent indicating the BU-FYEng programs "seems like a desperate money grab by the university posing as a 'helpful' program". Even given the negative perceptions of these 3 commuter students, all three indicated they are planning to continue in the program ("No" response to Question 20). Negative program perceptions among these respondents do not seem to negatively influence their desire to continue as an engineering major.

Finding 11: For commuter students, the MOST HELPFUL features of the BU-FYEng program included MATLAB, teamwork, engineering skills, resources, faculty interaction, and the confirmation of engineering major choice. This finding aligns with and supports both the academic life and organizational and learning skills factors in Hayden's (2017) model.

Question 11 states "*What part of BU-FYEng do you think will be the LEAST HELPFUL to you as you progress through your degree?*". Among commuter students, 10 of 16 students provided an open-ended response to Question 11. Of the 10 responses provided, 7 were negative (70%) and 3 were positive (30%). The 7 negative responses provided specific details, with respondents indicating MATLAB, Arduino, and EGR 101 were what these respondents felt would be the LEAST HELPFUL as they progress through their degree. One commuter respondent had critical feedback for EGR 101, saying:

> *The EGR 101 class was not particularly helpful, even though the professor was excellent. When the professor was teaching what he wanted to teach it was great, but the actual course seemed poorly organized and was difficult to follow.*

Given this question is asking respondents to indicate what they felt was LEAST HELPFUL about the BU-FYEng program, one would expect that all responses would be negative. However, 3 of 10 commuter responses for Question 11 were positive. The positive responses were non-specific, indicating that all aspects of the program were positive, and/or they could not think of anything that was LEAST HELPFUL.

Finding 12: Commuter students perceived EGR 101 as the LEAST HELPFUL feature of the BU-FYEng program, specifically characterizing it as a busy work course, that it is a waste of time, and useless for those that have chosen a major. This finding supports the notion that some BU-FYEng program curricular and design features are

perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Question 12 states "*Is there anything else you would like to share with us about your BU-FYEng experience?*". Among commuter students, 7 open-ended responses were provided to Question 12. The responses provided were mixed, with 3 (42.8%) negative responses, 2 (28.6%) positive responses, 1 (14.3%) neutral response, and 1 (14.3%) mixed response that was both positive and negative. Among the responses to Question 12, for commuter students, themes coded were singular, with no responses similar enough to generate the same theme. Themes for the negative responses include MATLAB, the workload being too heavy, and poor project guidance in EGR 215. The respondent with critical feedback regarding the workload being too heavy indicated "*these 2 credit hour classes often required more effort than my 3 and 4 credit hour classes did"*. The 2 positive responses were informative as well, with themes for these 2 responses being the BU-FYEng program is helpful overall, and the program is useful for understanding engineering disciplines. One positive response was particularly instructive, with the respondent indicating:

> *the FYE program helped me learn a lot more about the different disciplines. There are fewer blurred lines to me between a few of the disciplines. I enjoyed the content we learned, and I learned what I truly like and dislike.*

The 7 responses included 1 neutral response from a student indicating they are not planning to continue in the program next term ("No" response to Question 20). The response provided indicated the respondents "*choice to change my major was not impacted by the FYE program*".

Finding 13: For commuter students, themes coded were singular, with no responses similar enough to generate the same theme. No factors from Hayden's (2017) model were found to be in alignment with commuter student responses to Question 12.

Secondary Research Question 3

Secondary research question 3 "*How does transfer status impact the experience of BU-FYEng students?*" explored the experience of this subpopulation of students. To understand the experiences and perceptions of transfer students in the BU-FYEng program, a cross tabulation analysis was conducted in SPSS to understand the relationship between transfer students and all other variables within the data set. Of the 126 complete responses, on Questions 2 and 3 of the survey, 9 students indicated they were completing either EGR 103/112 or EGR 215 which are the BU-FYEng courses specifically designed for transfer students. The responses from these 9 students were analyzed separately to gain an understanding of the perceptions and experiences of this BU-FYEng subpopulation of students.

Question 20 asked "Are you planning on continuing your enrollment in the BU-FYEng program next semester?" and students were provided with Yes/No response options. Of the 9 transfer students that provided complete responses to the survey, all 9 indicated "Yes" and were planning to continue enrollment in the BU-FYEng program next semester. Question 21 asked "What factors contributed to your continued enrollment?" in which students were provided ten response options. The response prompt for this item was to "check all that apply". Table 11 displays the Question 21 frequency counts and percentages of each response option for this subpopulation of students:

Table 11

Frequency and Percent of Factors Contributing to Continued Enrollment and Corresponding Factors in Hayden's (2017) Model for 9 TRANSFER Respondents

Q21 "What factors contributed to your continued enrollment?"	Frequency	Percent of "Yes" Respondents Choosing Factor	Corresponding Factors in Hayden's (2017) Model
Financial Aid	5	55%	financial circumstances
Peer Mentoring	0	0%	organizational & learning skills
Connection with Faculty	1	11%	academic life
Friends/cohort	2	22%	life transition academic life social life
Campus resources	3	33%	academic life
Innovation Center Lab	1	11%	academic life
FYE Open Lab	0	0%	academic life
My academic program	4	44%	academic life
Living Learning Program	0	0%	life transition academic life social life
My experience in BU-FYE	2	22%	ALL 7 factors

Finding 14: For transfer students, financial aid, their academic program (their major), and campus resources were the three most important factors that contributed to continued enrollment in the BU-FYEng program. This finding aligns with and supports the financial circumstances, academic life, and social life factors in Hayden's (2017) model.

Finding 15: For transfer students, their friends/cohort, and their experience in the BU-FYEng program were additional factors that contributed to continued enrollment in the BU-FYEng program. This finding aligns with and supports all seven factors of Hayden's (2017) model.

Question 6 "My introductory engineering course(s) helped me with…" asked respondents to indicate their level of agreement (using a 5-point Likert scale) with several

statements aligned with BU-FYEng program learning objectives. Table 12 displays the distribution of the 9 transfer student responses to Question 6.

Table 12

Frequency and Percent of Question 6 Responses and Corresponding Factors in Hayden's (2017) Model for 9 TRANSFER Respondents

Q6 "My introductory engineering course(s) helped me with…"	**Frequency and Percent of Likert Scale Responses**						**Corresponding Factors in Hayden's (2017) Model**
	Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**	**Total**	
Making an informed major choice	0 (0%)	1 (11.1%)	2 (22.2%)	4 (44.4%)	2 (22.2%)	9 (100%)	Academic Life
Learning about the Engineering and Computer Science majors at BU	2 (22.2%)	1 (11.1%)	2 (22.2%)	3 (33.3%)	1 (11.1%)	9 (100%)	Academic Life
Learning about Engineering and Computer Science career options	2 (22.2%)	0 (0%)	1 (11.1%)	5 (55.6%)	1 (11.1%)	9 (100%)	Academic Life
Developing teamwork skills	2 (22.2%)	1 (11.1%)	1 (11.1%)	5 (55.6%)	0 (0%)	9 (100%)	Academic Life Organizational & Learning Skills
Developing real-world problem-solving skills	2 (22.2%)	1 (11.1%)	0 (0%)	6 (66.7%)	0 (0%)	9 (100%)	Academic Life Organizational & Learning Skills
Understanding the practice of engineering	2 (22.2%)	0 (0%)	2 (22.2%)	5 (55.6%)	0 (0%)	9 (100%)	Academic Life
Understanding being a licensed Professional Engineer (PE)	2 (22.2%)	2 (22.2%)	3 (33.3%)	1 (11.1%)	1 (11.1%)	9 (100%)	Academic Life
Developing skills useful to my engineering major coursework	3 (33.3%)	2 (22.2%)	1 (11.1%)	3 (33.3%)	0 (0%)	9 (100%)	Academic Life Organizational & Learning Skills

Finding 16: Transfer students agree that the BU-FYEng program helps them with 6 of 8 program learning objectives listed (Q6 statements). This finding aligns with and

supports both the academic life and organizational & learning skills factors in Hayden's (2017) model.

Finding 17: Transfer students disagree that the BU-FYEng program helps them with understanding being a licensed PE, and developing skills useful to my engineering major coursework. This finding supports the notion that some BU-FYEng program curricular and design features are not perceived as helpful by all subpopulations of students but aligns with and supports the academic life factor in Hayden's (2017) model.

Open-ended feedback from transfer student respondents was minimal but informative. Open-ended responses derived from Questions 10, 11, and 12 were designed to elicit candid feedback from students about their perceptions of the BU-FYEng program. Open-ended response data were separated and coded for themes using Microsoft Excel. All open-ended responses were coded in two ways: (a) as either positive, negative, or neutral; and (b) coded for themes based on the content of the response (e.g., connection to faculty, teamwork, resources, etc.). In some instances, students gave mixed responses in which they indicated something was positive and then indicated something else was negative. In such instances the codes for these responses were separated so that positive and negative responses can be aggregated to better understand overall student perceptions.

Question 10 states "*What part of BU-FYEng do you think will be the MOST HELPFUL to you as you progress through your degree?*". Among the 9 transfer student respondents, only 3 provided open-ended feedback to Question 10. Of the 3 responses, 2 were negative and 1 was positive. The 2 negative responses, it turns out, are from transfer students that are also commuter students, whose responses were included in the analysis

to secondary research question 2. The content of these 2 negative responses describes the BU-FYEng program as being motivated by financial gain from students. Themes from the 1 positive response to this question indicated that, via the EGR 215 course, friends and career advice were perceived as the MOST HELPFUL as this student as they progress through their degree.

Finding 18: For transfer students, there was not enough data among the open-ended responses to generate the same theme about the MOST HELPFUL features of the BU-FYEng program. No factors from Hayden's model were found to be in alignment with commuter student responses to Question 10.

Question 11 states "*What part of BU-FYEng do you think will be the LEAST HELPFUL to you as you progress through your degree?*". Among the 9 transfer student respondents, 4 provided open-ended feedback to Question 11. All 4 responses were coded negatively, which aligns with the fact that the question is asking about students' perception of what part of the BU-FYEng program they think will be the LEAST HELPFUL to them moving forward. As with Question 10, 2 of these responses were from respondents that are also commuter status as well. Of the 4 responses, themes indicated that "all" of the program was least helpful, as well as information sessions and MATLAB.

Finding 19: There was not enough data among transfer student respondents to Question 11 to generate the same theme about the LEAST HELPFUL features of the BU-FYEng program, all themes were coded singularly. No factors from Hayden's model were found to be in alignment with commuter student responses to Question 10.

Question 12 states "*Is there anything else you would like to share with us about your BU-FYEng experience?*". Among the 9 transfer student respondents, only 2 provided open-ended feedback to Question 12. One response was coded positively, and the other coded negatively. The theme for the positive response was regarding faculty, providing praise for a specific BU-FYEng instructor. The negative response was long and detailed and was also included in the previous research sub question focused on commuter students. The response was coded as "EGR 215" being negative, and the respondent providing the following specific feedback:

> *I don't like how we are doing the project in EGR 215, the professor has provided VERY little help with it and we as first year engineering students lack essential skills needed to perform this project. Also, we have had to find or buy almost all our materials, which is very unfortunate for college students because we don't have very much income, if any. I feel like the project should be restructured so that the students will be given all materials needed to complete the project, we are just assigned to figure out which materials to use and not to use and how to construct it. I'm displeased with this class.*

Finding 20: There was not enough data among transfer student respondents to Question 11 to generate the same theme about the LEAST HELPFUL features of the BU-FYEng program. No factors from Hayden's model were found to be in alignment with commuter student responses to Question 10.

While open-ended response data from transfer students was informative, there was not enough data to generate discernable themes for responses to Questions 10, 11, and 12.

Secondary Research Question 4

Secondary research question 4 "*How does first generation status impact the experience of BU-FYEng students?*" explored the experience of this subpopulation of students. To understand the experiences and perceptions of first-generation students in

the BU-FYEng program, a cross tabulation analysis was conducted in SPSS to understand the relationship between transfer students and all other variables within the data set. Of the 126 complete responses, 20 students indicated "No" to Question 23 "*Did one or both of your parents attend college?*". The responses from these 20 students were analyzed separately to gain an understanding of the perceptions and experiences of this BU-FYEng subpopulation of students.

Question 20 asked "Are you planning on continuing your enrollment in the BU-FYEng program next semester?" and students were provided with Yes/No response options. Of the 20 First Generation students that provided complete responses to the survey, all 20 indicated "Yes" and were planning to continue enrollment in the BU-FYEng program next semester. Question 21 asked "What factors contributed to your continued enrollment?" in which students were provided ten response options. The response prompt for this item was to "check all that apply". Table 13 displays the Question 21 frequency counts and percentages of each response option for this subpopulation of students.

Finding 21: For first generation students, financial aid, their academic program (their major), and their friends/cohort were the three most important factors that contributed to continued enrollment in the BU-FYEng program. This finding aligns with and supports the financial circumstances, academic life, social life, and life transition factors in Hayden's (2017) model.

Table 13

Frequency and Percent of Factors Contributing to Continued Enrollment and Corresponding Factors in Hayden's (2017) Model for 20 FIRST GENERATION Respondents

Q21 "What factors contributed to your continued enrollment?"	Frequency	Percent of "Yes" Respondents Choosing Factor	Corresponding Factors in Hayden's (2017) Model
Financial Aid	14	70%	financial circumstances
Peer Mentoring	5	25%	organizational & learning skills
Connection with Faculty	3	15%	academic life
Friends/cohort	8	40%	life transition academic life social life
Campus resources	4	20%	academic life
Innovation Center Lab	5	25%	academic life
FYE Open Lab	4	20%	academic life
My academic program	9	45%	academic life
Living Learning Program	5	25%	life transition academic life social life
My experience in BU-FYE	6	30%	ALL 7 factors

Finding 22: For first generation students, their experience in the BU-FYEng program, the LLP, peer mentoring, and the innovation Center Lab were additional factors that contributed to continued enrollment in the BU-FYEng program. This finding aligns with and supports all seven factors of Hayden's (2017) model.

Question 6 "My introductory engineering course(s) helped me with…" asked respondents to indicate their level of agreement (using a 5-point Likert scale) with several statements aligned with BU-FYEng program learning objectives. Table 14 displays the distribution of the 20 first generation student responses for Question 6.

Table 14

Frequency and Percent of Question 6 Responses and Corresponding Factors in Hayden's (2017) Model for 20 FIRST GENERATION Respondents

Q6 "My introductory engineering course(s) helped me with…"	Frequency and Percent of Likert Scale Responses						Corresponding Factors in Hayden's (2017) Model
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Total	
Making an informed major choice	5 (25%)	1 (5%)	3 (15%)	8 (40%)	3 (15%)	20 (100%)	Academic Life
Learning about the Engineering and Computer Science majors at BU	4 (20%)	1 (5%)	3 (15%)	11 (55%)	1 (5%)	20 (100%)	Academic Life
Learning about Engineering and Computer Science career options	4 (20%)	2 (10%)	5 (25%)	8 (40%)	1 (5%)	20 (100%)	Academic Life
Developing teamwork skills	1 (5%)	4 (20%)	2 (10%)	13 (65%)	0 (0%)	20 (100%)	Academic Life Organizational & Learning Skills
Developing real-world problem-solving skills	4 (20%)	2 (10%)	4 (20%)	9 (45%)	1 (5%)	20 (100%)	Academic Life Organizational & Learning Skills
Understanding the practice of engineering	4 (20%)	0 (0%)	2 (10%)	12 (60%)	2 (10%)	20 (100%)	Academic Life
Understanding being a licensed Professional Engineer (PE)	4 (20%)	1 (5%)	6 (30%)	8 (40%)	1 (5%)	20 (100%)	Academic Life
Developing skills useful to my engineering major coursework	4 (20%)	4 (20%)	3 (15%)	6 (30%)	3 (15%)	20 (100%)	Academic Life Organizational & Learning Skills

Finding 23: Most first-generation students agree, across all BU-FYEng program learning objectives listed (Question 6 statements), that the BU-FYEng program helps them with all program learning objectives listed. This finding aligns with and supports both the academic life and organizational & learning skills factors in Hayden's (2017) model.

Open-ended feedback from first generation student respondents was minimal but informative. Open-ended responses derived from Questions 10, 11, and 12 were designed to elicit candid feedback from students about their perceptions of the BU-FYEng program. Open-ended response data were separated and coded for themes using Microsoft Excel. All open-ended responses were coded in two ways: (a) as either positive, negative, or neutral; and (b) coded for themes based on the content of the response (e.g., connection to faculty, teamwork, resources, etc.). In some instances, students gave mixed responses in which they indicated something was positive and then indicated something else was negative. In such instances the codes for these responses were separated so that positive and negative responses can be aggregated to better understand overall student perceptions.

Question 10 states "*What part of BU-FYEng do you think will be the MOST HELPFUL to you as you progress through your degree?*". Among the 20 first generation student respondents, 16 provided an open-ended response to Question 10. First generation student perception regarding the MOST HELPFUL aspects of the BU-FYEng program was very informative. Of the 16 responses to this question, 13 (81.3%) were coded as positive and 3 (18.7%) coded as negative. Themes among the 13 positive responses include resources, professor interaction, and influence major choice. Additional themes include friends, teamwork, and MATLAB. One respondent indicated that they felt "*the various engineering resources available to me and how to get in contact with them*" will be the MOST HELPFUL to them as they progress through their degree. The 3 negative responses were coded as "all" and were overall negative. Among the 3 negative responses, 2 are from students that also have commuter and transfer status - the overall

negative responses from these 2 students have been mentioned in the results to research sub question 2 exploring the perceptions of respondents with commuter status.

Finding 24: For first generation students, the MOST HELPFUL features of the BU-FYEng program include resources, professor interaction, and influence major choice. This finding aligns with and supports the academic life factor in Hayden's (2017) model.

Finding 25: For first generation students, the MOST HELPFUL features of the BU-FYEng program also include friends, teamwork, and MATLAB. This finding aligns with and supports both the social life, and organizational & learning skills factors in Hayden's (2017) model.

Question 11 states "*What part of BU-FYEng do you think will be the LEAST HELPFUL to you as you progress through your degree?*". Among the 20 first generation student respondents, 16 provided an open-ended response to Question 11. Of the 16 responses to this question, 14 (87.5%) were negative and 2 (12.5%) were positive.

Themes among the negatively coded responses include EGR 101, MATLAB, and all aspects of the program are least helpful. One respondent indicated:

> *A lot of the coursework was so generalized that if you knew what you wanted to do before coming in. You have to do a lot of homework and projects for fields that you may not be at all interested in or skilled at. It reminds me of the saying that talks about asking a fish to climb a tree as well as a monkey.*

Additional themes coded negatively included poor guidance on class assignments, and poor timing of events. Positive responses to a question asking about what is LEAST HELPFUL is not common, however the 2 that were included were general in nature, indicating that "none" of the program is least helpful (meaning, all aspects of the program are perceived as helpful by these 2 respondents).

Finding 26: First generation students perceived EGR 101, MATLAB, and all (aspects of the program) as the LEAST HELPFUL features of the BU-FYEng program. This finding supports the notion that some BU-FYEng program cu6rricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Question 12 states "*Is there anything else you would like to share with us about your BU-FYEng experience?*". Among the 20 first generation student respondents, 8 provided an open-ended response to Question 12. Responses to this question were mostly negative but informative, with 6 (75%) negative responses and 2 (25%) neutral responses. Themes among the negatively coded responses from Question 12 were all varied with no theme generated twice. Singular themes generated from individual responses include poor project alignment, MATLAB, and program restructuring. Feedback was informative, with one respondent indicating in part:

> *I have an idea of what EGR 101 should be. Start off by talking about how engineers differ from other scientists and what makes them unique. Then talk about what makes [BU] such a good engineering school and the resources that [BU] offers like MathSkeller and the Innovation Center. Maybe have another day talk about Engineering ethics and what Engineers could expect from the job. Then for the rest of the semester have each day dedicated to each specific engineering major offered at [BU]. That way, people who are undecided can be guided towards the Engineering that interests them, and those that are decided will know what other types of Engineers do.*

Among the first-generation respondents to this Question 12, respondents also indicated that they felt the program was geared toward mechanical or civil engineering, and computer science.

Finding 27: For first generation students, themes coded for Question 12 were singular, with no responses similar enough to generate the same theme. No factors from

Hayden's model were found to be in alignment with commuter student responses to Question 12.

Secondary Research Question 5

Secondary research question 5 "*How does gender identity impact the experience of BU-FYEng students?*" explored the experience of students based on reported gender identity. To understand the experiences and perceptions of students in the BU-FYEng program based on their gender identity, a cross tabulation analysis was conducted in SPSS to understand the relationship between gender identity and all other variables within the data set. Question 17 of the survey, which is designed for respondents to provide their gender identity, asks "I identify as…", and respondents are provided with 3 options: "a man", "a woman" and "something else". Of the 126 complete responses, 92 respondents identified as "a man", 33 respondents identified as "a woman", and 1 respondent indicated that they identified as "something else" other than a man or a woman. As stated previously, this response was coded as "unknown". To gain an understanding of the perceptions and experiences of students based on their gender identity, response data for secondary research question 5 were separated by gender identity for analysis.

Question 20 asked "Are you planning on continuing your enrollment in the BU-FYEng program next semester?" and students were provided with Yes/No response options. As stated, prior, 115 of the 126 complete responses indicated "Yes" to Question 20 "Are you planning on continuing your enrollment in the BU-FYEng program next semester?", and 11 respondents indicated "No". Response data from the 11 respondents indicating "No" to Question 20 (7 male, 4 female) was excluded from the analysis of

Question 21 response data. Table 15 displays the Question 21 frequency and percentage of each response option aligned with the 115 Question 20 "Yes" responses.

Table 15

Frequency and Percent of Factors Contributing to Continued Enrollment by GENDER IDENTITY and Corresponding Factors in Hayden's (2017) Model for 115 CONTINUING Respondents

Q21 "What factors contributed to your continued enrollment?"	Female	Male	Corresponding Factors in Hayden's (2017) Model
Financial Aid	10 (34.5%)	40 (43.4%)	financial circumstances
Peer Mentoring	2 (6.9%)	6 (6.5%)	organizational & learning skills
Connection with Faculty	8 (27.6%)	14 (15.2%)	academic life
Friends/cohort	18 (62.1%)	48 (52.1%)	life transition academic life social life
Campus resources	5 (17.2%)	19 (20.6%)	academic life
Innovation Center Lab	4 (13.8%)	12 (13%)	academic life
FYE Open Lab	2 (6.9%)	8 (8.7%)	academic life
My academic program	17 (58.6%)	53 (57.6%)	academic life
Living Learning Program	6 (20.7%)	16 (17.4%)	life transition academic life social life
My experience in BU-FYE	8 (27.6%)	22 (23.9%)	ALL 7 factors

Finding 28: For both female and male students, their academic program (their major), their friends/cohort, and financial aid were the three most important factors that contributed to continued enrollment in the BU-FYEng program. This finding aligns with and supports the financial circumstances, academic life, social life, and life transition factors in Hayden's (2017) model.

Finding 29: As a secondary factor, connection with faculty ranked higher among females (27.6%) than males (15.2%). This finding aligns with and supports the academic life factor in Hayden's (2017) model.

Finding 30: For the student with gender identity coded as unknown, their academic program (their major), and their friends/cohort were the two most important factors that contributed to their continued enrollment in the BU-FYEng program. This finding aligns with and supports the financial circumstances, academic life, social life, and life transition factors in Hayden's (2017) model.

Question 6 "My introductory engineering course(s) helped me with…" asked respondents to indicate their level of agreement (using a 5-point Likert scale) with several statements aligned with BU-FYEng program learning objectives. Table 16 displays the distribution of the 92 responses from male students (NOTE: the student with gender identity coded as unknown provided a strongly agree response across all question 6 statements).

Question 6 "My introductory engineering course(s) helped me with…" asked respondents to indicate their level of agreement (using a 5-point Likert scale) with several statements aligned with BU-FYEng program learning objectives. Table 17 displays the distribution of the 33 responses from female students.

Finding 31: With respect to gender identity, across all BU-FYEng program learning objectives listed (Q6 statements), both male and female students agree that the BU-FYEng program helps them with all program learning objectives listed. This finding aligns with and supports both the academic life and organizational & learning skills factors in Hayden's (2017) model.

Table 16

Frequency and Percent of Question 6 Responses and Corresponding Factors in Hayden's (2017) Model for 92 MALE Respondents

Q6 "My introductory engineering course(s) helped me with…"	Frequency and Percent of Likert Scale Responses						Corresponding Factors in Hayden's (2017) Model
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Total	
Making an informed major choice	16 (17.4%)	12 (13%)	17 (18.5%)	33 (35.9%)	14 (15.2%)	92 (100%)	Academic Life
Learning about the Engineering and Computer Science majors at BU	9 (9.8%)	11 (11.9%)	18 (19.6%)	41 (44.6%)	13 (14.1%)	92 (100%)	Academic Life
Learning about Engineering and Computer Science career options	7 (7.6%)	13 (14.1%)	25 (27.2%)	37 (40.2%)	10 (10.9%)	92 (100%)	Academic Life
Developing teamwork skills	5 (5.4%)	7 (7.6%)	19 (20.7%)	46 (50%)	15 (16.3%)	92 (100%)	Academic Life Organizational & Learning Skills
Developing real-world problem-solving skills	8 (8.7%)	9 (9.8%)	23 (25%)	40 (43.5%)	12 (13%)	92 (100%)	Academic Life Organizational & Learning Skills
Understanding the practice of engineering	9 (9.8%)	7 (7.6%)	17 (18.5%)	48 (52.2%)	11 (11.9%)	92 (100%)	Academic Life
Understanding being a licensed Professional Engineer (PE)	13 (14.1%)	12 (13%)	23 (25%)	34 (37%)	10 (10.9%)	92 (100%)	Academic Life
Developing skills useful to my engineering major coursework	13 (14.1%)	15 (16.3%)	18 (19.6%)	34 (37%)	12 (13%)	92 (100%)	Academic Life Organizational & Learning Skills

Table 17

Frequency and Percent of Question 6 Responses and Corresponding Factors in Hayden's (2017) Model for 33 FEMALE Respondents

Q6 "My introductory engineering course(s) helped me with…"	Frequency and Percent of Likert Scale Responses						Corresponding Factors in Hayden's (2017) Model
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Total	
Making an informed major choice	3 (9.1%)	4 (12.1%)	9 (27.3)	14 (42.4)	3 (9.1%)	33 (100%)	Academic Life
Learning about the Engineering and Computer Science majors at BU	3 (9.1%)	5 (15.1%)	3 (9.1%)	20 (60.6%)	2 (6.1%)	33 (100%)	Academic Life
Learning about Engineering and Computer Science career options	4 (12.1%)	5 (15.1%)	8 (24.2%)	14 (42.4)	2 (6.1%)	33 (100%)	Academic Life
Developing teamwork skills	2 (6.1%)	0 (0.0%)	6 (18.2%)	22 (66.7%)	3 (9.1%)	33 (100%)	Academic Life Organizational & Learning Skills
Developing real-world problem-solving skills	2 (6.1%)	0 (0.0%)	8 (24.2%)	21 (63.7%)	2 (6.1%)	33 (100%)	Academic Life Organizational & Learning Skills
Understanding the practice of engineering	2 (6.1%)	1 (3%)	8 (24.2%)	21 (63.7%)	1 (3%)	33 (100%)	Academic Life
Understanding being a licensed Professional Engineer (PE)	4 (12.1%)	6 (18.2%)	8 (24.2%)	14 (42.4)	1 (3%)	33 (100%)	Academic Life
Developing skills useful to my engineering major coursework	3 (9.1%)	7 (21.2%)	10 (30.3%)	10 (30.3%)	3 (9.1%)	33 (100%)	Academic Life Organizational & Learning Skills

Open-ended responses derived from Questions 10, 11, and 12 were designed to elicit candid feedback from students about their perceptions of the BU-FYEng program. Open-ended response data were separated and coded for themes using Microsoft Excel. All open-ended responses were coded in two ways: (a) as either positive, negative, or neutral; and (b) coded for themes based on the content of the response (e.g., connection to

faculty, teamwork, resources, etc.). In some instances, students gave mixed responses in which they indicated something was positive and then indicated something else was negative. In such instances the codes for these responses were separated so that positive and negative responses can be aggregated to better understand overall student perceptions.

Question 10 states "*What part of BU-FYEng do you think will be the MOST HELPFUL to you as you progress through your degree?*". Among the 126 survey respondents, 86 students provided an open-ended response to question 10. Of the 86 responses for Question 10, 63 (73.3%) were from individuals that identified as male and 23 (26.7%) were from individuals that identified as female. There were no open-ended responses provided by the individual that identified as "unknown" for Question 10.

Regarding what male students view as the MOST HELPFUL part of the BU-FYEng program, among the 63 responses provided by individuals that identified as male, 50 (79%) were coded as positive, and 13 (21%) coded as negative. Themes from the positive responses include skills, teamwork, MATLAB, resources, professor interaction, and influence major choice. Among the many varied positively coded responses included one respondent indicating "*learning how to work with a team and being able to choose the major that was right for me*" was the MOST HELPFUL, and another indicated "*the practical skills with coding and circuitry were very useful*". Among the 13 negative responses by individuals that identified as male, themes include waste of time, and "all", meaning, the entire program was perceived to be least helpful. Among the 13 negative responses indicating all the program was LEAST HELPFUL, 10 of them were coded as

"all", one respondent specifically indicated "*nothing helped me with Chemical Engineering through [BU-FYEng]*".

Regarding what female students view as the MOST HELPFUL part of the BU-FYEng program, the 23 (26.7%) of 86 responses provided by individuals that identified as female were mixed. Among the 23 responses provided by individuals identifying as female, there were 17 (74%) responses coded positive and 6 (26%) responses coded negative. The 17 positive responses made by individuals that identified as female were coded with themes that include skills, teamwork, professor interaction, friends, and influence major choice. Among the 6 negative responses by individuals that identified as female, themes include teamwork-lopsided (3 of 6 negative responses), and "all" (2 of 6 negative responses), meaning, the entire program was least helpful to those 2 students. Regarding what female students view as the MOST HELPFUL part of the BU-FYEng program, one of the negative responses coded as "teamwork-lopsided" indicated "*teaching me to put up with unhelpful group mates and that if I really want to get a good grade I need to sacrifice my free time to compensate for what my group members won't do*". Additionally, it was noted that among the negative responses provided by females to Question 10, one respondent indicated "*I have dropped engineering as a result of the FYE program*".

Finding 32: For male students, regarding the MOST HELPFUL features of the BU-FYEng program, themes from the positive responses included skills, teamwork, MATLAB, resources, professor interaction, and influence major choice. This finding aligns with and supports the academic life factor in Hayden's (2017) model.

Finding 33: For female students, regarding the MOST HELPFUL features of the BU-FYEng program, themes from the positive responses included skills, teamwork, professor interaction, friends, and influence major choice. This finding aligns with and supports the academic life factor in Hayden's (2017) model.

Finding 34: For female students, for Question 10, the negatively coded theme "teamwork-lopsided" emerged. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Question 11 states "*What part of BU-FYEng do you think will be the LEAST HELPFUL to you as you progress through your degree?*". Among the 126 survey respondents, 84 students provided an open-ended response to question 11. Of the 84 responses for Question 11, 61 (72.6%) were from individuals that identified as male and 23 (27.4%) were from individuals that identified as female. There were no open-ended responses provided by the individual that identified as "unknown" for Question 11.

Regarding what male students view as the LEAST HELPFUL part of the BU-FYEng program, among the 63 responses provided by individuals that identified as male, 57 (90.5%) were coded as negative, and 4 (9.5%) coded as positive. The mostly negative responses to Question 11 are logical given the question is asking respondents to provide information regarding what they view to be the LEAST HELPFUL aspects of the BU-FYEng program. Among the 57 negative responses provided by individuals that identified as male, themes include EGR 101, EGR 103, MATLAB, information sessions, and many other varied themes. Among the male respondents indicating EGR 101 was the

LEAST HELPFUL, one respondent indicated specifically, in part "*that class is a waste of time that just gave me random assignments with no context instead of actually teaching me the difference between the different types of Engineers or what Engineers do*". Among the male respondents indicating MATLAB was the least helpful part, one respondent indicated specifically "*I don't understand why I had to learn how to use MATLAB because I am not interested in coding or computer science and my major does not require [us] to have coding skills*". Themes from the 4 positive responses provided by individuals that identified as male were general in nature, and all 4 were coded "all', meaning, all aspects of the BU-FYEng program were viewed as helpful - nothing was indicated as being LEAST HELPFUL.

Regarding what female students view as the LEAST HELPFUL part of the BU-FYEng program, among the 23 responses provided from individuals that identified as female, 22 (95.6%) responses were coded as negative and 1 (4.4%) as positive. The mostly negative responses to Question 11 are logical given the question is asking respondents to provide information regarding what they view to be the LEAST HELPFUL aspects of the BU-FYEng program. Among the 22 negative responses provided by individuals that identified as female, themes include MATLAB, Arduino, information sessions, EGR 101, and many other varied themes. Among the respondents indicating that EGR 101 is the LEAST HELPFUL aspect to the BU-FYEng program, one respondent indicated "*EGR 101 was a pointless course for people who had already chosen a major within engineering*". Among the respondents indicating that MATLAB and Arduino are the LEAST HELPFUL aspect to the BU-FYEng program, one respondent indicated in part "*I do not think that the small amount of MATLAB or Arduino*

that I learned in FYE will be useful at any time over the future". The 1 positively coded response among the 23 female respondents to Question 11 indicated that "none" of the aspects of the BU-FYEng program are LEAST HELPFUL, meaning this respondent perceives all aspects of the program to be helpful.

Finding 35: For male students, EGR 101, EGR 103, MATLAB, information sessions emerged as negatively coded themes, indicating these features are what male students felt were the LEAST HELPFUL aspects of the BU-FYEng program. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Finding 36: For female students, MATLAB, Arduino, information sessions, and EGR 101 emerged as negatively coded themes, indicating these features are what female students felt were the LEAST HELPFUL aspects of the BU-FYEng program. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Question 12 states "*Is there anything else you would like to share with us about your BU-FYEng experience?*". Among the 126 survey respondents, 56 students provided an open-ended response to question 12. Of the 56 responses for Question 12, 36 (64.3%) were from individuals that identified as male and 20 (35.7%) were from individuals that

identified as female. There were no open-ended responses provided by the individual that identified as "unknown" for Question 12.

Regarding what male students would like to share about their BU-FYEng experience, among the 36 responses from individuals that identified as male, 22 (61.1%) were coded as negative, 6 (16.6%) were coded as positive, 5 (13.9%) were coded as neutral, and 3 (8.4%) were coded as mixed positive and negative. Given that respondents can provide any type of response to this question, responses were varied but often constructive in nature. Themes among negatively coded responses were varied, with much of the feedback revolving around ways or recommendations to restructure the program or remove it altogether. One respondent provided a recommendation to make EGR 101 an elective, indicating:

> *I believe that EGR 101 should not be a required class because it is just busy work and doesn't teach a person who is already committed to engineering anything. It could maybe be an elective if a student was considering entering engineering and wanted to learn more about what they were getting into, but other than that it is a complete waste of time.*

Among the positively coded responses, one respondent indicated "*Overall pretty satisfied! It gave me a good idea of what engineering is like*". Neutral responses by these male respondents also provided varied constructive feedback, with one respondent specifically indicating:

> *In my opinion, EGR 101 should meet for a 2-hour period rather than one, and each week the class should actually visit the different departments around campus to hear a description from the department's professors. This would be much more beneficial than spending 1 week discussing the different disciplines, and then completing vague projects with murky concepts. Then, in 103, we should be taught basic engineering reasoning so that in our introductory major-specific classes (e.g., MNG 201), we could complete a more major-related project there.*

Male respondents provided mixed positive and negative feedback all provided responses that were very instructive, with one respondent in particular indicating:

> *While the purpose of the FYE program is sound and appreciated, its execution feels impractical and unnecessary to the studies of the engineering students. Courses tend to be tilted towards students interested in programming and CAD design, providing little chance for departments other than CS to shine through. This leads to team projects being led by a single student, rather than functioning as a balanced team effort.*

Male respondents to Question 12, overall, had mixed but constructive feedback regarding what they wanted administrators to know about the BU-FYEng experience.

Regarding what female students would like to share about their BU-FYEng experience, among the 20 responses to Question 12 from individuals that identified as female, 9 (45%) responses were negative, 7 (35%) responses were neutral, 3 (15%) were positive, and 1 (5%) response was mixed both positive and negative. All responses were varied but constructive in nature. Negative responses were varied, with each response coded uniquely, and the theme EGR 101 being the only theme aligned to more than 1 negative response. Among the 2 responses coded EGR 101, one student indicated "*101 seemed very drawn out, and there was not really that much that I took away from the course*". One response coded "rigor differences" was informative, with the respondent indicating "*assignment difficulty and length vary significantly between professors. This has caused the classes to become more of a burden and eliminates any possibility for enjoyment*". Neutral and positively coded responses among individuals that identified as female were also varied but instructive, with one respondent indicating:

> *I think the [BU-FYEng] info sessions would be more impactful if you just had a few scheduled days in class where the different sections came to talk to the students. The students don't pay as much attention when they're forced to go to the meetings and have to answer questions. They just focus on the questions and don't take in as much info.*

Finding 37: For male students, themes coded for Question 12 were singular, with no responses similar enough to generate the same theme. No factors from Hayden's

(2017) model were found to be in alignment with commuter student responses to Question 12.

Finding 38: For female students, themes coded for Question 12 were singular, with no responses similar enough to generate the same theme. No factors from Hayden's (2017) model were found to be in alignment with commuter student responses to Question 12.

Secondary Research Question 6

Secondary research question 6 "*How does race/ethnicity impact the experience of BU-FYEng students?*" explored the experience of this subpopulation of students. As stated, prior, the variable BIPOC was created, enabling the separation and analysis of response data among white and non-white (BIPOC) respondents (Garcia, 2020). To understand the experiences and perceptions of BIPOC students in the BU-FYEng program, a cross tabulation analysis was conducted in SPSS to understand the relationship between BIPOC students and all other variables within the data set. Of the 126 complete responses, on Questions 18 and 19 of the survey, 29 students (23%) indicated they were non-white (BIPOC), by either choosing "Yes" to Question 19 "*Are you Spanish, Hispanic, or Latinx, or none of these?*" (in which "Yes" responses are recoded as Hispanic) or indicated a race other than white as a response to Question 18 "*I identify as:*", and 8 race options were provided to choose from. The responses from these 29 students were analyzed separately to gain an understanding of the perceptions and experiences of this BU-FYEng subpopulation of students.

Question 20 asked "Are you planning on continuing your enrollment in the BU-FYEng program next semester?" and students were provided with Yes/No response options. Of the 29 BIPOC students that provided complete responses to the survey, 25

indicated “Yes” and were planning to continue enrollment in the BU-FYEng program next semester, 4 indicated they were not planning to continue. Question 21 asked “What factors contributed to your continued enrollment?” in which students were provided ten response options. The response prompt for this item was to “check all that apply”. Given that Question 21 asked about factors contributing to their continued enrollment, only the 25 “Yes” responses were analyzed, the 4 “No” responses were excluded in the analysis. Table 18 displays the Question 21 frequency counts and percentage of each response option aligned with the 25 Question 20 “Yes” responses:

Table 18

Frequency and Percent of Factors Contributing to Continued Enrollment and Corresponding Factors in Hayden’s (2017) Model for 25 CONTINUING BIPOC Respondents

Q21 “What factors contributed to your continued enrollment?”	Frequency	Percent of “Yes” Respondents Choosing Factor	Corresponding Factors in Hayden’s (2017) Model
Financial Aid	11	44%	financial circumstances
Peer Mentoring	1	4%	organizational & learning skills
Connection with Faculty	2	8%	academic life
Friends/cohort	14	56%	life transition academic life social life
Campus resources	6	24%	academic life
Innovation Center Lab	5	20%	academic life
FYE Open Lab	2	8%	academic life
My academic program	14	56%	academic life
Living Learning Program	1	4%	life transition academic life social life
My experience in BU-FYE	2	8%	ALL 7 factors

While response data was not included for the 4 “No” respondents to Question 21, response data from these 4 “No” respondents (NOT CONTINUING) is valuable and was included in the analysis of response data for other survey items included in the study.

Finding 39: For BIPOC (non-white) students, their academic program (their major), their friends/cohort, and financial aid were the three most important factors that contributed to continued enrollment in the BU-FYEng program. This finding aligns with and supports the financial circumstances, academic life, social life, and life transition factors in Hayden's (2017) model.

Finding 40: For BIPOC (non-white) students, the Innovation Center Lab was an additional factor that contributed to continued enrollment in the BU-FYEng program. This finding aligns with and supports the academic life factor of Hayden's (2017) model.

Question 6 "My introductory engineering course(s) helped me with…" asked respondents to indicate their level of agreement (using a 5-point Likert scale) with several statements aligned with BU-FYEng program learning objectives. Table 19 displays the distribution of the 29 BIPOC student responses for Question 6.

Finding 41: Across all BU-FYEng program learning objectives listed (Q6 statements), the majority of BIPOC (non-white) students agree that the BU-FYEng program helps them with all program learning objectives listed. This finding aligns with and supports both the academic life and organizational & learning skills factors in Hayden's (2017) model.

Open-ended responses derived from Questions 10, 11, and 12 were designed to elicit candid feedback from students about their perceptions of the BU-FYEng program. Open-ended response data were separated and coded for themes using Microsoft Excel. All open-ended responses were coded in two ways: (a) as either positive, negative, or neutral; and (b) coded for themes based on the content of the response (e.g., connection to faculty, teamwork, resources, etc.). In some instances, students gave mixed responses in

Table 19

Frequency and Percent of Question 6 Responses and Corresponding Factors in Hayden's (2017) Model for 29 BIPOC Respondents

Q6 "My introductory engineering course(s) helped me with…"	Frequency and Percent of Likert Scale Responses						Corresponding Factors in Hayden's (2017) Model
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Total	
Making an informed major choice	3 (10.3%)	4 (13.8%)	5 (17.2)	12 (41.4%)	5 (17.2)	29 (100%)	Academic Life
Learning about the Engineering and Computer Science majors at BU	1 (3.4%)	5 (17.2)	8 (27.6%)	11 (37.9%)	4 (13.8%)	29 (100%)	Academic Life
Learning about Engineering and Computer Science career options	4 (13.8%)	3 (10.3%)	10 (34.5%)	12 (41.4%)	3 (10.3%)	29 (100%)	Academic Life
Developing teamwork skills	0 (0%)	2 (6.9%)	7 (24.1%)	16 (55.2%)	4 (13.8%)	29 (100%)	Academic Life Organizational & Learning Skills
Developing real-world problem-solving skills	2 (6.9%)	0 (0%)	9 (31%)	14 (48.3)	4 (13.8%)	29 (100%)	Academic Life Organizational & Learning Skills
Understanding the practice of engineering	2 (6.9%)	0 (0%)	6 (20.7%)	18 (62.1%)	3 (10.3%)	29 (100%)	Academic Life
Understanding being a licensed Professional Engineer (PE)	2 (6.9%)	4 (13.8%)	6 (20.7%)	13 (44.8%)	4 (13.8%)	29 (100%)	Academic Life
Developing skills useful to my engineering major coursework	1 (3.4%)	3 (10.3%)	10 (34.5%)	10 (34.5%)	5 (17.2%)	29 (100%)	Academic Life Organizational & Learning Skills

which they indicated something was positive and then indicated something else was negative. In such instances the codes for these responses were separated so that positive and negative responses can be aggregated to better understand overall student perceptions.

Question 10 states "*What part of BU-FYEng do you think will be the MOST HELPFUL to you as you progress through your degree?*". Among the 29 BIPOC survey respondents, 14 open-ended responses were provided for Question 10 by BIPOC (non-white) students. Among the 14 responses from BIPOC students, 11 (78.6%) responses were coded positively, and 3 (21.4%) responses were coded negatively. Themes among the 11 positively coded responses included skills, teamwork, and influence major choice. Among the responses coded "skills" included one respondent that specifically indicated "*knowing how use laser cutters and 3d printers*" was MOST HELPFUL, and another response coded "influence major choice" indicating "*it showed me what I was in for in the program during my college years and what to expect*". Themes among negatively coded responses were all general in nature, with the theme "all" used to code 2 of 3 negatively coded responses. One of the 3 negatively coded responses was informative, with the respondent indicating:

> *I do not think any part of first year Engineering has helped me make any decision, with the exception of the FYEIS for Chemical Engineering. That FYEIS helped me learn more ways to get involved in my campus with my major. It also helped me learn more about the research opportunities on campus.*

Negatively coded responses to Question 10 from BIPOC students included 1 response by a BIPOC individual indicating they are not continuing in the BU-FYEng program next term ("No" response to Question 20). The negatively coded response provided from that individual (female, Black or African American) was an indication they are not continuing next semester in an engineering major, specifically stating "*I am no longer pursuing an engineering/computer science degree*" with no additional detail provided.

Finding 42: For BIPOC students, the MOST HELPFUL features of the BU-FYEng program include skills, teamwork, and influence major choice. This finding aligns with and supports the academic life factor in Hayden's (2017) model.

Question 11 states "*What part of BU-FYEng do you think will be the LEAST HELPFUL to you as you progress through your degree?*". Among the 29 BIPOC survey respondents, 14 responses for Question 11 were provided by BIPOC (non-white) students. All 11 responses provided by non-white (BIPOC) respondents were coded negatively, with themes including EGR 101, all, and other varied themes. Among the negatively coded responses with the EGR 101 theme, one respondent indicated in part "*EGR 101 needs a massive overhaul, and trust me I'm not the only Engineer who has complained about this class. Everyone describes it as 'a waste of time' for a reason*".

Finding 43: BIPOC students perceived EGR 101 and "all" (aspects of the program) as the LEAST HELPFUL features of the BU-FYEng program. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Question 12 states "*Is there anything else you would like to share with us about your BU-FYEng experience?*". Of the 56 open-ended responses provided to Question 12, 9 responses were provided by non-white (BIPOC) students. Among the 9 responses from BIPOC students, 5 (55.5%) were negative, 3 (33.3) were neutral, and one (11.2%) was mixed as both positive and negative. Only the theme "coding" emerged among 2 of the 5 negatively coded responses. Of the 2 responses coded in this manner, one respondent

indicated "*I really disliked the way the coding was taught. It really goes against things taught in CS215 and is not organized well*". One additional respondent indicated:

> *The way that coding [is taught] in EGR102 is not the way [it is] taught in other classes like CS215. A lot of people had problems transitioning into C++ due to ways that coding was taught using MATLAB. I would recommend talking to the CS department to get a better way of teaching certain things for coding.*

Neutral feedback was varied but constructive, with one respondent indicating in part to "have a way for students to test out of EGR 102 if they have taken similar courses in high school like Project Lead the Way Digital Electronics or Principles of Engineering". Additional feedback from Question 12 by BIPOC students was constructive, and included the need for program restructuring, and the workload being too heavy.

Finding 44: For BIPOC (non-white) students, for Question 12, singular themes were coded negatively, with neutral feedback being varied but constructive. This finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful but is part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model.

Students Not Continuing

Inspection of the data and ensuing analysis revealed, of the 126 complete responses, 11 (8.7%) indicated "No" to Question 20 "Are you planning on continuing your enrollment in BU's College of engineering next semester?". While analyzing the responses of this subpopulation of respondents was not planned as part of the original study it is important to gain an understanding of the survey responses and perceptions of students choosing *NOT* to continue in the BU-FYEng program. Since sufficient data was provided to look at responses among these students, an analysis of their responses was conducted.

Given these respondents were not planning to continue in an Engineering major at BU, Question 21 response data regarding the factors contributing to continued enrollment in the BU-FYEng program was not included in the analysis. While the survey instrument was not designed to include supplementary questions asking these individuals to provide further details, the response data from Questions 6, 10, 11, and 12 for this subset of respondents was informative. Demographically, of the 11 respondents indicating they are not continuing ("No" response to Question 20), 4 (36.4%) are women and 7 (63.6%) are men, with 4 BIPOC students among them. Of these 11 respondents, none are transfer students, none are first generation students, and only 1 is a commuter student.

Question 6 "My introductory engineering course(s) helped me with…" asked respondents to indicate their level of agreement (using a 5-point Likert scale) with several statements aligned with BU-FYEng program learning objectives. Table 20 displays the distribution of the 11 responses to Question 6 by respondents NOT CONTINUING in the BU-FYEng program the following term.

Finding 45: Students not continuing in the BU-FYEng program agree that the BU-FYEng program helps them with 6 of 8 program learning objectives listed (Q6 statements). This finding aligns with and supports both the academic life and organizational and learning skills factors in Hayden's (2017) model.

Finding 46: Students not continuing in the BU-FYEng program neither agree nor disagree that the BU-FYEng program helps them with understanding being a licensed PE. No factors from Hayden's model were found to be in alignment with responses from students not continuing.

Table 20

Frequency and Percent of Question 6 Responses and Corresponding Factors in Hayden's (2017) Model for 11 NOT CONTINUING Respondents

Q6 "My introductory engineering course(s) helped me with…"	Frequency and Percent of Likert Scale Responses						Corresponding Factors in Hayden's (2017) Model
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Total	
Making an informed major choice	1 (9.1%)	1 (9.1%)	0 (0%)	7 (63.6%)	2 (18.2%)	11 (100%)	Academic Life
Learning about the Engineering and Computer Science majors at BU	1 (9.1%)	1 (9.1%)	2 (18.2%)	6 (54.5%)	1 (9.1%)	11 (100%)	Academic Life
Learning about Engineering and Computer Science career options	1 (9.1%)	1 (9.1%)	1 (9.1%)	7 (63.6%)	1 (9.1%)	11 (100%)	Academic Life
Developing teamwork skills	0 (0%)	0 (0%)	2 (18.2%)	5 (45.5%)	4 (36.4%)	11 (100%)	Academic Life Organizational & Learning Skills
Developing real-world problem-solving skills	0 (0%)	1 (9.1%)	4 (36.4%)	5 (45.5%)	1 (9.1%)	11 (100%)	Academic Life Organizational & Learning Skills
Understanding the practice of engineering	0 (0%)	0 (0%)	4 (36.4%)	6 (54.5%)	1 (9.1%)	11 (100%)	Academic Life
Understanding being a licensed Professional Engineer (PE)	1 (9.1%)	4 (36.4%)	3 (27.3%)	2 (18.2%)	1 (9.1%)	11 (100%)	Academic Life
Developing skills useful to my engineering major coursework	1 (9.1%)	0 (0%)	7 (63.6%)	2 (18.2%)	1 (9.1%)	11 (100%)	Academic Life Organizational & Learning Skills

Finding 47: Students not continuing in the BU-FYEng program disagree that the BU-FYEng program helps them with developing skills useful to their engineering major coursework. This finding is logical given these respondents are not continuing and supports the notion that some BU-FYEng program curricular and design features are not

perceived as helpful by all subpopulations of students but aligns with and supports the academic life factor in Hayden's (2017) model.

Of the 11 students not continuing, only 6 (54.5%) provided open-ended feedback: all open-ended feedback provided was provided by respondents identifying as white males, except for comments provided from 1 Black or African American female, who provided the following response across all 3 open ended items: "*I am no longer pursuing an engineering or computer science major*". No additional information was provided from BIPOC or non-male individuals among these 11 respondents. Therefore, for these 11 respondents, only 5 provided qualitative feedback usable for analysis, which is discussed below as it relates to the open-ended response data provided from Questions 10, 11, and 12.

Question 10 states "*What part of BU-FYEng do you think will be the MOST HELPFUL to you as you progress through your degree?*". The results for question 10 for these 5 responses were mixed, with 2 (40%) being positive, and 3 (60%) being negative. Individually, no discernable theme was found to emerge among open-ended responses to Question 10 for these students. Together, the 2 positive responses indicated the problem solving and time management skills learned were helpful, as well as the friends made along the way. The 3 negative responses were somewhat informative, in that 1 specifically indicated they are "*changing majors as a result of the BU-FYEng program*", though they did not specify why. The other 2 negative responses were not as informative, in that they indicated the entire program was not helpful but providing no further detail. The other indicated they do not think the program is helpful since they are changing majors but providing no additional detail as to whether the program had the unintended

benefit of helping them decide engineering was not a good major or career choice for them.

Finding 48: For students not continuing in the BU-FYEng program, themes coded for Question 10 were singular, with no responses similar enough to generate the same theme. No factors from Hayden's model were found to be in alignment with responses from students not continuing to Question 10.

Question 11 states "*What part of BU-FYEng do you think will be the LEAST HELPFUL to you as you progress through your degree?*" All 5 (100%) of the open-ended responses to Question 11 were negatively coded, however, no discernable theme was found to emerge among open-ended responses to Question 11 for these students. The results for Question 11 were informative nonetheless, with one very specific response provided, indicating "*EGR 101 was a pointless course for people who had already chosen a major within engineering*". Additional feedback provided indicated the additional stress of the program was least helpful, or that the entire program was not helpful.

Finding 49: For students not continuing in the BU-FYEng program, themes coded for Question 11 were singular, with no responses similar enough to generate the same theme. No factors from Hayden's model were found to be in alignment with responses from students not continuing to Question 11.

Question 12 states "*Is there anything else you would like to share with us about your BU-FYEng experience?*". Feedback was very specific and informative for the 5 responses provided, with 1 (20%) positive response, 2 (40%) negative responses, and 2 (40%) neutral responses. The positive response indicated the program "*is a great way to*

build your skills in working with others", and the 2 negative responses with feedback indicating the program is a waste of time, is structured terribly, is busy work, and causes unnecessary stress. The two neutral responses indicated that the program helped them to decide that engineering is NOT the right major or career field for them, with one respondent indicating:

> *my choice to change my major[s] was not impacted by the FYE program. If anything, this program made me more hesitant to change it. I just feel like my 'calling' is in a different field, but still has many overlaps with EGR.*

Finding 50: For students not continuing in the BU-FYEng program, themes coded for Question 12 were singular, with no responses similar enough to generate the same theme. No factors from Hayden's model were found to be in alignment with responses from students not continuing to Question 12.

Conclusion

Analysis of the survey data in Chapter 4 revealed many useful insights with respect to how students perceived their experience in the BU-FYEng program, as well as an understanding of the factors present in the BU-FYEng program that influence student persistence decisions. A discussion of the overall results will take place in the next chapter.

CHAPTER 5. DISCUSSION & CONCLUSION

Chapter 1 provided an overall introduction to the study and an overview of study design. The literature review conducted in Chapter 2 explored the theoretical underpinnings guiding study design and introduced Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College. The planned analysis laid out in Chapter 3 showed how study design aligned with the factors in Hayden's model. The in-depth analysis conducted in Chapter 4 produced varied results, illuminating our understanding of how students perceived their experience in the BU-FYEng program, as well as an understanding of the factors present in the BU-FYEng program that influence student persistence decisions. Chapter 5 provides a discussion of the findings from Chapter 4 organized by the factors within Hayden's model. Subsections of the discussion will focus on the factors within Hayden's model aligned with the results from Chapter 4, placed within the context of the BU-FYEng program to better understand and illuminate program strengths and weaknesses as students perceive them. Doing so demonstrates the alignment between the factors within Hayden's model and BU-FYEng program outcomes and features.

Comprehensive Persistence Models Revisited

Before embarking on a discussion of the results of this study, it is important to revisit the conceptual frameworks used to guide study design. As stated, prior, Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College was adapted from Reason's (2009) Comprehensive Model of Influences on Student Learning and Persistence, and the theoretical foundations of this study are rooted in Tinto's (1975) Theory of Student Departure and Astin's (1994)

Theory of Student Involvement. Reason's (2009) model mapped the factors that influence overall student persistence decisions, and Hayden (2017) adapted Reason's (2009) model to further refine the understanding of factors influencing persistence decisions among first year engineering students. Utilizing Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College to guide study design, survey questions were aligned with the factors present in the Hayden's model.

As shown in Figure 4 (p. 25), Hayden's (2017) model provides a comprehensive framework to understand the interrelated factors impacting persistence decisions among first year engineering students. First year engineering students are impacted by factors inherent within the Organizational Context (Academic Life and Academic Policies) and Individual Student Experiences (Life Transition, Social Life, Academic Performance, Organizational & Learning Skills, and Financial Circumstances) that, together, influence persistence decisions. All 7 factors included in Hayden's model (academic life, academic policies, life transition, social life, academic performance, organizational & learning skills, and financial circumstances) align with specific survey questions and response options.

The BU-FYEng Program Revisited

Additionally, before engaging in the discussion of findings, revisiting the Bluegrass First Year Engineering (BU-FYEng) program features and outcomes is needed. As stated in Chapter 1, the BU College of Engineering implemented a common curriculum for all incoming engineering students in fall 2016. Across the first 2 semesters of study BU-FYEng program students typically complete a 5-credit hour common curriculum that is spread over 2 semesters. First-time first semester freshmen complete a

5-credit hour sequence: EGR 101 “Engineering Exploration I” (1cr) and EGR 102 “Engineering Exploration II” (2cr) in their first semester, then EGR 103 “Fundamentals of Engineering Computing” (2cr) in their second semester. Transfer students complete EGR 112 “Engineering Exploration for Transfer Students” (1cr) in their first semester and EGR 103 “Engineering Exploration II” (2cr) in the second semester; or complete just EGR 215 “Introduction to the Practice of Engineering for Transfer Students” (3cr). Most transfer students complete a programming course prior to transfer and can waive EGR 102 “Fundamentals of Engineering Computing”. The variation in which courses a transfer student will complete for the BU-FYEng program depends on their academic preparation and timing of entry. Through the common curriculum model, the BU-FYEng program seeks to expose all undergraduate engineering students to the various engineering major/career paths offered in the college so they can make an informed major/career choice. The BU-FYEng program includes engineering design coursework that emphasizes teamwork as well as engineering computing coursework that exposes all engineering students to computer programming. Students enter the college as an undeclared engineering major, then declare their engineering major later while completing the second semester of the BU-FYEng program in preparation for year 2 registration.

All incoming engineering freshman and transfer students are required to complete the common curriculum, which features hands-on design team projects that provide students with an understanding of what it is like to be an engineer working on a cross-functional team (Hubbard, 2017a). The program also introduces students to all engineering major disciplines offered at BU so that they can make an informed choice of

major (BU-FYEng-Website). The BU-FYEng program features include on-campus housing in which engineering students live and study together (residential living-learning program), co-curricular programming (learning about majors and career paths, career panels, guest speakers), peer mentoring, cross-functional team-based assignments, real world engineering problem solving, connection with faculty, connection with fellow students, and open and supported lab space (Innovation Center Lab and FYE Open Lab).

Discussion

Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College, takes into consideration the various factors in the first-year experience of engineering students that impact persistence decisions. As seen in Hayden's (2017) model, the first year of college for engineering students is impacted by factors inherent within the Organizational Context (Academic Life and Academic Policies) and Individual Student Experiences (Life Transition, Social Life, Academic Performance, Organizational & Learning Skills, and Financial Circumstances) that influence student persistence decisions. While student pre-college characteristics and experiences are included in Hayden's framework and are important to understand, these factors were not aligned with study design and therefore not included in this study. This is discussed in more detail in the Study Limitations section of this chapter. To better understand how each factor within Hayden's model influences student persistence decisions among BU-FYEng students, the discussion that follows is organized into subsections that align with the domains and factors.

The Organizational Context

Academic life and Academic Policies are factors within the institution's Organizational Context of Hayden's (2017) model. The organizational context includes

things like the policies, the culture of the institution, and institutional type. The BU-FYEng program is situated within the Organizational Context of BU's College of Engineering, encompassing both the Academic Life and Academic Policies factors of Hayden's model. The requirement that ALL undergraduate BU students admitted into a "pre-engineering" major complete the BU-FYEng program, and then declare their engineering major is, in and of itself, an academic policy of the BU College of Engineering. Thus, the BU-FYEng program *is* the academic life of undergraduate students in the College of Engineering - its social norms, culture, and policies are all interwoven and connected for these students. Nonetheless, the discussion that follows will attempt to separate these factors where possible but will note where there is overlap among the factors in Hayden's model.

Academic Life

The academic life factor of Hayden's model encompasses all things that interact and interrelate within the completion of required courses. This includes the academic curriculum, the course content, pedagogies, and related aspects of teaching and learning, as well as institutional resources. For this study, students that referred to any feature or learning outcome of the BU-FYEng program are viewed as referring to a feature within the academic life of the BU-FYEng students. Thus, all statements from Question 6 are aligned with the Academic Life factor, in which respondents were asked to indicate their level of agreement with statements that are aligned with BU-FYEng program learning outcomes. Themes coded during analysis of open-ended responses (Questions 10, 11, and 12) that revolve round BU-FYEng curricular, course, or program-related features were aligned with the Academic Life factor of Hayden's (2017) model. Additionally, all

response options for Questions 21, except peer mentoring and financial aid, were also aligned with the academic life factor.

As we saw in Finding 1, for all respondents continuing in the BU-FYEng program, their academic program (their major), their friends/cohort, and financial aid were the three most important factors that contributed to continued enrollment. For their academic program (their major), this finding aligns with and supports the academic life factor in Hayden's (2017) model. Other Question 21 response options that align with the academic life factor include their experience in the BU-FYEng program, connection with faculty, campus resources, and the LLP - ALL of which are features of the program, and thus part of the academic life of BU-FYEng students. These findings suggest that students are really attached to their major, but also view other program features and institutional resources as important factors in their continued enrollment in the BU-FYEng program. This finding also implies that students perceive their experience in the BU-FYEng program to be positive - a lack of responses to this selection would indicate that students are not perceiving their experience in the BU-FYEng program to be contributing to their desire to persist.

With respect to findings from open-ended responses (Question 10, 11, and 12), respondents felt that the MOST HELPFUL features of the BU-FYEng program include teamwork, professor interaction, learning basic engineering skills, and information sessions (to learn about other engineering majors) - all of which are program features that are aligned with the academic life factor in Hayden's (2017) model. This is true across all subpopulations within the study as well. Overwhelmingly, respondents perceived EGR 101 as the LEAST HELPFUL feature of the BU-FYEng program, specifically

characterizing it as a busy work course, that it is a waste of time, and useless for those that have chosen a major. Students' view of learning MATLAB was mixed and was cited often in open-ended feedback as both a MOST HELPFUL and LEAST HELPFUL aspect of the BU-FYEng program. As stated, prior, this finding supports the notion that some BU-FYEng program curricular and design features are perceived as negatively impactful, but part of the overall BU-FYEng program design, and thus aligns with and supports the academic life factor Hayden's (2017) model. Additionally, across all responses to Question 12 asking students "*Is there anything else you would like to share with us about your BU-FYEng experience?*", students perceive the BU-FYEng program as providing inadequate academic preparation for all engineering majors offered, and the workload associated with the program as too heavy and too stressful for the number of units earned.

As mentioned, the response options from Question 6 are aligned with BU-FYEng program learning outcomes and are therefore all aligned with the academic life factor in Hayden's (2017) model. For almost all respondents in this study, most students agree that the BU-FYEng program helps them with ALL program learning objectives listed. Transfer students disagreed that the BU-FYEng program helped with being a licensed PE, and developing skills useful to my engineering major coursework. Understandably, students indicating they are not continuing neither agree nor disagree that the BU-FYEng program helps them with understanding being a licensed PE, and disagree that the BU-FYEng program helps them with developing skills useful to their engineering major coursework.

Based on the combination of responses from each survey question, one can see that BU-FYEng program elements and features align directly with the academic life

factor in Hayden's (2017) model in many ways, though student perception of program features and outcomes are not all positive.

Academic Policies

Hayden's (2017) study concluded that "the way academic policies are perceived by students can influence student persistence in engineering", particularly those in which poor academic performance necessitated students change majors to a non-engineering major. Within the academic setting in which Hayden's study took place, students began studies in the engineering major they chose upon entry, and a subset of students changed majors along the way either to another engineering major, or a non-engineering major. Also, students with poor academic performance were required to change majors outside of the College of Engineering (to a non-engineering major) and were not given the opportunity to attempt success in a different engineering major. The design of the BU-FYEng program eliminates this problem, in that students do not choose their engineering major until the 2nd year of studies, and poor academic performance (overall) within the first year is not linked to performance within a specific engineering major, but the BU-FYEng program, which prepares students for ALL undergraduate engineering majors offered at BU. While this study did not specifically address student perception of academic policies (or their impact on persistence decisions) within the College of Engineering at BU, students could provide open-ended feedback of any kind, specifically in Question 12 "*Is there anything else you would like to share with us about your FYE experience?*"

As stated, prior, the requirement that ALL BU students admitted into the "pre-engineering" major complete the BU-FYEng program, and then declare their engineering major is, in and of itself, an academic policy of the BU College of Engineering. It is

important, therefore, to recognize that many students do not want to complete the BU-FYEng program at all, and instead, want to simply begin studies in the engineering major they have chosen. This is evidenced in their open-ended feedback those that say "all" aspects of the program are the LEAST HELPFUL, or otherwise provide an overall negative set of responses. While there may be a tendency to dismiss these negative responses as the "axe grinding" of unhappy students, it is more than that given the rather pervasive negative view of the BU-FYEng program by a seemingly unhappy and vocal subset of respondents. Regarding respondent feedback indicating that "all" of the program is LEAST HELPFUL, much of it revolved around the generally negative but pervasive theme that students who had already chosen their major were somehow negatively impacted by having to complete the BU-FYEng program and seem to overlook the program benefits. However, easing major choice among undergraduates is an important aspect of the program design, and one that students do not always see or understand the true benefit until years later as they are embarking on, or are entrenched in, their engineering career.

Specific attention was also paid to responses made by students answering "No" to Question 20 "*Are you planning on continuing your enrollment in UK's College of Engineering next semester?*", to understand if persistence decisions were made based on academic policies. Among the 11 responses provided by students NOT CONTINUING in an engineering major the next semester ("No" response to Question 20), only one response indicated the student was "*changing majors as a result of the BU-FYEng program*", though the respondent did not specify why they were changing majors, and whether it was related to (poor) academic performance. As stated in Chapter 2, a key

design feature of the BU-FYEng program is that it eases the pressure and process of choosing an engineering major for undergraduate students by exposing them to the various fields offered in year 1, so they declare the engineering major they want as they begin year 2.

Individual Student Experiences

As mentioned in Chapter 2, in Hayden's (2017) model, the Peer Environment and Individual Student Experiences domains in Reason's (2009) model were combined and further refined to reflect the specific experiences of engineering students in their first year. Academic Performance, Organizational & Learning Skills, and Financial Circumstances were added as sub factors, and Life Transition and Social Life were added as subfactors. These adaptations were made to align the framework with the local context in which Hayden's (2017) study was conducted: first year engineering students. Within the Individual Student Experiences domain, Hayden adapts Reason's (2009) model by including five factors that research has shown are particularly impactful to students in their first year: life transition, social life, academic performance, organizational and learning skills, and financial circumstances. An understanding of how these five factors influence persistence decisions among BU-FYEng students takes place in the subsections that follow.

Life Transition

In Hayden's (2017) model, life transition is the time of students' lives when they transition from high school to college and is characterized by a sense of excitement and a newly formed sense of independence. During the first year of college students face a lot of new things, and for some, it is their first foray into being responsible for themselves, their studies, and their success. As mentioned, engineering is an academically rigorous

undergraduate major in which the first year is foundational, with students taking a set of challenging and time-consuming courses that include calculus, chemistry, physics, and engineering computing. Many undergraduate engineering students do not perform well in their first year due to various factors including the transition from high school to college, academic rigor, insufficient academic preparation, and the significant amount of time engineering students need to spend to be successful. Thus, many engineering undergraduates do not persist, and change majors or drop out.

The friends and social connections each student have during this transition helps them to stay connected and strengthens their desire to persist. As Finding 1 indicates, for all respondents continuing in the BU-FYEng program, their academic program (their major), their friends/cohort, and financial aid were the three most important factors that contributed to continued enrollment. This finding aligns with and supports the life transition factor in Hayden's (2017) model. Across all findings included in this study, findings aligned with the life transition factor of Hayden's model, included only alignment to responses from Question 21. Responses from open-ended items 10, 11 and 12, did not yield themes coded in alignment with the life transition factor of Hayden's (2017) model.

Social Life

Hayden's (2017) model describes the social life factor as the social aspect of college which includes making friends, having friends, and being supported by friends. The support students received from friends is critical to their success in the first year of college. Social life also includes things like the culture within the BU-FYEng program. The program's culture is not a tangible feature, but rather, the social fabric of the program, which includes the social norms, the expectations of student performance,

living arrangements, study habits, and much more. As mentioned in the Life Transition section, the friends and social connections each student has during this transition helps them to stay connected and strengthens their desire to persist. As discussed, decades of higher education research support the notion that academic programs designed to promote learning, adjustment, and retention, like living-learning communities, are positively associated with student persistence and completion, and living on campus was perhaps the most consistent contributor to a range of positive college outcomes (Mayhew et al., 2016; Pascarella & Terenzini, 2005).

As Finding 1 indicates, for all respondents continuing in the BU-FYEng program, their academic program (their major), their friends/cohort, and financial aid were the three most important factors that contributed to continued enrollment. This finding aligns with and supports the social life factor in Hayden's (2017) model. Across all findings included in this study, findings aligned with the social life factor of Hayden's model, included findings aligned only to responses from Question 21. With respect to responses from open-ended items 10, 11 and 12, among all subpopulations within the study, only first-generation students provided feedback which was coded in a manner that aligned with the social life factor of Hayden's model. Specifically, first generation students indicated the MOST HELPFUL features of the BU-FYEng program also include friends, teamwork, and MATLAB. This finding aligns with research supporting the notion that integrated first year curriculum programs, like the BU-FYEng program, positively influence student persistence decisions. Additionally, the residential LLP is a defining feature of the BU-FYE program, with approximately 85% of first year students living on campus in the BU Engineering LLP. This feature enables BU-FYE students to live

together and study together, interweaving the social and academic experiences of students. One might think that student responses would place the LLP as one of the primary factors contributing to their continued enrollment, yet it is considered a secondary factor. While friends/cohort is among the top 3 factors, and LLP is not, these factors are interwoven into the fabric of the BU-FYEng program, so much so that students may not be recognizing its importance. Friends/cohort and LLPs may be perceived as the same thing for students living on campus.

Academic Performance

In Hayden's (2017) model, academic performance revolves around individual student academic performance in an engineering major, and how that can influence student persistence decisions negatively. Poor academic performance in an academically rigorous major like engineering often leads students to choose another major. Understanding persistence decisions among this population requires understanding the reasons students choose to continue studying in this academically pathway, and the reasons they choose to pursue other options and change majors outside of engineering. While the instrument used in this study does ask students if they plan to continue in an engineering major the next semester, given that it lacks supplementary questions for those choosing "No" to Question 20, the instrument was designed to understand the reasons students are choosing to continue, not choosing to depart. This is a weakness that is discussed in more detail in the Limitations section of this chapter.

Among all research findings from this study, academic performance was not mentioned once among all respondents throughout all open-ended response questions. One might expect that students not continuing in the program may indicate that academic performance led to their departure from the program. However, among the 11 responses

provided by students NOT CONTINUING in an engineering major the next semester ("No" response to Question 20), respondents provided no indication that they were leaving engineering due to poor academic performance. As mentioned earlier, one respondent specifically indicated they are "*changing majors as a result of the BU-FYEng program*", though they did not specify why.

While initially it may seem that this is a null finding, the lack of open-ended themes around students experiencing poor academic performance is informative. As stated earlier, findings from higher education research focusing on academic performance indicates "comprehensive strategies for promoting student success that combine student services (such as academic advising, tutoring, mentoring) with curricular interventions (such as first year seminars, learning communities, supplemental instruction, shorter-term developmental courses), financial aid, or other strategies have the potential to dramatically improve retention and graduation" (Mayhew et al., 2016, p. 552). The BU-FYEng program *is indeed* a comprehensive strategy to promote student success, and intentionally combines student services (academic advising, peer mentoring, and tutoring) with curricular interventions (integrated first year curriculum, supplemental instruction, LLP), and was designed with the intention of providing an integrated set of courses and experiences that enable students to see engineering as a field of options, and are able to choose the academic path that best suits them.

Organizational & Learning Skills

Organizational and learning skills, like time management, learning strategies, and study skills, are particularly important for first year engineering students given their higher course enrollment and more rigorous course load. For students in the BU-FYEng program, these organizational and learning skills are taught in EGR 101 via individual

and group assignments and reinforced throughout the other 2 BU-FYEng courses EGR 102 and 103 through more advanced individual and team based academic exercises. As students advance, they also learn teamwork skills and real-world problem-solving skills, both of which are learning outcomes aligned with compilation of their BU-FYEng program. For Question 21, the organizational & learning skills factor is aligned with the peer mentoring response option since peer mentors assist BU-FYEng students with learning and mastering these skills.

Although the organizational & learning skills factor of Hayden's (2017) model is aligned with the peer mentoring response option from Question 21, across all research questions in this study, peer mentoring was not selected as a primary factor that respondents felt contributed to their continued enrollment in the BU-FYEng program. Five of 20 (25%) first generation respondents, however, did indicate peer mentoring was an important factor, though other factors had higher counts and response rates. With respect to responses from open-ended items 10, 11 and 12, among all subpopulations within the study, only first-generation students provided feedback which was coded in a manner that aligned with the organizational and learning skills factor of Hayden's model. Specifically, first generation students indicated the MOST HELPFUL features of the BU-FYEng program also included teamwork (among friends and MATLAB). This finding aligns with and supports the organizational & learning skills factor in Hayden's model. While this factor was not mentioned much among respondents in this study, it is nonetheless an important factor ensuring the success of first year engineering students.

Financial Circumstances

Having the financial means to pay for college and its associated costs is of concern to all students. The financial circumstances factor in Hayden's (2017) model

deals with the financial circumstances that individual students face. Financial Aid was among the three most important factors from Question 21 that contributed to continued enrollment, as we saw in Finding 1 which aligns with and supports the financial circumstances factor in Hayden's model. Across all findings included in this study, findings aligned with the financial circumstances factor of Hayden's model, included only alignment to responses from Question 21. Responses from open-ended items 10, 11 and 12, did not yield themes coded in alignment with the financial circumstances factor of Hayden's model, including responses among students not continuing in the BU-FYEng program. Not surprisingly, and understandably, having the financial means to achieve your goal of earning a college degree in engineering is perceived by students as a very important factor in their continued enrollment.

Conclusion

As indicated, the theoretical foundations of this study are rooted in Tinto's (1975) Theory of Student Departure and Astin's (1994) Theory of Student Involvement. Decades of persistence research took place, and it was noted that (Pascarella & Terenzini, 1991) future studies should focus on the interrelationship between social and academic integration, investigating how these factors influence retention, persistence, and goal attainment among students. Additionally, it was noted that future studies should include race and ethnicity as variables and should include student perceptions about the quality of instruction (Pascarella & Terenzini, 1991). Pascarella and Terenzini (1991) further concluded that future studies on involvement theories like Tinto's and Astin's should be expanded to include the role of financial aid, the role of the college major, and the influence of peer, faculty, and advisor relationships on student persistence. More comprehensive models to student persistence were needed, and Reason's (2009)

Comprehensive Model of Influences on Student Learning and Persistence, and more recently Hayden's (2017) Comprehensive Model of Influences on Student Persistence in Engineering During the First Year of College, have filled that gap.

The goal of this study was to understand the impact a first-year engineering program has on undergraduate student persistence in engineering at one institution of higher education. FYEng feature a uniform first year curriculum for undergraduate engineering students and are designed to strengthen retention and increase graduation rates. As a result of this study, a better understanding of which factors present in the BU-FYEng program influence student persistence in engineering was achieved. Our understanding is benefitted by study design which aligned with recommendations made by higher education researchers in the past: to understand student perceptions about the quality of instruction; to include race and ethnicity as variables; and to gain an understanding of the role of peer and faculty relationships in student persistence decisions (Pascarella & Terenzini, 1991).

Academic policies are an important part of the overall structure and fabric of any academic program, but a policy that may serve to solve one problem may give rise to another. The BU-FYEng program *is indeed* an academic policy by requiring all students to complete the program before choosing their engineering major. While this does eliminate the problem of changing majors inherent in Hayden's (2017) study, it does give rise to the perception that the program itself is worthless and a waste of time to those that, in their mind, have already chosen their major. While not expressly included as a BU-FYEng program goal or outcome, the program also serves to confirm major choice among students that feel they know which major is right for them. Major confirmation is

a feature of the BU-FYEng that is not highlighted by administrators, and so is overlooked by students as a program benefit. Adding content within the curriculum highlighting that both major confirmation, and exposure to all engineering majors are program features would benefit overall student perception positively.

Study Limitations

This study has two key limitations that need to be included in the discussion. First, while Hayden's (2017) model was utilized to guide this study's design, the survey instrument was created and administered without the guidance of Hayden's model, resulting in incongruent alignment between the factors within the model and study findings. Specifically, survey items seeking information about student pre-college characteristics and experiences were not taken into consideration, and therefore not included in the survey instrument. Additionally, since the data were de-identified prior to analysis, an understanding of student pre-college characteristics and experiences (sociodemographics, economic background) could not be performed in this study. While this is viewed as a study limitation, in that the absence of student pre-college characteristics and experiences in instrument design renders study design incongruent with Hayden's model, research has shown that the experience students have in their first year of college has been found to be more impactful on persistence to the second year than pre-college characteristics (Kuh et al., 2008).

Second, this study focuses on the factors present in the BU-FYEng program that influence persistence positively, and the survey instrument was designed with that goal in mind. However, with this survey instrument and study design, attention was not being paid to the factors that *do not* influence persistence. For example, question 20 asks "Are you planning on continuing your enrollment in UK's College of Engineering next

semester?" and "Yes/No" are the response options. When a student chooses "No", ideally, supplemental questions would be presented to the respondent asking *why* they are not planning to continue their enrollment. This is an improvement that can be made with future iterations of this survey, if administered. Understanding persistence decisions among this population requires understanding the reasons they choose to stay, and the reasons they choose to leave. The instrument used in this was designed to understand the former, not the latter.

Recommendations for Future Research

It is recommended strongly that this population be studied again in the local context, utilizing Hayden's (2017) framework to guide study and instrument design. Taking into consideration the study limitations mentioned, a new instrument should be developed that addresses weaknesses in study design. While the survey instrument utilized in this study does collect both quantitative and qualitative data from respondents, for future studies, more student perception data should be collected in the form of interviews or focus groups with students who completed the first-year engineering program, as well as those who did not complete the program and/or changed majors. Qualitative research like focus groups and interviews would serve to provide a more detailed and granular understanding of student perceptions in their first year, which can guide decision-making among FYEng program administrators with respect to academic and social programming, living arrangements, policies and procedures, and more. Including questions that lead to a better understanding of the impact academic policies play in student persistence decisions is also needed. Additional qualitative research in this area would benefit this body of knowledge tremendously.

Recommendations for BU-FYE Program Administrators

First, student perception was particularly negative for those that felt confident they had already chosen their engineering major, and those that felt they were being "forced" to learn programming even though they feel their chosen major does not utilize it. To augment negative perception among students, BU-FYE program administrators would be wise to promote the learning objectives of the program consistently, using consistent language and messaging, so that students are able to understand the BU-FYEng program goals more readily.

Second, restructuring EGR 101 Major and Career Exploration would be wise. EGR 101 is organized such that BU-FYEng students attend information sessions, outside of formal class time, to learn about engineering majors and career paths. Critical feedback provided via open-ended responses indicated that was not a constructive use of student time, often leading to a negative perception of the experience. Constructive feedback provided indicated that those information sessions need to be held during class time, while adding more in-depth discussion of career paths by including a panel of various engineering professionals with differing careers and academic paths. This would enable students to learn information about their desired path directly from individuals in that engineering field, as well as learn about other engineering fields.

Finally, if possible, BU-FYEng program administrators would be wise to implement an equity-based program or process that enables students that cannot afford to live in the Engineering LLP their first year to do so via a supplemental funding source. Equity refers to fairness and justice and is different from equality: whereas equality means providing the same to all, equity means recognizing that we do not all start from the same place and must acknowledge and adjust imbalances (National Association of

Colleges and Employers, 2022). Some students choose NOT to live in the Engineering LLP due to cost, and instead, choose to live off campus with some commuting from more than 30 minutes away. These students are at a disadvantage compared to students living in the Engineering LLP since they are not gaining from the integrated learning and social environment, which can impact their overall experience and persistence decision making. With respect to access to the Engineering LLP, BU-FYEng program administrators should attempt to reach a goal of 100% of incoming BU-FYEng students living in the Engineering LLP. All students deserve the best chance for success regardless of their financial circumstances. BU-FYE program administrators would be wise to take an equitable approach to the situation, leverage resources where possible, and provide supplemental funding to commuter students in their first year, enabling them to live and learn alongside their BU-FYEng peers.

REFERENCES

Al-Holou, N., Bilgutay, N., Corleto, C., Demel, J., Felder, R., Frair, K., Froyd, J. E., Hoit, M., Morgan, J., & Wells, D. L. (1999). First-year integrated curricula: Design alternatives and examples. *Journal of Engineering Education, 88*(4), 435-448.

Alkin, M. C., & Vo, A. T. (2011). *Evaluation essentials: From A to Z*. Guilford Publications.

American Society for Engineering Education. (2016). *Engineering by the numbers: ASEE retention and time-to-graduation benchmarks for undergraduate engineering schools, departments and programs*. Brian L. Yoder.

Astin, A. W. (1975). *Preventing students from dropping out.* Josey-Bass.

Astin, A. W. (1977). *Four critical years: Effects of college on beliefs, attitudes, and knowledge.* Josey-Bass.

Astin, A. W. (1985). *Achieving educational excellence* (1st ed.). Jossey-Bass.

Astin, A. W. (1994). *What matters in college: Four critical years.* Josey-Bass.

Astin, A. W. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development*, *40*(5).

Berger, J. B., & Milem, J. F. (2000). Organizational behavior in higher education and student outcomes. *Higher Education: Handbook of Theory and Research, 15*, 268-338.

Braxton, J. M., Hirschy, A. S., & McClendon, S. A. (2011). *Understanding and reducing college student departure*. John Wiley & Sons.

Braxton, J. M., & Lien, L. A. (2000). The viability of academic integration as a central construct in Tinto's interactionalist theory of college student departure. In J. M. Braxton (Ed.), *Reworking the student departure puzzle* (pp. 11-28). Vanderbilt University Press.

Braxton, J. M., Sullivan, A. S., & Johnson, R. (1997). Appraising Tinto's theory of college student departure. In J. Smart (Ed.), *Higher education: Handbook of theory and research* (Vol. 12, pp. 107–164). Agathon.

Carnevale, A. P., Smith, N., & Strohl, J. (2013). *Recovery: Job growth and education requirements through 2020.* Georgetown Public Policy Institute.

Colorado State University. (2022). *Reliability and validity.* WAC Clearinghouse. https://wac.colostate.edu/resources/writing/guides/reliability-validity/

Corleto, C. R., Kimball, J. L., Tipton, A. R., & MacLauchlan, R. A. (1996, November). Foundation coalition first year integrated engineering curriculum at Texas A&M University-Kingsville: Development, implementation, and assessment. *Technology-Based Re-Engineering Engineering Education Procceeds of Frontiers in Education FIE'96 Annual Conference, 3*, 1141-1145.

Department of Education. (2019). *Digest for education statistics: Table 326.10.* National Center for Education Statistics. https://nces.ed.gov/programs/digest/d19/tables/dt19_326.10.asp

DeVellis, R. F. (2012). *Scale development: Theory and applications* (Vol. 26). Sage publications.

Doolen, T. L., & Biddlecombe, E. (2014). The impact of a cohort model learning community on first-year engineering student success. *American Journal of Engineering Education*, *5*(1), 27-40.

Flanagin, A., Frey, T., & Christiansen, S. L. (2021). Updated guidance on the reporting of race and ethnicity in medical and science journals. *Journal of the American Medical Association*, *326*(7), 621-627.

Friar, K. (1994). An integrated first-year curriculum-The foundation coalition and the University of Alabama. *Proceedings of 1994 IEEE Frontiers in Education Conference - FIE '94, 1994,* 209-212. https://doi.org/10.1109/FIE.1994.580510

Froyd, J. E., & Rogers, G. J. (1997, November). Evolution and evaluation of an integrated, first year curriculum. *Proceedings Frontiers in Education 1997 27th Annual Conference. Teaching and Learning in an Era of Change, 2*, 1107-1113.

Garcia, S. E. (2020, June 17). Where did BIPOC come from. *The New York Times*. https://www.nytimes.com/article/what-is-bipoc.html

Hayden, M. C. (2017). *The first year of college: Understanding student persistence in engineering* (Publication No. 10282143) [Doctoral dissertation, University of California, San Diego]. ProQuest Dissertations and These Global.

Hoit, M., & Ohland, M. (1998). The impact of a discipline-based introduction to engineering course on improving retention. *Journal of Engineering Education*, *87*(1), 79-85.

Hubbard, B. (2017a). Assessing upper-level students to determine the impact of first-year engineering programs: A review of existing tools and processes [Unpublished manuscript]. University of Kentucky, College of Education.

Hubbard, B. (2017b). First year experience programs and theoretical frameworks guiding student development, student success, and retention [Unpublished manuscript]. University of Kentucky, College of Education.

Hubbard, B. (2016a). *University of Kentucky College of Engineering first year experience program: Implementation evaluation plan* [Unpublished manuscript]. University of Kentucky, College of Education.

Hubbard, B. (2016b). *University of Kentucky first year engineering: An evaluation study* [Unpublished manuscript]. University of Kentucky, College of Education.

Kee, R. J., & Al Akkad, R. (2000). *Effective first-year engineering program improves graduation potential* [Paper presentation]. ASEE Annual Conference, St. Louis, MO, USA. https://peer.asee.org/effective-first-year-engineering-program-improves-graduation-potential

Knight, D. W., Carlson, L. E., & Sullivan, J. F. (2003, June). *Staying in engineering: Impact of a hands-on, team-based, first-year projects course on student retention* [Paper presentation]. 2003 American Society for Engineering Education Annual Conference & Exposition, Nashville, TN, USA.

Kuh, G. D., Cruce, T. M., Shoup, R., Kinzie, J., Gonyea, R. M. (2008). Unmasking the effects of student engagement on first-year college grades and persistence. *The Journal of Higher Education, 79*(5), 540-563.

Lichtenstein, G., McCormick, A. C., Sheppard, S. D., & Puma, J. (2010). Comparing the undergraduate experience of engineers to all other majors: Significant differences are programmatic. *Journal of Engineering Education*, *99*(4), 305-317.

Mayhew, M. J., Rockenbach, A. N., Bowman, N. A., Seifert, T. A., & Wolniak, G. C. (2016). *How college affects students: 21st century evidence that higher education works* (Vol. 1). John Wiley & Sons.

Nardi, P. M. (2014). *Doing survey research: A guide to quantitative methods* (3rd ed.). Paradigm.

National Association of Colleges and Employers. (2022). *Equity.* https://www.naceweb.org/about-us/equity-definition/

Noel, L., Levitz, R., & Saluri, D. (1985). *Increasing student retention: Effective programs and practices for reducing the dropout rate*. Josey-Bass.

Ohland, M. W., Sheppard, S. D., Lichtenstein, G., Eris, O., Chachra, D., & Layton, R. A. (2008). Persistence, engagement, and migration in engineering programs. *Journal of Engineering Education*, *97*(3), 259-278.

Olds, B. M., & Miller, R. L. (2004). The effect of a first-year integrated engineering curriculum on graduation rates and student satisfaction: A longitudinal study. *Journal of Engineering Education*, *93*(1), 23-35.

Pascarella, E. T. (1985). College environmental influences on learning and cognitive development: A critical review and synthesis. *Higher Education: Handbook of Theory and Research*, *1*(1), 1-61.

Pascarella, E. T., & Terenzini, P. T. (1991). *How college affects students* (Vol. 1). Jossey-Bass.

Pascarella, E. T., & Terenzini, P. T. (2005). *How college affects students* (Vol. 2). Jossey-Bass.

Reason, R. D. (2009). An examination of persistence research through the lens of a comprehensive conceptual framework. *Journal of College Student Development*, *50*(6), 659-682.

Rendón, L. I., Jalomo, R. E., & Nora, A. (2000). Theoretical considerations in the study of minority student retention in higher education. In J. M. Braxton (Ed.), *Reworking the student departure puzzle* (pp. 127-156). Vanderbilt University Press.

Rompelman, O. (2000). Assessment of student learning: Evolution of objectives in engineering education and the consequences for assessment. *European Journal of Engineering Education*, *25*(4), 339-350.

Statista. (2021). *Mean annual wage in the U.S., by major occupational group 2020*. https://www.statista.com/statistics/218235/median-annual-wage-in-the-us-by-major-occupational-groups/

Terenzini, P. T., & Reason, R. D. (2005). *Parsing the first year of college: Rethinking the effects of college on students* [Paper presentation]. Annual Conference of the Association for the Study of Higher Education, Philadelphia, PA, USA.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45*(1), 89-125.

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.). University of Chicago Press.

Torpey, E. (2018). *Engineers: Employment, pay, and outlook.* Bureau of Labor Statistics. https://www.bls.gov/careeroutlook/2018/article/engineers.htm

Torpey, E. (2020). *Education pays, 2020*. Bureau of Labor Statistics. https://www.bls.gov/careeroutlook/2021/data-on-display/education-pays.htm

Trochim, W. M. K. (2006). *Research methods knowledge base: Internal validity.* Insights Association. https://www.socialresearchmethods.net/kb/intval.php

Upcraft, M. L., & Gardner, J. N. (1989). *The freshman year experience: Helping students survive and succeed in college.* Josey-Bass.

Upcraft, M. L., Gardner, J. N., & Barefoot, B. O. (2005). *Challenging & supporting the first-year student*. Josey-Bass.

Willson, V. L., Monogue, T., & Malave, C. (1995, November). First year comparative evaluation of the Texas A&M freshman integrated engineering program. *Proceedings Frontiers in Education 1995 25th Annual Conference. Engineering Education for the 21st Century, 1*, 3a6.13-3a6.19.

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