UNIVERSITY OF CALIFORNIA, IRVINE

Motivations Influencing the Choice and Pursuit of a Baccalaureate Engineering Degree for Low-Income Transfer Students

Thesis

Submitted in partial satisfaction of the requirements

for the degree of

MASTER OF SCIENCE

in Mechanical and Aerospace Engineering

By

Leo Salgado

Thesis Committee:
Professor Lorenzo Valdevit, Chair
Professor Derek Dunn-Rankin
Dr. Sharnnia Artis

2020

DEDICATION

I dedicate this thesis to my loving and supportive wife, son, and daughter.

Table of Contents

List of Figures

List of Tables

ACKNOWLEDGMENTS

I would like to thank both of my advisors Professor Lorenzo Valdevit and Dr. Sharnnia Artis for allowing me to join the program and for their continuous support. Both have provided exceptional guidance and a unique place to learn and enabled my growth as both a researcher and an individual.

This work was sponsored by the National Science Foundation via a Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) Program at the University of California, Irvine (Award # 1742627).

The assistance of Professor Jacquelynne Eccles, Professor Zahra Naroozi, Dr. Anna-Lyna, and Hye Rin Lee in the setup of the experiments and collection of the data is gratefully acknowledged.

ABSTRACT OF THE THESIS

Motivations Influencing the Choice and Pursuit of a Baccalaureate Engineering Degree for Low-Income Transfer Students

By

Leo Salgado

Master of Science in Mechanical and Aerospace Engineering

University of California, Irvine, 2019

Professor Lorenzo Valdevit, Chair

Dr. Sharnnia Artis, Co-Chair

The transfer pathway in engineering disciplines, especially for low-income students, is often seen as an opportunity to expand the science and engineering workforce, particularly when transferring from a two-year community college to a four-year institution. This study focused on low-income engineering transfer students' motivational factors that led them to choose and continue to pursue an engineering baccalaureate degree.

This studied used Eccles's (1983) expectancy-value theory of motivation as the guiding theoretical framework to show the relationship between competence and value beliefs as the motivating actions towards earning an engineering degree. This theory relates competence to, "Can I earn an engineering degree?" and task value beliefs to, "Do I want to earn an engineering degree?" Twenty students (12 first-year and 8 second-year low-income engineering transfer students) were interviewed about their experiences in engineering for this study. Additionally, these twenty students completed a survey collecting data on their demographics, recognition, social belongingness, performance, and value beliefs. Results showed that students mainly chose

to pursue a baccalaureate degree in engineering due to financial rewards, family influences, faculty support, and early interest. Furthermore, students' motivation to continue to pursue an engineering degree was attributed to prestige, engineering experiences acquired, financial and academic support, faculty, and peer support, and gain of engineering knowledge throughout their academic journey.

Two limitations of this study are: (a) the small size of the data, and (b) the belonging of the entire data set to a very specific cohort. This cohort was provided with financial and academic support to navigate through their studies. Based on the results of this work, several opportunities for future studies are identified: (1) a longitudinal study to track students' motivation and how that motivation transitions over time; (2) a comparison of two-year community college students transferring to a four-year institution who received financial support by applying for it versus students that were provided with a full financial tuition package; and (3) a research study about low-income engineering transfer students who do not belong to a cohort and are not receiving financial support. Overall, this study helped explore the experiences of low-income engineering transfer students' and the motivations leading them to choose and pursue an engineering degree.

1. INTRODUCTION

1.1. Overview

Throughout most of the 20th century, the United States has been known for being one of the most technologically advanced countries in the world. However, due to the low number of science and engineering (S&E) degrees conferred, it appears to have fallen behind other countries. The “America’s STEM Crisis Threatens Our National Security” (2019) report highlights that “Americans’ basic STEM skills have modestly improved over the past two decades,” but the country “continue(s) to lag behind many other countries” [1]. Furthermore, India and China are producing almost half of the total science and engineering degrees (S&E) globally. By comparison, the United States is only producing 10% [1]. In 2012, the President’s Council of Advisors on Science and Technology (PCAST) Report, stated that to maintain a preeminence role in science and technology the country needed to produce an additional one million STEM professionals, requiring a 34% increase over current rates [2].

With an increase of 34% of the current rates needed annually for STEM professionals, the United States must implement educational strategies to fulfill this need. These strategies include increasing: STEM awareness, participation, retention, and graduation rates at the community college and university level. Community colleges can contribute to providing future STEM professionals, as community colleges lay a significant role in undergraduate education in the United States. Additionally, community colleges attract students from various groups and backgrounds encompassing different genders, races, religions, socioeconomic status, majors, and underrepresented groups.

It has been noted that community colleges and four-year institutions have been experiencing an increase in enrollment from various underrepresented groups. However, for low-income engineering transfer students, an underrepresented group, graduation rates are extremely low when compared to high-income engineering transfer students both at community colleges and four-year institutions.

This study used mixed-method research, exploratory analysis, and grounded theory approach to explore low-income engineering transfer students shared experiences to identify motivational factors that led them to choose and continue to pursue engineering. The well-known Eccles's (1983) expectancy-value theory was utilized as the main framework for this study, in conjunction with the engineering identity model previously validated by Godwin (2016) and a sense of belonging, a model widely studied amongst underrepresented students by Hurtado and colleagues. This study used the expectancy-value theory framework and the engineering identity model due to the close relationship between attainment value to identities (Eccles, 2009) and because both have been used to explain career-related choices [3], [4]. The incorporation of the notion of a sense of belonging motivated by its identification as an influential factor in students' motivation and engineering development, especially for minority groups [5]–[9].

Results showed key motivations for students to choose engineering are the perceived financial rewards engineering offers, family influences, faculty support, and early interest. Their motivation to continue to pursue an engineering degree was linked to prestige, engineering experiences acquired, financial and academic support, faculty and peer support, mentoring, tutoring, the engineering community, and gain of engineering knowledge throughout their academic journey.

1.2. Statement of the Problem

Despite the need for STEM professionals to maintain leadership in the math and sciences in the United States, more research to better understand low-income engineering transfer students is needed. There is limited published research exploring the experiences of low-income engineering transfer students who started at a two-year community college and transferred into a four-year institution. Additionally, there is a limited amount of published literature regarding low-income engineering transfer students' motivation in choosing and pursuing engineering baccalaureate degree attainment. Ultimately, the trajectory of low-income engineering transfer students' educational journey from community college to a four-year institution is considered a complex journey that needs to be understood to increase retention and graduation rates.

Institutions have seen an increase in engineering enrollment from various underrepresented groups. This is evident as the "traditional" transfer student is no longer the majority [10]–[12]. Hence, academic infrastructure and student support need to be restructured to better fit the non-traditional student, which can increase retention rates, minority representation, and graduation rates.

1.3. Significance of the Study

This study offered some significant findings on motivational factors that influenced low-income engineering transfer students' decision to choose and pursue engineering. Firstly, this study illustrated that students' experiences contribute to their motivation through competence and value beliefs, engineering identity, and a sense of belonging. Secondly, this study tried to understand the complex journey of low-income engineering transfer students. Thirdly, this study offered new understandings of low-income engineering transfer students' participation at a two-year community college and the beginning of their academic journey at a four-year institution. Lastly, this study highlighted important supportive academic factors and their importance that influence the pursuit of a baccalaureate degree amongst low-income engineering transfer students.

2. ENGINEERING TRANSFER STUDENTS

Students who do not attend a four-year institution directly from high school are most likely to attend a two-year community college. Students that attend community colleges can obtain a vocational certificate or an associate degree. Community colleges provide a pathway for students to earn advanced degrees and they prepare students to transition to four-year institutions [13]. Students who transfer from a two-year community college to a four-year institution are known as transfer students.

2.1. Transfer Students

A transfer student is defined by The National Student Clearinghouse Research Center (2017), as a student who traditionally attends a two-year community college and transfers to a four-year institution. Students attending a community college have many educational paths. Common educational paths are to earn an associate degree(s) and obtain a baccalaureate by transferring to a four-year institution.

Some of the reasons why students begin their academic journey at a community college are (a) cost of tuition: public and private universities are much more expensive, (b) class size: small class size and less crowded lectures, (c) flexibility: typically designed to cater who have jobs or family of their own, (d) lower expectations: students are not expected to be full-time or graduate within two years and (e) student culture and campus life: no need to adjust to living in dorms or participate in campus life.

Flexibility at the community college is often what provides students the ability to complete their educational paths without a scheduled time for completion. For example, students at a community college have the flexibility to enroll in as little as one class a semester. Students at a four-year institution, students are expected to be enrolled in classes fulltime. Additionally, at a four-year institution, students do not have the same flexibility due to the expected graduation timeframe. Also, part-time students at the community college are common because a great number of students must work in addition to attend school. Many community college students are; first generation (42%), receive financial aid (46%) and are considered an underrepresented ethnic group (45%) [14].

Approximately 20% of graduate students seeking a doctorate, attended a community college, while 6% of these students earned an associate degree at a community college [13]. However, research also showed that transfer students have a lower completion rate towards baccalaureate degree attainment [16]. Despite their community college preparation, 50% of transfer students majoring in STEM majors will obtain a baccalaureate degree [15]. Additionally, 50% of the total number of engineering transfer students will graduate with an engineering degree [17]. This is significant with engineering transfer students, as graduation rates in the field of engineering are low [18]. Ultimately, community colleges can successfully source many potential engineering students to four-year institutions if these students are properly supported throughout their academic journey.

With all the research regarding community college students, there seem to be some missed opportunities once these community college students transfer to a four-year university. Research has shown that transfer students are often switching their majors upon transferring. This is specifically true for, underrepresented and minority engineering transfer students are deciding to drop or switch to a different field once they transition to a four-year institution [15], [17].

2.2. Underrepresented Transfer Students

Underrepresented and minority engineering transfer students consist of a subset group of community college transfer students from underrepresented groups. These groups include low-income students, minorities, first-generation students, and women in engineering. A high percentage of women, who are often underrepresented in the fields of engineering, attend community college, as a step to continue their education and eventually transfer to a four-year institution [17]. Additionally, low-income and minority groups in the United States account for 52% of students who are pursuing an undergraduate degree, and 42% of them are enrolled in a community college [10], [15].

2.3. Low-Income Transfer Students

Community college appeals to many low-income students as studies have shown that students from a low-income background are at a disadvantage due to the limited economic resources [11]. One of the main concerns for low-income students is tuition costs [19], [20]. A lack of financial resources available to low-income students inhibits their option to solely focus on their education. These low-income students tend to work at earlier stages of their academic careers. Many of these low-income students find themselves working during high-school and are more likely to work full-time during college. Working makes it difficult for these students to fully focus on academics and increases the likelihood of not majoring in engineering or science [19], [20]. Furthermore, low-income families often do not prioritize a college education for their adult children. Instead, the goal is for their adult children to gain employment after high school [19].

Despite all of these challenges, students from a low-income background have increased their enrollment in college over the past decade [21]–[26]. Yet, even with an increased enrollment for these low-income students, there continues to be a disparity among graduation rates. For example, 10% of low-income students graduate with a four-year degree. However, 76% of high-income students graduate with a four-year degree [26], [27]. In a study of 50 undergraduate participants majoring in physical sciences or engineering, 92% were first-generation or low-income students [22].

2.4. Transfer Student Sense of Belonging

In addition to several disadvantages, a major challenge that engineering transfer students encounter at a four-year institution is a sense of belonging. A sense of belonging or seeing oneself as socially connected is a basic human motivator [28], [29]. A sense of belonging contributes to persistence, retention, and increases graduation rates [28]. However, a sense of belonging is considered a difficult task to achieve among engineering transfer students [28], [30]. Additionally, engineering transfer students identify that a lack of sense of belonging is an important factor in students' decision not to pursue an engineering degree [28], [31].

The complexity of undergraduate engineering programs can create a lack of sense of belonging among transfer students. This can create isolation for engineering transfer students when they face challenges [28], [29], [31]–[33]. A lack of sense of belonging can influence students' ability to integrate into the engineering community [28], [31], [33], [34]. Further, it influences students' confidence in completing an engineering degree and contributes to students' ability to develop and access support [28], [31], [35]. Studies have shown that low-income transfer students struggle to form and participate in study groups, peer networks, academic organizations [28], [30], [33].Without improving engineering transfer students' sense of belonging they will continue to be underrepresented in the field of engineering. This can potentially lead to a loss of a diversity of talents, as well as improve the socioeconomic status of many low-income transfer students [22], [36]–[38]. Additionally, the United States will continue to struggle in STEM leadership, as studies have shown that the increasing participation of low-income students can potentially alleviate staffing shortages in STEM [36], [37].

Much research has been conducted on transfer students and underrepresented groups. However, very little research examines low-income engineering transfer students who are pursuing a baccalaureate degree. To better understand low-income engineering transfer students, one must understand motivational factors. Additionally, one must see that the idea of a ‘traditional’ engineering student has changed. Engineering students in the past were: white males, aged 18-24, middle class, and strong in math and science. Yet, research illustrates that many engineering students at post-secondary institutions no longer fit the description of a ‘traditional’ engineering student. This is evident through low-income engineering students no longer fitting the description of a ‘traditional’ engineering student [10]–[12]. Being categorized by a mold, educational infrastructure needs to be re-evaluated to support the non-traditional student category.

2.5. Low-Income Engineering Transfer Students Barriers

As engineering students no longer fit a ‘traditional’ engineering student mold, the engineering infrastructure must be re-evaluated. The engineering infrastructure is key to the success of all engineering students. Additionally, it is most important for low-income engineering transfer students, as they have a low retention level. Currently, the engineering infrastructure is seen as an ecosystem discipline that consists of several subcategories. Each engineering subcategory tends to form an ecosystem and a shared culture of its own. For example, mechanical and civil engineering disciplines fall under the engineering major, but students from each discipline tend to connect with students from their discipline. Furthermore, each discipline has its admission process, overarching policies, design, and accreditation criteria [39]. Research has shown that students' demonstrated differences in preferred learning styles, specifically women and minority students [40]. Some of these differences can be attributed to the size of the classroom, student-to-faculty interaction, and course curriculum adjustment. Attrition has been noted as a result of poor quality of teaching, advising, lack of student-faculty interaction, and a sense of belonging. These are leading factors that cause student migration [41]. With all these differences it is difficult to ensure that low-income engineering transfer students are fully supported and motivated in all fields of engineering.

Many studies have examined engineering transfer students' motivation to continue to pursue an engineering degree. One study that emerged from the APS found that engineering transfer students were either persisters or non-persisters in their engineering degree attainment. The difference between persisters or non-persisters was related to students' motivation to study engineering. Student motivation ranged from the influence of a parent or high school mentor to their confidence in math and science or their intention to attain an engineering degree [42]–[44]. However, another study showed that students who chose to switch or drop their engineering major were students influenced by their parents or academic advisors, choose engineering for materialistic reasons or their academic achievements in math or science [32], [45], [46]. These two studies show contradictory results, which illustrates that the support an engineering transfer student receives may not be consistent support that the student receives throughout their academic journey. This inconsistent support results in engineering transfer students changing majors or dropping out of their undergraduate program. Furthermore, research has shown that engineering transfer students who left their engineering studies but later resumed them were influenced by friends, teachers, advisors, or professors [43]. Influence and support from others are necessary for engineering transfer student success.

2.6. Summary

It is important to identify the key motivational factors that lead to low-income transfer students' decision to leave or switch from their engineering major. With more research about low-income engineering transfer students, institutions will be able to implement or modify existing programs with the intent to increase student retention and graduation rates. Studies have shown some key factors regarding engineering transfer students changing their major or dropping out to be; a lack of interest in the subject, misconceptions about the field, academic difficulties, perceived inability to succeed in the field, conceptual difficulty, a lack of sense of belonging [4], [47], [48]. From the student's perspective, switching or dropping out from engineering might be a reflection of the reasons transfer students originally chose engineering as a major [4]. Additionally, choosing engineering might be based on students' personal beliefs, motivational factors, experiences, and influential factors. In the end, students' decisions to choose engineering as a major and the motivational factors behind students' decision to choose and pursue engineering have not been fully explored [4], [43].

3. REVIEW OF THE LITERATURE

This chapter synthesizes the literature that addresses relevant work and the importance of identifying motivational factors of low-income transfer students. Furthermore, it identifies the framework, relevant models used in this study. Overall, it emphasizes that motivational factors, engineering identity, and a sense of belonging may shape transfer students' experiences in ways that contribute to choosing and pursuing engineering at four-year institutions.

3.1. Scholarly Topics

To support this study and provide a meaningful understanding of its context, three scholarly topics of literature were reviewed: 1) motivation, 2) engineering identity, and 3) sense of belonging.

The topics were selected to better understand what motivates students to choose and pursue engineering degrees. Moreover, to increase retention, as it is vital to understand students' goals, objectives, and the decision-making process. This is essential to create a diversified and scholarly engineering workforce [4].

To better understand student motivation in engineering, interest in engineering needed to be examined. Interest in engineering can vary from student to student. Some students are interested in engineering because of; curiosity, personal beliefs, tinkering, a self-perception as being creative, problem-solving, interest in a math or science, the need to care for others, or the desire to be an engineer. Some of these interests in engineering become a students' engineering identity. Together, motivational factors and engineering identity seem to contribute to the decision-making process of choosing and pursuing engineering. Additionally, a sense of belonging plays a significant role in low-income engineering transfer student's motivation, identity, and persistence.

3.2. Motivation Definition

Several studies have identified the main reasons students reported leaving engineering. These studies show that motivational factors are more important than academic factors in retaining engineering students [47]–[49]. Focusing on motivational factors, student's motivation can be influenced via a family member, faculty member, by their community, academic performance, materialistic or personal preferences. Further, motivation has been known to be a determinant factor when it comes to choosing and pursuing a task, specifically engineering.

To understand motivational factors, the driving mechanism that pushes students to choose and pursue engineering needs to be defined. According to the Management Study Guide (MSG), motivation is defined as the needs, desires, wants, or drives within the individuals. Motivation is considering a process consisting of three stages: 1) a felt need or drive; 2) a stimulus in which needs must be aroused; 3) when needs are satisfied, the satisfaction or accomplishment of goals. Additionally, motivation is considered a psychological phenomenon that can be influenced by success, recognition, desires, and satisfaction. Motivation can be categorized differently depending on the area that is being analyzed. To expand on the definition of motivation, it is considered a "fundamental human need" like physiological safety, love, esteem, and self-actualization [50]–[52].

In the context of this study, motivation encompasses an array of variables and is defined as the means to "move", as a form of action and is measured as the time spent on a task, assessment of personality traits, and capture of various cognitive-based processes [50], [51],

[53], [54]. The interpretation of motivation itself could vary among individuals, therefore research on motivation has led to the development of several motivational theories.

3.3. Motivational Theories

The development of such theories shows the importance of trying to understand the factors or driving mechanism(s) behind individuals' motivation that leads to their decision-making process or engaging in a task. Modern theories of motivation have been developed based on beliefs, engagement, control, attribution, values, interest, goal-driven, and achievement-related choices [54].

3.3.1. Control Theory

In control theory, the expectancy of success is based on the ability to control one's success and failures, it emphasizes the idea that behavior is not affected by an external stimulus [55]. The focus is to be able to understand individuals' choices about pursuing engineering based on the expectancy of success and other personal factors. A possible disadvantage of the control theory is that it might not capture the entire domain as to why originally students choose and continue to pursue engineering. It leaves out the fact that choosing and pursuing engineering might originate or be influenced by students' experiences.

3.3.2. Self-Determination Theory

Self-determination theory focuses primarily on choices individuals make without external influences or interference [56], [57]. It is based on individuals seeking out optimal stimulation and challenging activities due to the need for competence [54]. Competence is an important factor, but it might be insufficient to determine the decision process of choosing to major in engineering. It must be acknowledged that when it comes to deciding on choosing to major in engineering, an individual's decision to choose engineering as a major might require confirmation in their ability to complete tasks which leads to the expectancy of success, not a failure. However, this theory does not include influential or external factors.

3.3.3. Flow Theory

Flow theory focuses on the state of concentration and engagement that can be achieved when completing a task that challenges an individual's skills [58]. The theory highlights an important aspect of engagement and contributes to pursuing engineering after the decision of choosing engineering has been made. Yet, the theory does not account for what led to choosing engineering in the first place. One important aspect of choosing engineering as a major could be that it was chosen based on previous interest or decided based on external influential factors.

3.3.4. Interest Theory

Interest theory focuses on the level of engagement due to personal preferences individuals interact influenced by a particular content or due to a stimulating task that may be found interesting [59], [60]. According to U. Scheifele (1198, p. 93), "from the standpoint of interest theory, a learner is intrinsically motivated when his or her main incentive for learning is related to qualities of the respective knowledge domain" [60].

3.3.5. Goal Theory

Goal theory focuses on task performance, it identifies that specific and challenging goals along with proper feedback contribute to higher and better task performance. Achievement in goal theory depends on subjective purposes, achievement goals that differentially influence school achievement via variations in the quality of the cognitive self-regulation process [61].

3.4. Expectancy-Value Theory of Achievement Motivation

Currently, one of the most used motivational models to study students' career choices in engineering is the expectancy-value theory [3]. The expectancy-value theory developed by Eccles et al. (1983), is considered, according to Lauermann et al. (2017), the most influential theory for explaining students' learning behavior and achievement-related choices [62]. The theory indicates that the students' task choice and level of engagement are driven by two subjective task-specific beliefs: (a) the expectancy that an individual can succeed in a task and (b) the value individuals attach to the task. The theory is composed of two fundamental questions "Can I do this?" and "Do I want to do this?", which provides a framework to understand achievement-related choices, a) why students choose engineering as a major but most importantly b) why students continue to pursue engineering. This theory, from the students' perspective, consists of a set of values and beliefs that provide a deeper understanding of the influential factors that students take into consideration of their expectancy to succeed and the value they see in the decision of choosing and pursuing engineering. In the context of engineering, I looked at the way competence and value beliefs are shaped by many contributing factors such as past experiences, the influences of socializers (e.g., parents, teachers and peers), personal identity beliefs (uniqueness of ourselves), and collective identity beliefs (the aspects of ourselves that tie us to others) [63], [64]. Eccles and colleagues proposed that students' expectancies for success and their subjective task values are directly related to their educational and behavioral choices [48], [54], [63].

3.4.1. Expectancy of Success

Expectancy for success is defined as the individuals' beliefs as to how well they will do in the task [54]. Overall, students are more inclined to engage in an activity in which they expect to succeed and foresee value in it.

The expectancies for success construct is conceptually related to other constructs that refer to self-evaluations of competences, such as academic self-concept [65]. Due to its strong correlation between self-concept and expectancy for success, both constructs have been combined as one or used interchangeably [66], [67]. Other studies have found expectancy of success to be similar to Bandura's (1997) self-efficacy construct and self-concept of ability [4], [68]. There is a strong similarity between self-competence, self-concept (beliefs about oneself), and self-efficacy (ability to exert control over one's motivation, behavior, and social environment). Furthermore, self-competence, self-concept, and self-efficacy are all constructs used to study self-perceptions [69].

The importance of similar but slightly different measures of expectancy of success, self-efficacy, self-conception, and self-competence is the ability to fully capture students' confidence from different perspectives. Students' level of confidence plays an important role when students question if they can complete a certain task. This confidence can be considered the initial step to task engagement or choosing engineering degree attainment. Additionally, Eccle's expectancy-value theory expectancy of success and competence beliefs are used interchangeably.

Studies on competence beliefs have identified: a) self-efficacy serves as a mediator between positive feedback and better performance [4], [70], and b) among first-year engineering students self-efficacy beliefs originate from mastery experiences and social comparisons [4],

[71], [72]. It is imperative to highlight how self-efficacy originates and its relationship to mastery experiences. Self-efficacy in terms of engineering is captured by the comparison of one engineering student's experiences with other students' experiences or performance. Positive feedback and improved academic performance contribute to a sense of self-efficacy because "successful performance accomplishments provide the most authentic evidence of whether one can bring about success." [73]. Ultimately, students' engineering experiences become self-efficacy. Additionally, self-efficacy directly correlates to beliefs, which leads to expectancy of success as influencing engineering experiences which in turn is influenced by a sense of belonging.

3.4.2. Value Beliefs

Value beliefs are the values foreseen when engaging in a task or activity. Furthermore, value beliefs focus on the desire to engage, or the importance of engaging, in a task or activity. Value beliefs have been used interchangeably with subjective task values. Eccles defines subjective task values (STV) as the individual's incentives for engaging in different tasks or activities based both on the nature of the task and how well it aligns with personal values, goals, and needs. Subjective task values consist of four categories [64], [74]:

1) Attainment value: The individual's perception of how performance on the task reflects on the individual and how this reflection matches with self-concept
2) Intrinsic or interest value: The enjoyment experienced in doing the task
3) Utility value: The perceived future importance of engaging in the task that may be directly or indirectly related to the task itself

4) Relative cost: The price of success or failure in terms of effort, time, and/or psychological impact

The cost value is defined as the perceived effort, loss of valued alternatives, and the psychological cost of failure [74]. It is considered the negative aspect of motivation that identifies the loss of time, or resources because of engaging in a task.

Utility value is determined by how well a task relates to current and future goals, such as career goals [62]. It can be categorized as the usefulness of engaging in a certain task. Such usefulness is foreseen as a tool or skill that could allow individuals to reach a goal or complete a task.

Attainment value is seen as a self-reflection of the student within the engineering field. It provides an identity as the student continues to pursue engineering and as they acquire academic knowledge and engineering experience. Within the engineering realm, recognition by others as a fellow engineer provides a sense of reassurance and confirmation. In addition to personal importance and achievement, studies have identified a correlation between attainment value and personal identity. Attainment value has been linked to identity-related issues specifically with high achievement on a certain task, as it reflects an important aspect of the self [67].

Intrinsic or interest value can take various forms. For instance, it can relate to curiosity in terms of internal interest. It pleases oneself to learn something new or accomplish what others within your community have not reached (family, friends, or surroundings). The personal interest aspects are “what if I could do this” or “what can I learn or gain from it.” The most influential constructs from the expectancy-value theory are attainment value and interest value [74]. Both constructs capture students’ motivational values, beliefs, and certain aspects of identity.

In a qualitative study by Matusovich (2010), the results showed a career choice process about engineering being consistent with students' sense of self (attainment value), rather than interest. Furthermore, results indicate various types of value or personal importance patterns participants assigned to earning an engineering degree. A differentiating feature was "whether or not participants choose engineering as a major because it is consistent with their identity or sense of self" [4].

Studies have shown that the expectancy-value theory captures an array of variables related to the process of career-choice decisions. Furthermore, similarities found between attainment value and interest provide a level of degree of importance as to what motivates students to choose and pursue engineering. Furthermore, it is noted that the choice of engineering can be attributed to students' identity or sense of self. Students' choosing and pursuing engineering from a motivational model highlight a certain level of relationship between the expectancy-value theory of motivation attainment value and identity, leading us to explore engineering identity within the focus of engineering-related choices.

3.5. Engineering Identity

Literature has noted that "Identity is complex, multi-faceted and changes over time" and varies by discipline, in the context of engineering, engineering identity has not been fully conceptualized or directly measured [75]. In the study by Patrick and Borrego (2016) on engineering identity and found out that even with the "long history of deep theoretical, qualitative and quantitative work on the many facets of engineering identity development, existing measures of engineering identity are still very crude." It was noted that identity could essentially be different from another construct such as self-efficacy or the expectancy-value theory of achievement of motivation model [75]. However, just recently that some studies have explored the idea of differentiating such constructs. Furthermore, the idea of engineering identity consists of feeling like an engineer or seeing oneself as an engineer, but it also acknowledges the social-cultural and environmental factors that shape the “becoming” an engineer or in the process of ‘doing’ engineering [75].

Other studies have shown a relationship between personal or collective identities with attainment and intrinsic values. Expectancy-value theory of achievement of motivation, Eccles (2009) argued that personal and collective identities can influence the level of engagement based on the degree of consistency with one’s central values and identities [63]. Using an engineering identity model, studies have attributed educational and professional persistence to engineering identity [76].

In a study conducted by Verdin and colleagues (2018), identity is defined as “being recognized as a certain ‘kind of person,’ in a given context,” [77]. Within the context of engineering, the authoring of oneself was categorized by; interest, recognition, and performance/competence [77], [78]. These three constructs are defined as, (a) recognition is defined as a form of being recognized by others and needed for engineering identity development, (b) interest is defined as a key role and the attraction towards engineering as well as a formal understanding of it, and (c) performance/competence is defined as the individuals’ belief of being competent and be able to perform effectively in engineering [76], [77]. The three constructs were also used in a study at a post-secondary institution with the purpose to identify engineering identity levels of influence when it comes to choosing engineering as a major. Results from the study identify pre-cursors, factors, and moderators of engineering identity [77]. The precursors of engineering identity were noticeable due to the strong connection between the developments of multiple identities for students entering college. Factors consist of physics, math, and general sciences which are important to engineering identity development. Moderators are based on beliefs about performance/competence, recognition, and interest that influence subject-specific identities.

The EI model was previously used to understand physics and math identities and engineering career outcomes [79]–[82]. Studies have shown that engineering identity is an influential factor when it comes to choosing and pursuing engineering [76], [80]. A qualitative study conducted by Matusovich et al., (2010) concluded a differentiating feature was "whether or not participants choose engineering as a major because it is consistent with their identity or sense of self" [4]. Furthermore, engineering students find themselves most motivated when they identify themselves with the engineering discipline and within the community, they are mostly associated with [77].

Other studies tried to understand identity correlation to the choice of engineering by focusing on students' self-ascribed engineering identity through structural equation modeling [80]. Results showed that performance/competence is needed to develop an identity and without recognition and interest as mediating factors, identity development is difficult to achieve. Further, the study identified that students' physics, math, and general sciences identities are important factors for engineering identity development. A surprising factor that the study noted was that performance/competence beliefs were insufficient for identity development, but recognition and interest beliefs assisted

actualize students' identities [80]. An important factor of the study was the relationship between self-efficacy to performance/competence which was considered a key factor in persistence. The conclusion of the study identified engineering identity as a clear influential factor to choose and pursue engineering as a career [80].

Engineering identity can be considered a motivational factor that influences students to choose and pursue engineering. Based on students' level of commitment and participation in a discipline. Additionally, students identified themselves with the discipline, and at the same time, which leads to further development of an identity within the community they are mostly associated with, engineering identity [77].

Engineering students have shown a relationship between motivation and engineering identity based on engineering experiences, attainment or interest value, and their correlations. Research has shown that there seems to be a relationship between motivational factors, engineering identity, and sense of belonging which can influence students' motivation. Furthermore, student participation within an engineering community creates or expresses some level of engineering identity and a sense of belonging based on the level of interest, participation, or commitment.

A sense of belonging influences undergraduate engineering students' motivation as well as engineering identity. For example, Hurtado and colleagues' extensive work has shown that a sense of belonging can influence the students' decision to leave or switch from an engineering program. This is particularly true for underrepresented groups [5]–[9].

Engineering identity illustrates an internal stimulus from the students' perspective that leads to choosing and continuing to pursue engineering degree attainment. The model identifies several characteristics that an individual experiences as an engineering student. Some of these characteristics consist of being recognized as an engineer, performing like an engineer, and feeling like an engineer. Additionally, such characteristics illustrate the importance of personal variables that influence motivation and lead to career-choice decisions. Moreover, a sense of belonging is an influential factor that could be substantial to the students' engineering development and ultimately the students' motivation.

3.6. Sense of Belongingness

Researchers have defined a sense of belonging as a “sense of affiliation and identification with the university community” and integration into the college system [83], [84]. Studies have shown the importance of a sense of belonging when there is a noticeable discrepancy in retention, performance, and satisfaction between underrepresented groups (firs-generation, underrepresented minorities, women, and low socioeconomic status) and those of dominant groups (white, male) among engineering departments across the United States [85], [86]. Sense of belonging can be experienced when students need to see themselves belonging to a certain group, in a particular role, as problem solvers or as the “ kind of people who would want to understand the world scientifically” [80], [87]. Students who acquired a sense of belonging received positive influences on their level of motivation, engagement, and achievement [88].

A study about first-generation college students’ engineering identity and belongingness concluded that there is a direct effect of engineering identity to students’ persistence of effort. Furthermore, there was an indirect effect of engineering identity to student’s consistency of interest, attributed to engineering belongingness [77]. The results highlighted how underrepresented engineering students often find themselves struggling to identify themselves or seeing themselves as engineers. This creates a correlation with engineering identity, recognition, and performance/competence beliefs in engineering that can influence students’ sense of belonging in engineering and passion to persist in engineering. This is especially true for first-generation college students [77].

A study conducted on underrepresented students during their first quarter of college focused on identifying the effects that ENGR 101 had on an engineering identity and sense of belonging. It was noted that students' engineering identities were influenced by certain engineering assignments and overall the course had a positive impact on their sense of belonging [85].

To further highlight students' sense of belonging, it is important to consider that some students may have no experience in an engineering community of practice. To increase university acclimation, institutions have focused on transfer summer programs before enrollment. Such programs allow students to receive hands-on experiences, exposure to the university community, faculty interaction, and develop personal and professional skills [89]. An important aspect of these programs is that it allows faculty-to-student interaction which could potentially increase student interest, engagement, and sense of belonging to the field by allowing faculty to answer questions about the field, research, experiences, course material advising, faculty approaching tips, available resources, or where to seek for assistance. It has been noted that those students like to discuss their interests among peers and especially among faculty members. Discussing their interest gives reassurance about their goals from someone with a similar background which can influence their decision to pursue engineering or discover an engineering path [43].

Other studies identified trends within interventions and learning programs consisting of the personal and collaborative learning environment and using tutors and peer reviews which resulted in higher grade point averages increased graduation and retention rates and lower drop-out rates [18]. The reason for these programs was to develop a certain level of comfort and a sense of belonging by providing support, hands-on activities, and a cohort experience. They provide exposure to the engineering community and enable students to experience engineering to increase their level of motivation and continue to pursue an engineering degree. It is important to highlight that engineering exposure and involvement influenced the student's sense of belonging. Motivation in engineering was also been linked to a sense of belonging when feeling part of a greater community [90]. Further, it directly related to how well a participant perceived themselves to fit into the classification of an engineer [91].

A sense of belonging plays a significant role in engineering identity development and students' motivation, especially in low-income engineering transfer students. Studies have shown that a sense of belonging is an important aspect of inclusion and academic integration. Furthermore, it reflects students' level of engagement and academic performance when students have found a sense of belonging within a community. On the other hand, lack of sense of belonging can be the leading factor for students' decision to not choosing and pursuing engineering. Students' sense of belonging is relevant to this study since it influences students' motivation, engineering identity development, and ultimately an important factor for pursuing engineering degree attainment.

3.7. Framework and Models

This study used the expectancy-value theory as the main framework and engineering identity and sense of belonging as adopted models. To better understand why transfer students' chose and pursued engineering with the intent to graduate with a baccalaureate degree, the study adopted Wigfield & Eccles's (2000) expectancy-value theory of achievement motivation as the guiding framework (see Fig. 1). Furthermore, Godwin's (2016) engineering identity model (see Fig. 2) and a sense of belonging were analyzed.

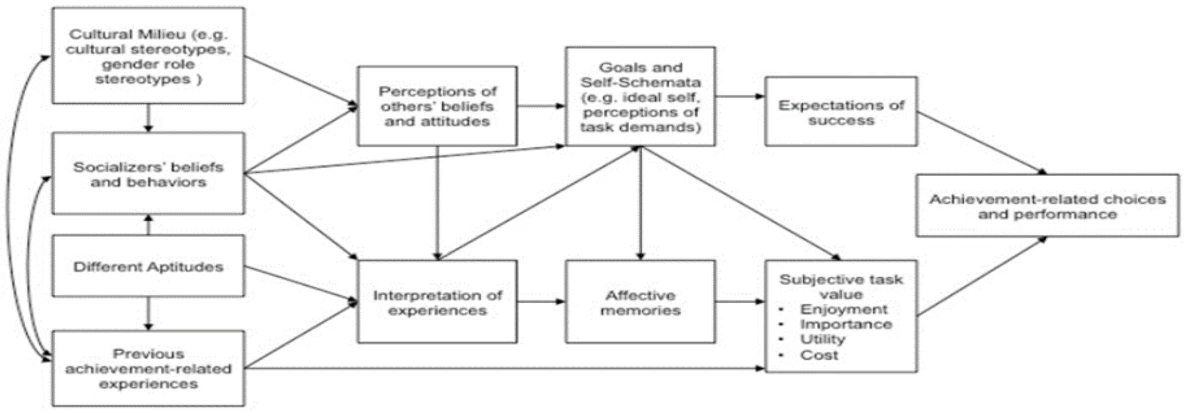

Figure 1: Expectancy-value theory of achievement motivation (simplified and adapted from Wigfield and Eccles, 2000)

Both the expectancy-value theory and engineering identity models are categorized as career choice models. However, in this study, the expectancy-value theory of achievement motivation model provided a more explicit framework to examine students' values and beliefs in choosing engineering as a major [4]. Within the framework, this study utilized a simplified version of the expectancy-value theory of achievement motivation model (see Fig. 1). The simplified version used in this study did not include the construct of "cost," as it relates to the negative aspect of motivation. According to Wigfield & Eccles (2000), the cost value is defined as the perceived effort, loss of valued alternatives, and the psychological cost of failure [74].

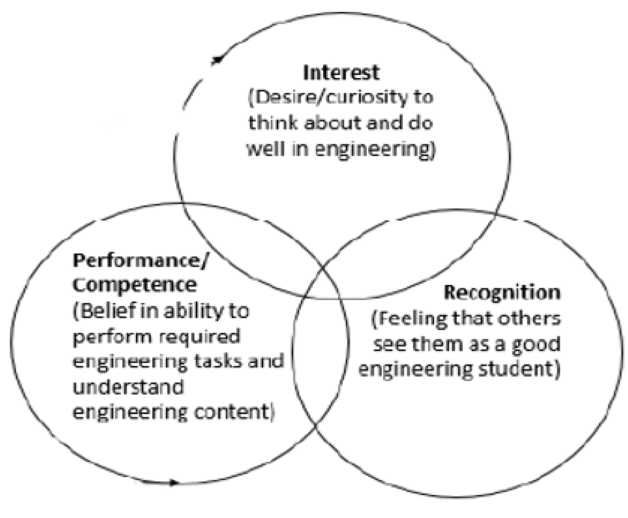

Figure 2: Engineering identity model (adopted from Godwin, 2016)

3.7.1. Expectancy-Value Theory of Achievement Motivation

This study used a simplified version of Eccles's expectancy-value theory (EVT) model which suggests that choices to engage in certain tasks or activities are shaped by competence and value beliefs, not the cost associated with it. Students' decision to choose and purse engineering is attributed to competence beliefs. This is evident in the question of ability, "Can I do this task?" Furthermore, task beliefs were addressed in the question of "Do I want to do this task?" Answering both questions before deciding to engage in a certain task, is essential. This is especially true when students were choosing and pursuing engineering degrees. Moreover, the model was used because it allowed the study to explore student's beliefs, as well as a wide array of values that students assign to earning an engineering degree [4].

3.7.2. Engineering Identity Model and Sense of Belonging

This study utilized the simplified EVT model as well as the engineering identity model. The engineering identity (EI) model validated by Godwin, consists of interest, recognition, and performance (Godwin, 2016). Additionally, Godwin's EI model has been used in research for career outcomes for students in physics and math [79]–[82], [92]. This reinforces the idea of foreseeing a career outcome for engineering students by using the EI model. For this study, the EI model analyzed the process of students becoming engineers, seeing themselves as engineers, feeling like an engineer, or participating in engineering.

The process of becoming an engineer also includes a sense of belonging. A sense of belonging captures a students' level of inclusion or belonging to an engineering community or in the field of engineering. A sense of belonging is considered a determinant factor of students' success, especially for underrepresented engineering students [5], [7]–[9]. In this study, a sense of belonging was incorporated into the EVT and EI models to characterize "the human need to belong" since it is also "the most powerful motivator of social behavior" [93], [94].

Within both models used in this study, an overarching question is asked: What motivates, a low-income engineering transfer student from a community college to succeed in engineering?

3.8. Purpose of the Study

The purpose of this study is to identify motivational factors that lead to the decision of choosing and pursuing engineering degree attainment. Additionally, this study intends to reduce the gap in the literature about low-income engineering transfer students' motivation to choose and pursue engineering degree attainment. Moreover, most of the existing literature on students' experiences in engineering has been conducted in the four-year context without fully addressing low-income transfer students who began at the community college and then transferred to a four-year institution [95]–[97].

This study included first-and-second year transfer students from community colleges that are pursuing a baccalaureate degree in engineering. Thus, this study navigates the educational journey towards baccalaureate degree attainment that these students experienced. Furthermore, this study aimed to expand the understanding of the motivation that influenced students' decision to choose and pursue engineering among low-income community college transfer students.

3.9. Research Questions

Three fundamental questions were developed for this study to identify the motivational factors that led low-income engineering transfer students to choose and pursue engineering.

- RQ1: Why do low-income transfer students choose engineering as a major?
- RQ2: Why do low-income transfer students continue to pursue engineering?
- RQ3: When do low-income transfer students believe that they are engineers?

The first two questions were developed to help explore students' values and beliefs for choosing and pursuing an engineering degree. These two questions fall under the category of the expectancy-value theory of motivation achievement. Question three was developed to explore students' Engineering Identity (EI). Additionally, the questions were developed to identify a gap in the existing research literature about low-income engineering transfer students. Furthermore, the study hoped to bring attention to low-income engineering transfer students' needs, desires, interests, expectations, and misconceptions about engineering.

3.10. Summary

Several studies have identified that motivational factors are more important than academic reasons in retaining engineering students [47], [48], [98]. Studies have defined motivation as the means to "move', as a form of action and is measured as the time spent on a task, assessment of personality traits, and the capture of various cognitive-based processes [53], [54], [99], [100]. Modern theories of motivation have been developed based on beliefs, engagement, control, attribution, values, interest, goal-oriented, and achievement-related choices [54]. Therefore, motivation is considered a powerful and influential factor for students' success.

The study adopted a simplified version of the expectancy-value theory of achievement motivation as its main framework. The expectancy-value theory of achievement motivation is considered one of the most influential theories for explaining students' learning behavior and achievement-related choices [74]. The theory is composed of two fundamental questions "Can I do this?” and “Do I want to this?” Both questions addressed the student’s competence beliefs and subjective task values. These two questions enabled the study to understand the achievement-related choices from the students' shared experiences.

Additionally, studies have shown attainment value, from the expectancy-value theory, to have a close relationship to engineering identity. This study adopted the engineering identity model previously validated by Godwin (2016). The model was utilized in this study because, in previous studies, engineering identity has been identified as an influential factor when it comes to choosing and pursuing engineering degree attainment [76], [80].

Lastly, this study adopted a sense of belonging because studies have identified it as an influential factor in students’ decision to persist within an engineering program [5]–[9]. Furthermore, highlighting students’ retention, performance, and satisfaction, studies have shown the importance of a sense of belonging among underrepresented groups in the field of engineering [85], [86]. Additionally, this was seen through a study conducted of a group of underrepresented college students who experienced a positive impact on their engineering identity and sense of belonging [85].

In this study, students’ motivation to choose and pursue engineering can be modeled by the expectancy-value theory of achievement motivation, engineering identity, and a sense of belonging. These models identified key influential factors that low-income engineering transfer students seeking engineering degree attainment may experience. Such models provided a structure in this study to fully explore low-income engineering transfer students' experiences from the students’ perspective which led students to choose and pursue engineering.

The following chapter serves as a guide for the research approach used in the study. The approach consisted of; (1) design of the study, (2) recruitment (3) sample selection, (4) site selection, (5) data collection, (6) data analysis, and (7) validity and reliability.

4. METHODOLOGY

This chapter explains the methodology process used in this study to gather and analyze the questions asked of low-income engineering transfer students that successfully transitioned from a two-year community college into a four-year institution with the intent to pursue and graduate with an engineering degree. A systematic approach was used in this study to categorize data into themes and codes that represented key terms related to motivation, engineering identity, and a sense of belonging.

4.1. Design of Study

In this study, grounded theory was used to better understand the shared experiences of low-income engineering transfer students who decided to choose and pursue engineering. Structuring data into smaller units of meaning is considered a grounded theory approach. Also, grounded theory is defined as the methodology that guides researchers in developing a theory out of data, thus making the theory "grounded" in the data [101]. In this study, grounded theory was used to categorize the participants' responses on a smaller scale. In conjunction, an exploratory analysis was used to examine the data found in the quantitative and qualitative analysis. An exploratory analysis was used to identify trends beyond formal modeling or hypothesis testing. Additionally, the constructs from the models provided subcategories of each construct to fully capture key arguments that led low-income engineering transfer students to choose and pursue engineering.

This study also used a mixed research method approach to collect and interpret the data gathered from low-income engineering transfer students that chose and continued to pursue engineering. The mixed-method approach is:

> A mixed research method involves the collection or analysis of both quantitative and/or qualitative data in a single studying which the data are collected concurrently or sequentially, are given a priority, and involve the integration of the data at one or more stages in the process of research [102], [103]

In this study, the mixed research method approach provided flexibility with the semi-structured interviews and online surveys that were administered. Also, the mixed research method approach was useful in understanding the contradictions between the quantitative and qualitative findings. Furthermore, the mixed research method approach ensured that the study findings were grounded in participants' shared experiences.

To ensure subjectivity within this study the words from the participants were not altered. Subjectivity was accomplished by writing down field notes and memos in a reflective journal during each semi-structured interview, observation, and document analysis. The data gathered in this study was subsequently investigated closely, to ensure that all perspectives were examined and presented equally. The study preserved the context of the data without altering form, meaning, or purpose [102].

4.2. Participant Demographics

All the participants in this study were classified as being of low-income socioeconomic status by the Office of Financial Aid and Scholarships. A selected sample selection initiated the data collection process for this study. Selecting a set of low-income engineering transfer students was the focus of the study, as these students could provide insight into why they chose and pursued an engineering degree. With approval from the Institutional Review Board (IRB) from the University of California, Irvine (UCI), a total of twenty participants were selected for this study. Out of the twenty participants, twelve of the participants were first-year and eight were second-year low-income engineering transfer students. Additionally, the twenty students who participated in this study were enrolled at UCI full-time and were part of a cohort. In this study, both male and female participants were interviewed, however, most of the participants were male (see Table 1). The participants' age range was from 20 to 25 years old, with an average age of 22 years of age. Most of the participants identified their race/ethnicity as being white (see Table 2).

Table 1: Gender description (N=20)

Description	*N*	*%*
Male	14	70
Female	6	30

Table 2: Participant's Race/Ethnicity (N=20)

Description	*N*	*%*
Asian	6	30
Hispanic or Latina(o)	4	20
Hispanic or Latina(o), White	2	10
White	8	40

Out of the twenty participants majoring in engineering, Mechanical Engineering was the highest chosen major out of the five self-reported majors (see Table 3).

Table 3: Participant's Engineering Major

Description	*N*	*%*
Biomedical Engineering	6	30
Chemical Engineering	1	5
Electrical Engineering	1	5
Mechanical Engineering	11	55
Mechanical & Aerospace Engineering	1	5

4.3. Recruitment, Interviewing and Surveys

The recruitment process for this study was based on being admitted to the Scholarship in Science, Technology, Engineering, and Mathematics (S-STEM) program. To participate in the S-STEM program, there were three main requirements that students needed to be part of. Those requirements included that students must be a: 1) transfer student, 2) low-income student and 3) an engineering major. The initial recruitment process for the S-STEM program included emails sent to incoming engineering transfer students who had recently been admitted and had met the criteria. Using the three requirements as a filter, the research team pre-selected those students. An invitation to attend an information session about the S-STEM Program was sent via email to the pre-selected students.

Each application was reviewed by a committee. During the reviewing process, weekly meetings were held to discuss students' applications, supplemental material, and provide updates about the program. During the meetings, updates were given about the number of participants and the different strategies to be implemented for the recruitment process. The director and co-director of the program and two graduate researchers attended each meeting.

4.3.1. Surveys

Surveys were administered twice during the ten-week 2019 fall quarter. The first survey was implemented during week one and the second survey was implemented during week eight. Participants were emailed an online survey (Instrument 1) with instructions to complete it by the end of week one. For the second survey (Instrument 2) was emailed to participants at the beginning of week eight with instructions to be completed by the beginning of week nine. Both surveys were administered in consideration to course management and to avoid mid-terms and final exams. Additionally, participants were informed that their participation was voluntary and that all personal information would be kept completely confidential.

In this study, the survey questions used were anchored on a 5-point scale. Within this scale participants were asked to rate the likelihood to engage in a particular task from “1-not at all” to “5-extremely” and a 100-point scale by using a slider from “1-a little” to “100-a lot.”

4.3.2. Semi-Structured Interviews

At the end of the 2019 fall quarter, in-person interviews were administered at an on-campus conference room or over the phone for the twenty participants. All interviews were recorded and transcribed by a third party. A semi-structured interview was used, as it could provide the flexibility to combine a pre-determined set of open-ended questions (questions that prompt discussion). These questions provided the opportunity to explore themes or responses further, as participants shared their experiences in their terms. The semi-structured interviews ranged from 20 to 30 minutes in length. Before the recording of each interview, the interviewer read the Institutional Research Board (IRB) protocol consent form. The interviewer also explained the purpose of the study to each participant and their rights as a human research participant. The first prompt of each interview was requesting consent from the interviewees to participate in the interview. After obtaining consent, the conversation was followed by the pre-determined set of questions. If any of the questions were found to be inconclusive, follow-up questions were asked. For instance, some of those questions were: “Tell me more about that” or “Can you give me an example of that?” or “How did you experience this moment?” These follow-up questions were designed to encourage elaboration. Additionally, each recording was heard after the interview to ensure clarity.

The data collected was stored on a password-protected personal computer. The recorded audio and transcribed interviews were stored in a drive only accessible to the research team. The confidentiality of the participants was preserved throughout the data collection and analysis by utilizing a self-selected pseudonym for each participant. The mapping of the participants' real names and self-selected pseudonyms were stored in a password protected file and a password-protected computer.

4.4. Researcher Bias & Positionality

In this study, the researcher's role was to collect and analyze the data. The researcher focused on understanding the data and utilize inductive research processes to code the data obtained from the students' experiences. The researcher is a Mechanical and Aerospace Engineer and a Master of Science Student from the University of California, Irvine. The researcher's interest in engineering education was based on the researcher's own experience of being a low-income, attended a two-year community college, and transfer to a four-year institution. More specifically, the researcher was influenced by his struggles that low-income engineering transfer students continue to face in and outside of the classroom. Being part of this research study, enabled the researcher to explore similar stories of low-income engineering transfer students. Ultimately, the researcher hoped to shed light on the motivational factors that low-income engineering transfer students experience as the driving mechanism(s) that lead them to choose and pursue an engineering degree.

4.5. Overview of Semi-Structured Interviews

Qualitative data was obtained from each semi-structured interview, collected at the end of the 2019 fall quarter. Following Institutional Review Board (IRB) protocol, before the study engaged in interviews, participants were asked to consent for this study and if they had any questions, they were able to contact the research team and the IRB office by phone or email. The interviews followed a written outline that guided how to conduct the recorded interviews. The recorded interviews were heard for clarity, which was later transcribed verbatim. Each recorded interview was analyzed separately while being heard for clarity and after being transcribed for keywords and phrases before looking across all cases for themes and patterns. The analysis consisted of a three-category strategy. The strategy included: a) case-oriented, b) variable-oriented, variables across cases, c) mixed strategies, using a combination of both [4], [104]. Each recorded interview was separately heard for unique words or phrases, then compared to the others to identify the key terms that were found among participants. Mixed strategies were implemented when a theme was discovered but explained differently. All phrases were compared to other phrases or themes to reassess the classification of its code.

A three category of data analysis strategy identified trends in messages as well as explored the content in which the messages changed. To analyze the data and code development, the study implemented a mixed strategy. The mixed strategy gave the same level of importance to each of twenty individual cases, the eight constructs from expectancy-value theory (EVT), engineering identity (EI), and sense of belonging. Further, results were presented with variable-oriented assertions that evolved around the three categories of EVT and EI and sense of belonging. The variables related to EVT were competence, interest, attainment, and utility. For

EI the variables were interest, recognition, and performance. A sense of belonging was used as its variable.

The coding process started with a case-based approach where interviews were heard repeatedly. Key terms that were mentioned repeatedly or were unique were written down. The codes were developed inductively from the recordings and referenced the constructs of EVT, EI, and sense of belonging. The initial set of codes were categorized by its uniqueness, resemblance to the constructs, and others were developed by their repetition. After being transcribed, interviews were read repeatedly and then coded using DEDOOSE. Initially, a list of codes and themes were developed before inputting them into the software. After inputting the transcribed documents into the software, new themes emerged and were added to the list. Code overlapping was identified and addressed by writing short memos and placing them under a general category. A finalized list of codes by comparing all categories and sub-categories from all twenty interviews was created to maintain the consistency across cases.

4.6. Study Analysis

All low-income engineering transfer student’s shared experiences and the data collected from the surveys were analyzed via Excel, R programming language, and the DEDOOSE Software. The software is a cross-platform app use for analyzing qualitative and mixed methods research with text and audio. R programming language is used for statistical and graphical analysis.

This study used quantitative methods to explore topics in engineering. Quantitative methods were used as they “are a good fit for deductive approaches, in which a theory or hypothesis justifies the variables, the purpose statement, and the direction of the narrowly defined research questions" [105]. In this study, quantitative research was used to quantify the numerical data as well as the data that could be transformed into usable statistics. One quantitative method used in this study was in the form of an online survey.

The survey data was analyzed via Excel and R programming language. To meaningfully compare whether the two means were different, the sampling distribution of paired difference means needed to be known. Additionally, a normality test was used to determine if the dataset was well-modeled by a normal distribution. According to the Central Limit Theorem, the distribution of sample means for an independent, random variable, will become closer and closer to a normal distribution as the size of the sample increases, even if the original population distribution is not normal itself.

If the data showed an abnormality, a Wilcoxon signed-rank test was to be used. The Wilcoxon signed-rank test was used as a non-parametric statistical hypothesis test to compare the two related mean samples. The Wilcoxon test is used to analyze related samples, matched samples, or repeated measurements on a single sample to assess whether their population means ranks differ. To test for a significant difference between the pre- and post-surveys, results were evaluated under the following P-value categories, and a 95 percent confidence interval:

a) $\alpha = 0.05$
b) $P \leq \alpha$ means that the test hypothesis is false or should be rejected
c) $P > \alpha$ is the probability that the null hypothesis is true, should not be rejected

4.7. Summary

This chapter introduced the research questions to capture key motivational factors that led low-income engineering transfer students to choose and continue to pursue engineering degree attainment. Twenty participants were chosen for this study. Out of the twenty participants, 12 of them were first-year low-income engineering transfer students and 8 of them were second-year low-income engineering transfer students. Additionally, four participants were female, and 16 participants were male. Data gathering consisted of two surveys and a semi-structured interview. Surveys were conducted at the beginning and towards the end of the fall quarter. The semi-structured interview was conducted at the end of the fall quarter. The design component for this study was a mixed research method approach using grounded theory and exploratory analysis. Data collection and review procedures were analyzed to effectively interview low-income engineering transfer students and ensure the validity and confidentiality of the data. Data analysis was performed using the DEDOOSE software and R programming language. All interviews and surveys were conducted with full participants' consent.

5. FINDINGS

Mixed-method research was used to gather the data from low-income engineering transfer students shared experiences. Based on the shared experiences a grounded theory and exploratory analysis approach were used to answer the three fundamental questions asked in this study. The three research questions that were asked are answered in the quantitative and qualitative results.

5.1. Quantitative Results

Quantitative results enabled the study to ascertain the specific effects on students' expectancy of success, value beliefs, engineering identity, and sense of belonging as they experienced their first quarter at a four-year institution. It should be noted that following the Central Limit Theorem, the distribution of sample means for an independent, random variable, will become closer and closer to a normal distribution as the size of the sample increases, even if the original population distribution isn't normal itself. In this study, the sample size was considered a small sample, therefore a normal distribution cannot be assumed.

The study sought to identify how participants' motivation, engineering identity and sense of belonging changed over the first quarter. To determine if the participants' motivation did in fact change over the fall quarter, the means of the pre-and post-surveys for all participants were compared and calculated. Further, the paired mean difference of each construct was calculated. The paired mean differences for each construct, are shown in Table 4. Furthermore, the means were identified for each participant as they were considered independent from one another.

Table 4: Paired Mean Difference for All Participants

ID	Competence (EVT)	Attainment (EVT)	Interest (EVT)	Utility (EVT)	Recognition (EI)	Interest (EI)	Performance (EI)	Sense of Belonging
P1	-0.33	0.17	0.33	5.63	1.50	0.50	0.50	0.44
P2	0.67	0.33	0.33	1.00	5.25	0.00	0.50	0.00
P3	-1.00	-0.50	-12.00	-7.13	-5.25	-0.50	-2.00	-0.67
P4	-0.33	0.00	0.00	-3.25	-0.25	0.00	0.50	0.56
P5	-1.00	0.67	-12.00	4.13	-8.63	0.00	1.00	0.11
P6	-0.33	0.50	1.00	5.50	0.13	-1.25	0.00	-0.78
P7	-0.33	-0.17	1.67	-2.75	-1.00	0.00	-1.00	-0.11
P8	-0.33	-0.17	-25.67	-22.38	-6.63	0.50	0.50	-0.33
P9	2.33	0.00	0.00	0.00	6.25	0.00	1.00	0.22
P10	-1.33	-0.50	10.00	-5.88	-0.75	-0.50	1.00	-0.33
P11	0.67	0.00	-2.33	-2.13	-0.75	0.75	0.50	0.22
P12	-1.00	-0.50	3.33	-4.25	0.25	0.50	0.50	0.22
P13	-0.33	0.67	3.33	0.00	5.63	0.50	-0.50	-0.22
P14	0.33	-1.33	1.00	-0.88	-0.25	-1.75	-1.00	-0.78
P15	0.67	0.50	9.67	12.00	-2.75	0.00	1.50	0.00
P16	1.67	1.50	13.33	4.00	-6.13	1.25	-0.50	0.33
P17	0.00	-0.17	10.00	3.13	1.13	0.25	0.50	-0.22
P18	0.33	0.17	26.67	18.75	5.13	0.50	1.00	0.00
P19	0.00	0.33	-8.33	-13.88	-7.75	1.00	0.00	-0.44
P20	-0.67	0.00	-8.00	0.63	-4.00	0.00	0.00	-0.22

Excel was used to analyze data normality, which showed the data of each construct as being of skewness, kurtosis, or bi-modal shape (see Fig. 3). This meant that the data did not follow the normal bell curve shape.

A nonparametric test was used to analyze the data because of data abnormality. Using a **Wilcoxon** test in this study, concluded that the observed differences were not statistically significant between the pre- and post-survey paired means.

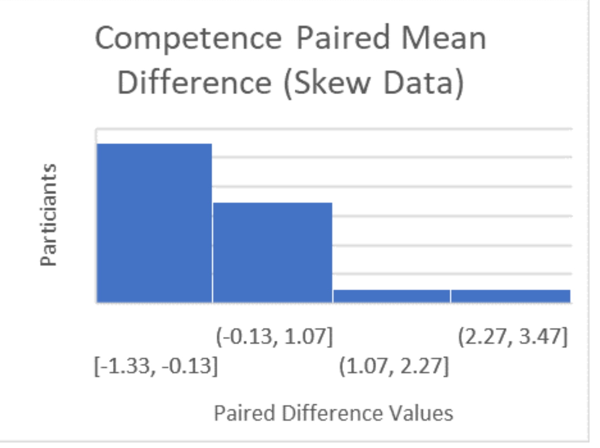

Figure 3: Competence Paired Difference (Skewed Data)

Results from the nonparametric test showed P-values, for each category, above the 0.05 alpha criteria, shown in Table 5. Most of the P-values are within the tenth-place value which is not enough to reject the null hypothesis.

Table 5: Wilcoxon Non-Parametric Test Results

ID	*Competence (EVT)*	*Interest (EVT)*	*Attainment Value (EVT)*	*Utility Value (EVT)*	*Interest (EI)*	*Recognition (EI)*	*Performance (EI)*	*Sense of Belonging*
P-Value	*0.76*	*0.53*	*0.47*	*0.95*	*0.39*	*0.32*	*0.24*	*0.21*

The study was also able to answer the three fundamental questions by using the mean average of the pre- and post-survey and paired mean differences from all the participants for each construct (see Table 6). It must be noted that values were normalized for utility value, recognition, and sense of belonging questions by using a scale from 0 to 100.

Table 6: Mean Averages of All Participants for Each Construct

ID	Competence (EVT)	Interest (EVT)	Attainment Value (EVT)	Utility Value (EVT)	Interest (EI)	Recognition (EI)	Performance (EI)	Sense of Belonging
Pre-Survey Average Mean	3.78	3.02	4.3	3.25	4.44	3.20	4.08	3.98
Post-Survey Average Mean	3.76	3.12	4.4	3.19	4.56	2.78	4.28	3.88
Paired Difference Average Mean	0.02	0.10	0.08	-0.06	0.12	-0.42	0.2	-0.10

5.1.1. Why Do Low-Income Transfer Students Choose Engineering?

To answer this question, the study relied mostly on the pre-survey, as student's enrollment in an engineering program was decided before their enrollment at a four-year institution. Additionally, based on the calculated mean values of each construct from the pre-survey, the most significant results for choosing engineering as a major were from the attainment value (EVT), interest (EI), performance (EI), and sense of belonging constructs. However, the other constructs identified in the survey analysis are also significant. This is evident as the participants responded with values equal or higher than a three on the anchored 5-point scale. Such values indicate that participants chose engineering because of their expectancy to succeed, subjective task values, engineering identity, and felt a sense of belonging as a future engineer.

5.1.2. Why Do Low-Income Transfer Students Continue to Pursue Engineering?

To answer question number two, this study analyzed the paired difference average mean of each construct. Participants indicated a positive increase of competence (EVT), attainment value (EVT), utility value (EVT), and interest (EI). Which in turn indicates that participants were influenced by the role students had taken as engineers, seeking research or internship opportunities, hands-on experiences where students were able to apply theory into the concept, and the attraction of working for large corporations or just the fact of seeing themselves as a future engineer. Furthermore, as participants had already taken the role of an engineering student at a four-year university and identifying themselves as engineers, made them more prone to continue pursuing an engineering degree. These participants had taken additional responsibilities as an engineering student and developed a certain level of importance.

Additionally, the remaining constructs were not significantly different. Therefore, the remaining constructs are still considered a key identifier of students' motivation to continue to pursue engineering. Ultimately, talented low-income engineering transfer students continued to pursue engineering because of their expectancy to succeed, subjective task values, engineering identity, and felt a sense of belonging as a future engineer.

5.1.3. When Do Low-Income Transfer Students Believe That They Are Engineers?

Question number three was answered via the pre- and post-survey and the paired difference mean average difference. Participants indicated a paired mean average value for the pre-survey and a 2.78 for the post-survey under the construct of recognition. This indicates that participants felt like engineers to some extent or in the process. Additionally, this illustrates that participants were aware of what an engineer is, yet participants did not have specific details of what engineers do. For example, engineering is known as a technical career but to what level of problem-solving and mathematics skills are needed. The average mean paired difference of the construct was analyzed and showed a decrease. The decrease was due to the participants' lack of confidence or challenges encountered during their course trajectory in engineering. The construct difference also displayed the uncertainty that participants did not yet feel like engineers. Furthermore, the participants might have been demonstrating characters associated with Imposter Syndrome. Despite their accomplishments in engineering, their responses showed a decrease in recognition which illustrates the fact that they might be considering themselves as engineers in progress.

5.2. Qualitative Results

In conjunction with the survey data, twenty interviews were analyzed using content analysis for their entries [106]. A priori and deductive coding scheme were used with an initial category titled “choosing” and “pursuing.” The study used constructs from the EVT and EI models and a sense of belonging to categorize the first domain area. Each interview was analyzed in the form of text data. After all, interviews were analyzed, additional codes emerged, and classified into a second domain area (see Table 7).

Table 7: Codes and Themes Summary

1st Domain Area	***2nd Domain Area***
Competence Belief	*Intellectual Development*
Attainment Value	*Social Persuasion*
Interest (EVT)	*Mastery Experience*
Utility Value	*Attention to Human Ethical values*
Recognition	*Personal Integrity*
Interest (EI)	*Achieving Inner Satisfaction*
Performance	
Sense of Belonging	

Constructs of the models helped validate and establish that the results provided enough evidence to answer the research questions. The second domain was categorized as to how participants perceived choosing and pursuing engineering degree attainment from the student's perspective. It was developed to explain the student's motivation to pursue engineering from the students' perspective. Each category of the second domain reflected a more general area of personal importance that students felt motivated to engage in the task that led to choosing and pursuing engineering.

For both domains, the themes and codes were categorized based on the extracted quotes following the participants' experiences that influenced their motivation to choose and pursue an engineering degree.

5.2.1. Constructs

5.2.1.1. The expectancy of Success (Competence, EVT)

The expectancy of success is defined as individuals' beliefs as to how well they will do in a task [54]. In this study, the expectancy of success was identified when participants gave responses to the semi-structured interview questions in a form of a) achievement (making things possible, completing a task and overcoming barriers), b) preparedness (prepared for a certain task enabled them to excel), c) being good at math and science (being good in a certain subject is a requirement to become an engineer), and d) success as an engineer (understand and be able to apply engineering concepts). Among other themes, math and science were identified as being essential to be a successful engineer and in choosing and pursuing engineering.

Table 8: Results for Competence Related Items

Constructs	Sub-Code	Example
Competence (EVT)	Successful engineer	"the person that uses several tools from different science fields like math, physics, chemistry, etcetera, with the goal or objective to apply it in many different fields"
		"Working with my team and throwing ideas and the whole system of the project was done for engineers"
	Preparedness	"If you want to make a good life then you have to follow what's going on in the world"
		"If we're not focusing just on the job and industry, then yes. So, because I see myself in this way and I see myself that I'm going to like to become a really good engineer in the future."
	Good at Math and Science	"I kind of mastered about math, but besides math, I won the chemistry that makes them make me go in this major instead of the other major."
		"I used to be a little bit better at math than most other students. So, I thought that would be more fun than just reading or whatnot."
	Achievement	"I chose engineering because I just wanted to prove to myself that I can be able to take the challenge and prove to myself that I can be good at math and engineering."
		"When I notice I'm doing better, it's kind of pushes me to do more. On the converse, sometimes it's either/or when I'm not doing good, sometimes I'll be motivated to do better next time."

Table 8 identifies significant quotes for the competence construct from the shared experiences of the participants. Furthermore, from the shared experiences, the study concluded that the participants perceived successful engineers as having the ability to apply engineering knowledge to real-world applications, contribute to society, create, and contribute to engineering projects. Additionally, preparedness was shown as a level of adaptation, ability to focus, and a long-term career. Being good at math and science was considered a need due to the engineering course work. Participants experienced the need to be good at math and science when they transitioned from a community college to a four-year institution. Additionally, participants expressed that being good at math and science was acquired at a young age, as well as throughout their academic journey. The achievement was expressed as a form of accomplishment, wanting to do better on future tasks, facing challenges, and being self-motivated to prove to be good at math and become an engineer.

5.2.1.2. Attainment Value (EVT)

Attainment value is the importance students attach to a task as it relates to the conception of their identity and ideals or their competence in a given domain [107]. This study identified attainment value when participants highlighted the importance of a) the need to care for others, b) engineering knowledge gain, c) engineering skills improvement, d) financial reward, and e) personal accomplishment (see Table 9).

Table 9: Results for Attainment Value (EVT) Related Items

Constructs	Sub-Code	Example
Attainment (EVT)	Care for Others	"So, the end goal that I just want to be an engineer helping others as what just makes me to just get through the engineering courses"
		"I feel like, as a woman and minority, it's important that I make become an engineer to show the younger generations that it's possible."
	Engineering Knowledge Gain	"What can you gain from engineering is a lot of things, but I think one of the most important things is the knowledge that you'll gain."
		"Sharing your knowledge in that constructive way is the most important thing about being an engineer."
	Engineering Skills Improvement	"I feel like you can gain a lot of skills if you work for them because I think becoming an engineer is what you make of it."
		"From engineering, I think I gain to be purposeful and wise, and have dedication and try for what I want to be."

	Financial Reward	"Seeing them make a better wage than what I was making was a motivation of me becoming an engineer."
		"Really the financials, that's a big thing. I know, just about any field in engineering pays very well."
	Personal Accomplishment	"I want to do it just because I know it's supposed to be hard. I can prove it to myself that I can do it."
		"I just wanted to prove to myself that I can be able to take the challenge and prove to myself that I can be good at math and engineering"

This study concluded that personal accomplishment was expressed as the ability to take upon challenges as an engineer and having the ability to thrive in engineering courses. Financial reward was expressed as a career in engineering could provide stability and a higher salary. Engineering skills improvement was seen as a form to develop problem-solving, analytical, design, technical, and intellectual skills to be used in real-world applications. Such skills could provide confidence and give the ability to explore engineering opportunities. Engineering knowledge was expressed as a gain, benefit, and productivity to share this knowledge at a later point. Care for others was expressed as the ability to care for family members, underrepresented groups, future generations, or society by following the path of an engineer.

5.2.1.3. Interest (EVT)

Interest from the EVT point of view is seen as the enjoyment of performing a task. Within this study, enjoyment of performing a certain task was shown when participants obtained a) engineering challenges, b) hands-on experience (research, internships, group projects), c) experienced problem-solving d) engineering courses and c) academic support (see Table 10).

Table 10: Results for Interest (EVT) Related Items

Constructs	Sub-Code	Example
Interest (EVT)	Engineering Challenges	"I like challenges. I feel like if I did something else, then I wouldn't be fully utilizing my potential"
		"I think the topics, even though the courses are really hard, they're really interesting"
	Hands-on Experience	"I knew I wanted to become an engineer when I was working in the profession field, and in an industry where there's a lot of engineers."
		Like having something that you made, actually being able to hold it in your hands, that kind of motivates you to continue with engineering for me."
	Problem Solving	"That I'm good at problem-solving. I've always liked doing just problem-solving stuff."
		"Getting straight A's might be a good thing, but I think success really comes from for me at least, just being happy with what you're doing, being content."
	Engineering Courses	"I chose engineering because I really like the subject."
		"As an engineer, in many of my classes that I've already taken, I noticed that there's lots of critical thinking problems, and honestly, I enjoy things that challenge me."
	Academic Support	"Then I would say the library for sure, and then the computer rooms that we have. Those kinds of resources I really enjoy."
		"And then at the university, there's a lot of programs there where they teach you a lot about what engineering is, and about the clubs.

The study concluded that participants expressed enjoyment when facing challenges within engineering courses and projects were identified as being similar to real-world applications. Furthermore, enjoyment was expressed when participants received hands-on experiences. The hands-on experience was described as internship or research opportunities. It included workforce exposure, design, manufacturing, tinkering, and applied theory to real-world applications. Additionally, participants expressed problem-solving opportunities as a form of interest or enjoyment. While performing a task, participants expressed being satisfied with the results when they showed a certain level of academic success and problem-solving skills. Participants showed interest when enrolled in engineering courses where they were exposed to the material subject. Moreover, participants enjoyed challenges that led to expanding their engineering toolbox. Outside of engineering academics, there were numerous organizations and resources on campus that encouraged engineering student's involvement. Participants felt a sense of enjoyment while studying in lab spaces, joining engineering organizations, networking among other engineering students from different engineering majors, and having academic support when needed.

5.2.1.4. Utility Value (EVT)

In this study utility value referred to the perceived usefulness of engaging in a task. Participants identified the utility value of engineering as being a useful tool. They also felt that being an engineer would allow them to give back to others. Further, participants expressed engineering as being useful in terms of developing or having the ability to create (see Table 11).

Table 11: Results for Utility (EVT) Related Items

Constructs	**Sub-Code**	**Example**
Utility (EVT)	Usefulness	"create products" or "build the right products"
		"problem solve" or "obtain a stable job"
		"a way to gain knowledge" or "gain prestige"
	Give Back to Others	"The feelings that you get from giving back to others by making the products that they are in need of."
		"Well, helping people, making things a little better in the world."
		I chose biomedical engineering was that I was into both, in engineering and medical, and more helping the humans and the world making it a little better."

In this study, participants expressed engineering as being useful for participants to manufacture or implement their ideas. Many participants expressed an interest to develop products that could benefit society. Participants also shared that engineering would provide a stable job, expand their knowledge, or gain them recognition. Furthermore, participants expressed the usefulness of engineering when they were engaged in engineering projects, research opportunities, and internships. Engineering was expressed as being able to give back to others by making the world a better place or by solving a problem that affected their communities. Ultimately, participants expressed enjoyment when making useful products and sharing their engineering knowledge with others.

Engineering identity results consist of interest, recognition, and performance. Furthermore, the results evaluated the individuals' experiences to categorize their level of engineering identity when feeling like an engineer, performing like an engineer, or being recognized as an engineer.

5.2.1.5. Interest (EI)

Interest was characterized as the attraction towards engineering as well as a formal understanding of it. Participants expressed attraction towards engineering as a career choice, early interest, faculty influence & support, family influence & support, previous engineering exposure, or role models (see Table 12).

Table 12: Results for Interest (EI) Related Items

Constructs	Sub-Code	Example
Interest (EI)	Career Choice	"So, my career goal is to work for an Aerospace company, doing modeling and simulations"

		"I know that with engineering, you can market yourself in many different fields, pretty much."
	Early Interest	I had this inkling that I would be somebody to build something in the future."
		"When I was a kid, I would see the TV remote, and just break it apart and see what's inside and just put it back in."
	Faculty Influence & Support	I met a lot of engineering professors, and that really also helped me to be on that way, and make sure that I'm in the right path."
		"Well, every professor that I met so far, they really had a really good influence on me, and they really helped me from the beginning when I was in college."
	Family Influence & Support	"You know, what motivates me for engineering is similar to what motivates me for school. I would say it's my family."
		I want a stable job that I can help provide, I hope, provide my parents later on."
	Previous Engineering Exposure	"I do have a family friend that is a professional engineer that has shown me a little bit about what it's like to be an engineer"
		"Honestly, since I was a kid, I always knew I wanted to do engineering because I was very involved in it."
	Role Models	"My motivation I think mainly comes from the people before me, such as Elon Musk and Leonardo da Vinci and the people with great minds,"
		"Professor, Dr. Alex Sim. He used to work for NASA and then he retired and now he just does science projects from NASA."

Interest in engineering was expressed as a career choice. Some examples that participants shared were to work for an aerospace company, have a stable job, or become a business owner. Participants indicated attraction towards engineering as an early interest. The early interest ranged from as early as childhood or halfway through community college. Additionally, participants indicated that they later realized that tinkering with electronic equipment, playing with Legos, or building something was closely related to engineering. Other participants indicated their interest in engineering with wanting to attend a STEM event or wanting to join an engineering club because it seemed interesting. Previous exposure contributed to the participants' interest in engineering. Exposure was obtained via engineers who already worked in the field. Some examples of exposure to the engineering field were a tour of an engineering facility, real-life experiences with an engineer, or involvement with engineering at a young age. Some participants indicated that interest in engineering was not directly influenced by attraction or material subject. Participants indicated attraction towards engineering due to what it could provide and by its ability to provide financial relief to family members. Participants mainly expressed engineering as being a way to provide parental support and financial relief. Another form of interest was in the form of faculty and role models who encouraged participants to seek an engineering major. Furthermore, the faculty acted as a form of guidance when participants showed a certain level of academic performance. This resulted in faculty asking participants to enroll in engineering courses or provided guidance and support towards the path of engineering. Other participants sought engineering because they admired previous accomplishments and achievements from great scientists, mathematicians, and physicists.

5.2.1.6. Recognition (EI)

In this study, recognition was defined as a form of being recognized by others, which was needed for the participants' self-engineering identity development. Participants expressed recognition as a) self-recognition, engineering in progress or not yet, and b) recognized by others, among peers, professors, and professionals. The recognition occurred when participants were participating in engineering projects, research exposure, internship opportunities, or had joined the engineering workforce (see Table 13).

Table 13: Results for Recognition (EI) Related Items

Constructs	Sub-Code	Example
Recognition (EI)	Self-Recognition: In Progress	"Engineer in training and training because I mean I don't have my degree yet."
		"I assumed that from the point from now until me getting my degrees, two years and two quarters"
	Recognized by Others	"I think the most times that people view me as an engineer is where they actually see my project in person."
		"if you come up with a solution, you have to be able to present it to other people to make them agree with you."
	Recognized by Peers	"I'm really good and I take the lead and they really follow what I say, and they understand that I know what I'm doing."
		"Many times, I've tried to take the lead of many projects and what not. I've seen people really look up to me. Even my peers, people that have higher grades."
	Recognized by Professors	"For example, with my research professor, he's really nice and he really makes it feel like he respects me"
	Project, Internship & Research Participations	"Yes, I do. I would say so. Some of the projects I work on if I would've not gone to school, or haven't studied any engineering."
		"When I'm sharing a project that I worked on or a design or anything that shows this person is like on engineering path."

Recognition was expressed as self-recognition when participants identified themselves as engineers. Most participants indicated that they were engineers in progress. Also, many participants felt that to feel like an engineer or call themselves an engineer, an engineering degree was necessary. Yet, other participants indicated that even after degree attainment they might not be able to call themselves engineers. Apart from self-recognition, participants indicated the need to be recognized by others, including professors and peers to consider themselves engineers was significant. Recognition by professors was expressed when participants were involved in research opportunities. These opportunities allowed the participants to experience a certain level of respect and satisfaction. Additionally, recognition by others was acknowledged when participants were asked about their major. When responding “engineering,” participants felt a sense of pride when they were told that they must be very smart to be studying engineering. Lastly, peer recognition was expressed by participants as working on course projects or just by being part of an engineering community.

5.2.1.7. Performance (EI)

Performance was defined as the participants’ belief in being competent and be able to perform effectively in engineering. Participants expressed performance as a personal characteristic. Such characteristics consisted of developing engineering skills, becoming hardworking, and self-evaluation on personal performance (see Table 14).

Table 14: Results for Performance (EI) Related Items

Constructs	Sub-Code	Example
Performance (EI)	Engineering Skills	“An engineer is a person who can think about a problem and try to solve it in a scientific way with math, physics, or programming for different ways, to solve a problem”
		“So, I would say I'm an engineer in one way because I'm able to solve those kinds of rough problems based on what I learned.
	Hardworking Skills	“Sometimes he got higher than me, a higher grade than me, and then I have to put me study more and more to get higher, and so that's where.”
		“The fact that I spent hours and nights and completely study until I... My sacrifices being rewarded I think contributed to me continuing this path of these courses.”
	Self-Evaluation	“So, of course, I have more knowledge about engineer than them. And then some problem that I learn in class, they don't have.”

		"I know for myself my grades are not my strongest skill." And "but that theory, the knowledge, understanding is much greater the concepts."

Participants expressed their belief of being competent and capable to perform effectively in engineering required problem solving, creativity, and communication skills. Being hardworking was an additional important engineering characteristic needed to encounter difficult tasks and challenges. Additionally, there were levels of competitiveness among engineering students. Participants expressed the need to work harder when their academic performance was low and the need to overcome certain challenges. When encountering a challenge or a difficult task, participants performed a self-evaluation. The self-evaluation would help the participant identify what was required to complete the task. If academic performance did not reach a high level of performance, participants were aware that they needed to make improvements. Additionally, participants experienced a negative performance when participants in group project settings or when they were excluded from certain activities.

5.2.1.8. Sense of Belonging

A sense of belonging was noted by participants as attaining comfort by asking questions during lecture, seeking assistance, faculty-to-student and peer interaction, and university community inclusion (see Table 15).

Table 15: Results for Sense of Belonging Related Items

Constructs	Sub-Code	Example
Sense of Belonging	Comfortable Asking Questions	"Yeah, in class whenever there's the opportunity to raise my hand, and I would write down questions or approach the professor after class to ask questions"

		"in general, like I'm really confident like if I have a question, I can approach somebody and ask them."
	Comfortable Seeking Assistance	"No, I feel like the resources were there. I think I can just go and get it, like take advantage of it."
		"If I wanted to talk to someone, I need someone I'll definitely go out and be like, "Hey, I need this."
	Peer Interaction	"I know a lot of my peers have already taken the courses so I can ask them for help, ask them for advice."
		"Connected to my friends. I know that for sure. Usually, if they're my peer, they'll become my friend."
	Faculty-to-Student Interaction	"I am extremely comfortable, and I am aware that I can reach out to them in their office hours and talk to them about concerns."
		"So, I feel like there's easy communication between the faculty and student."
	University Inclusion	"I think it's very supportive with the engineering community. Because everyone's experiencing the same courses and stuff, so they're very understanding and they're very helpful"
		"Being involved in the community, through a resource like UC LEADS I was able to meet very numerous influential individuals"

Participants expressed having acquired a sense of belonging when they felt comfortable asking questions during a lecture or after class. Participants were not hesitant to raise their hands during the lecture or attend office hours to ask questions. Furthermore, students felt comfortable reaching out to professors and teaching assistants (TAs) via email to inquire about a homework problem or exam question. Additionally, seeking assistance among peers or outside the engineering community was not uncommon. Participants indicated feeling comfortable seeking out tutoring or mentoring assistance or emailing counselors with academic plan questions. Faculty-to-student interaction was not uncommon among participants, especially when a faculty mentor was assigned to a participant. Overall, a friendly environment was expressed as being part of the university community. Participants felt that other students were welcoming and friendly. If needed, participants felt comfortable asking questions and making friends among students from different engineering departments.

5.2.2. Domain Areas

The most repeated themes are shown in Table 16. These themes were identified as the most repeated motivational factors that led low-income engineering transfer students to choose and continue to pursue engineering degree attainment.

Table 16: Second Domain Area from the Participant's Perception

Domain Area	***Code / Theme***
Intellectual Development	*Engineering knowledge*
Social Persuasion	*Faculty and Peer Influence*
Mastery Experience	*Internship and Research Experience*
Attention to Human Ethical values	*Family Values and Community Support*
Personal Integrity	*Hardworking, Honesty, and Dedication*
Achieving Inner Satisfaction	*Early Interest, and Personal Goals*

From the student's perspective aside from a career choice, themes and codes were developed to formulate a generalized domain area where participants expressed motivation to choose and pursue engineering.

5.2.2.1. Intellectual Development

Participants reflected that gaining knowledge motivated them to choose and pursue engineering. Knowledge in engineering was found to be crucial as participants felt that engineering is learned. Additionally, knowledge was an intricate process that required discipline and understanding of real-life applications. A participant described it as:

> "No one's born knowing how to do engineering or any of these difficult courses, but one has to have the discipline to sit down and learn everything and this isn't very easy stuff. It's very easy to just give up on it or just learn half of it or learn as much as you need to pass. To actually understand the subjects and apply it in the real world you have to really have the discipline to understand the theory and not just the problems and how to apply to understand how everything's implemented together."

Another participant seemed to be fascinated by knowledge and described it as:

> "I'm a really big fan of knowledge and knowing science and how to apply technology in the field."

Technology advancement was something participants addressed and saw opportunities along with it. Its importance was explained as:

> "I chose engineering because I figured that with the technological advances that we're experiencing and stuff like that, I just feel like it's just a booming field and there's just a lot of opportunities there."

5.2.2.2. Social Persuasion

Faculty and peer interaction were among the most common themes of motivation to choose and pursue engineering. Faculty interaction was described as a supportive and inspiring aspect. Participants expressed their interest based on how professors provided support, answered questions, and showed passion about the subject. Additionally, peer influence played an important role when participants lacked confidence, needed assistance with course material, or provided a sense of inclusion. Faculty support was acknowledged to be a motivational factor, especially when participants were seeking support and were able to get questions answered regarding the subject material. In addition to faculty, teaching assistants also influenced participants' motivation. A participant described it as:

> "the professor, even though he had 30 to 40 students in his office hours, he made sure to stay like eight, 10 hours every time we had a midterm. The day before the midterm, he would always stay eight to ten hours, which I thought was really… said a lot about how much he cares about his students. The teaching assistants (TAs) were really, for the class specially, they were really supportive and always made sure that we understood the problem before going ahead."

Faculty support in a classroom environment and the teaching methodology was inspiring when professors showed a level of passion about the subject which in turned motivated students to seek future enrollment in upper-division engineering courses. One participant described it as:

> "I would love to take their master classes, but at this point I already have enough on my plate. But I am really considering retaking some of the professors, they are really good. Some of them are really inspiring"

Participants who were surrounded by others with similar interests in engineering. Those that provided support to the participants contributed to their motivation. Student support in the field of engineering was obtained when participants found classmates to study, collaborate on assignments, and group projects with. The support was also moral. Participants highlighted the importance of being surrounded by smart individuals who were encouraging. One of the participants stated:

> "The people I am surrounded by, they're always pushing me when I feel down. They're always reassuring me that I'm actually smart and that I would make a good engineer"

Participants described their motivation as a great accomplishment to society. Furthermore, participants portrayed role models as an influential factor, if someone else did it, I can do it, by describing it as:

> "My motivation I think mainly comes from the people before me, such as Elon Musk and Leonardo da Vinci and the people with great minds, because they've pursued this path and they did great things, and that motivates me to become like them."

5.2.2.3. Mastery Experience

Participants recognized that a research or internship opportunity in real-world applications would help them thrive in engineering. Participants found value in hands-on experience. Having hands-on experience consisted of course projects, conducting research, and internship opportunities within the field of engineering. It would allow them to build confidence and slowly progress into becoming an engineer. Many described that they were engineers in progress and that it would take some sort of engineering experience or participation in a real-world project to be fully considered an engineer. A participant explained his research experience as:

> "I was able to work along with a professor who worked in the industry before and also I worked along Ph.D. students who also worked in the industry before… So, I basically

worked with engineers, and I was able to get their response that I was successful in my work"

Furthermore, participants shared that as their engineering experiences continued in forms of networking, collaboration, and challenging tasks they began to realize some of the required engineering skills need, these skills included patience and critical thinking. A participant described such requirements as:

"Yeah, you gain a lot of things by meeting a lot of people, because engineering requires a lot of group work and teamwork. You are going to go through a lot of obstacles and that's going to require a lot of patience, so you are going to definitely develop a lot of patience and critical thinking along the way."

Most of the participants recognized that they were not considered engineers, but the participants defined themselves as an engineer in progress. One participant described it as:

"But I am a work in progress obviously, we're not engineer yet, we don't have a degree. But I definitely consider myself to be a thinker in the way of engineering"

5.2.2.4. Personal Integrity

Motivation in engineering varied from participants. Some participants were motivated in engineering due to personal or financial gain. While other participants expressed their motivation towards engineering as honesty, personal integrity, possible failure, hardworking and it was just meant for them to be engineers. A participant addressed their motivation as a form of personal core values. This participant was not afraid of failure and was proud of what he had accomplished. He expressed his accomplishment as:

> "Honesty and integrity are probably the biggest ones because even though I did poorly, I think I'm still proud of what I did and how far I've come, and I'm never embarrassed to say that I failed, and a lot of engineers do fail while they're in school."

Another participant encompassed motivation as an event that was meant for him to embrace, the participant expressed it as:

> "I felt like it fit with me, for sure. Like I said, I like to work with my hands. I like to create things, solve problems, this felt like it was for me."

Other participants described their motivation based on the time and work they had already applied to accomplish the task. A student expressed it as:

> "Hardworking, just dedication, mentally strong too. A lot of these tests are stressful, to say the least. If you break under stress or pressure very easily, I don't think you will end up getting through the school"

5.2.2.5. Achieving Inner Satisfaction

Most participants in this study identified having an interest in engineering during their childhood, high school, or while in community college. Interest varied from tinkering, recognition, personal goals, prestige, career goals, or just being challenged. Their interest created satisfaction through a sense of accomplishment or a form of recognition. One participant described interest in engineering as originating from:

> "When I was a kid, I would see the TV remoter, and just break it apart and see what's inside and just put it back in. So that is an engineer to me"

Another participant described interest as being surrounded by other engineers during family gatherings and seeking to be like them. Engineering exposure influenced the participant to choose engineering as a major and view it as prestigious. The participant stated:

> "Well, when I was growing up, I was surrounded by a lot of friends. My family didn't really have any engineers, but friends of the family had engineers that I grew up with. And I was wanting to like to be like them, and you're always attracted by the money, but having the prestige and being able to call yourself an engineer is one of the things that really set aside and made me want to pursue the career"

Another participant described it more as a moment of accomplishment by explaining it as:

> "I felt like every time I overcome the challenge, I felt more accomplished when I accomplished something in, let's say, chemistry."

5.2.2.6 Attention to Human and Ethical Value

Family influence was the most important motivator among participants. An important aspect of motivation was highlighted when participants felt that they needed or had to support their family, provide higher living standards, or having been supported by their family to pursue higher education. Apart from upholding a tradition, most participants felt that they were in debt to their family. Participants shared that their parents did not have the financial resources to support their children through higher education but with the effort they did. Participants believed that they had to thrive in their academics, or the sacrifices of their families would be a form of failure and disappointment. In addition to family influence, other participants found diversity and lack of participation of underrepresented groups to be a motivator. This was especially evident for women in engineering. One participant shared that having family support to pursue higher education was about recognizing her family's sacrifices. He participant stated:

> "I will say for sure is my family because I know they put a lot of effort and they have been supporting me a long time."

Another participant described motivation as keeping a tradition in the family to continue to pursue an engineering degree. Keeping the family tradition was described as:

> "I primarily believe my motivation to pursue engineering is just how fun it is to create something new. It's been a big part of my family and I want to continue the tradition of engineering, and it's been more of a cultural thing in my case within my family."

The lack of underrepresented groups in engineering was seen when one of the participants stated that the lack of women in engineering was her motivator. While another participant shared that women engineers could equally perform. The participant described it as:

> "I think one the reasons that I really, really wanted to do it, obviously after all that I told you was that when I figured out there are not many girls in engineering, it makes me even more motivated to become an engineer. Because I think there shouldn't' be any difference. Because I think there should not be any different. No matter if you are men or women you can do all do the same thing. It does not matter. So, that was one of the reasons."

A participant described the financial aspect as their motivator. This participant shared how hard his mother had to work, increased his motivation, which in turn became his dream and aspiration to become an engineer. The participant expressed it as:

> "I guess the financial aspect really helps. Also, being able to support a family. Since especially coming from low income with a mother that works a lot, it definitely adds a lot of motivation to my dreams and aspirations to become an engineer."

Another participant expressed her decision to choose engineering by wanting to take care of an environmental issue that was affecting her community. She identified the problem and realized that engineering had a real-life application. At that time, the only possible way to solve that issue was to become an engineer and she stated by:

> "I want to become an engineer for a very long time ago when I was a little girl when my. The town with the very dirty river is because of manufactory. So, I want to become an engineer to solve that problem, and help people have a better health."

Based on the shared experiences, categorized as a 1st domain and second domain, provided significant evidence to answer the three fundamental research questions.

5.2.3. Why Do Low-Income Transfer Students Choose Engineering?

In the semi-structured interview, participants were asked to share why they chose engineering as a major? Results indicated that most of the participants chose engineering because of early interest, ability to care for others, engineering interest, or the benefits of engineering. Early interest included early childhood, high school, and early community college interest in engineering. Ability to care for others entailed family, community, and global influence. Engineering experiences involved exposure to the field, engineering challenges, engineering experience, creativity, being good at math and science, and innovation/technology. The benefits of engineering captured job opportunities, engineering knowledge, financial reward, and usefulness.

Students' responses provided noticeable trends that indicate when and why low-income engineering transfer students chose engineering as a major. A noticeable trend was shown when participants indicated choosing engineering due to an early interest. Early interest originated in early childhood and during high school. This trend illustrates that students' decision to choose engineering degree attainment was influenced mostly during adolescence. The participants shared that during their adolescence, family financial struggles or family health-related issues were the greatest motivators to pursue engineering. This trend was supported when students indicated that engineering would provide the means to support their family or address a global problem (i.e. alleviate financial hardships, finding a cure, or making products affordable). Furthermore, becoming an engineer would provide stability or solutions (i.e., job opportunities, usefulness, and bring financial reward). Lastly, engineering interest illustrated how their interest occurred during adolescence and not before. Interest was shown based on their level of involvement with an engineering-related task(s) or experience(s) (i.e., exposure to the field, engineering experience, engineering challenges, or being good at math and science) and not historical event(s) or engineering related subject (i.e. landing of the moon, time travel, back to the future, or energy efficiency).

Frequency counts and the number of participants for each category are shown in Table 17. It must be noted that the frequency counts and the number of participants offset is due to how the participants described that specific theme differently.

Table 17: Choosing Engineering Results (Frequency counts and number of Participants)

Category	***Theme***	***Frequency Count***	***N (%)***

Earlier Interest	*Early Childhood*	*7*	*6 (30%)*
	High School	*9*	*7 (35%)*
	Community College	*3*	*3 (15%)*
Ability to Care for Others	*Family*	*4*	*4 (20%)*
	Community	*2*	*2 (10%)*
	Global	*7*	*7 (35%)*
Engineering Interest	*Exposure to the Field*	*22*	*14 (70%)*
	Engineering Challenges	*7*	*6 (30%)*
	Engineering Experience	*10*	*7 (35%)*
	Creativity	*9*	*8 (40%)*
	Being Good at Math & Science	*9*	*7 (35%)*
	Innovation/Technology	*6*	*5 (25%)*
Benefits of Engineering	*Job Opportunities*	*8*	*6 (30%)*
	Engineering Knowledge	*7*	*6 (30%)*
	Financial Reward	*10*	*7 (35%)*
	Usefulness	*8*	*7 (35%)*

Out of all the categories, the most significant theme that led students to choose engineering as a major was exposure to the field expressed by 70% of all the participants. Exposure to the field was related to an early interest. One participant described it as:

> "I knew I wanted to become an engineer at a very young age, around seven or eight years old. My family takes me to a lot of engineering events within their companies and one of them is an engineer."

Based on the level of involvement a participant stated:

> "I wanted to do engineering because I was very involved in it."

Working in the engineering field, a participant decided to choose engineering due to exposure and realizing the difference in wages:

> "I wanted to become an engineer when I was working in the professional field, and in the industry where there's a lot of engineers. Seeing them make a better wage than what I was making was a motivation of me becoming an engineer."

Overall, participants expressed that engineering exposure, engineering involvement, attending an engineering event, or working in the field were the most significant factors that led participants to choose and pursue engineering.

5.2.4. Why Do Low-Income Transfer Students Continue to Pursue Engineering?

When participants were asked to share their experiences as to why they continued to pursue engineering, participants' responses were categorized by student support, engineering experiences, the engineering community, engineering interest, benefits of engineering, and individual integrity. Participants illustrated that one of the reasons they continue to pursue engineering is one of the main reasons they chose engineering, the benefits engineering can provide.

A noticeable trend is the importance of student support and engineering community, it highlights the need for student support from various sources to continue to pursue engineering.

Furthermore, engineering interest and engineering experience provided the necessary tools to embraced engineering. Moreover, initially, family struggles were seen as a burden but they became a motivational factor in the form of support and ambition to continue to pursue engineering. Lastly, a noticeable trend is shown by individual integrity where it illustrates the level of commitment to succeed in engineering. Pursuing engineering themes and frequency counts are shown in Table 18.

Table 18: Pursuing Engineering Frequency Count Results

Category	*Theme*	*Frequency Count*	*N (%)*
Student Support	*Academic*	*22*	*14 (70%)*
	Family	*31*	*17 (85%)*
	Mentorship	*15*	*10 (50%)*
Engineering Experience	*Engineering Challenges*	*23*	*13 (65%)*
	Engineering Courses	*32*	*13 (65%)*
	Group Projects	*8*	*6 (30%)*
	Research and Internships	*10*	*8 (40%)*
Engineering Community	*Peer Influence*	*30*	*16 (80%)*
	Faculty-to-Student Interaction	*38*	*16 (80%)*
	Inclusion	*12*	*8 (40%)*
Engineering Interest	*Exposure to the Field*	*12*	*9 (45%)*
	Being Good at Math & Science	*7*	*5 (25%)*
	Attraction towards engineering	*24*	*14 (70%)*
	Enjoyment	*22*	*12 (60%)*
Benefits of Engineering	*Job Opportunities*	*12*	*7 (35%)*
	Engineering Knowledge	*10*	*7 (35%)*
	Financial Reward	*16*	*10 (50%)*
	Usefulness	*13*	*8 (40%)*
Individual Integrity	*Self-Motivation*	*17*	*12 (60%)*
	Innovative	*5*	*5 (25%)*
	Hardworking	*11*	*8 (40%)*
	Ethical Values	*10*	*7 (35%)*
	Determination	*12*	*7 (35%)*
	Goals	*13*	*8 (40%)*

Based on the percentage of all the participants indicated was an influential factor to continue to pursue engineering were academic support (70%), family influence (85%), peer influence (80%), faculty-to-student interaction (80%), and attraction towards engineering (70%). An interesting factor is that only 50% of the participants pursued engineering due to financial rewards.

Participants described the influential factor of academic support most often as a form of mentorship while participating in academic programs.

A participant acknowledged mentorship when joining a program as:

> "Yeah. I have like, for example, in my organization, like in the actual STEM program, there are mentors, many mentors actually, and professors who are part of it who are there to support the students."

Similarly, participating in a program enabled participants to seek advice and collaborate among other students with the same interests. One participant described it as:

> "Okay, so let's start with the S-STEM program. So obviously I go and I talk to other fellow engineering students and I get their point of view about studying at UCI and ask about their experience and their advice as to how to be successful with doing in school"

Participants viewed academic support and personal contribution as being important. A participant described it as:

> "I feel like without some of the resources that have been given at my school, at UCI, at IVC, I wouldn't be where I am today. So, I think that, for example, there's tutoring. Especially right now at UCI, we're given everything we need pretty much. It's very resourceful. And yeah, I'd say that it's 50% doing what you need to... No, I'd say it takes a

lot out of you to do it. But as far as being able to, it's a lot about the resources that are at hand."

Additionally, academic support and mentorship were mentioned as a way to push forward. It was described as:

> "The support group that I found within UC Irvine is a really strong source of support. I feel it'd be a lot harder if I didn't have a group of students rooting for me to make it. It'd be a lot harder if I was alone in the university struggling instead of having like mentees and mentors and others in the same organization with the same morals and the same hope and aim that I have to keep pushing me forward."

Academic support was also found in the form of engineering resources, such as study spaces. A participant's motivation to continue to pursue engineering was influenced by the resources the engineering department offered and expressed it as:

> "Oh, at UCI? Oh, okay. So over here I think there's a lot of different research opportunities in engineering, engineering department, that I really think they're so interesting, and I really wanted to participate in those. So that's one of the reasons that it keeps me motivated in engineering here."

An important aspect of academic support was having a study space with longer hours of operation where students can study and prepare for exams. A participant expressed such support as:

> "The first one is, of course, a space study. The library is very good for the first quarter, but then I have to move because there are more people that come in. So, I moved to the ALP because it's a new place, and then have a lot of space So can go there than study.

> And then I moved there. And I study with my friend in there, and also I... This is outside of school, but it's a place many people go to study and not just to hang out, but study."

Family played a significant role in the participants' motivation. Family influence was presented in the form of the need to support a single parent or provide financial support. In the context of student support, participants found family support as a reminder to themselves of why it was so important to continue to pursue an engineering degree. Participants who experienced their family struggle gave them aspirations to continue to be successful in their studies. Furthermore, participants who were not asked to contribute economically to their household found encouragement to pursue engineering. An example of this was when the researcher asked the question about pursuing engineering to a participant. The participant stated:

> "What helps me pursue engineering? I would say, my parents"

In addition to family support, another participant added the fact that the participant grew up with a single mom. This participant also shared that sometimes that the family struggled financially to make ends meet. Taking such facts into consideration, the need to follow through the participant's education was expressed as:

> "You know, what motivates me for engineering is similar to what motivates me for school. I would say it's my family." And "Growing up, I had a single mom with my three brothers, so it was tough at times. And I know that as an engineer, if I'm good at being an engineer and I follow through with it and I enjoy it and I can also make a good income out of it, then I know I'm safe.

Further, having a hardworking mother who worked a lot, was a positive influence for one participant's motivation to continue to pursue engineering. This participant viewed engineering as a solution to financial relief. This participant expressed it as:

> "Since, especially coming from low income with a mother that works a lot, it definitely adds a lot of motivation to my dreams and aspirations of becoming an engineer. Being able to provide financially and take care of a family."

Family influence also motivated students to continue to pursue an engineering degree in different ways. Some participants wanted to provide financial support; while others wanted their parents not to work so much or become the main source of income. Additionally, family support motivated a participant when a difficult situation arose. One participant stated, as to when "my dad was sick" and the participant wanted to "provide my family with the money in case he passed away." In some situations, motivational influence to pursue engineering was found when a difficult situation transpired.

Faculty-to-student interaction was described as working on research projects and "having a discussion about the topic", or attending office hours, asking questions during the lecture. Peer influence was described as having the support when "needed help with the homework" or "share lecture notes", or "study for exams together." Attraction towards engineering was noted when participants mentioned "wanting to work for a large aerospace corporation" or "solving problems as engineers."

5.2.5. When Do Low-Income Transfer Students Believe That They Are Engineers?

The answer to research question number three, when do students believe they are engineers, two questions were asked; a) Do you see yourself as an engineer? and b) Do you believe you are already an engineer? Results indicated that the majority of low-income transfer engineering students believed they were engineers in progress. Some participants indicated to feel like an engineer when participants had participated in projects, research, and internship opportunities and were recognized by their peers and professors. The engineer in progress was the most significant response.

Engineer in Progress

Throughout this study, participants viewed themselves as engineers in-progress. Responses vary from (see Table 19):

Table 19: Do you see yourself as an engineer?

Question	***Response***
Do you see yourself as an engineer?	*"not yet"*
	"I'd say halfway"
	"No, I don't have all the skills to be an engineer right now"
	"Yeah, I don't believe I am an engineer yet"
	"No, I don't. I think in order to be a full-fledged engineer you would need a degree or years and years of experience."
	"I don't believe I'm a full engineer yet"
	"No, I don't think so yet"
	"I don't feel confident"

Participants acknowledged that being an engineer required additional hands-on experience and an engineering degree or higher education.

When the researcher asked participants if they believed themselves to be engineers, most participants responded with a “not yet” response. A follow-up question was asked, tell me more about that. Participants expressed that to be an engineer, they would need engineering experience or having an engineering degree. Engineering experience consisted of group projects, research, internships, or engineering field. Participants identified themselves as engineers when they have had some engineering experience or had interacted with professors or engineering professionals. Participants' responses are shown in Table 20.

Table 20: Responses-Do you believe you are already an engineer?

Question	***Requirements to Fell Like an Engineer***
Do you believe you are already an engineer?	*“If you've been part of a company for 30 years, and maybe for 10 of those years you were doing design, and prototype stuff, then yeah, you're probably an engineer.”*
	“Having the degree, I think you'd be an engineer. So, having the degree and then having the experience, I think you're already an above-average engineer.”
	“No, I don't. I think in order to be a full-fledged engineer you would need a degree or years and years of experience.”
	“I don't have that much experience right now working on machines, hands-on things. I just have theoretical knowledge so far. I don't have the actual real-life experience.”
	“So, I just cannot see and feel myself as an engineer. But I think I need to have a work experience to call myself an engineer.”
	“Okay. Yes. I think I can see myself as an engineer because during the summer, I had a full-time internship at a medical company and this medical company did mostly CAD drawings and AutoCAD, AutoCAD it's solid works drawings for medical devices and I think in that environment, communicating with my team and talking to other people in different disciples like machining for example, or process development or R&D, I think that during that time in the summer, I really learned what it meant to be an engineer. I think I have the capability because of the projects that I completed in that timeframe I was there.”
	“I would ... yeah. Okay. I would say, back to the internship again, I was able to work along with a professor who worked in the industry before, and also, I worked along with Ph.D. students who also worked in industry before along with basically they are engineers. So, I basically worked with engineers, and I was able to get their response that I was successful in my work.”
	“I believe they do. Just kind of taking the fact that I've had these experiences and I've had all these opportunities to do work with really prestigious professors at other schools.”

Results from both questions indicated that students felt that they were engineers in progress. Furthermore, participants identified themselves as engineers when they; working among fellow engineers and professors or when their peers provided them enough confidence to consider themselves engineers. A substantial trend is that students needed continuous support and experience as an engineer. Additionally, reassurance and recognition of doing engineering, feeling like an engineer, and being an engineer were necessary.

5.2.6. Unexpected Findings

The semi-structured interviews identified a few interesting findings. The first finding was from a participant who described that financial aid alleviated some of the financial constraints associated with educational costs. However, this participant stated that if financial resources were not available, the participant would have to drop out of school and find a job. Then after saving enough money, the participant could then continue to pursue an engineering career. The participant described their situation as:

> "So definitely helps me a lot. If I didn't have these resources, I might end up doing like other people, drop one year, earn bunch of money, save up so much money and then go to school, take a loan, you know to do that stuff."

One interesting finding from this quote was that the participant would have to drop out of school and save money to be able to return to school. From this specific situation, a few questions arose; a) how long does it take to earn enough money to fully support one's education, b) what are other potential factors that would prevent the student from returning and continuing to pursue an engineering degree, and c) how difficult would be returning to school be after finding a job and

d) if the job does not relate to engineering, would the student continue to pursue an engineering degree or chooses a different path?

Another interesting finding in this study was the level of motivation and confidence needed to pursue an engineering degree when a student has not done well during his early academic career. In this study, the participant who had not done well early in their academics mentioned that they did not have role models. Additionally, this participant shared that the lack of role models emerged from their low-income background. The participant described their experience as:

> "So, I feel like I did so poorly in my early years in academia because I didn't have any role models or any examples that someone from my social-economic background can make it in a field of engineering or anything as challenging as this."

Despite this participant's past academic performance, the participant had a willingness to thrive in the field and to help others, especially those from the same background. The desire to help others was common among the participants in this study. Other participants shared the passion to teach and encourage others to follow a similar path. One participant described this passion as:

> "So, I feel like it would be really rewarding to make it in the field of engineering and not just survive but thrive in this field. Just to set an example for any other underrepresented students too, so as an example, to show them that we can make it in this challenging field and just because there's not a lot of us doesn't mean we can't be top of our class, making them very rewarding universities and make it a really prestigious grad schools."

One participant had a lower academic performance before entering a community college was attributed to not having a role model. Two questions that can be drawn from this participant's situation are: what is the driven mechanism to continue to pursue engineering? and what drives the participant to become a role model in the challenging field of engineering?

The third interesting finding in this study relates to diversity. Concern for diversity was seen in four out of the twenty participants. These four participants indicated feeling underrepresented in the field of engineering and wanted to become role models for future generations. A participant felt that there were not "enough Hispanic professors" or "professors and mentors that come from very poor backgrounds" or feel "like we could have more representation". Additionally, the participant stated:

> "that we can make it in this challenging field and just because there's not a lot of us doesn't mean we can't be top of our class, making them very rewarding universities and make it a really prestigious grad school."

Similarly, participants expressed the need to represent an underrepresented group when choosing and pursuing engineering. One participant said it was feeling like, "as a woman and minority, it's important that I make become an engineer to show the younger generations that it's possible." Or noticing that "there's not that many girls in engineering, it makes me even more motivated to become an engineer." This participant further stated:

> "I have six uncles who are all engineers, and I thought that they're doing is really cool. And besides, there's no woman in the family who has been doing engineering yet. So, I kind of want to give it a try."

Ultimately, these four participants noticed certain disadvantages among underrepresented groups and want to make a difference.

The fourth interesting finding in this study was with one participant and the time that they had already invested in studying engineering. This participant felt that they needed to continue to pursue an engineering major because any desire to study something else was outweighed by how much time they had already put into engineering. This participant shared that the only possible solution was to push forward. Additionally, this topic raises the question as to, when engineering students feel that it is too late to change majors? This topic illustrates a glimpse of the numerous struggles that engineering students face. Ultimately, demonstrating more need to support and motivate low-income engineering transfer students throughout their academic journey.

6. DISCUSSIONS

6.1. Synopsis

Previous studies have shown that motivational factors are more important than academic factors in retaining engineering students [47]–[49]. Additionally, other studies identified engineering identity as being an influential factor to choose and pursue engineering as a career [80]. Moreover, studies have shown that a sense of belonging can influence the students' decision to leave or switch from an engineering program, particularly true for underrepresented groups [5]–[9]. On the contrary, previous studies have shown that those students who acquired a sense of belonging received positive influences on their level of motivation, engagement, and achievement [88].

Results from this study indicate that low-income engineering transfer students choose and continue to pursue engineering degree attainment due to the opportunities engineering offers, financial reward, ability to care for others, and student commitment. Furthermore, the decision to choose engineering degree attainment is mostly influenced during their adolescence where financial struggles and health-related issues affect them the most. Additionally, continuous support from faculty, peers, and family is an important motivational factor for low-income engineering transfer students to continue to pursue baccalaureate degree attainment.

Findings from this study can assist post-secondary institutions to develop a pathway model that can reduce barriers and can increase retention and graduation rates at two-year community colleges and four-year institutions. Through the questions asked and responses given in this study, a reduced gap in the research literature about low-income engineering transfer students may be useful to increase student enrollment and retention. Additionally, the findings may allow programs to better understand and address low-income engineering transfer students' needs, desires, interests, expectations, and misconceptions of students about entering four-year institutions. Furthermore, it may guide faculty, counselors, mentors, and staff on how to inform a student on the type of support and resources are available when entering an undergraduate engineering program.

This study provided detailed information about what types of experiences can motivate low-income engineering transfer students to choose and pursue an engineering degree. For example, early interest, faculty-to-student interaction, family influence, hands-on experiences, peer influence, and financial support emerged as critical factors that positively influence the student's decision to choose and pursue engineering. Additionally, upon transferring to the four-year institution, transfer students indicated that they were more interested in finding research and internship opportunities because they felt that it was a necessary experience post-graduation. Students highlighted that such opportunities were competitive and hard to come by.

Participants in this study indicated that they had gained motivation during their transition from a two-year community college to a four-year institution. Participants identified that this motivation was attributed to having participated in the one-week summer program which provided a level of comfort and the opportunity to get acclimated to the university community. During this one-week program, the participants were able to familiarize themselves with a classroom environment and awareness of potential resource centers for future assistance and support. Furthermore, participants were assigned a peer and faculty mentor that met with the participants individually, three times a quarter, or as needed. Additionally, this support was intended to guide the students through the next steps and challenges ahead. This support enabled students to gain confidence and some level of sense of belonging. Ultimately, this motivated participants to continue to be enrolled and thrive in their engineering courses.

It should be noted that all participants were already admitted to an undergraduate engineering program and self-selected to participate in this study. The process of choosing an engineering degree was already pre-determined. Additionally, academic, and financial support was already in place, which may have influenced the decision to pursue engineering. The sample used in this study was specifically low-income engineering transfer students that met a minimum GPA requirement.

6.2. Cohort Experience

Participants in this study were part of a cohort that required students to participate in certain required activities. One of the required activities was that participants had to attend a one-week residential engineering program on the university campus. This program intended to allow students to acclimate with the university community, experience engineering hands-on exposure, and meet other engineering students before the beginning of the academic year. The program was considered a success since students reported an increased level of confidence that after attending the one-week on-campus summer program. Students stated that through the program, "we were able to build friendships and create some bonding", and once the academic year started, they "felt that they already knew each other" and were "familiar with some of the resources and had a study room where they were able to study." Additionally, they were able to discuss "which courses they were going to be taking" and "possibly share class notes and were planning to work together on group projects." Through the program, students acquired a sense of belonging and were more motivated to continue their enrollment in engineering courses. One key aspect was that students were highly interested in conducting research. Within the first week of the fall quarter, some participants had already contacted faculty members. One student stated, “he allowed me to join his research even though I wasn't officially settled into school yet.” Additionally, the participants appeared to be more motivated and prepared to be part of an undergraduate engineering program at a four-year university.

6.3. Study Limitations

Limitations to the study include sample size, sample profile, lack of a control group, and short-term length. Despite some limitations, this study produced important results related to motivational factors of low-income engineering transfer students.

Overall, this study provided a valuable contribution to the knowledge base and provided a better understanding of what motivational factors can positively influence the decision of choosing and pursuing a baccalaureate degree in the field of engineering. Additionally, the research indicated the continuous academic and financial support helped improve students’ level of academic engagement by enabling students to remain focused on their academics, rather than the financial cost of their education.

7. CONCLUSIONS

The study used the expectancy-value theory framework, engineering identity model, and a sense of belonging to capture the participants' experiences to identify the motivational factors that led low-income engineering transfer students to choose and pursue engineering. This study consisted of a small sample that provided reliable information to answer the three fundamental research questions.

Qualitative results identified that participants initially choose engineering because of an earlier interest (EI - exposure to the field or tinkering) and its usefulness (utility value – financial reward, ability to care for others, job opportunity, real-world application). As participants continued to pursue engineering, participants move from choosing engineering to enjoying engineering. This change consisted of engineering interest (interest-EVT), a gain of engineering knowledge, hands-on experience (research and internship opportunities, group projects), exploring opportunities, and faculty-to-student interaction. Additionally, participants felt they were creating an engineering toolbox through their academic journey that would provide them with the necessary skills to develop, create, problem-solve, and implement into real-world engineering applications.

Furthermore, degree attainment was the key to the participant's goal completion. Many participants identified themselves as being engineers in progress and that a degree would make them engineers. On the contrary, other participants expressed that more than a degree was needed to be recognized as an engineer. These participants felt that it would require work experience, higher education, or possibly more, to feel like an engineer.

Lastly, the expectancy-value theory of motivation achievement framework used in this study was based on two questions; a) “Can I Do It?” and b) “Do I want to Do It?” Participants answered the question (a) by expressing confidence (competence), and hard work and dedication (from the participants’ perspective, attention to human and ethical values). Question (b), wanting to do it was not fully expressed or answered for the low-income engineering transfer participants in this study. The choice to pursue an engineering degree for most participants was based on the family living situation. Furthermore, those participants indicated that choosing and pursuing engineering was to find a stable well-paying job, support, and assist their parents financially or to care for others. For those participants, studying engineering was considered a need and not a choice. Engineering was considered a well “paying job” that would provide “job opportunities” and “stability.” Passion to pursue an engineering degree was not a significant topic for the talented low-income engineering transfer students of this study. However, for engineering transfer students that are not considered low-income, passion is considered the leading motivational factor that led them to choose and pursue an engineering degree. Additionally, research shows that only 50% of the total number of engineering transfer students will graduate with an engineering degree [17]. Ultimately, low-income engineering transfer students can fill the need for STEM professions in the United States, but these students need to be fully supported to increase their motivation to choose and pursue baccalaureate degree attainment.

7.1. Implications

Despite the limitations of this study, several implications are offered based on the participants' shared experiences. Firstly, participants showed signs of impostor syndrome which can influence students’ motivation to pursue an engineering degree. Secondly, concerning capital theory, participants drew attention to the need for higher education. Furthermore, participants identified themselves as human capital by helping their peers with problem-solving, sharing class notes, creating study groups, or tutoring sessions. Thirdly, time management, and adaptation skills between commuters and non-commuters was an intricate subject. Participants shared that they experienced a loss of time as much as three hours a day from travel time to and from the university. Furthermore, participants who commuted experienced a direct involvement of family struggles, lack of study spaces, and concentration while trying to focus on their academics versus those taking advantage of residence hall living and community involvement. The participants who were non-commuters were able to fully focus on their education and limit their involvement in family struggles. Fourthly, given that low-income engineering transfer students are debt adverse and are more aware of tuition costs than other undergraduate students, participants expressed no signs of being distressed about the ability to pay for tuition cost or school supplies. Lastly, this study illustrates the motivational factors that low-income transfer engineering students face yet there remains an opportunity to capture the challenges and struggles. The need to understand the fundamental characteristics of a low-income engineering transfer student needs to be further explored. Those students are the ones that do not qualify for financial aid, cannot afford school supplies (i.e., books, a laptop, etc.) and must work full-time to pay for their academics and support themselves. Furthermore, the implications of this study allow for further research on the challenges that low-income engineering transfer students face. Additional questions to be asked are:

a) What are the most difficult challenges that a student faces while pursuing their engineering education?

b) How do you overcome those challenges?

a. How do you plan to overcome those challenges?

c) What resources are needed to better support and motivate a student from a low-income socioeconomic background?

d) What are the reasons you chose UCI?

e) If you did not have funding would you still attend UCI?

f) If you were to pay for tuition cost, which university would you attend to?

g) If you need to pay for your tuition or school supplies and were able to obtain loans, would you request them or work while studying?

h) Are you aware of all the resources available to engineering students?

a. List them

Ultimately these implications illustrate that students will acclimate to the university environment and learn to be resourceful. Additionally, the student's socioeconomic status will affect the time and energy that they can dedicate to their education.

REFERENCES

[1] A. Herman, "America's STEM Crisis Threatens Our National Security," 2019.

[2] A. Enriquez, E. Dunmire, T. Rebold, N. Langhoff, and E. Schiorring, "Work in Progress: Creating Alternative Learning Strategies for Transfer Engineering Programs," no. June, pp. 26.1749.1-26.1749.27, 2015.

[3] A. R. Taylor, W. C. Lee, B. D. Lutz, H. M. Matusovich, and C. Hampton, "A failed attempt to develop a measure of engineering students' subjective task-value for diversity and inclusion in engineering," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2018-June, 2018.

[4] H. M. Matusovich, R. A. Streveler, and R. L. Miller, "Why do students choose engineering? A qualitative, longitudinal investigation of students' motivational values," *J. Eng. Educ.*, vol. 99, no. 4, pp. 289–303, 2010.

[5] M. Estrada *et al.*, "Improving underrepresented minority student persistence in STEM," *CBE Life Sci. Educ.*, vol. 15, no. 3, pp. 1–10, 2016.

[6] S. Hurtado, "Degrees of Success Bachelor's Degree Completion Rates among Initial STEM Majors," *Nurs. Stand.*, vol. 25, no. 18, p. 61, 2010.

[7] S. Hurtado and D. F. Carter, "Effects of college transition and perceptions of the campus racial climate on Latino college students' sense of belonging," *Sociol. Educ.*, vol. 70, no. 4, pp. 324–345, 1997.

[8] S. Hurtado and L. Ponjuan, "Latino Educational Outcomes and the Campus Climate," *J. Hispanic High. Educ.*, vol. 4, no. 3, pp. 235–251, 2005.

[9] C. G.-W. S.Hurtado, A. Ruiz Alvarado, "Inclusive Learning Environments: Modeling a Relationship Between Validation, Campus Climate for Diversity, and Sense of Belonging," *Annu. Conf. Assoc. Stud. High. Educ.*, no. August, p. 32, 2012.

[10] American Association of Community College (AACC), "AACC Fast Facts 2019," p. 2, 2019.

[11] J. M. Smith and J. C. Lucena, "Invisible innovators: how low-income, first-generation students use their funds of knowledge to belong in engineering," *Eng. Stud.*, vol. 8, no. 1, pp. 1–26, Jan. 2016.

[12] & P. and P. S. S. U.S. Department of Education, Office of Planning, Evaluation and Policy Development and Office of the Under Secretary, "Advancing diversity and inclusion in higher education," 2016.

[13] N. S. Board, "Higher Education in Science and Engineering," *Natl. Sci. Found.*, vol. 7, 2019.

[14] D. L. Jackson and F. S. Laanan, "Desiring to Fit: Fostering the Success of Community College Transfer Students in STEM," *Community Coll. J. Res. Pract.*, vol. 39, no. 2, pp. 132–149, 2015.

[15] P. Leggett-Robinson, B. Villa, and S. Mooring, "Two-Year Community: A 3+8 Model of Undergraduate Research for Community College STEM Majors," *J. Coll. Sci. Teach.*, vol. 044, no. 04, 2015.

[16] R. M. Fauria and M. Fuller, "Transfer Student Success: Educationally Purposeful Activities Predictive of Undergraduate GPA," *Res. Pract. Assess.*, pp. 39–52, 2015.

[17] M. R. Anderson-Rowland and A. A. Rodriguez, "Sophomore transfers: Who are they and what support do they need?," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 122nd ASEE, no. 122nd ASEE Annual Conference and Exposition: Making Value for Society, 2015.

[18] T. P. Scott, S. S. Thigpin, and A. O. Bentz, “Transfer Learning Community: Overcoming Transfer Shock and Increasing Retention of Mathematics and Science Majors,” *J. Coll. Student Retent. Res. Theory Pract.*, vol. 19, no. 3, pp. 300–316, 2017.
[19] R. K. Agrawal, M. L. Stevenson, and C. Gloster, “Understanding the reasons for low representation of ethnic minority students in STEM fields,” *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2016-June, 2016.
[20] S. Hurtado, C. B. Newman, M. C. Tran, and M. J. Chang, “Improving the rate of success for underrepresented racial minorities in STEM fields: Insights from a national project,” *New Dir. Institutional Res.*, vol. 2010, no. 148, pp. 5–15, 2010.
[21] X. Chen, “First-Generation Students in Postsecondary Education: A Look at Their College Transcripts,” *Education*, no. July, p. 83p., 2005.
[22] S. Conrad, S. S. Canetto, D. Macphee, and S. Farro, “What Attracts High-Achieving Socioeconomically Disadvantaged Students to the Physical Sciences and Engineering.,” *Coll. Stud. J.*, vol. 43, no. 4, pp. 1359–1369, 2009.
[23] J. Engle and V. Tinto, “Moving beyond access: College success for low-income, first-generation students,” *Pell Inst. study Oppor. High. Educ.*, pp. 1–38, 2008.
[24] T. T. Ishitani, “A longitudinal approach to assessing attrition behavior among first-generation students: Time-Varying Effects of Pre-College Characteristics,” *Res. High. Educ.*, vol. 44, no. 4, pp. 433–449, 2003.
[25] E. T. Pascarella, C. T. Pierson, G. C. Wolniak, and P. T. Terenzini, “First-generation college students: Additional evidence on college experiences and outcomes,” *J. Higher Educ.*, vol. 75, no. 3, pp. 249–284, 2004.
[26] S. R. Relles, “Funds of High School to College Knowledge: Exploring Low-Income Student Perceptions of College Writing,” *Educ. Forum*, vol. 81, no. 3, pp. 281–300, 2017.
[27] J. and M. Engle and Lynch, “Charting a Necessary Path: The Baseline Report of Public Higher Education Systems in the Access to Success Initiative,” 2009.
[28] E. Litzler and C. Samuelson, “How underrepresented minority engineering students derive a sense of belonging from engineering,” *ASEE Annu. Conf. Expo. Conf. Proc.*, 2013.
[29] G. M. Walton and G. L. Cohen, “A question of belonging: Race, social fit, and achievement,” *J. Pers. Soc. Psychol.*, vol. 92, no. 1, pp. 82–96, 2007.
[30] R. D. Atkinson *et al.*, “Increasing the Success of Minority Students in Science and Technology,” *Econ. Educ. Rev.*, vol. 29, no. 2, pp. 1–36, 2010.
[31] R. M. Marra, K. A. Rodgers, D. Shen, and B. Bogue, “Leaving engineering: A multi-year single-institution study,” *J. Eng. Educ.*, vol. 101, no. 1, pp. 6–27, 2012.
[32] E. S. and N. M. Hewitt, *Talking about leaving: Why undergraduates leave the sciences Boulder*. Boulder, Colorado: Westview Press, 1997.
[33] M. C. Tate, Erika D. and Linn, “How Does Identity Shape the Experiences of Women of Color Engineering Students? on JSTOR,” *J. Sci. Educ. Technol.*, vol. 14, no. 5/6, pp. 483–493, 2005.
[34] J. P. Bean, “Leaving College: Rethinking the Causes and Cures of Student Attrition,” *J. Higher Educ.*, vol. 59, no. 6, pp. 708–711, 1988.
[35] D. Cole and A. Espinoza, “Examining the academic success of Latino students in science technology engineering and mathematics (STEM) Majors,” *J. Coll. Stud. Dev.*, vol. 49, no. 4, pp. 285–300, 2008.
[36] National Science Board, “Science & Engineering Indicators 2020,” *High. Educ. Sci. Eng.*, vol. 7, pp. 1–67, 2019.

[37] U. S. C. of Commerce, "TAPPING AMERICA ' S POTENTIAL The Education for Innovation Initiative," 2015.
[38] M. M. Nauta, D. L. Epperson, and K. M. Waggoner, "Perceived causes of success and failure: Are women's attributions related to persistence in engineering majors?," *J. Res. Sci. Teach.*, vol. 36, no. 6, pp. 663–676, 1999.
[39] S. M. Lord, M. W. Ohland, R. A. Layton, and M. M. Camacho, "Beyond pipeline and pathways: Ecosystem metrics," *J. Eng. Educ.*, vol. 108, no. 1, pp. 32–56, 2019.
[40] C. Blue, "STEM Scholars Bridge Program for Increased Student Retentions, Internship and Career Exploration at University of Southern Maine," pp. 26.1397.1-26.1397.10, 2015.
[41] O. Almatrafi, A. Johri, H. Rangwala, and J. Lester, "Retention and persistence among STEM students: A comparison of direct admit and transfer students across engineering and science," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2017-June, 2017.
[42] H. Y. Chan and X. Wang, "Momentum Through Course-Completion Patterns Among 2-Year College Students Beginning in STEM: Variations and Contributing Factors," *Res. High. Educ.*, vol. 59, no. 6, pp. 704–743, 2018.
[43] J. Cruz and N. Kellam, "Beginning an Engineer's Journey: A Narrative Examination of How, When, and Why Students Choose the Engineering Major," *J. Eng. Educ.*, vol. 107, no. 4, pp. 556–582, 2018.
[44] S. Sheppard *et al.*, "Exploring the engineering student experience: Findings from the Academic Pathways of People Learning Engineering Survey (APPLES)," *Tech. Rep. CAEE-TR-10-01*, no. September 2010.
[45] H. M. Matusovich, R. A. Streveler, and R. L. Miller, "Why Do Students Choose Engineering? A Qualitative, Longitudinal Investigation of Students' Motivational Values," *J. Eng. Educ.*, vol. 99, no. 4, pp. 289–303, Oct. 2010.
[46] K. L. Meyers, M. W. Ohland, A. L. Pawley, S. E. Silliman, and K. A. Smith, "Factors relating to engineering identity," *Glob. J. Eng. Educ.*, vol. 14, no. 1, pp. 119–131, 2012.
[47] L. Y. Santiago and R. A. M. Hensel, "Engineering attrition and university retention," *ASEE Annu. Conf. Expo. Conf. Proc.*, 2012.
[48] F. Wu, W. Fan, C. Arbona, and D. De La Rosa-Pohl, "European Journal of Engineering Education Self-efficacy and subjective task values in relation to choice, effort, persistence, and continuation in engineering: an Expectancy-value theory perspective Self-efficacy and subjective task values in relation to choice, effort, persistence, and continuation in engineering: an Expectancy-value theory perspective," 2019.
[49] E. Godfrey, T. Aubrey, and R. King, "Who leaves and who stays? Retention and attrition in engineering education," *Eng. Educ. 2010 Inspiring Next Gener. Eng. EE 2010*, vol. 0052, 2010.
[50] R. M. Latta and R. L. Patten, "A test of Weiner's attribution theory inertial motivation hypothesis," *J. Pers.*, vol. 46, no. 2, pp. 383–399, 1978.
[51] E. L. Leggett and C. S. Dweck, "A Social-Cognitive Approach to Motivation and Personality," *Psychol. Rev.*, vol. 95, no. 2, pp. 256–273, 1988.
[52] A. H. Maslow, "A Theory of Human Motivation," *Psychol. Rev.*, vol. 50, pp. 370–396, 1943.
[53] M. Stachowsky and A. J. B. Milne, "What Makes a Good Assessment? Assessments for Learning," *Proc. Can. Eng. Educ. Assoc.*, pp. 1–8, 2018.
[54] J. S. Eccles and A. Wigfield, "Motivational Beliefs, Values, and Goals," *Annu. Rev.*

Psychol., vol. 53, no. 1, pp. 109–132, 2002.
[55] J. B. Gregory, J. W. Beck, and A. E. Carr, "Goals, feedback, and self-regulation: Control theory as a natural framework for executive coaching," *Consult. Psychol. J.*, vol. 63, no. 1, pp. 26–38, 2011.
[56] E. L. Deci and R. M. Ryan, "Self-Determination Theory: A Macrotheory of Human Motivation, Development, and Health," 2008.
[57] R. M. Ryan and E. L. Deci, "Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being Self-Determination Theory," Ryan, 1985.
[58] M. Csikszentmihalyi, *Flow, and the Foundations of Positive Psychology*. 2014.
[59] S. Hidi and K. A. Renninger, "The Four-Phase Model of Interest Development," *Educ. Psychol.*, vol. 41, no. 2, pp. 111–127, 2006.
[60] A. Krapp, "An Educational-Psychological Theory of Interest and Its Relation to SDT Interest : A Rediscovered Motivational Concept in," *Handb. self Determ. Res.*, no. Csikszentmihalyi 1975, pp. 405–426, 2002.
[61] M. V Covington, "GOAL THEORY, MOTIVATION, AND SCHOOL ACHIEVEMENT: An Integrative Review," 2000.
[62] J. Meyer, J. Fleckenstein, and O. Köller, "Expectancy value interactions and academic achievement: Differential relationships with achievement measures," *Contemp. Educ. Psychol.*, 2019.
[63] J. Eccles, "Who am I, and what am I going to do with my life? Personal and collective identities as motivators of action," *Educ. Psychol.*, vol. 44, no. 2, pp. 78–89, 2009.
[64] J. S. Eccles, "Subjective task value and the Eccles et al. model of achievement-related choices," *Handb. competence Motiv.*, no. January, pp. 105–121, 2005.
[65] J. Guo, P. D. Parker, H. W. Marsh, and A. J. S. Morin, "Achievement, motivation, and educational choices: A longitudinal study of expectancy and value using a multiplicative perspective," *Dev. Psychol.*, vol. 51, no. 8, pp. 1163–1176, 2015.
[66] J. Eccles, A. Wigfield, R. D. Harold, and P. Blumenfeld, "Age and Gender Differences in Children's Self-and Task Perceptions during Elementary," 1993.
[67] H. Gaspard, A. Wigfield, Y. Jiang, B. Nagengast, U. Trautwein, and H. W. Marsh, "Dimensional comparisons: How academic track students' achievements are related to their expectancy and value beliefs across multiple domains," *Contemp. Educ. Psychol.*, vol. 52, pp. 1–14, 2018.
[68] R. J. Shavelson, J. J. Hubner, and G. C. Stanton, "Self-Concept: Validation of Construct Interpretations," *Rev. Educ. Res.*, vol. 46, no. 3, pp. 407–441, 1976.
[69] A. L. Wilkinson, "The Relevance of Student Self-Perceptions to School Psychology," pp. 1–20, 2004.
[70] M. Alias and N. A. H. M. Hafir, "The relationship between academic self-confidence and cognitive performance among engineering students," *2009 Res. Eng. Educ. Symp. REES 2009*, no. January 2009, 2009.
[71] M. A. Hutchison-Green, D. K. Follman, and G. M. Bodner, "Providing a voice: Qualitative investigation of the impact of first-year engineering experience on students' efficacy beliefs," *J. Eng. Educ.*, vol. 97, no. 2, pp. 177–190, 2008.
[72] C. B. P. Hutchison, "Contact, anxiety, and young people's attitudes and behavioral intentions towards the elderly," *Educ. Gerontol.*, vol. 36, no. 6, pp. 451–466, 2010.
[73] A. Sewell and A. St George, "Developing efficacy beliefs in the classroom," *J. Educ.*

Enq., vol. 1, no. 2, pp. 58–71, 2000.
[74] A. Wigfield and J. S. Eccles, "Expectancy – Value Theory of Achievement Motivation," *Contemp. Educ. Psychol.*, vol. 25, pp. 68–81, 2000.
[75] A. D. Patrick and M. Borrego, "A review of the literature relevant to engineering identity," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2016-June, 2016.
[76] A. Godwin, "The development of a measure of engineering identity," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2016-June, 2016.
[77] D. Verdín, A. Godwin, A. Kirn, L. Benson, and G. Potvin, "Understanding How Engineering Identity and Belongingness Predict Grit for First-Generation College Students," *Collab. Netw. Eng. Comput. Divers. Conf.*, 2018.
[78] A. Godwin, G. Potvin, Z. Hazari, and R. Lock, "Identity, Critical Agency, and Engineering: An Affective Model for Predicting Engineering as a Career Choice," *J. Eng. Educ.*, vol. 105, no. 2, pp. 312–340, 2016.
[79] H. Carlone and J. Angela, "An experimental investigation of some properties of individual iconic ...," *J. Res. Sci. Teach.*, vol. 44, no. 8, pp. 1187–1218, 2007.
[80] A. Godwin, G. Potvin, Z. Hazari, and R. Lock, "Understanding engineering identity through structural equation modeling," *Proc. - Front. Educ. Conf. FIE*, pp. 50–56, 2013.
[81] Z. Hazari, G. Potvin, R. M. Lock, F. Lung, G. Sonnert, and P. M. Sadler, "Factors that affect the physical science career interest of female students: Testing five common hypotheses," *Phys. Rev. Spec. Top. - Phys. Educ. Res.*, vol. 9, no. 2, pp. 1–8, 2013.
[82] M. Varelas, *Identity construction and science education research: Learning, Teaching, and being in multiple contexts*. 2012.
[83] M. Hoffman, J. Richmond, J. Morrow, and K. Salomone, "Investigating 'Sense of Belonging' in First-Year College Students," *J. Coll. Student Retent. Res. Theory Pract.*, vol. 4, no. 3, pp. 227–256, 2002.
[84] D. Verdín and A. Godwin, "First-Generation College Students Identifying as Future Engineers," *Pap. Present. 2018 Annu. Meet. Am. Educ. Res. Assoc.*, 2018.
[85] E. E. Liptow, K. Chen, R. Parent, J. Duerr, and D. Henson, "A sense of belonging: Creating a community for first-generation, under-represented groups and minorities through an engineering student success course," *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2016-June, 2016.
[86] J. Oakes, "Chapter 3: Opportunities, Achievement, and Choice: Women and Minority Students in Science and Mathematics," *Rev. Res. Educ.*, vol. 16, no. 1, pp. 153–222, 1990.
[87] N. W. Brickhouse, P. Lowery, and K. Schultz, "What kind of a girl does science? The construction of school science identities," *J. Res. Sci. Teach.*, vol. 37, no. 5, pp. 441–458, 2000.
[88] K. Osterman, "Students' Need for Belonging in the School Community," *Rev. Educ. Res.*, vol. 70, no. 3, p. 323, 2000.
[89] B. R. A. Hirst, G. Bolduc, L. Liotta, and B. W. Packard, "Cultivating the STEM Transfer," *J. Coll. Sci. Teach.*, vol. 43, no. 4, pp. 12–23, 2014.
[90] R. W. Lent, S. D. Brown, J. Schmidt, B. Brenner, H. Lyons, and D. Treistman, "Relation of contextual supports and barriers to choice behavior in engineering majors: Test of alternative social cognitive models," *J. Couns. Psychol.*, vol. 50, no. 4, pp. 458–465, Oct. 2003.
[91] M. A. Hutchison, D. K. Follman, M. Sumpter, and G. M. Bodner, "Factors influencing the self-efficacy beliefs of first-year engineering students," *Journal of Engineering Education*,

vol. 95, no. 1. Wiley-Blackwell Publishing Ltd, pp. 39–47, 01-Jan-2006.
[92] Z. Hazari, G. Sonnert, P. M. Sadler, and M.-C. Shanahan, "Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study," *J. Res. Sci. Teach.*, p. n/a-n/a, 2010.
[93] R. F. Baumeister and M. R. Leary, "The Need to Belong: Desire for Interpersonal Attachments as a Fundamental Human Motivation," vol. 117, no. 3, pp. 497–529, 1995.
[94] K. L. Lewis, J. G. Stout, S. J. Pollock, N. D. Finkelstein, and T. A. Ito, "Fitting in or opting out: A review of key social-psychological factors influencing a sense of belonging for women in physics," *Phys. Rev. Phys. Educ. Res.*, vol. 12, no. 2, pp. 1–10, 2016.
[95] J. G. Baker and M. G. Finn, "Can a merit-based scholarship program increase science and engineering baccalaureates?," *J. Educ. Gift.*, vol. 31, no. 3, pp. 322–337, 2008.
[96] R. Hurtado, S., Hughes, B.E., Eagan, M.K. & Paul, and P. P. Reid, *Understanding the educational and career pathways of engineers*, vol. 2018-June. Washington: The National Academy Press, 2018.
[97] D. Lubinski and C. P. Benbow, "Special Section : Doing Psychological Science Study of Mathematically Precocious Youth After 35 Years," *Perspect. Psychol. Sci.*, vol. 1, no. 4, pp. 316–345, 2006.
[98] E. Godfrey, T. Aubrey, and R. King, "Engineering Education a Journal of the Higher Education Academy Who leaves and who stays? Retention and attrition in engineering education Who leaves and who stays? Retention and attrition in engineering education," 2006.
[99] C. S. Dweck Ellen L Leggett *et al.*, "Psychological Review A Social-Cognitive Approach to Motivation and Personality," Psychological Association, Inc, 1988.
[100] M. Preston, R. Michael Latta, and R. Michael, "Achievement Motivation and Achievement: The Role of Locus of Control Recommended Citation," 1978.
[101] K. Charmaz, "Constructionism and grounded theory," *Handb. Constr. Res.*, pp. 397–416, 2008.
[102] J. W. Creswell, W. E. Hanson, V. L. Clark Plano, and A. Morales, "Qualitative Research Designs: Selection and Implementation," *Couns. Psychol.*, vol. 35, no. 2, pp. 236–264, 2007.
[103] V. L. P. Clark, M. Gutmann, and W. E. Hanson, "An Expanded Typology for Classifying Mixed Methods Research Into Designs," pp. 159–196, 2007.
[104] M. Miles and H. Michael, *Qualitative Data Analysis*, Second Edi. Thousand Oaks London New Delhi: SAGE Publications Indi Pvt. Ltd., 1994.
[105] M. Borrego, E. P. Douglas, and C. T. Amelink, "Quantitative, qualitative, and mixed research methods in engineering education," *J. Eng. Educ.*, vol. 98, no. 1, pp. 53–66, 2009.
[106] S. Stemler, "An overview of content analysis," *Pract. Assessment, Res. Eval.*, vol. 7, no. 17, pp. 2000–2001, 2001.
[107] E. J. Wigfield, Allan, "Expectancy-value theory of achievement motivation: A developmental perspective.," *Educ. Psychol. Rev.*, vol. 6, no. 1, pp. 49–78, 1994.