Providing Co-curricular Support:
A Multi-case Study of Engineering Student Support Centers

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ABSTRACT

In response to the student retention and diversity issues that have been persistent in undergraduate engineering education, many colleges have developed Engineering Student Support Centers (ESSCs) such as Minority Engineering Programs (MEPs) and Women in Engineering Programs (WEPs). ESSCs provide underrepresented students with co-curricular support using student interventions in the form of programs, activities, and services. However, ESSCs have a relatively short history and there are gaps in our knowledge about these support systems. While the *practice* of providing students with co-curricular support has been evaluated, *theories* of co-curricular support have not been as thoroughly investigated; we know very little about how co-curricular support functions alongside engineering curricula. In an effort to help close the gaps in current literature, the purpose of my study was to explore how the student interventions offered alongside engineering curricula influence the undergraduate experience. To address this purpose, I used a multi-case study design to explore the particulars of six ESSCs housed at four institutions. I focused on the ESSC administrators (those who provide support) and undergraduate students (those who receive support) using multiple qualitative data collection methods. The primary result of this study was the Model of Co-curricular Support (MCCS), which is a version of Tinto's Model of Institutional Departure that I repurposed to demonstrate the breadth of co-curricular assistance required to comprehensively support undergraduate engineering students. The MCCS illustrates how a student's interaction with the academic, social, and professional systems within a college–as well as the university system surrounding the college–could influence the success he or she has in an undergraduate engineering program. More specifically, the MCCS is a conceptual model for constructing and evaluating support systems and individual student interventions that prioritize undergraduate engineering students. Within my study, I also identified several classifications of ESSCs and highlighted some pros and cons associated with various classifications and configurations. Ultimately, this research combines student-retention theory with student-support practice in a way that could facilitate future collaborations among educational researchers and student-support practitioners.

DEDICATION

To those who wanted to be engineers but needed a little more help.

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CHAPTER 1. Introduction

1.1. Background

Despite continued efforts to retain undergraduate students, engineering degree programs still face stable yet unfavorable student attrition rates (Ohland, Sheppard, Lichtenstein, Eris, Chachra, & Layton, 2008; Seymour & Hewitt, 1997). Additionally, student diversity has been a persistent problem in engineering, and the number of bachelor's degrees awarded to underrepresented populations has not sufficiently increased since the mid-1990s (Chubin, May, & Babco, 2005; National Science Foundation & National Center for Science and Engineering Statistics, 2013). Under these circumstances, there remains an urgent need for policies, programs, and resources intended to effectively support students from underrepresented populations as they progress through undergraduate engineering degree programs (May & Chubin, 2003; Ohland, Brawner, Camacho, Layton, Long, Lord, & Washburng, 2011). Accordingly, the engineering education community has given much attention to curricular changes and instructional practices that influence student success (Brown, Hershock, Finelli, & O'Neal, 2009; Felder, Felder, & Dietz, 1998; Vogt, 2008). However, we have not given the same amount of attention to extracurricular practices such as co-curricular support. Co-curricular support refers to university-provided assistance that is non-curricular yet complementary to the curricula (see Figure 1), and it includes interventions such as mentoring programs, orientation activities, and tutoring services.

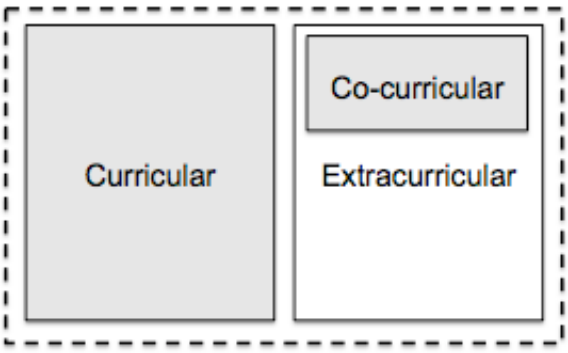


Figure 1 – Institutional Positioning of Co-curricular Support

While the *practice* of providing students with co-curricular support has been evaluated, *theories* (and scholarship) of co-curricular support have not been as thoroughly investigated. Co-curricular support is an advantageous area to investigate because many of the experiences linked to a student's decision to leave engineering can be mitigated by appropriately directed student

interventions (e.g., Allen, 1999; Amenkhienan & Kogan, 2004; Fletcher, Newell, Anderson-Rowland, & Newton, 2001a; Fletcher, Newell, Newton, & Anderson-Rowland, 2001b; Single, Muller, Cunningham, Single, & Carlsen, 2005; Vesilind, 2001). By advancing the scholarship of co-curricular support, we can better understand how it functions alongside engineering curricula and, hopefully, create an environment that provides students with comprehensive support, ultimately increasing the likelihood of students persisting in the field of engineering.

1.2. Introduction to Engineering Student Support Centers

In response to the unfavorable student attrition and the disconcerting lack of diversity, many engineering colleges have developed Engineering Student Support Centers (ESSCs). ESSCs are mechanisms for institutions to provide engineering students with co-curricular student interventions such as orientation activities, academic advising, student organizations, and tutoring (Hermond, 1995; Malcom, 2008). Commonplace examples of ESSCs include the Minority Engineering Program (MEP) and Women in Engineering Program (WEP). A shortcoming with our current understanding of ESSCs is that the area of co-curricular support is historically practice-oriented and much of the existing research around ESSCs focuses on measures such as student satisfaction or sheer recruitment and retention numbers (Brainard & Carlin, 1998; Hermond, 1995; Lam, Doverspike, & Mawasha, 1999; Ohland & Zhang, 2002; Van Aken, Watford, & Medina-Borja, 1999). While these measures are important, there is little research to help us understand *how* ESSCs are intended to work. Consequently, we know little about the intentions guiding ESSCs or the components of the institutional experience ESSC administrators (i.e., those in charge of ESSCs) aim to influence. By better understanding the intentions guiding ESSCs and the impact ESSCs are intended to have on a student's institutional experience, co-curricular support can be better leveraged to offer student interventions that contribute to resolving the retention and diversity problems in engineering degree programs. To date, studies have examined the use of individual student interventions (i.e., mentoring and summer bridge programs) at a micro level (e.g., Allen, 1999; Dickerson, Solis, Book Womack, Zephirin, & Stwalley, 2014; Lee & Cross, 2013; Lee, Seimetz, & Amelink, 2014b), but there is an existing need to examine the *system* of support ESSCs provide and how it functions alongside engineering curricula to influence the undergraduate student experience.

The problem I address in my dissertation is our lack of understanding as an engineering education research and practice community with regard to the following areas: (1) the deliberate outputs, outcomes, and objectives guiding ESSCs, and (2) how co-curricular support systems functions alongside engineering curricula to influence the undergraduate student experience. **Outputs** are the immediate products that result from the internal operation of student interventions (Harrell, Burt, Hatry, Rossman, Roth, & Sabol, 1996); **outcomes** are the skills, knowledge, and behaviors that students attain through participation in student interventions (Spurlin, Rajala, & Lavelle, 2008); and **objectives** are broad statements that describe the accomplishments that student interventions (hopefully) prepare students to achieve (Spurlin et al., 2008). Developing a deeper understanding in these areas is important with regard to evaluating and better leveraging co-curricular support in engineering, and to date few studies have examined ESSCs comprehensively (Hackett & Martin, 1998; Knight & Cunningham, 2004; Lee, Kajfez, & Matusovich, 2013; Shehab, Murphy, & Foor, 2012; Van Aken et al., 1999). I addressed this problem by closely examining the system of support provided by multiple ESSCs.

1.3. Introduction to Tinto's Model of Institutional Departure

To address our need to better understand the intentions guiding ESSCs and the function of co-curricular support in engineering, I used Tinto's (1994) Longitudinal Model of Institutional Departure to investigate how ESSC administrators aim to influence the undergraduate experience using student interventions and how students experience these interventions. It is important to note that the choice to persist in or leave engineering is a complex process and many forces push and pull students towards and away from completion of their degrees (Ambrose, Lazarus, & Nair, 1998; Reichert & Ahsher, 1997; Seymour & Hewitt, 1997; Walden & Foor, 2008). Acknowledging this complex process, Tinto's Model outlines components of the institutional experience that have been proven to be key elements in the choice to stay. According to Tinto (1994), the institutional experience is defined as (1) academic performances, (2) faculty/staff interactions, (3) extracurricular involvement, and (4) peer interactions. In other words, engineering students that have positive interactions with faculty, staff, and peers along with positive academic performances and extracurricular experiences are less likely to leave their current degree program.

In accordance with the ideas behind Tinto's Model, I completed this study with the assertion that ESSC administrators provide student interventions with the goal of positively altering several aspects of the undergraduate experience. I also asserted that ESSC administrators construct student interventions to influence these aspects in hopes of helping students attain and achieve specific outcomes and objectives. For example, ESSC administrators may aim to produce positive peer interactions because they believe students will form student groups, earn better grades, and ultimately graduate with an engineering degree. My two assertions are reasonable because much of the existing literature on co-curricular support focuses on the experiences students have while participating in student interventions and impact measures such as grade point average and graduation rates (e.g., Allen, 1999; Dickerson et al., 2014; Fletcher et al., 2001b; Murphy, Gaughan, Hume, & Moore Jr, 2010; Samuelson, Litzler, Staples, Smith, & Amelink, 2014; Whalin & Pang, 2014).

1.4. Purpose of the Study

In an effort to help close the gaps in current literature, the purpose of my study was to explore how the student interventions offered alongside engineering curricula influence the undergraduate experience, particularly for underrepresented students, from the administrative and student perspectives. To accomplish this, the following overarching research question guided my work: **How do engineering student support centers use student interventions to provide undergraduate engineering students with co-curricular support?** Answering my overarching question included answering the following research questions:

RQ1. How are existing engineering student support centers typically configured?

RQ2. What outcomes and objectives do administrators aim to help students attain and achieve through student interventions?

RQ3. What outputs do administrators aim to produce through student interventions?

RQ4. What experiences do engineering students have with student interventions?

RQ5. How do student experiences align with the configurations, outputs, and outcomes? What gaps, if any, exist?

To engage in this work, I interacted with the systems of actors who influence ESSCs using a multi-method qualitative multi-case approach where each of six ESSCs represented an individual case. Specifically, I focused on the ESSC administrators (those who provide support) and

undergraduate engineering students (those who receive support) at multiple institutions. I used open-ended surveys, document artifacts, individual interviews, and focus groups to examine each ESSC. I examined ESSCs as whole units encompassing all interventions. By including the perspectives of both groups (students and administrators), my approach was consistent with recommendations by Borrego, Froyd, and Hall (2010) that suggested studies concerning the diffusion of innovations in engineering education focus on the systems of actors who influence the adoption of practices rather than focusing on one specific group.

1.5. Significance of the Study and Contributions

Answering my research questions led to six contributions towards our understanding of ESSCs and co-curricular support. The primary contribution of my dissertation is the MCCS, which is a conceptual model for constructing and evaluating support systems and individual student interventions (programs, activities, and services) that prioritize undergraduate engineering students specifically. In producing this model, I made five additional contributions as well: (1) I identified and developed definitions for various ESSC classifications; (2) I provided descriptions of current co-curricular student interventions, including a comprehensive list of mechanisms (programs, activities, and services) currently used to facilitate co-curricular support; (3) I provided descriptions of the pros and cons associated with multiple ESSC classifications, which should be considered when student-support practitioners develop or modify existing systems of support; (4) I operationalized the output variables included in the MCCS; and (5) I operationalized the integration variables included in the MCCS. The significance of my study is that, combined, these products of my research further our understanding of co-curricular support and how it can be leveraged to positively influence the undergraduate experiences of diverse populations of engineering students, in particular underrepresented students.

1.6. Audience

The audience (or stakeholders) for this work includes ESSC administrators, engineering colleges, engineering students, and, more broadly, society. **ESSC administrators** and **engineering colleges** are stakeholders for the same primary reason: advanced understanding of co-curricular support will result in research-based recommendations for providing creative and more inclusive/race-neutral support strategies that could be needed in the future as a result of

continued challenges to affirmative action (e.g., "Fisher v. University of Texas at Austin," 2011; "Grutter v. Bollinger," 2003). **Engineering students** are stakeholders because an improved understanding of co-curricular support will contribute to the effort to enhance the undergraduate experience. Lastly, **society** is a stakeholder because we will need to recruit and retain more students from talent pools traditionally underrepresented in engineering as they begin to make up a larger percentage of the United States' population (Turns, Linse, VanDeGrift, Eliot, Jones, & Lappenbusch, 2006), and the co-curricular support provided by engineering colleges will aid the retention of these students. In "Rising Above the Gathering Storm" (Augustine, 2007), the National Society of Engineers recommends that we "[m]ake the United States the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world" (p. 2). Co-curricular support provides an avenue for realizing this vision and Tinto's Model provides a lens to examine how engineering colleges can provide support that increases the likelihood of this occurring.

Ultimately, ESSC administrators, engineering colleges, engineering students, and society are stakeholders in this study because the results will assist institutions in their efforts to support diverse populations of engineering students in comprehensive, effective, inclusive, and creative ways. I envision engineering colleges that house student support systems capable of assisting *all* admitted students, and improving our understanding of co-curricular support creates an ideal opportunity to realize this vision. The key to this potential influence is the practice-informed, research-based model offered by my project for constructing and evaluating co-curricular mechanisms: the model was developed using theory as well as the voices of ESSC administrators and undergraduate students, increasing the likelihood that the strategies are grounded in the literature and can and will be implemented. While prior research has explored the impact of ESSCs with regards to grade point averages and graduation rates, few (if any) have focused on the expansive functions of co-curricular support in engineering.

1.7. Scope

It should be noted that my dissertation only investigated co-curricular support at large, four-year, research-intensive universities and that the focus of this project was entirely on institutional

action (or here, ESSC action) in contrast to student characteristics and factors external to the institution. While I acknowledge the impact that student characteristics and external factors can have on the retention and persistence of engineering students, I was only concerned with the actions ESSCs can take to assist in the efforts to improve diversity and retention. In the future, my work could be expanded to consider student characteristics and external factors.

1.8. Summary

In summary, the purpose of this study was to examine how the student interventions offered alongside engineering curricula influence the undergraduate student experience. I identified a need to investigate co-curricular support for the following reasons: (1) engineering degree programs lose a significant amount of qualified students who are not replaced; (2) many of the problems students face can be mitigated with appropriately directed co-curricular support; and (3) the engineering education community knows very little about how support systems function alongside curricula. Through a qualitative multi-case study, I used Tinto's Model of Institutional Departure as a lens to explore how ESSC administrators aim to influence the undergraduate experience using co-curricular student interventions and how students experience different ESSCs. My study addresses the disconnect between student-retention theory and student-support practice in the current literature and is directly geared towards ESSC administrators, engineering colleges, engineering students, and society. The primary result of this study is a Model of Co-curricular Support (MCCS) specifically geared towards the construction and evaluation of support systems and student interventions in engineering.

In Chapter 1, I present the foundation for my dissertation by outlining background information about the topic. I introduce ESSCs and Tinto's Model, and I specify the purpose of the study, guiding research questions, significance of the work, audience, and scope. In Chapter 2, I provide a detailed overview of existing literature related to the topics of retention-related experiences in engineering, ESSCs, and Tinto's Model of Institutional Departure. I outline the methods used to conduct the multi-method qualitative multi-case study in Chapter 3. I present the research findings in Chapter 4. Lastly, I integrate the results of my dissertation with previous studies and discuss the major conclusions in Chapter 5.

1.9. Terminology

To facilitate understanding of the subsequent chapters in my dissertation, the following terms—which are sorted in a functional order to assist the reader—have been operationalized to keep language consistent within my document because the language around this topic is not universal within the literature:

- **Co-curricular** is complementing, but not part of, the curriculum.
- **Engineering Student Support Center (ESSC)** is a mechanism established by an institution to provide co-curricular interventions (programs, services, and activities) that prioritize engineering students with the aim of positively influencing their success.
- **Program** is an interconnected set of experiences that require prolonged involvement such as summer bridge programs, learning communities, and mentoring programs.
- **Activity** is a condensed experience that does not require prolonged involvement from participants such as orientation activities and workshops.
- **Service** is regularly available assistance or resources such as opportunity advertising or study lounges.
- **ESSC administrator** is a person directly involved in the planning or implementation of the student interventions provided by an ESSC; this includes faculty and staff.
- **Classification** is the category of an ESSC based on the target populations.
- **Structure** is the arrangement of an ESSC with regard to the student interventions (programs, activities, and services) employed.
- **Configuration** is the form of an ESSC that results from the classification and structure.
- **Outputs** are the immediate products that result from the internal operation of student interventions.
- **Outcomes** are the skills, knowledge, and behaviors that students attain through participation in student interventions.
- **Objectives** are broad statements that describe the accomplishments that student interventions prepare students to achieve.
- **Underrepresented Minority (URM)** is a student who identifies as African-American/Black, Hispanic/Latino, or Native-American (NACME, 2009).

- **Retention** is degree completion from the perspective of the institution (or here, engineering college) (Tinto, 2010). Therefore, retention will refer to keeping students within the engineering college where they initially enroll.
- **Persistence** is degree completion from the perspective of the student (Tinto, 2010). Therefore, persistence will refer to keeping students within engineering in general.

CHAPTER 2. Literature Review

2.1. Introduction

At the present time, the engineering education research community has conducted little, if any, research related to the theory of co-curricular support. Advancing the theory of co-curricular support is fundamental to ensuring that future efforts to support undergraduate engineering students from a diverse population are grounded in practice-informed research. In this chapter, I extend the arguments presented in Chapter 1 regarding the need for research on co-curricular support. I begin by describing the challenges faced by underrepresented students in engineering degree programs. I then discuss previous studies that examined ESSCs to highlight the gap in the existing literature. Finally, I introduce Tinto's Model of Institutional Departure and discuss why it was appropriate given the purpose and contexts of the study.

2.2. Challenges Faced by Underrepresented Students

As a field, engineering remains challenged in retaining students in general, and students from specific demographics have remained persistently underrepresented despite years of effort (Lichtenstein, McCormick, Sheppard, & Puma, 2010; Marra, Rodgers, Shen, & Bogue, 2012; Meyers, Stlimman, Gedde, & Ohland, 2010; National Science Foundation & National Center for Science and Engineering Statistics, 2013; Ohland et al., 2008; Su, 2010; Walden & Foor, 2008; Yoder, 2012). With regard to the retention of engineering students in general, Seymour and Hewitt (1997) and, more recently, Ohland et al. (2008) have shown stable rates of outward migration (i.e., retention rates of 53% and 57%, respectively) and miniscule inward migration. Similarly, the National Science Foundation and National Center for Science and Engineering Statistics (2013) has shown persistent lack of diversity with regard to bachelor's degrees awarded in engineering to women and underrepresented minorities (URMs). For example, there were 87,761 bachelor's degrees awarded in engineering during the year 2012, of which only 16,367 were awarded to women, 7,203 were awarded to Hispanic Americans, 3,587 were awarded to African Americans, and 355 were awarded to Native Americans. When we consider the general retention and diversity problems collectively, it is evident that we should heavily focus on retaining students—particularly underrepresented students—once they are successfully recruited. In order for this to happen, we must consider why otherwise qualified students in engineering degree programs are not retained.

Accordingly, many researchers have examined barriers that may force otherwise qualified underrepresented students to leave following enrollment in an engineering degree program (Ambrose et al., 1998; Brown, Morning, & Watkins, 2005; Lee et al., 2014b; Seymour & Hewitt, 1997; Walden & Foor, 2008). To provide examples of these barriers, I review the findings of Ambrose et al. (1998) and Brown et al. (2005) because these studies highlight the retention-related experiences of underrepresented students in engineering and emphasize the barriers a student may face because of gender or race/ethnicity that are typically discussed in studies examining these populations (e.g. Ambrose et al., 1998; Amelink & Creamer, 2010; Lee, Matusovich, & Brown, 2014a; McGee & Martin, 2011; Ohland et al., 2011; Su, 2010; Van Aken et al., 1999; Wentling & Camacho, 2008). I also review Seymour and Hewitt (1997) because this work provides insight into retention-related experiences while emphasizing the barriers faced by engineering students in general, regardless of gender or race/ethnicity.

When considering the retention of underrepresented students in engineering, gender and race/ethnicity are often studied independently. Therefore, in this section I present two studies, with each one providing an example of the barriers faced by one of the groups. First, Ambrose and colleagues (1998) examined persistence in engineering from the perspective of female engineers by interviewing 42 engineers and computer scientists at various career points. Through in-depth interviews, three important deterring factors for women were highlighted: (1) occupational stereotypes associated with the male dominated fields; (2) obstacles such as peers with negative attitudes and sexism/harassment; and (3) challenges with integrating engineering, particularly engineering careers, with their personal lives. However, the researchers noted that there are "no universal constants." They proposed that because becoming a scientist or engineer is not often seen as a "natural" career choice for women, each individual "finds, develops, and expresses her interest in engineering in a different way" (Ambrose et al., 1998, p. 366). Second, Brown and colleagues (2005) examined the experiences of African-American engineering students—particularly their perceptions of campus climate—by surveying individuals attending four conferences supported by the National Society of Black Engineers. The results of this study indicated that those attending Historically Black Colleges and Universities (HBCUs) perceived less racism/discrimination and reported having the most positive college experiences. The authors proposed that the perceptions of racism/discrimination may impact student success, the

ability to recruit other black students, and alumni relationships (Brown et al., 2005). The barriers revealed by these studies are those that impact the retention of underrepresented students specifically.

In addition to the barriers faced by underrepresented students specifically, researchers have also investigated the barriers engineering students face in general. Seymour and Hewitt (1997) provide insight into why qualified students leave science, math, and engineering (SME) and switch into non-science based disciplines by interviewing hundreds of undergraduate students who started their college careers in natural science, mathematics, or engineering and scored at least a 650 on the math portion of the SAT. Prior to this body of work, little research had explored the range of reasons students in general depart from engineering as previous research tended to focus on women and racial/ethnic minorities. The reasons for leaving engineering attributed to the undergraduate experience included, but were not limited to, the following: (1) difficulties with the curriculum, which includes the pace, workload, and grades received; (2) competitive and unsupportive culture; (3) perception of a "weed-out" tradition; (4) difficulties with instructors, including faculty and teaching assistants; and (5) losing interest in the original major or finding another major more appealing (Seymour & Hewitt, 1997). The results of this study suggest that the existence of these negative experiences (i.e., barriers) presents an additional threat to retaining students whether or not they are in underrepresented populations.

When the results from Seymour and Hewitt (1997) are combined with those of Ambrose (1998) and Brown (2005), we have a more complete picture of the barriers in engineering that may force otherwise qualified students to depart following enrollment in an engineering degree program. A summary of these barriers is presented in Table 1. In the table, a brief description of each barrier emphasized in the studies is presented in addition to which type of barrier it is (denoted by X): *common* represents barriers identified by Seymour and Hewitt, *gendered* represents barriers identified by Ambrose, and *raced* represents barriers identified by Brown. Furthermore, it is important to acknowledge the intersection of these dimensions of identity in addition to other dimensions not discussed above, such as class and sexuality (Riley & Pawley, 2011). That is to say, a student who has gender and racial minority status may face the same problems as a majority student in addition to problems connected to race, gender, or other identity dimensions.

For example, a Black female can potentially face the common problems outlined by Seymour and Hewitt (1997), the gendered problems outlined by Ambrose (1998), and the raced problems outlined by Brown (2005).

Table 1: Barriers to Engineering Degree Completion

Barriers in Engineering	Common	Gendered	Raced
Difficulties with the curriculum	X	X	X
Competitive and unsupportive culture	X	X	X
Perception of a "weed-out" tradition	X	X	X
Difficulties with instructors	X	X	X
Losing interest in the original major	X	X	X
Occupational stereotypes	-	X	X
Sexism (harassment)	-	X	X
Racism (stereotypes, discrimination)	-	-	X

It should be noted that Table 1 is not meant to be comprehensive or to suggest that common barriers are experienced with the same severity or frequency across groups or individuals. It is meant to highlight the wide range of barriers a student may face in engineering and to illustrate the possibility of additional barriers when considering gender and race/ethnicity.

In summary, underrepresented students face many challenges in pursuit of a bachelor's degree in engineering, and engineering degree programs as a whole can lose otherwise qualified students. If the engineering education community wishes to address the retention and diversity problems, we must account for these barriers in our solutions. One way of addressing these problems is providing co-curricular support to remove as many obstacles as possible. In the next section, I discuss a common mechanism for supporting engineering students—Engineering Student Support Centers.

2.3. Engineering Student Support Centers

ESSCs have a relatively short history. In the late 1970s, recently desegregated universities began housing ESSCs in the category of Minority Engineering Programs (MEPs) to recruit and improve the retention of URM students in engineering degree programs (Morrison & Williams, 1993). Around the same time, institutions also began housing ESSCs in the category of Women

in Engineering Programs (WEPs) to assist women in a similar manner. Over time, MEPs and WEPs commonly existed at more schools, and ESSCs with distinctive target populations surfaced as well. Given the relatively short history of ESSCs, it is not surprising that there are gaps in our knowledge about these support systems as a whole.

Despite the research on the individual interventions offered by ESSCs (e.g. Amenkhienan & Kogan, 2004; Fletcher et al., 2001b; Lee et al., 2014b), very little is known about how the systems of support offered by ESSCs are intended to influence the undergraduate experiences (i.e., how ESSCs intersect with research on barriers to engineering degree completion) or the realities of assisting students in this manner because little research has attempted to examine ESSCs holistically. There are three notable studies that examine ESSCs: (1) Hackett and Martin's (1998) examination of "Faculty Support for Minority Engineering Programs," (2) Knight and Cunningham's (2004) "Inside Look at the Structure of Women in Engineering Programs," and (3) Shehab, Murphy, and Foor's (2012) examination of "The Impact of Redesigning a Minority Engineering Program." I describe each of these studies in this section to provide an overview of what is already known about the collective ESSC.

Hackett and Martin (1998) examined faculty perceptions with regard to the "value and appropriateness" of both MEPs overall and common MEP interventions by surveying 191 faculty members from over 30 schools with varying size, institutional type, and location. Engineering faculty were asked to complete a survey and rate the value and appropriateness of MEPs as well as the following MEP interventions: (1) professional societies based on gender or ethnicity (e.g., National Society of Black Engineers), (2) scholarships, (3) a student study center, (4) a summer bridge program, (5) a tutoring program, (6) a career fair, and (7) an awards banquet. Through the study, the researchers concluded that engineering faculty were not as supportive of interventions that physically segregated students such as study centers, award banquets, or career fairs; support such as scholarships and tutoring programs were more favorable to engineering faculty as these interventions did not physically separate students based on race or gender (Hackett & Martin, 1998). The results of this study suggest that classification and structure can impact the manner in which an ESSC operates, particularly with regard to how it is viewed by engineering faculty.

Knight and Cunningham (2004) examined Women in Engineering Programs by interviewing 28 ESSC administrators from 26 institutions throughout the United States. Through analysis of the interviews, the researchers provided an initial understanding of WEPs from the ESSC administrator perspective. To determine which interventions directors believed were most effective, the researchers asked participants which current intervention they would keep if allowed only one. Ten of the 28 directors said mentoring because of the low financial cost and ability to help numerous students build academic and social support networks. Additionally, directors believed orientation activities, research programs, academic advising, summer programs, classroom clustering, and learning communities were useful as well and reported that female faculty members were more eager to become involved than male faculty members (Knight & Cunningham, 2004). Similar to the study by Hackett and Martin, the results of this study provide further evidence suggesting that classification and structure impact the manner in which an ESSC operates. In particular, Knight and Cunningham provide insight with regard to how ESSC administrators decided which student interventions to offer (e.g., low financial cost) and how resources restrict them.

More recently, Shehab, Murphy, and Foor (2012) examined the influence that the configuration of an MEP has on students by analyzing interviews from over one hundred engineering students with varying races/ethnicities (i.e., URMs and Asian-Americans), academic levels, and majors. The researchers used data that was originally collected for a project aiming to identify factors that lead to the different success rates among populations. However, it emerged that many student experiences were strongly affected by changes made to the local MEP. By analyzing the data chronologically (i.e., as it aligned with MEP administrative and physical changes), the researchers identified three components of MEP design that influenced the experience of the students involved: (1) the mission, (2) the physical space, and (3) the personnel. That is to say, as administrative control of the MEP changed, the mission of the MEP expanded to include first-generation college students; the office was relocated to a more professional environment that included a reception area and advisor offices; and the personnel associated with the MEP changed. As a result of these changes, students (primarily African-American students) felt as if they lost their safe space and the MEP lost its identity—the new mission modified the target population from *minority* to *multicultural* (Shehab et al., 2012). The results of this study

provided an initial understanding of how ESSC configuration can impact the function of an ESSC from the student perspective, particularly the impact that physical space and the center's scope with regard to target population can have on the student experience.

In summary, previous studies have examined ESSCs, and faculty, administrator, and student perspectives all show that the configuration of an ESSC matters. However, we know little about ESSC configuration or how these mechanisms function alongside engineering curricula. Furthermore, we also know little about how the intentions guiding ESSCs compare and contrast across classifications because previous studies have examined MEPs and WEPs separately and have not included any additional classifications. As a result, the engineering education research and practice community has a limited understanding of the various structures and classifications for providing co-curricular support. It is important to understand ESSC configurations and the intentions behind them because different ESSCs may have completely different purposes and, thus, are structured differently intentionally. My research begins to fill this gap by using Tinto's Model of Institutional Departure to examine ESSCs of varying configurations from multiple perspectives.

2.4. Theoretical Framework

I used Tinto's (1994) Longitudinal Model of Institutional Departure to define what constituted the institutional experience and to theorize my research findings. Tinto's Model focuses on institutional action and emphasizes the role an institution has in the education process. The model was designed to address the process of student departure as it occurs and is centered on events that occur *while* students are immersed in their undergraduate experience (Tinto, 1994; Tinto, 2012). More specifically, Tinto's Model attempts to explain how a student's interaction with the academic and social systems within an institution can influence whether he or she decides to persist towards degree completion. The model suggests that positive institutional experiences allow students to integrate into the academic and social systems of a university and induce student commitment to the institution, while negative institutional experiences (e.g., facing barriers) have an adverse effect (Tinto, 1994). As a result, the institutional experiences believed to facilitate academic and social integration are key components of my proposed study. As shown in Figure 2, academic integration is influenced by the student's academic performance

and interactions with faculty and staff, and social integration is influenced by the student's involvement with extracurricular activities and interactions with his or her peers.

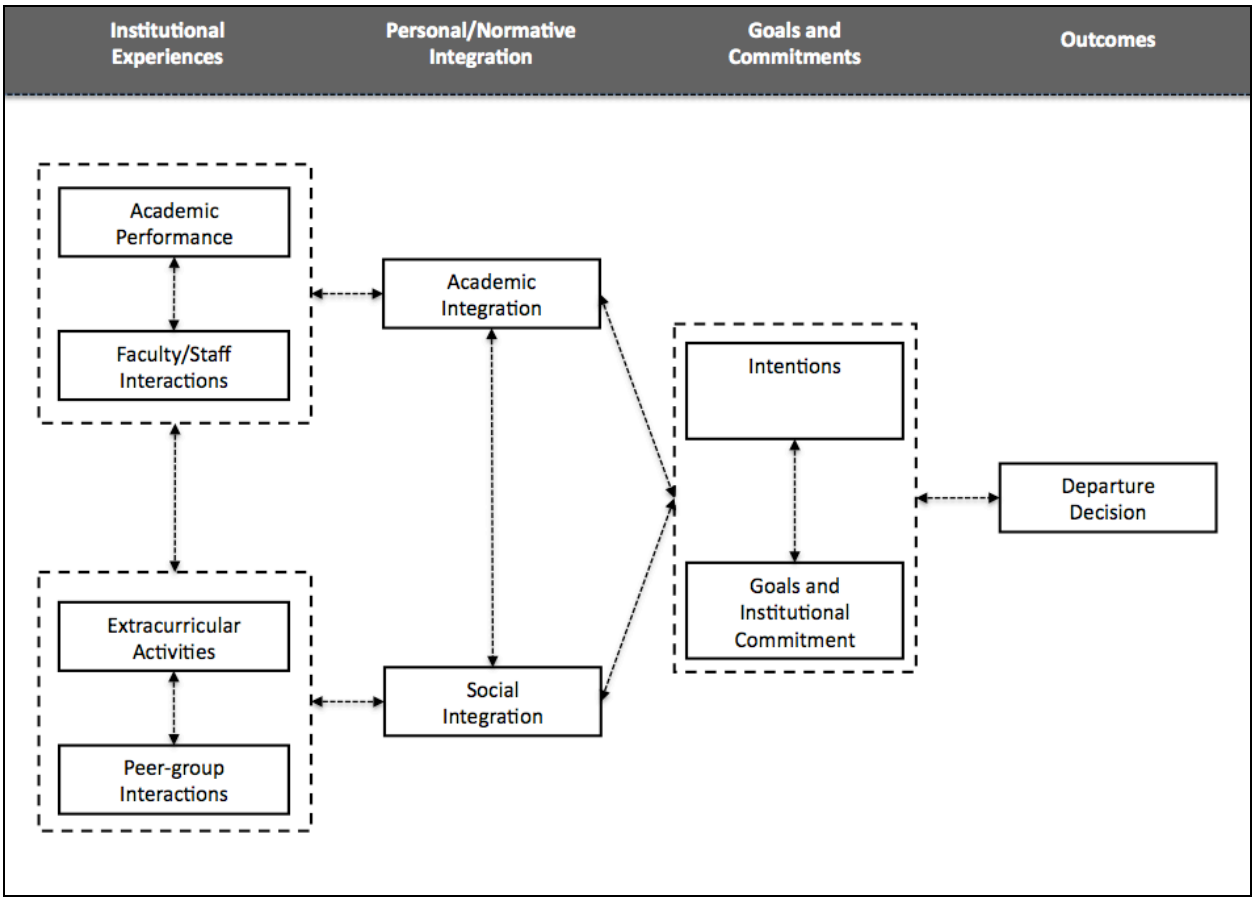


Figure 2 – Subset of Tinto's (1994) Longitudinal Model of Institutional Departure

In general, Tinto's Model is traditionally used to quantitatively examine departure at the university level (Braxton, 2000; Tinto, 1994), and researchers often focus their studies on isolated components (e.g., Barnett, 2011; Berger & Braxton, 1998; Okun, Goegan, & Mitric, 2009). For example, Berger and Braxton (1998) examined the influence that organizational attributes have on social integration and student departure by studying over 700 undergraduates from a highly selective, private, residential, research-oriented university; Barnett (2011) examined the impact of validation from faculty on academic integration to determine if these experiences positively influenced student departure by studying over 300 students enrolled in an introductory level English course at a community college; and Okun and colleagues (2009) examined the effect that the perceived quality of each university a student had the opportunity to

attend and his or her institutional preference have on initial institutional commitment by studying over 1,100 first-year college students at a large state university. From these studies, it is evident that Tinto's Model can be used to provide insight with respect to the issues that impact student departure when examining discreet components.

Though less frequently, researchers also use Tinto's Model in qualitative studies to provide a richer understanding of how the process represented in Tinto's Model actually occurs in college environments (e.g. Christie & Dinham, 1991; Palmer, Davis, & Maramba, 2011). For example, Christie and Dinham (1991) examined the influence of the social system on social integration by interviewing 25 full-time, residential and non-residential, first-year students at a large, public, research university to examine student perceptions of the college experience and gain insight with regard to how specific activities facilitated social integration. Palmer and colleagues (2011) explored the factors that academically under-prepared Black males attributed to their success by interviewing 11 Black male students who entered a public HBCU as "academically under-prepared" and persisted to graduation. From these studies, it is evident that Tinto's Model can also be used to examine the actions an institution can take to improve the undergraduate experience.

2.4.1. Application of Tinto's Model

While past studies have improved our understanding of student departure at the university level, we remain limited in our understanding of specific actions that can be taken and the challenges that institutions (or here, engineering colleges) face while serving various stakeholders (Tinto, 2006). Consequently, I used Tinto's Model as a lens to qualitatively examine institutional action that is taken at the college level and focused my study on the institutional components collectively. I took such an approach because qualitative perspectives provide descriptions that allow change agents (i.e., student-support practitioners) to make connections between the cases in the study and their respective institutions (Borrego, Douglas, & Amelink, 2009), and considering the components collectively allowed me to explore and operationalize the overall functions of ESSCs instead of isolated components. Tinto (2006) supports such an approach in the following statement:

> In the world of action, what matters are not our theories per se, but how they help institutions address pressing practical issues of persistence…[C]urrent theories of student leaving typically utilize abstractions and variables that are, on one hand, often difficult to operationalize and translate into forms of institutional practice and, on the other, focus on matters that are not directly under the immediate ability of institutions to influence. (p. 6)

As stated above, theories alone do not provide practitioners with understanding of specific forms of institutional practice or the actuality of these practices in distinct settings. While studies similar to those previously summarized contribute to Tinto's Model and our theoretical understanding of student departure, the results are not well suited to address the task of providing student-support practitioners (i.e., ESSC administrators) with insight into providing effective co-curricular support. However, using Tinto's Model to inform my study resulted in insights specifically geared towards these practitioners regarding actions that can be taken in their particular settings to provide students with comprehensive support.

In relation to Tinto's Model, I conducted this study with the following propositions: (1) ESSC administrators aim to support engineering students by implementing student interventions that result in positive institutional experiences, and (2) students who participate in these interventions have an influenced undergraduate experience. Both propositions are visually represented in Figure 3. As defined in Chapter 1, outputs represent the institutional experiences as a result of participating in interventions, and outcomes/objectives represent a collapsing of the model component that occurs subsequent to those experiences. The categories included as *outputs* and *outcomes/objectives* in Figure 3 come directly from Tinto's Model.

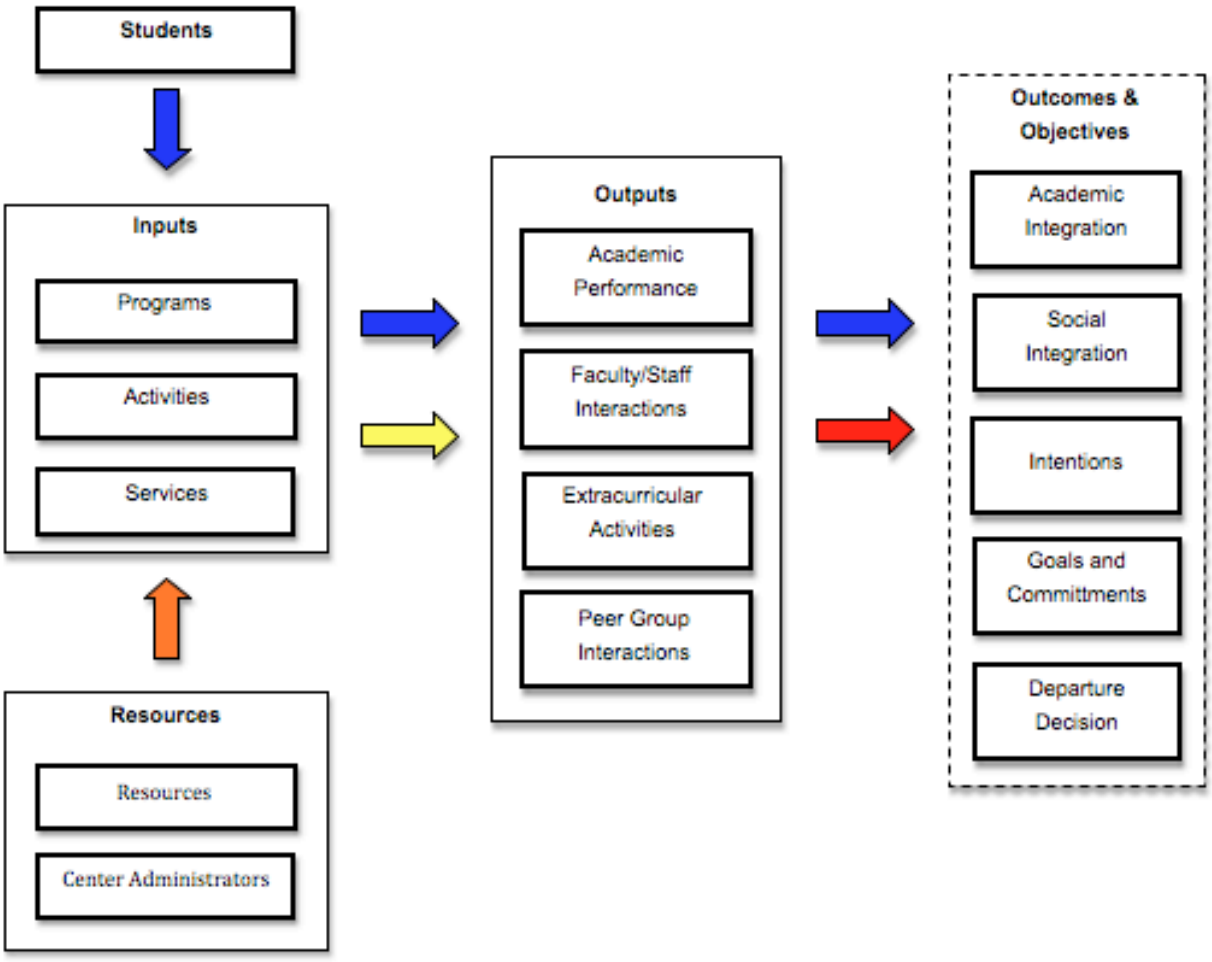


Figure 3 – Initial Propositions (Adaptation of Tinto's Model)

Note that Tinto illustrates the *Departure Decision* as an outcome in Figure 2 (i.e., the subset of Tinto's Model) and the components listed in Figure 3 (i.e., my initial propositions) only represent imaginable outcomes/objectives. The remaining components in Figure 3 are a proposed depiction of how co-curricular support happens via student interventions. These components represent ESSCs and the inputs (i.e., student interventions) of which they are composed: programs, activities, and services. The orange, yellow, and red arrows in Figure 3 represent the ESSC administrator perspective and the blue arrows represent the student perspective. In particular, the *red arrow* represents the intentions of ESSC administrators regarding the outcomes and objectives they aim to help students attain or achieve (e.g., sustained interest in engineering); the *yellow arrow* represents the outputs (e.g., interactions with engineering peers)

they aim to produce through the inputs; and the *orange arrow* represents the use of resources by ESSC administrators to produce inputs or student interventions. The *blue arrows* represent the experiences of students with the ESSC(s) at their respective institution: students participate in inputs, experience outputs, and attain/achieve outcomes and objectives.

If properly guided, ESSCs can intentionally provide interventions that produce effective outputs, thus increasing the likelihood of the outcomes and objectives being attained and achieved by students. For example, ESSC administrators could have the objective of improving student retention and believe positive peer-group interactions increase the chances of this occurring. As a result, ESSCs might offer a mentoring program that is focused on establishing a peer support network for incoming engineering students.

2.4.2. Appropriateness of Tinto's Model

The purpose of my study required that I use a theoretical lens that paid adequate attention to the role of the institution and operationalized what the undergraduate experience entailed. Tinto's Model was appropriate for the purpose of the study given that it meets each of these requirements. First, Tinto's Model was designed to serve as a guide for institutional action (Tinto, 1994). According to Tinto (1994):

> [The model] is structured to allow institutional planners to identify those elements of the institutional environment, academic and social, which may interfere with degree completion. In permitting such identification the model is intended to enable institutional officials to ask and answer the question, how can the institution be altered to enhance retention on campus? (p. 113)

In other words, Tinto's Model is well suited for investigating the institutional actions intended to enhance the undergraduate experience and can contribute to the development of research products that colleges can use to examine the current and potential influence of co-curricular support at their respective institutions. Tinto's Model also operationalized what constituted the *institutional experience* (academic performance, faculty/staff interaction, extracurricular

involvement, and peer-group interactions) and provided a holistic way to view the undergraduate experience during my investigation.

It was also imperative that I select a model that was appropriate for examining the undergraduate experience within the engineering discipline. Tinto's Model was appropriate in this regard because the four components outlined by the model (as constituting the institutional experience) are four areas consistently represented in the current discourse in engineering education. More specifically, each component has been considered in numerous studies conducted about engineering students: (1) academic performance (e.g., Amenkhienan & Kogan, 2004; Borrego et al., 2010; Fletcher et al., 2001b; May & Chubin, 2003; Ohland & Zhang, 2002; Reichert & Ahsher, 1997), (2) faculty/staff interactions (e.g., Brown et al., 2009; Matusovich, Lee, Janeski, & Winters, 2011; Newman, 2011; Simmons & Martin, 2014; Vogt, 2008; Winters, Matusovich, & Streveler, 2010), (3) extracurricular activities (e.g., Foroudastan & Campbell, 2005; Khorbotly & Al-Olimat, 2010; Sánchez-Alejo, Aparicio, Álvarez, & Galindo, 2010; Tsui, 2010; Wankat, 2005), and (4) peer-group interactions (e.g., Allen, 1999; Amenkhienan & Kogan, 2004; Anderson-Rowland, 1998; Lee & Cross, 2013; May & Chubin, 2003; Simmons & Martin, 2014). Though these researchers did not use Tinto's Model per se, each study provides insight regarding the institutional experiences of undergraduate engineering students as outlined by Tinto and demonstrates the appropriateness of the model for the discipline.

Lastly, it was necessary that I select a model that paid adequate attention to (1) the aspects of the undergraduate experience that are targeted by the student interventions typically provided by ESSCs and (2) the barriers in engineering that students may face. First, Tinto's Model is suitable for considering the student interventions typically provided by ESSCs because the constructs in the model that represent the institutional experience align with the aspects of the undergraduate experience that are typically targeted these mechanisms. Hermond (1995) provides evidence for this claim by stressing the existence of seven common support strategies in MEPs—the oldest and one of the most common ESSC structures. In particular, he identified (1) matriculation, (2) orientation, (3) academic advising, (4) student organizations, (5) tutoring/academic workshops, (6) personal counseling, and (7) financial aid as common strategies for retention efforts and each aligns with the institutional experiences outlined by Tinto to some extent. For example,

matriculation strategies are retention efforts that occur the summer before freshman year. Designed to ease this transition, these programs center around academic reviews (i.e., academic performance), social activities (i.e., peer group interactions), and interacting with faculty and staff (i.e., faculty/staff interactions) (Fletcher et al., 2001a; Haden & Lapan, 2007; Murphy et al., 2010). Though ESSCs will not provide identical interventions, the institutional actions outlined in Tinto's Model are appropriate for examining ESSCs as evidenced by some of the common strategies. Second, Tinto's Model is suitable for considering the barriers in engineering because the constructs in the model that represent the institutional experience (i.e., undergraduate experience) are broad enough to encompass student interventions intended to address the barriers in engineering listed in Table 1. For example, interventions intended to help students overcome difficulties with the curriculum could be related to academic performance. Likewise, interventions intended to help students overcome or avoid harassment or discrimination could be related to peer-group interaction.

2.5. Summary of Chapter 2

Through the offering of student interventions, ESSCs have the potential to improve the institutional experience of undergraduate engineering students and remove many of the barriers that underrepresented students may face in pursuit of undergraduate engineering degrees. While much of the existing research around ESSCs focuses on measures such as grade point averages or graduate rates, we know little about the configurations, outputs, outcomes/objectives, or the student experience with these support systems. Tinto's Model provides an appropriate research lens for my dissertation and offers a way to identify institutional action that can be taken to provide co-curricular support. This chapter provided an overview of the challenge of graduating students in engineering, outlined our current understanding of ESSCs, and demonstrated the appropriateness of Tinto's Model given the purpose and context of my dissertation. In the next chapter, I discuss the research methods used to fulfill that purpose.

CHAPTER 3. Research Methods

3.1. Introduction

The purpose of this multi-case study was to explore the ESSC administrator and student perspectives on how student interventions offered alongside engineering curricula influence the undergraduate experience, particularly for underrepresented students. The overarching research question for my study was as follows: **How do engineering student support centers use student interventions to provide undergraduate engineering students with co-curricular support?** To address this question, I answered a series of sub-questions:

RQ1. How are existing engineering student support centers typically configured?

RQ2. What outcomes and objectives do administrators aim to help students attain and achieve through student interventions?

RQ3. What outputs do administrators aim to produce through student interventions?

RQ4. What experiences do engineering students have with student interventions?

RQ5. How do student experiences align with the configurations, outputs, and outcomes? What gaps, if any, exist?

To answer these research questions, I used Tinto's (1994) Model of Institutional Departure as a theoretical lens and the case study research approach (Stake, 2006; Yin, 2009) to guide my research design and to direct my decisions with regard to data sources, participant selection, data collection, and data analysis. More specifically, I used a multi-method, multi-case study design to explore the particulars of several ESSCs from the ESSC administrator and student perspectives.

In this chapter, I describe the research methods I used in my dissertation. First, I provide a synopsis of my philosophical perspective. Next, I give an overview of the research design and define the unit of analysis. I then describe each research phase, including participant recruitment and selection. Subsequently, I describe the analysis procedures that I used. Finally, I discuss the validity and reliability of the research as well as the limitations and bias I brought to the study.

3.2. Philosophical Perspective

My philosophical perspective as a researcher had a strong influence on my research design. I brought a pragmatic worldview perspective to this study. According to Creswell (2009),

pragmatists are concerned with real-world, practice-oriented problems and use whatever methods are available and most suitable to meet the purpose of the research. As a pragmatist, I wanted to study the practice-oriented problem of providing effective co-curricular support and, specifically, how ESSCs provide student interventions in the real-world context of their college/university.

In alignment with my worldview and the purpose of the study, I chose a research design that involves strategies and methods that provide variability with regard to data sources and data collection. I used a qualitative strategy of inquiry (i.e., multi-case study approach) and multiple data collection methods (e.g., interviews and open-ended surveys) to explore the intentions of ESSC administrators and the experiences of students. These methods worked well for my study because they allowed me to gather data needed to explore how co-curricular support functions alongside engineering curricula in context. By using multiple qualitative methods and multiple data sources, I was able to triangulate and provide two points of view of each ESSC (Stake, 2010); this dual perspective ultimately allowed me to blend the ESSC administrator and student perspectives and better understand co-curricular support in engineering. Through the study, I provide insight into the complexity and realities of supporting engineering students using co-curricular student interventions.

3.3. Research Design & Unit of Analysis

I adopted a multi-method, qualitative, multi-case study approach (Stake, 2006; Yin, 2009). In qualitative research, a case study is an in-depth inquiry of a bounded system based on the collection of data from various sources. Case studies are used to seek understanding of larger phenomenon by focusing on specific examples, i.e. cases (Creswell, 2007; Rossman & Rallis, 2012; Stake, 2006; Yin, 2009). For my study, the phenomenon of interest was the ways institutions provide undergraduate engineering students with co-curricular support. In order to better understand this phenomenon and to increase the likelihood of information about it being obtained through the study, I had to carefully select cases (Stake, 2006). However, before I could select the cases for my study, I had to clearly define the unit of analysis (Yin, 2009). The unit of analysis established the bounded systems and specified what was to be studied (Rossman & Rallis, 2012). In my study, the unit of analysis also determined what constituted a distinct case.

For this project, I defined the unit of analysis as an individual ESSC–as opposed to all of the co-curricular support offered at an institution. For example, I considered an MEP and WEP separate ESSCs even if both were housed at the same university. How I defined the unit of analysis was a direct result of my overarching question and several propositions I set forth. My overarching question was: *How do engineering student support centers use student interventions to provide undergraduate engineering students with co-curricular support?* The propositions I brought into the study are as follows. First, while a student may take advantage of the programs, activities, and services offered by multiple ESSCs (e.g., the women of color with access to both a MEP and WEP simultaneously may be involved in both ESSCs), ESSC administrators are likely to only have direct involvement with the interventions provided by their respective ESSC. I also make the proposition that the outputs, outcomes, and objectives associated with an ESSC–as well as the barriers faced and support received by ESSC administration–can vary across ESSCs/ administrations within the same institution.

The implication of my unit of analysis–as defined by me–was that a single university could potentially have multiple cases with separate administrations or one case with a single administration. Therefore, each ESSC represented a single case in my dissertation. Furthermore, my unit of analysis made it possible for me to select cases with shared institutional context; this allowed me to potentially examine the influence of ESSC structure and classification (i.e., which target populations are being supported by the ESSC) within a university. For example, an MEP would constitute an individual case even if a WEP were present at the same institution as long as they had distinct leadership. However, in instances where an MEP and WEP existed jointly–under single or overlapping leadership–the combination would represent a single case and, thus, be classified as a Women & Minority Engineering Program (WMEP).

As shown in Figure 4, the unit of analysis–the ESSC in this instance–established a bounded system for each case. More specifically, the unit of analysis (1) influenced the focus of data collection and data analysis, (2) established what conclusions and statements could be made as a result of my study (Patton, 2002), and (3) provided boundaries for distinguishing what was included in the case from what was considered external to the case (Yin, 2009). Based on the unit of analysis, I collected data with regard to each program, activity, and service that was

considered a part of an ESSC from the perspective of the ESSC directors, and ESSC resources included the personnel subsystem (e.g., ESSC administrators) and physical the resources (i.e., offices, lounges, etc.) that were considered a part of the ESSC from the perspective of the ESSC director. I included personnel that the ESSC director considered a part of the administration even if he or she was not formally employed by the ESSC, and I investigated interventions that were significantly supported by or considered a physical part of the ESSC even if such interventions were not technically connected to the ESSC according to the university.

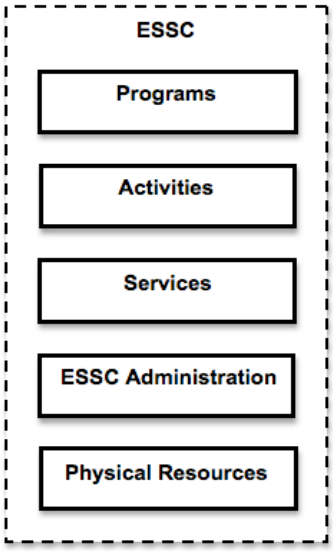


Figure 4 - Unit of Analysis

3.4. Research Phases and Data Collection

I examined ESSCs using a multiple-phased strategy because this approach allowed me to use the preliminary information from each phase to inform the data collection procedures of subsequent phases in real time. The integration of each phase was essential due to the exploratory nature of the study. In this section, I discuss each research phase and the research methods used to examine the bounded systems in the study.

I began the study with a review of the literature and an Internet search of ESSCs nationwide (Phase 1) to identify what was already known about co-curricular support and to establish a baseline understanding of ESSC configuration. I then used a pilot case (Phase 2) to develop the data collection instruments and to develop an initial coding strategy to be used in subsequent

phases: I applied each of the data collection and analysis methods with the pilot case first. Next, I deployed a national survey to ESSC administrators (Phase 3) to verify the structures identified during the review of the literature and the Internet search conducted during Phase 1, and to recruit potential partner ESSCs. Once potential partners were recruited, I selected five more ESSCs (a total of six including DEP1, which served as the pilot case) and I reviewed online document artifacts from each ESSC (Phase 4) to establish a baseline understanding of the interventions provided by each ESSC and to personalize the research protocols as needed. Next, I deployed open-ended surveys to student participants (Phase 5) to collect information about their individual (or isolated) experiences with their respective ESSC and to recruit potential focus group participants. Lastly, I visited each site for 3-5 days and conducted individual interviews with ESSC administrators and focus groups with students (Phase 6) to collect additional information about each ESSC and the collective student experiences. Table 2 summarizes the overall study design. In the subsequent sections, I discuss the data collection and analysis methods for each phase.

Table 2: Research Methods Overview

Phase	Data Collection Methods	Research Question(s) Addressed
1 Baseline Understanding	• Internet Search [Websites] • Literature Review	• How are existing engineering student support centers typically configured? **(RQ1)**
2 Instrument Development	• Interviews [Admin] • Interviews [Students] • Open-ended surveys [Students] • National survey [Admin]	*(Interview protocol and survey development)*
3 Classification Confirmation	• National survey [Admin]	• How are existing engineering student support centers typically configured? **(RQ1)** *(Interview protocol and survey personalization)*
4 Case Selection	• Case selection • Document analysis [Websites]	• How are existing engineering student support centers typically configured? **(RQ1)** • What outcomes and objectives do administrators aim to help students achieve through student interventions? **(RQ2)** • What outputs do administrators aim to produce through student interventions? **(RQ3)**
5 Student Survey Distribution	• Open-ended surveys [Students]	• What experiences do engineering students have with student interventions? **(RQ4)**
6 Site Visits	• Interviews [Admin] • Focus groups [Students]	• How are existing engineering student support centers typically configured? **(RQ1)** • What outcomes and objectives do administrators aim to help students achieve through student interventions? **(RQ2)** • What outputs do administrators aim to produce through student interventions? **(RQ3)** • What experiences do engineering students have with student interventions? **(RQ4)** • How do the student experiences align with the configurations, outputs, and outcomes? What gaps, if any, exist? **(RQ5)**

3.4.1. Phase 1: Establishing a Baseline Understanding of ESSCs

I began the study by establishing a baseline understanding of ESSCs with regard to two specific areas: (1) how prevalent ESSCs are at various types of institutions; and (2) how ESSCs can be classified given the existing landscape. To explore the configurations of ESSCs and to determine their prevalence, I compiled a preliminary list of reputable (i.e., well thought-of) and/or diverse engineering programs, investigated whether or not they had an ESSC, and, if so, determined in what classification. I was particularly interested in reputation and diversity because I believed the combination of the categories would result in an initial list of institutions that were excelling in the areas of retention and/or diversity and provide a useful starting point for establishing a baseline as to whether such places commonly housed ESSCs. To increase my chances of

developing such a list, I included institutions ranked high in engineering as well as those graduating the most underrepresented students by using the following lists:

1. Best Undergraduate Engineering Programs Rankings (where doctorate is highest degree) from the 2012 U.S. News & World Report;
2. Best Undergraduate Engineering Programs Rankings (where doctorate not offered) from the 2012 U.S. News & World Report;
3. Bachelor's Degrees awarded to Black or African-Americans (2010-2011) from the ASEE School Profiles;
4. Bachelor's Degrees awarded to Women (2010-2011) from the ASEE School Profiles;
5. Bachelor's Degrees awarded to Hispanics (2010-2011) from the ASEE School Profiles.

Lists 1-2 were selected because the U.S. News & Report is a recognized leader in college rankings and provided a suitable source of identifying reputable engineering colleges. I selected 10 schools from each list because the names of the top 10 schools from each list was readily available online and I wanted to equally represent both institutional categories. List 3-5 were selected because the American Society of Engineering Education (ASEE) collects and publishes the leading data on engineering colleges in the United Stated and provided an accurate source of identifying the nation's leaders with regard to awarding engineering degrees to students from underrepresented populations. I selected 15 schools from each list because the number of institutions included on each ranged from 19-50 and I wanted to equally represent each category while producing a manageable list for this exploratory phase with regard to quantity. I restricted the initial search because I planned on conducting a wider search once preliminary information was gathered to guide the process of identifying potential partner sites, which I further describe in Phase 3 as a part of case selection. The selection process resulted in a list of 50 universities from multiple regions of the nation with a range from very small to large, public to private, and undergraduate focus to very high research activity (Carnegie Foundation, 2012). Since many schools were represented on multiple lists, the total number of schools was less than adding the number of schools from each list together. For example, Georgia Tech showed up on List 1, 3, 4, and 5 since it was ranked highly and enrolled a large population of students from each underrepresented population.

During my search of websites, I investigated whether each school on the list housed an ESSC by reviewing the information listed under the respective college of engineering as well as the institution more broadly. The results from searching the website of each of the 50 institutions enabled me to develop five ESSC classifications and gather baseline information regarding their prevalence in the Unites States (See Table 3 for the results) (Lee & Matusovich, 2013). It should be noted that the definitions in Table 3 were intentionally generic (i.e., only specifying the advertised target populations) and were refined during Phase 3. Additionally, eight institutions offered both a WEP and MEP separately and were consequently counted twice so the percentages in Table 3 exceed 100% (i.e., each university that had a WEP also offered a MEP).

Table 3: ESSC Classifications (Preliminary) and Prevalence

Classification	Preliminary Definition	Prevalence
Minority or Multicultural Engineering Program (MEP)	Student support center that focuses on ethnic diversity without a specific focus on gender diversity.	10 Schools (20%)
Women in Engineering Program (WEP)	Student support center that focuses on gender diversity without a specific focus on ethnic diversity.	8 Schools (16%)
Women & Minority Engineering Program (WMEP)	Student support centers that separately focuses on ethnic and gender diversity in engineering but under common administration.	10 Schools (20%)
Diversity in Engineering Program (DEP)	Student support center that focuses on engineering students in general while targeting underrepresented populations; this includes centers that focus on broadening participation by targeting students from underrepresented populations or under-resourced high schools communally.	3 Schools (6%)
General Engineering support Program (GEP)	Student support center that focuses on students in general without a specific focus on broadening participation or diversity.	3 Schools (6%)
No ESSC Identified	N/A	25 Schools (50%)

In looking for patterns with regard to ESSC classifications, I found the following trends: (1) each large, public, research-intensive university (n = 16) offered an ESSC in some format; (2) ESSCs were not as prevalent in schools under different categories (e.g., small undergraduate focused institutions or HBCUs); (3) no patterns were found by setting (i.e., residential or non-residential) or geographic region. These finding assisted with the selection of cases in Phase 4, which I discuss in further detail in Section 3.44.

3.4.2. Phase 2: Instrument Development and Preliminary Data Collection

In the second phase of the study, I used the pilot ESSC to develop the data collection instruments and to develop the initial coding strategy; I discuss both in greater detail in the following sections.

Diversity in Engineering Program at University 1 (DEP1) served as the pilot case and primary site for instrument development in addition to providing useful research data. I selected DEP1 as the pilot case for several reasons. First, DEP1 represents one of the classifications revealed during Phase 1: DEP1 is a Diversity in Engineering Program (DEP). Second, DEP1 is located at a large, public, research-intensive university and, thus, represents the institutional type that most commonly offers ESSCs; this strengthened the transferability of my pilot results since I only selected cases located at such universities. Finally, my proximity and relationship with DEP1 allowed me to develop instruments prior to using them at other locations and enabled me to revisit the pilot case if necessary.

Instrument development was conducted during August and September of 2013 as part of Phase 2. I collected data from DEP1 using each of the proposed instruments, and then I developed the initial round of a priori codes using the collected data. Specifically, I conducted two interviews with ESSC administrators (director and assistant director) and a focus group with four undergraduate engineering students (upperclassman) that I knew were familiar with the informal and formal support provided by DEP1. I also asked each ESSC administrator to review the national survey and each student to review/complete the open-ended survey. Based on the preliminary a priori coding, I concluded that the protocols would elicit sufficient information about the phenomenon. I also updated the initial coding strategy and student survey to include *Professional Development,* which is not a component of the institutional experience as outlined by Tinto's Model yet emerged as salient from preliminary coding of the pilot data. The emergence of *Professional Development* is described further in the results section 4.2.

3.4.3. Phase 3: National Survey Distribution & Classification Development

In the third phase of the study, I distributed a national survey (Survey 1) to (1) identify ESSCs that were potentially interested in participating in my dissertation as partner sites and to (2) collect feedback on the accuracy of the preliminary ESSC definitions that I developed during Phase 1. Survey 1 (i.e., the administrators survey) can be found in Appendix A. I distributed Survey 1 to approximately 90 ESSCs throughout the nation using publically available email addresses. Survey 1 was distributed to schools from the initial sample (via Phase 1) as well as to a broader sample of ESSCs produced through the combination of a more extensive Internet search and reviewing the list with two experienced ESSC directors who could evaluate the completeness of the list and reveal ESSCs that were not initially included.

In order to identify partner sites through the survey, I asked ESSC administrators to provide general information about their respective ESSC. More specifically, administrators were asked to provide information such as the following:

- Name and location of the ESSC;
- A description and size of the target populations;
- How they would classify their respective ESSC regarding the classification options.

ESSC administrators were also surveyed with regard to the specific programs, activities, and services they provide (See Survey 1 for a list of choices) and asked them whether they would like to be contacted about the possibility of participating in the subsequent phase of this study.

To make sure I did not miss any important alternative classifications and to get feedback on the preliminary definitions for ESSC classifications developed during Phase 1, I also asked administrators to agree or disagree with each of the classifications (or to state that they were unfamiliar with the ESSC type) and to provide a reason when they disagreed; the survey resulted in feedback from 27 administrators. In general, administrators agreed with the classifications but did not believe the initial definitions for MEP, WEP, or DEP were complete. With regard to the definition for Minority or Multicultural Engineering Programs (MEPs), administrators suggested mentioning that gender is also a focus, mentioning that race is focused on as demonstrated by the federal guidelines, and removing the word “diversity” because it is too broad. With regard to the definition for Women in Engineering Programs (WEPs), administrators suggested that I

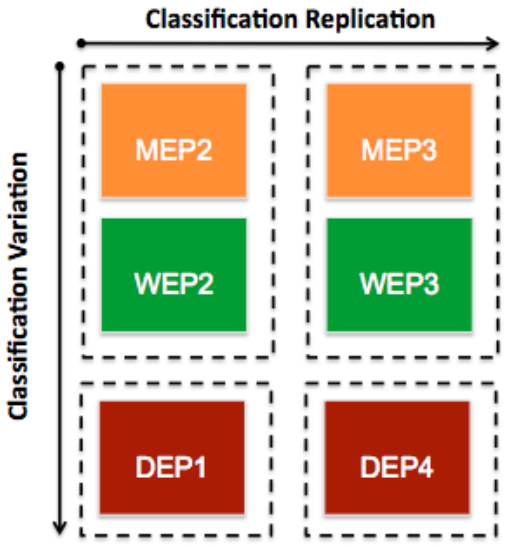
reference gender parity and mention that race is also a focus. Lastly, with regard to Diversity in Engineering Programs (DEPs), administrators suggested mentioning that DEPs attempt to identify and address the unique needs of underrepresented populations in effort to broaden participation and improve diversity. The revised list of ESSC classifications as a result of Phase 3 is presented in Table 4 below.

Table 4: ESSC Classifications (Revised Definitions)

Classification	Preliminary Definition	Revised Definition
Minority or Multicultural Engineering Program (MEP)	Student support center that focuses on ethnic diversity without a specific focus on gender diversity.	Student support center focused on race/ethnicity (as demonstrated by the federal guidelines) with less focus on gender while aiming to address the factors for underrepresentation of certain populations in engineering, specifically domestic students that are African-American, Hispanic, and Native American.
Women in Engineering Program (WEP)	Student support center that focuses on gender diversity without a specific focus on ethnic diversity.	Student support center focused on gender parity and underrepresentation in engineering with some focus on addressing the unique issues for women of color
Women & Minority Engineering Program (WMEP)	Student support centers that separately focuses on ethnic and gender diversity in engineering but under common administration.	Student support center that includes a MEP and WEP separately but under common administration
Diversity in Engineering Program (DEP)	Student support center that focuses on engineering students in general while targeting underrepresented populations; this includes centers that focus on broadening participation by targeting students from underrepresented populations or under-resourced high schools communally.	Student support center that focuses on engineering students in general and attempts to identify and address the unique needs of underrepresented populations in effort to broaden participation and improve diversity.
General Engineering support Program (GEP)	Student support center that focuses on students in general without a specific focus on broadening participation or diversity.	Student support center that focuses on engineering students in general without a specific focus on broadening participation or diversity

3.4.4. Phase 4: Case Selection & Document Artifacts

In the fourth phase of the study, I selected cases to be more closely examined in Phases 5 and 6 and I familiarized myself with the websites of the selected cases. First, I selected five more cases (in addition to DEP1, my pilot site) to represent three different ESSC classifications across four institutions. Including six cases was consistent with Stake's (2010) suggestion of including 4-10 cases. More specifically, I selected two cases from each classification represented in the pool of 19 potential partners sites that resulted from Phase 3: Multicultural or Minority Engineering Programs (MEP), Women in Engineering Programs (WEP), and Diversity in Engineering Programs (DEP). I did not have the option of selecting a Women & Minority Engineering Program (WMEP) or a General Engineering Program (GEP) because none of the ESSC administrators who indicated interest during Phase 3 were affiliated with an ESSC from either classification. I selected two cases from each of the classifications to be included in the study to be consistent with the replication logic for multi-case studies suggested by Yin (2009), who recommends including multiple cases that predict either similar results or dissimilar results for reasons that can be anticipated. In my study, I achieved both by including two cases from three different classifications (see Figure 5) as I anticipated a change in the target population resulting in dissimilar objectives, outcomes, outputs, and experiences.



(Note: These colors are used consistently throughout the remainder of this document to represent the respective classifications)

Figure 5 - Cases Selected

I also selected cases at institutions that were similar to those that most commonly housed ESSCs. Based on the institutional trends identified during Phase 1, I selected ESSCs that were housed at large, public, four-year, research-intensive universities (See Table 5). Following the table, I provide a brief description of each as an overview of each case. I developed these descriptions using data collected from ESSC administrators during the study and I discuss the particulars of each case in further detail in the following chapter.

Table 5: Institutional Overview (Carnegie Classifications)

Pseudonym	University	~ Total Pop.	Size	Control	Basic Carnegie Classification
DEP1	University 1	> 20,000	Large, 4-Year	Public	Research University
WEP2	University 2	> 20,000	Large, 4-Year	Public	Research University
MEP2					
WEP3	University 3	> 35,000	Large, 4-Year	Public	Research University
MEP3					
DEP4	University 4	> 35,000	Large, 4-Year	Public	Research University

DEP1 aims to serve approximately 800 engineering students annually through interventions that focus primarily on first-year students. DEP1 administration includes 4 full-time staff members. The primary programs offered by DEP1 include a mentoring program, summer bridge program, and learning community. DEP1 opened its doors around 1990 as an MEP and has since expanded in response to a shift in the legal environment. Until around the year 2000, DEP1 only targeted URMs, though it never turned anyone away. DEP1 is currently concerned with diversity more broadly and its demographics of specific interest include female students, Black or African-American students, Hispanic or Latino students, Native-American students, first-generation college (FGC) students, and students from under-resourced high schools.

WEP2 aims to serve approximately 1400 engineering and science students annually through interventions primarily focused on first-year and second-year students. WEP2 has been supporting women for more than 15 years and its administration includes 2 full-time staff member. The principal program offered by WEP2 is a student-to-student mentoring program. WEP2 offers additional programs, activities, and services geared towards women in engineering

and science as well (i.e. test banks and tutoring). Additionally, WEP2 allows students to suggest other interventions that could be provided to assist them as they prepare for their careers.

MEP2 aims to serve approximately 540 engineering and science students annually and has been welcoming underrepresented students for more than 20 years. MEP2 administration includes 2 full-time staff members. The interventions most central to MEP2 achieving its mission are a mentoring program and personal counseling/advising via the director. MEP2 also offers interventions such as a summer bridge program and tutoring. The programs offered by MEP2 target freshman that identify as Black/African-American or Hispanic/Latino, and the additional activities and services are available for all undergraduate students.

WEP3 aims to serve approximately 1,500 engineering students annually and has supported women in engineering at all academic levels since approximately 1990. WEP3 administration includes with 4 full-time staff members. The interventions offered by WEP3 focus on women in engineering, though men are welcome as well. The interventions most critical to WEP are those targeting the first- and second-year students. The connection WEP3 has with industry is also important and is manifested through numerous interventions as well.

MEP3 aims to serve approximately 1,200 engineering students annually and was established around 1970. MEP3 administration includes 4 full-time staff members. The interventions most important to MEP3 achieving its mission are those focused on academics (i.e., tutoring) and the partnerships MEP3 has with student organizations such as the National Society of Black Engineering (NSBE) and the Society of Hispanic Professional Engineers (SHPE). While open to all students, MEP3 is specifically invested in serving Native American students, Native Hawaiian students, Black or African-American students, and Hispanic or Latino students.

DEP4 aims to serve approximately 3,500 engineering students annually and was established around 2010. DEP4 administration includes 8 full-time staff members; it should be noted that DEP4 is establishing its identity and roles are still changing. The flagship programs of DEP4 are a scholar program and cluster of collectively branded activities. DEP4 is broadly concerned with diversity and its target population includes female students, Black or African-American students,

Hispanic or Latino student, Native-American students, FGC students, students from under-resourced high schools, and transfer students. Additionally, DEP4 targets majority students in hopes of providing them students with the skills necessary to be globally competent and effectively work across cultural dimensions.

After selecting these cases, I reviewed document artifacts (i.e., websites) individually to get an overview of each ESSC and the possible intentions of the ESSC administrators and/or document developer(s); this also allowed me to develop a foundational understanding of each ESSC with regard to the publicized outputs, outcomes, objectives, programs, activities, and services. By reviewing the websites, I focused on the perceived public ways that ESSC intended to influence the undergraduate experience of engineering students at each university, and I personalized the instruments used during subsequent phases of the study as necessary.

3.4.5. Phase 5: Open-ended Surveys

In the fifth phase of my study, I distributed open-ended surveys **(**Survey 2**)** to students from each case to solicit feedback with regard to the isolated experiences of students served by each ESSC and to recruit focus group participants for Phase 6. More specifically, I asked students to indicate whether the ESSC at their institutions had positively, negatively, or not influenced them with regard to each of the following:

- "The interactions you have with engineering faculty and staff"
- "The interactions you have with other students"
- "Your academic performance"
- "Your participation in extracurricular activities"
- "Your professional development"

For example, I used a closed-ended question to ask, "With regard to your participation in extracurricular activities, which of the following statements do you agree with?" and a student could select "[ESSC] has positively influenced my participation in extracurricular activities," "[ESSC] has negatively influenced my participation in extracurricular activities," or "[ESSC] has not influenced my participation in extracurricular activities." For each question, I also included an open-ended question to allow students to explain their answer, requesting they provide specific examples if possible. I used the closed-ended questions to determine whether students

typically had positive, negative, or neutral experiences and to sort the open-ended answers accordingly. A pilot-study sample of how a student answered this follow up question was, "From the relationships I have made through [ESSC], I have been informed of and recommended for other extracurricular activities that I otherwise wouldn't have known about or considered joining." The full survey, which I personalized using the document review from Phase 4, can be found in Appendix B. Personalization included listing potential major options, listing the specific programs and activities provided by the respective ESSC, and referring to the ESSC by the name students will recognize as opposed to "ESSC" or "The DEP at your university."

The sample populations for the open-ended surveys included undergraduate engineering students who were previously and/or currently members of the student population(s) supported by each respective ESSCs. To recruit participants, I sent the ESSC director at each partner site an email containing the link to the open-ended survey to be forwarded to students using either an ESSC-managed listserv or university mailing list. For each case, students were contacted via email and those who completed the survey were entered a raffle for a chance to win a $50 Amazon Gift card (one across all cases) or a $10 Amazon Gift Cards (10 within each case). In instances where the initial response rate was low, I requested one reminder email be sent as well. These efforts resulted in a total of 538 surveys being completed across the six cases.

Due to the methods used to distribute the surveys and variation in how each ESSC defined its target population, I do not have a response rate. However, I report the size of the annual target population for each ESSC (self-reported) and the number of completed surveys from each ESSC in Table 6. My hope is that this provides the reader with a sense of how many students each ESSC supports annually and how many students completed the survey. It is important to understand that comparing the number of surveys completed to the approximate target population does <u>not</u> represent the response rate since there was variation in how the surveys were distributed and in how each ESSC defined its target population with regard to gender, race/ethnicity, and academic level. For example, DEP1 reported a target population of 800 students (primarily first-year engineering students) and distributed the open-ended survey to all undergraduate engineering students (approximately 7,000 students) who previously had the opportunity to interact with DEP1. Conversely, DEP4 reported an approximate target population

of 3500 (all undergraduate students) and distributed the survey to students on an ESSC-generated listserv that contained a much smaller subset of students. As a result, a direct calculation of response rate should not be made; rather, the numbers in the table provide only a general sense of program size and number of study participants.

Table 6 - Response Summary for Student Surveys

Case	University	Target Population	Surveys Completed	Gender		Race and Ethnicity					
				M	F	W	B	H	A	N	O
DEP1	University 1	800	245	152	93	178	11	11	26	1	18
WEP2	University 2	1394	57	0	57	48	2	2	3	0	2
MEP2	University 2	549	20	10	10	0	14	4	0	0	2
WEP3	University 3	1800	111	0	111	57	3	12	31	0	8
MEP3	University 3	1200	46	22	24	2	4	32	0	0	8
DEP4	University 4	3500	59	15	44	34	4	3	14	0	4
M=Male; F=Female; W=White; B=Black; H=Hispanic; A=Asian; N=Native American; O=Two or more, other											

3.4.6. Phase 6: Administrator Interviews & Student Focus Groups

I visited each case/site during the sixth phase of the study during February, March, and April of 2014. During Phase 6, I conducted individual interviews with ESSC administrators (Interview 1) and focus groups with students (Interview 2). First, I interviewed ESSC administrators to get insight from the perspectives of those directing the respective student interventions and to allow them to expound on the information gathered from reviewing the ESSC documents. The sample population for individual interviews included university employees currently involved in an administrative capacity at each partner site. (Note that these interviews only included faculty/staff, though multiple sites employed graduate students.) To recruit participants, I sent each ESSC director an email requesting the contact information for the individuals he or she considered administration. I then contacted each ESSC administrator individually and invited him or her to participate in the study. ESSC administrators were contacted via email, providing each of these university employees an opportunity to participate in the study; this resulted in a total of 17 interviews being completed (Table 7).

Table 7 - Response Summary for Administrators Interviews

Pseudonym	University	Target Population	Admin. Interviews
DEP1	University 1	800	2
WEP2	University 2	1400	1
MEP2	University 2	550	1
WEP3	University 3	1800	4
MEP3	University 3	1200	4
DEP4	University 4	3500	5

The interviews focused on the programs, activities, and services provided by each ESSC. The semi-structured interview format allowed me to probe participant's responses further as needed (Berg, 2007). Consistent with interviewing methods identified by Creswell (2007), the interview protocol for ESSC administrators contained open-ended questions, which I personalized based on the results of reviewing the webpage from each ESSC. The salient interview questions were as follows and the full protocol and supporting prompts can be found in Appendix C:

- "Focusing on current engineering students, what purpose do you think [ESSC] serves within the college?"
- "With the purpose in mind, what programs, activities, and services are most critical to [ESSC] achieving its mission? Why?"
- "What advantages/disadvantages do you believe a student experiences if they participate in the programs offered through your center?"
- "How do you measure the success of these programs and activities?"
- "Do you believe the experiences of students who choose to be involved with [ESSC] are different than those who choose to not be involved? If so, how?"

I created these questions to elicit responses related to the outputs, outcomes, and objectives of ESSC sponsored interventions and to facilitate better understanding the function of the ESSC within the college by allowing me to investigate the intentions of the ESSC administrators with regard to influencing the experience of student participants.

At each site, I also conducted focus groups with students. The sample population for focus groups included students who indicated interest in participating in a focus group via the open-ended survey–every student that indicated interest was invited to participate–and students who were recruited during the site visits at either a previously scheduled event that the ESSC

administrators invited me to attend or in public space provided by the respective ESSCs. ESSC administrators were also asked to forward an additional recruitment email directly to a select few students (5-10) that they believed were aware of the ESSC initiatives and would be willing to participate in a focus group. To encourage participation, each student who participated in a focus group received a $10 Amazon Gift Card. The combination of these recruitment methods resulted in a total of 15 focus groups being completed with a total of 67 students in total (see Table 8). Consistent with focus group protocol best practices (Patton, 2002), I attempted to have each focus group contain 6 - 10 participants though the actual focus groups ranged from 1 to 11 students.

Table 8 - Response Summary for Focus Groups

Case	University	Target Population	Focus Groups		Gender		Race and Ethnicity					
			Groups	Participants	M	F	W	B	H	A	N	O
DEP1	University 1	800	5	20	11	9	6	5	2	5	0	2
WEP2	University 2	1394	2	15	0	15	13	0	1	1	0	0
MEP2	University 2	549	1	7	3	4	0	3	3	0	0	1
WEP3	University 3	1800	3	14	0	14	7	0	1	6	0	0
MEP3	University 3	1200	2	7	4	3	0	0	7	0	0	0
DEP4	University 4	3500	2	4	3	1	2	1	0	1	0	0
M=male; F=female; W=white; B=black; H=Hispanic; A=Asian; N=Native American; O=Two or more, other												

During these focus groups, we discussed the collective student experience with the respective ESSC. Consistent with recommendation from Patton (2002), I did not ask more than 10 primary questions during the focus groups. I used focus groups because the interaction among participants can enhance the quality of the data–allowing them to provide checks and balances of each other (Patton, 2002). The salient focus group questions were as follows and the full protocol and supporting prompts can be found in Appendix D:

- "How would you describe [ESSC] to incoming students or their parents?"
- "In what ways do you believe in the existence of [ESSC] impacts the experience of the engineering students who are involved?"
- "What sorts or problems or challenges does [ESSC] help students deal with or avoid?"
- "What do you think students, both involved and not involved, see as the advantages and disadvantages of being involved with [ESSC]?"

- "Are there any problems [ESSC] does not help students deal with that you believe they should?"

I targeted the collective experience during focus groups to provide a different perspective than the isolated experiences solicited through the open-ended surveys in Phase 3. As a result, I created these questions above to elicit responses related to the collective student experience with their respective ESSC, and to facilitate better understanding the function of the respective ESSC.

3.5. Data Analysis

Data analysis included analyzing data from webpages, surveys, interviews, and focus groups. From the ESSC perspective, the webpages tended to focus on specific outputs and intervention details, and the interviews tended to focus on outputs, outcomes, objectives, and how the interventions are intended to help students in a broader sense. From the student perspective, the surveys were primarily focused on specific output areas–which students were directly asked about–and the focus groups concentrated on how interventions generally helped students in a broader sense. Collectively, the analysis of the multiple data sources allowed me to form a complete picture of the co-curricular support provided to engineering students by each case.

I used the general approach of qualitative analysis presented by Miles and Huberman (1994) to guide my data analysis. Miles and Huberman describe qualitative analysis as three primary activities: (1) data reduction, (2) data display, and (3) conclusion drawing/verification. Data reduction is the process of transforming the data into focused units. Data display is the process of presenting the units in a visual format that allows valid conclusion to be drawn. Conclusion drawing and verification is the process of identifying patterns, constructing possible explanations, revealing potential configurations, and forming propositions. While these activities are distinct, I did not complete them consecutively and, to an extent, each occurred iteratively until final conclusions were reached. Additionally, I did not use identical procedure procedures to complete each of the primary activities due to the varying data sources and multiple research questions. For example, I did not analyze the open-ended surveys used to answer RQ4 the same way I analyzed the interviews with the ESSC administrators used to answer RQ3. More specifically, data was analyzed based on three categories: (1) *configuration* from the ESSC and student perspective; (2) *objectives*, *outcomes*, and *outputs* from the ESSC perspective; and (3)

outcomes and *outputs* from the student perspective (see Figure 6). In Figure 6, Row 1 represents the subset of data used to answer RQ1 (i.e., ESSC administrator interviews and ESSC websites) and a subset of the data used to answer RQ4 (i.e., student focus groups); Row 2 represents the subset of data used to answer RQ2 and RQ3 (i.e., ESSC administrator interviews and ESSC websites); and Row 3 represents a subset of the data used to answer RQ4 (student surveys). To answer RQ5, the student data and ESSC administrator data from Row 1 were compared against each other while the student data in Row 3 was compared to the ESSC data in Row 2. In this section, I discuss the strategies that were used to analyze the data represented in Figure 6. I begin with data reduction and then discuss data display and conclusion drawing/verification.

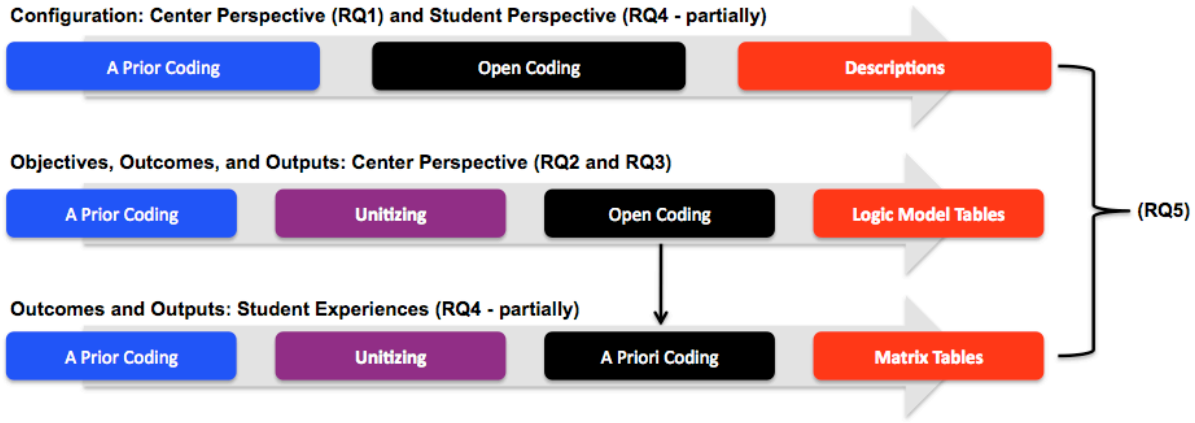


Figure 6 - Overview of Data Analysis

3.5.1. Data Reduction

I began data reduction by transforming ESSC documents into a format that could be analyzed through coding (i.e., word documents), transforming open-ended survey results into a format that could be analyzed through coding (i.e. word documents), and transcribing the individual interviews and focus group interviews verbatim. Subsequent to the data being transformed into an appropriate format, I used a priori codes to further reduce the data. I primarily based the a priori codes on Tinto's (1994) Model. When analyzing the data from the student and ESSC perspective, I commonly used a priori codes focused on the configuration (RQ1 and RQ4), outputs (RQ3 and RQ4), and outcomes (RQ2 and RQ4). In addition to these categories, I also analyzed the data form the ESSC perspective using a priori codes focused on objectives (RQ2) and contextual information needed to situate the findings. The a priori coding categories used for

the ESSC data (webpages and interviews) is presented in Table 10 and the coding categories used for the student data (focus groups and open-ended surveys) are presented in Table 11. I also include sample codes from the pilot case to demonstrate the type of data that was coded under each a priori code.

In the next step, I started with the data that had been coded using a priori codes. I further reduced specific segments of this data through the process of unitizing to facilitate subsequent analysis; this involved dividing data chunks into single concept coding units that could be further analyzed and compared across ESSC (Srnka & Koeszegi, 2007). I specifically unitized the following data: (1) statements from ESSC administrators about the *outputs* of specific interventions (RQ3); (2) statements from ESSC administrators about the *outcomes* and *objectives* of the ESSC (RQ2); and (3) statements from students about their isolated experiences via the open-ended survey (RQ4). The process of unitizing included dividing multi-concept original responses into multiple unitized statements and combining single-concept original responses that included the same concept into a single representative unitized statement. In instances where a single-concept original statement was unique, the response was reduced to a single unitized statement as well. In total, this process resulted in a list of unitized statements that represented the original responses provided students across ESSCs. Some examples are shown in Table 9.

Table 9 - Unitizing Examples

Original Response	Unitized Statements
"[DEP1] helps me study because I have study partners. It helps me understand concepts because of the wealth of upperclassman knowledge."	I had an easier time forming study groups and finding people to work with academically.
	I had access to students whom I could ask for academic assistance.
"The [learning community] academic events definitely had a positive influence on my grades last semester."	"I received academic assistance at the help sessions I attended."
"The exam reviews are helpful."	

I then open coded the ESSC data (unitized and non-unitized) using sub-codes that were developed inductively and embedded within the a priori codes from Table 10. I used open coding to develop subcategories (presented in Table 12) that disaggregated the data previously coded under configuration (RQ1), output (RQ2), and outcomes & objectives (RQ3). I also a priori coded the open-ended survey student data (unitized) using the sub-codes identified from open coding the ESSC data; this process was also embedded within the initial round of a priori coding. In Table 12, I list the subcategories embedded within each of the initial a priori codes. I also provide a short definition of the code and a summary of when the code was used both the ESSC and/or student data. Note that I did not provide sample codes for each of the 24 subcategories, as specific examples of each will be provided in the subsequent chapter. Additionally, the open codes developed inductively during the second round of analysis for the student focus groups (non-unitized) is not discussed until the results are presented in Chapter 4.

Table 10: A Priori Coding Categories for ESSCs (webpages & interviews)

A Priori		Description	Sample Code
Outcomes & Objectives		Broad statements about center goals or the accomplishments that interventions are preparing students to achieve	To help students make the transition from high school to college successfully
Outputs	Faculty/Staff Interaction	Outcomes related to students interacting with faculty or staff outside of the classroom	Students have access to faculty and graduate students, as community members
	Academic Performance	Outcomes related to improving the academic performance, academic preparation, or academic skills of a student	Students are encouraged to help each other with homework
	Peer Group Interaction	Outcomes related to students interacting with peers outside of the classroom	Students live in the same residential hall with the other first-year engineering students
	Extracurricular Activities	Outcomes related to student participation in activities not a required part of the engineering curriculum	Advisors discuss involvement in clubs and student organizations
	Professional Development	Outcomes related to improving the professional development of a student (industry or graduate school)	Students attend seminars intended to polish the non-academic skills (working on teams, communicating effectively, dealing with conflict, and selling their ideas)
	Miscellaneous	Outcomes related to a category not outlines by Tinto's Model of Institutional Departure. Examples include: getting to know the university or college, interactions with professional engineers, financial support, family issues, etc.	Provides students opportunity to visit the campus and make an informed decision about attending the college
Configuration and Context		Information important for understanding the configuration and context surround a center such as interventions provided, supports, barriers, and available resources. Statements during the interview that are important but do not fit somewhere else in particular.	"We get a lot of financial support from the college. We get a lot of people support from the college… people that volunteer to do different things… to have lunch with the students, to interact with them, advise them"

Table 11: A Priori Coding Categories for Students (Focus Group & Surveys)

	A Priori	Description	Sample Code
Outputs and Outcomes	Faculty/Staff Interaction	Experiences related to students interacting with faculty outside of the classroom	I had the opportunity to network with engineering faculty at the university
	Academic Performance	Experiences related to improving the academic performance, academic preparation, or academic skills of a student	I learned how to study and prepare for exams more effectively
	Peer Group Interaction	Experiences related to students interacting with peers outside of the classroom	I met a diverse group of engineering students
	Extracurricular Activities	Experiences related to student participation in activities not a required part of the engineering curriculum	I was encouraged to become involved in the university community
	Professional Development	Experiences related to improving the professional development of a student (industry or graduate school)	I receive assistance with developing my resume
Configuration	Advantages	Beliefs about the advantages, (or positive impacts, problems assisted with) of being involved with the center	"You get a different range of people, all across, you also get that different academic range. So you can have either a reality check or find someone who will help you get to where you want to be"
	Disadvantages	Beliefs about the disadvantages of being involved with the center or negative perceptions of the center; or the advantages of using a different resource instead of the center.	"When I came here, and I was like getting involved with [DEP1] and things like that, the same suspicious kind of crept up like, "Hey, am I shutting myself off by being involved?"

Table 12: Open Coding Categories for ESSCs (webpages & interviews) and Students (open-ended surveys)

	Open	Description
Outcomes & Objectives [admin only]	Improved Academic Performance	Improving the academic performance of engineering students; when the outcome or objective is related to improving the GPA or enhancing the academic development of the students
	Improved Student Retention/Graduation	Improving the retention and graduation rates of engineering students; when the outcome or objective is related to improving the engineering graduation or year-to-year persistence rates OR the university graduation rates of the students
	Improved Student Recruitment	Improving the recruitment of engineering students; when the outcome or objective is related to increasing the percentage or amount of any student group in the college
	Improved Student Support/Access	Improving the amount and/or quality of support receive by engineering students; When the outcome or objective is related to ensuring that students from underrepresented or underserved populations or first-year students are being supported or ensuring students have access to and are aware of university resources
	Improved career attainment	Improving and diversifying the post-graduate attainment of engineering students; When the outcome or objective is related to increasing the number of students who pursue a specific academic path (i.e., academic careers) or graduate study OR is related to improving career success or job attainment
	Improved Student Motivation	Improving the motivation of engineering students; when the outcome or objective is related to increasing the interest, confidence, or engagement engineering students have in university activities
	Improved Student Characteristics	Improving specific characteristics - believed to be desirable - of engineering students; when the outcome or objective is related to improving the professionalism, desire to give back, leadership skills, cross-cultural skills, or any other specific skills of engineering students
Faculty/Staff Interaction	Faculty/Staff Relationships	Establishing informal or formal relationships with faculty or staff; When the outcome is related to establishing sustained or reoccurring student interactions with a specific faculty member, such as through mentoring or advising OR When the student experience is related to sustained or reoccurring interactions with faculty/staff
	Faculty/Staff Proximity	Increasing the quantity of interactions students have with faculty or staff outside of the classroom; When the outcome is related to students being in proximity of faculty members by attending events that faculty/staff are either leading or attending OR When the experience is related to being in proximity of faculty members by attending events that faculty/staff are either leading or attending
	Faculty/Staff Information	Disseminating information related to interacting with faculty/staff; When the outcome is related to providing students with information that is intended to increase or improve the interactions students have with faculty/staff, including encouragement and referrals OR When the experience is related to receiving information that is intended to increase or improve the interactions students have with faculty/staff

Table 12 (continued) - Open Coding Categories (webpages & interviews) for ESSCs & Students (open-ended surveys)

	Open	Description [ESSC only]
Peer-Group Interaction	Intentional Grouping	Intentionally grouping students based on some part of their identities or academic circumstances; When the output is related to intentionally grouping students based on some part of their identities or their academic circumstances OR When the student experience is related to interacting with students of a specific demographic. Intentional pairing included the following combinations: • Students with other students of similar academic classification • URMs with other URMs • Women with women • Women and men • Lower-level students with upperclassmen • Prospective students with current students • Prospective students with other prospective students • Transfer students with other transfer students • Student leaders with other student leaders
	Student Proximity	Increasing the quantity of interactions students have with other students outside of the classroom; When the output is related to students being in proximity of other students by either living, attending events, or working with them or having access to a place where students can congregate informally OR When the student experience is related to interacting with students but there is not mention of a specific demographic
	Student Information	Disseminating information related to interacting with other students; When the output is related to providing students with information that is intended to increase or improve the interactions students have with other students OR When the student experience is related to receiving information that is intended to increase or improve the interactions students have with other students

Table 12 (continued) - Open Coding Categories (webpages & interviews) for ESSCs & Students (open-ended surveys)

	Open	Description
Academic Performance	Transferable Student Skills	Facilitating the development of content-independent student skills that contribute to academic performance; When the output is related to facilitating the development of content-independent student skills such as time management, study habits, etc. OR when the student experience is related to developing content-independent student skills
	Academic Monitoring	Monitoring a student's academic performance or development; When the output is related to monitoring students' academic performance and progress via the students themselves or someone else OR when the experience is related to having the academic performance of a student monitored via the student themselves or someone else
	Academic Resources	Providing students with access to resources that support their academic performance; When the output is related to providing students with access to resources that support their academic performance such as tutors, study sessions, test banks, etc. OR when the experience is related to having access to resources that support the student's academic performance such as tutors, study sessions, test banks, etc.
	Academic Information	Disseminating information related to improving students' academic performance or circumstances; When the output is related to providing students with information that is intended to improve their academic performance such as referrals, encouragement, or discussing procedures (or providing academic mentorship) OR When the outcome is related to receiving information that is intended to improve the student's academic performance
	Course preparation	Facilitating the development of content-dependent student skills that contribute to academic course preparation; When the output is related to facilitating the development of content-dependent student skills such as physics, calculus, etc. OR When the outcome is related to facilitating the development of content-dependent student skills such as physics, calculus, etc.
Extracurricular Involvement	Extracurricular Organizing	Center-sponsored events; When the output is related to organizing events (i.e., social, academic, professional, service, outreach, etc.) for students to participate in OR When the student experience is related to attending or participating in events organized by the center
	Extracurricular Partnerships	Center-sponsored entities that facilitate extracurricular involvement; When the output is related to providing students with access to entities that facilitate extracurricular involvement such as design studios, student organizations (or meeting places for them), or intramural teams OR When the student experience is related to having access to or participating in center-sponsored entities that facilitate extracurricular involvement such as design studios, student organizations, or intramural teams
	Extracurricular Information	Disseminating information related to improving or increasing students extracurricular involvement; When the output is related to providing students with information that is intended to improve or increase their extracurricular involvement such as advertisement or encouragement OR When the student experience is related to receiving information that is intended to improve the student's extracurricular involvement

Table 12 (continued) - Open Coding Categories (webpages & interviews) for Centers & Students (open-ended surveys)

	Open Code	Description
Professional Development	Employment Assistance	Facilitating the development of industry-independent student skills that contribute to obtaining employment or admittance; When the output is related to facilitating the development of skills that contribute to obtaining employment/admittance such as developing a resume, writing cover letter, preparing for career fairs, etc. OR When the experience is related to developing skills that contribute to obtaining employment/admittance such as developing a resume, preparing for a career fair, etc.
	Professional Experience	Center-sponsored experiences that contribute to the professional development of students via employment; When the output is related to sponsoring employment opportunities for students such as undergraduate research, mentoring, tutoring or other leadership positions OR When the experience is related to having an employment or volunteer opportunity via center sponsorship
	Career Opportunities	Disseminating information related to exposing students to career opportunities via an undergraduate engineering degrees; When the output is related to providing students with information that is intended to expose them to the career opportunities that are available for engineering students (or options outside of engineering if necessary) OR When the experience is related to receiving information that is intended to expose students to the career opportunities that are available for engineering students
	Career Role Models	Facilitating student access to role models further along different career trajectories; When the output is related to facilitating student access (often via networking) to role models further along in the career trajectory such as company-representatives, graduate students, faculty members, etc. OR When the experience is related to interacting with role models further along in the career trajectory such as company-representatives
	Professional Skills Development	Facilitating the development of industry-independent skills that contribute to successful professional performance; When the output is related to facilitating the development of skills that contribute to successful professional performance or professional mentoring OR When the experience is related to developing professional skills that contribute to professional performance
Special Circumstances	Financial Assistance	Facilitating student access to financial assistance/compensation; When the output is related to facilitating student access to financial assistance/compensation via referral, information, scholarships, or employment
	University Acclimation	Facilitating the acclimation of students into the university environment; When the output is related to facilitating the acclimation of students into the university environment and resources and opportunities available to students
	Acknowledging Student Success	Acknowledging student success; When the output is related to celebrating student success
	Identity Navigation	Facilitating students discussing life as an underrepresented engineering students; When the output is related to facilitating students discussing life as an underrepresented engineering students
	Misc. Resources or Discussion	Providing students with miscellaneous resources and/or discussion; When the output is not related to the other miscellaneous open codes

3.5.2. Data Display

To display the data, I employed two table formats: logic models and matrices. First, I developed a logic model table for co-curricular support using the following data: (1) the a priori output categories from the ESSC administrators (Table 10), (2) the emergent output categories from the ESSC administrators (Table 12), (3) the emergent outcomes and objectives from the ESSC administrators (Table 12), and (4) Tinto's Model. An example of a logic model table, minus the summary information, is provided in Table 13 below.

Table 13: Potential Logic Model Table (Data Display)

Inputs	Outputs	Outcomes		Objectives
		Short Team	Medium Term	Long Term

Logic models, as described by Yin (2009), are useful in case study evaluations as they visually represent events over time and can help define the visions and goals (or objectives and outcomes) of an ESSC as well as how programmatic actions will accomplish the goals (or the outputs). As an analytic technique, developing a logic model involved matching empirically observed events (i.e., outputs) to theoretically predicted events (i.e., outcomes and objectives) and assisted me in answering my research questions about the outputs, outcomes, and objectives, and the relationship between them. **Inputs** refer to the programs, activities, and services offered by ESSCs to provide undergraduate engineering students with co-curricular support. **Outputs** are the intended changes to the institutional experiences of students that result from the internal operations of the Inputs. **Outcomes** are the skills, knowledge, and behaviors that students should attain from experiencing the Outputs. **Objectives** are the accomplishment that students should be prepared to achieve attaining the Outcomes. In short, the model illustrates the process of students participating in **Inputs** to experience **Outputs** and attain **Outcomes** so they can achieve **Objectives**. Note that the definitions for Outputs, Outcomes, and Objectives are from Chapter 1

and have been reworded here only to illustrate the relationship between the constructs and Inputs.

Yin recommends defining the logic model prior to collecting data and then "testing" the model to see how well the data supports it. I presented a logic model in chapter 2 (see Figure 2) to represent a hypothetical model that the collected data allowed me to strengthen in the following ways: determine which outputs, outcomes, and objectives are included within (i.e., within-case displays) and across (i.e., a cross-case display) cases; provide description for the relationships represented in the model; and reveal alternative configurations for co-curricular support.

Second, I displayed the data from the student surveys by developing matrix tables including the following data: (1) the a priori output categories from the ESSC administrators, (2) Tinto's Model, (3) and the emergent output categories from the ESSC administrators. An example of a matrix table, minus the summary information, is provided in Table 14 below. Matrices, as described by Miles and Huberman (1994), are display formats with defined rows and columns, and are useful for understanding the connection between two lists. As an analytic technique, developing matrix tables involved summarizing the student experiences and administrative intentions and assisted me in understanding the connection between the two.

Table 14: Potential Matrix (Data Display)

Impact	Administrative Intentions	Student Experiences
Academic Performance		
Extracurricular Activities		
Peer Interactions		
Faculty & Staff Interaction		
Professional Development		
Integrations		
Intentions & Commitment		

The combination of the logic model and the matrices allowed me to visually represent the intentions of the ESSC administrations and the student experiences within the revealed areas in way that facilitated a direct comparison. Separately, I used the logic model table to answer RQ1, RQ2, RQ3 and I used the matrix table to answer RQ4 and RQ5.

3.5.3. Conclusion Drawing & Verification

To establish and verify conclusions, I developed analytic text. According to Miles and Huberman (1994), analytic texts are paragraphs that highlight and make meaning of the data displays: the displays will not explain themselves and the text is needed to draw conclusions. To develop the analytic text, I used several analysis tactics. First, I noted patterns and themes within each case. Second, I contrasted and compared the patterns and themes across cases. Lastly, I transformed the particulars into general statements about the phenomenon, providing co-curricular support for engineering students. To identify patterns and themes within and across cases, I used (1) data displays discussed in the previous section, (2) themes revealed through the student focus group, and (3) sorting features in Microsoft Excel. Logic model tables allowed me to visually see ESSC coverage with regard to outputs, outcomes, and objectives varied from case to case (RQ2 and RQ3). Matrices allowed me to visually see how the isolated student experiences aligned and varied with regard to the output categories and outcomes areas (RQ4 and RQ5). Themes revealed through student focus groups allowed me to investigate the relationship between the collective student experience and ESSC configuration (RQ4 and RQ5). And sorting features in Microsoft Excel allowed me to filter and sort the coded data by case, intervention area (program, activity, service), intervention category (e.g., summer bride program, mentoring programs, etc.), output category, and outcome/objective category to identify patterns and trends. Establishing the conclusions this way enabled me to develop analytic text within and across cases and answer each research question.

3.5.4. Summary of Data Analysis

In summary, the data analysis process included data reduction, data display, and conclusion drawing/verification and it slightly varies for data in different categories. Data reduction was achieved through a priori codes and open codes developed through the ESSC data; data display was achieved using a logic model table and matrices; and conclusion drawing and verification

was achieved through analytic text. Ultimately, data analysis allowed me to better understand co-curricular support in engineering from the ESSC and student perspectives and to identify areas of consensus and variation across cases.

3.6. Reliability and Validity

In a qualitative study, validity and reliability represent the accuracy of the findings and consistency of the research approach, respectively (Creswell, 2007), and are not treated separately. Instead, terms such as trustworthiness, credibility, and transferability are used to encompass both (Golafshani, 2003). In this section, I discuss the strategies I used to increase the quality and rigor of my study as it relates to trustworthiness, credibility, and transferability.

Trustworthiness is important in qualitative research as it refers to the confidence a reader has in the results reported at the conclusion of a study (Golafshani, 2003). I have established trustworthiness by providing the reader with a clear purpose statement and theoretical perspective (Borrego et al., 2009), by following acceptable multi-case study practices (Stake, 2006; Yin, 2009), and by following acceptable qualitative research practices (1994). These strategies will allow the reader to scrutinize the decisions I made and the procedures I followed. I also used member checking and triangulation. Member checking involved participants reviewing research finding (Rossman & Rallis, 2012) and occurred following Phase 6. During this process, administrators were provided with a report that included a description of their respective ESSC as well as each individual intervention and the accompanying outputs; they were given a chance to elaborate, correct, or remove information. Data triangulation occurred through the combination of data from Phase 4, Phase 5, and Phase 6 and involved the use of multiple sources of data, data collection periods, and data collection methods (Golafshani, 2003; Rossman & Rallis, 2012): during Phase 4, reviewing ESSC documents established the foundational understanding of each ESSC included as a case; during Phase 5, undergraduate students were surveyed to capture their individual experiences; and during Phase 6, individual interviews with ESSC administrators and focus group interviews with undergraduate students focused on the student interventions provided by each ESSC and furthered this understanding. The combination of data sources provided an extensive picture and served as a check-and-balance.

The credibility of a study refers to the believability of its results and it is directly related to the effort and intentions of the researcher (Golafshani, 2003). In addition to the methods used to establish trustworthiness–which demonstrates the effort I took as the research to complete the study in a valid and reliable manner–I establish credibility by presenting the perspective I brought to the study and pertinent information about myself. Since a list of comprehensive, universal questions to be addressed does not exist, I reported the information that I think impacted data collection or analysis (Patton, 1999). I particularly disclosed my experience with ESSCs–both as a participant and as an ESSC administrator (i.e., graduate assistant)–and my career aspirations. This information is further discussed in section 3.7.

It is also important for a qualitative study to have transferability. Transferability refers to the usefulness of the study, i.e., a reader's judgment about whether the research findings can be applied to another context (White & Marsh, 2006). Readers can only make this judgment if a thick descriptions of each case and its context is provided. Consequently, it is important that I provide enough information for a reader to make connections between the cases and his or her own situation (Baxter & Jack, 2008; Borrego et al., 2009). It is also important to include cases that other ESSCs are likely to share context with (Patton, 2002) and, for that reason, seeking discrepant cases was not essential. Instead of selecting cases that I thought would provide contradicting findings, I selected cases from similar institutional settings that provided an opportunity to learn about the nature of ESSCs in different environments (Stake, 2006); this improved transferability. Triangulation also improved transferability because findings based on multiple data sources can be transferred with more confidence (White & Marsh, 2006).

In conclusion, several strategies were used to improve the quality and rigor of my study. I have a clear purpose statement and sound theoretical perspective. I also designed the study to include diverse cases and followed acceptable multi-case study and qualitative research practices. During the study, I used triangulation and member checks to increase the trustworthiness and transferability of the study. After the study, I disclosed all of the procedures followed as well as any information, personal and professional, that may have impacted the collection or analysis of the data so that the study is transparent overall.

3.7. Bias

In addition to those previously mentioned to improve the validity and reliability of my study, I employed additional strategies to address the potential biases. In this section, I have addressed my personal bias and the possible biases as a result of my methodological decisions.

3.7.1. Researcher Bias

In a qualitative study, the researcher has a vital role: I decided what to study, determined what questions to ask, interacted with participants, and interpreted the data. Consequently, I must be transparent about who I am and how who I am influenced the study–disclosing my interests, biases, opinions, prejudices, and assumptions (Rossman & Rallis, 2012). In this section, I discuss my experience with ESSCs and the impact these experiences had on my study. Specifically, I interacted with ESSCs as an undergraduate participant and worked with an ESSC as graduate assistant. I also have career goals that directly relate to co-curricular support and ESSCs. The particulars of these experiences are summarized in Table 15.

My experiences with ESSCs and my career goals undoubtedly impacted my study. My predominately positive experiences gave me an optimistic disposition towards the impact ESSCs can have on the institutional experiences of engineering students. However, my intent is not to merely show that student support centers are valuable. I want to remain involved in this facet of engineering education and, accordingly, I have a genuine interest in examining alternative approaches to providing co-curricular support and developing student interventions

Table 15: Research Bias Overview

Experience	Description
Undergraduate Participation	The MEP at my undergraduate institution was vital to my achievement as an engineering student and sparked my interested in student retention. My first interaction with the MEP was as a participant in a bridge program the summer preceding my freshmen year. As a result of this rewarding experience, I remained involved with the MEP throughout my undergraduate tenure. I was a tutor for the bridge program during the summer of 2008 and I served as a mentor the following academic year. I also served the MEP in many informal capacities and became familiar with the Women in Engineering Program (WEP), which co-sponsored numerous events with the MEP and was located in the same building.
Graduate Participation	Since May 2011, I have been involved with a student support center in a different capacity. As a program assistant for a DEP, I worked directly with a residential community for engineering students, directed a five-week summer bridge program, and facilitated a group-mentoring program. I also mentor first-year engineering students formally and informally.
Career Goals	My career goal is to become a professor and develop/implement research-based interventions that serve to increase the number of underrepresented students earning STEM degrees, ultimately being involved in the administration of a student support center in some capacity.

My experiences also provided a common bond that I used to build a sense of shared understanding with the ESSC administrators. Since I have experience as a student participant and an ESSC administrator, I could establish co-membership with ESSC administrators and increase the likelihood of them working with me on this study (Rossman & Rallis, 2012). More explicitly, my undergraduate and graduate experiences influenced my selection of cases: Since I wanted to examine ESSCs holistically, I could only include ESSCs that had receptive gatekeepers. Gatekeepers are individuals who facilitate access to research sites (Rossman & Rallis, 2012). In this instance, the gatekeepers were the ESSC directors. Since I was acquainted with multiple ESSC directors prior to this study, these people were more prone to volunteer and I was prone to include these ESSCs as cases. The result of this bias was the inclusion of four ESSCs that were directed by someone I had contact with prior to the study: DEP1, WEP2, MEP2, and MEP3.

My varied experiences also impacted the study positively by removing my bias towards highlighting (or verifying) a particular ESSC structure. Bias towards verification, or a tendency for a case study to be used to confirm a researchers preconceived notions, is a common misunderstanding about case-study research (Flyvbjerg, 2006). The reader can be reassured that a bias toward verification did not exist in my study as I have had positive experiences with ESSCs of various classifications and was not inclined to make any specific approach look advantageous. Having been exposed to some of the advantages and disadvantage of each, I fully acknowledged that neither approach is perfect. On the contrary, I have had positive experiences

and may have been inclined to avoid making any approach look unfavorable.

Though impossible to eliminate bias from qualitative research, several strategies were used to address my personal bias. For example, I reflected on who I am and my perspective towards the topic during the design of the study (Cousin, 2005; Rossman & Rallis, 2012). By stating my beliefs prior to the study, I reduced the likelihood that I confounded previous experience with research findings; this occurred throughout the research design process and will be shared in reports (Malterud, 2001). Reviewing design decisions and discussing data analysis with other researchers (i.e., critical friends) is another way I have addressed personal bias (Rossman & Rallis, 2012); this resulted in my assertions being challenges by researchers with diverse perspectives. My critical friends included my dissertation committee, members of a faculty lead research group, and additional graduate students and faculty members with research interests similar to mine. The critical friends most actively involved in this process are listed in Table 16 below. I also reduced the impact my personal bias had on the study by: (1) keeping a log of my reactions and interpretation; (2) using multiple data sources; and (3) gathering data at various points in time (Cousin, 2005; Rossman & Rallis, 2012). These strategies addressed my personal bias, challenged my assertions, and improved the accuracy of what is reported.

Table 16: Critical Friends

Critical Friend	Relevant Qualifications	Research Involvement
Matusovich	Dr. Matusovich is a faculty member in engineering education, and her specializations included the role of motivation in learning, the development of engineering student & professional identifies, student experiences learning engineering, and career decision-making.	Dr. Matusovich is my research advisor and was involved during the entire analysis process. She reviewed the data reduction, data visualization, and analytic text process to make sure the decisions I made were sound.
Watford	Dr. Watford is a faculty member in engineering education and the director of an ESSC, and her specializations include diversity and retention. She has 20+ years of experience in co-curricular support.	Dr. Watford (committee member) was involved reviewing design decision and discussing data analysis.
Paretti	Dr. Paretti is a faculty member in engineering education. Her specialization includes gender, race, class, and engineering identities.	Dr. Paretti (committee member) was involved reviewing design decision and discussing data analysis.
Burge	Dr. Burge is a faculty member in educational research and evaluation, and her specialization was qualitative research and program evaluation.	Dr. Burge (committee member) was involved reviewing design decision and discussing data analysis.
Olgivie	Andrea Ogilvie is a second-year PhD student in engineering education. She has 10+ years of experience in the area of co-curricular support.	Andrea Ogilvie assisted with reviewing my data display process and assisted with ensuring the approach I took to developing analytic text was appropriate for stakeholders.
Carrico	Dr. Carrico has a PhD in engineering education and is currently a post-doc in engineering education.	Dr. Carrico reviewed the focus group transcripts and checked to make sure that my interpretations of the conversations were both accurate and complete (WEP only).
Cross	Kelly Cross is a fifth-year PhD student in engineering education.	Kelly Cross reviewed the focus group transcripts and checked to make sure that my interpretations of the conversations were both accurate and complete (DEP only).
Hampton	Cynthia Hampton is a first-year student in engineering education and has previous work experience in the area of co-curricular support.	Cynthia Hampton reviewed the focus group transcripts and checked to make sure that my interpretations of the conversations were both accurate and complete (MEP only).

3.7.2. Methodological Bias

In addition to personal bias, other sources of bias may have revealed themselves during the study. There is no way to identify every source of bias in advance (Stake, 2006). In this section, I discuss methodological sources of bias given the proposed design and the strategies I used to reduce the impact they potentially had.

Since I used individual interviews and focus groups during Phase 6 of my study, interviewer-induced bias was possible. For example, I may have reacted to something a participant said during an interview and impacted his or her future responses. Participants may have also assumed that I only wanted positive information and withheld negative experiences (Rea & Parker, 2005). Researcher bias may have also appeared once interviews and focus groups were conducted as researchers sometimes hear what they want to hear (MacNealy, 1997). To reduce researcher bias, I recorded and transcribed each individual and focus group interview (MacNealy, 1997). Member checks also reduced potential bias by allowing participants (ESSC administrators) to validate evidence; participants should agree with basic facts even if they disagree with my interpretations. Participants also had the opportunity to let me know if my choice of words is misrepresentative as personal bias may reveal itself in how the findings are worded (Yin, 1981). Using critical friends also addressed potential bias (Rossman & Rallis, 2012) as actively communicating with other researchers allowed me to confirm and rethink the decisions I made (Stake, 2006).

Due to the nature of my study, anticipated site entry problems also impacted my methodological decisions. In particular, it was imperative that I work with receptive gatekeepers or ESSC administrators that were eager to be involved in this study. As a result, I reached out to directors that I was already acquainted with and relied on the assistance of Dr. Bevlee Watford–who is an active, and well respected, member of the community I was studying–to recruit partner sites. While I had not yet selected cases per say, I preemptively and informally contacted several ESSC directors who previously expressed willingness to participate in my study. To reduce researcher bias, I distributed a survey to ESSC administrators (Survey 1) throughout the nation and inquired as to whether or not ESSCs would also be interested in participating in the study; this resulted in me considering and recruiting ESSCs beyond my personal network. Once potential partners were

identified, I communicated my selection process with critical friends–particularly my dissertation committee–to ensure I used sound logic to make final decisions.

3.7.3. Negative Results

Despite having positive experiences with ESSCs, I did commence the study believing it was possible for an ESSC to detract from the student experience. For example, Women in Engineering Programs could negatively impact female students by "spotlighting." According to McLoughlin (2005), spotlighting is "the singling out of women by gender in ways that make them uncomfortable" and can result from targeted assistance such as a WEP. Since it is impossible to anticipate every research finding, it was important that I remained open to the possibility of negative and positive results alike. The leading detraction I foresaw was the type of student interaction that results from both targeted (e.g., MEPs and WEPs) and non-targeted (e.g., DEPs) ESSCs. Targeted ESSCs could reduce an underrepresented student's interaction with the majority population through physical separation. Similarly, non-targeted ESSCs could fail to eliminate feelings of isolation felt by minority students on a predominately white campus. I view both instances as a detraction because women and URM engineering students can find it beneficial to establish relationships with those from similar backgrounds as well as white males (Amenkhienan & Kogan, 2004). Another possible detraction was a URM woman feeling forced to select one component of her identity on a campus where both an MEP and WEP exist. Lastly, ESSCs could also reduce the interaction students have with non-engineers. In this section, I discuss anticipated negative results and how I remained open to this possibility.

In order to remain open such findings, several strategies were taken during data collection, data analysis, and data reporting. To remain open to negative findings during data collection, I asked truly open-ended questions (or both the positive and negative version of a question) and prompted students to provide positive, negative, or neutral information through the open-ended survey; this minimized the solicitation of predetermined responses. Since response possibilities are often clear given the way a question is asked, it was important that I did not word questions in a way that suggested I was only interested in positive experiences (Patton, 1990). For example, instead of "How does [ESSC] improve the experience of undergraduate engineering students?" I asked "How does [ESSC] *influence* the experience of undergraduate engineering

students?" Probes were also be used to solicit both positive (advantages) and negative (disadvantages) experiences. To remain open to negative findings during data analysis, I allowed researchers not directly involved with the study to review my findings and clearly documented the link between the data and the conclusions (Borrego et al., 2009). Each method is important to establishing trustworthiness in a qualitative study, and they ensured that the findings reflected the data collected through each phase. To remain open to negative findings during data reporting, I withheld the identities of participants and ESSCs through the use of pseudonyms and reported on the results in aggregate. By removing identities, I will not be as concerned with negative findings impacting the future work of those involved (Yin, 2009). I also worked closely with ESSC administrators to make sure the language used in the final reports was based on factual information and that the level of anonymity was acceptable.

3.8. Limitations

In addition to my researcher and methodological biases, several methodological limitations should be considered when interpreting the results of this study. While these limitations do not invalidate this study, they do confine the conclusions that can be drawn. The main limitations of this study relate to student participation, the data sources, the case selection process, and–ultimately–the scope. First, I am unsure if students who had negative or limited experiences with the ESSC at their institution were less motivated to participate since participation was voluntary. While I offered financial incentives to encourage participation, the possibility of a biased sample was still present. Second, I only collected self-reported data and, therefore, was unable to confirm the effectiveness of the revealed practices. While I could assume that the ESSC administrators discarded ineffective practices, I was unable to collect the information necessary to confirm whether the strategies employed at any individual ESSC were more successful. Lastly, I did not collect data from each of the identified ESSC classifications as none of the ESSC administrators who volunteered to participate during Phase 3 were affiliated with a Women & Minority Engineering Program (WMEP) or a General Engineering Program (GEP). While I was able to include three of the five classifications revealed, I am unable to determine if certain perspectives were not revealed due to their uniqueness to WMEPs and GEPs. Additionally, resource constraints (i.e., time constraints and financial limitations) impacted which institutions (and how many) I could realistically include because travel can be very

expensive and time consuming. While I included an appropriate number of cases based on the literature, it is possible that I did not reach saturation or collect enough data to identify all of the differences within and between ESSC classifications. Notwithstanding these limitations, I believe the results of my study are still of quality as I took appropriate measures to ensure validity and reality throughout all phases of the work. The aforementioned steps have ensured that I provide a valuable contribution.

3.9. Institutional Review Board

Virginia Tech human subjects research approval through the Institutional Review Board (IRB) was obtained before any participants were contacted. The current IRB issued approval for this project is IRB 13-666 and the protocol approval covers the entire study.

3.10. Summary

Chapter 3 outlines the exploratory, qualitative, multi-case approach that I employed for my dissertation. Through the use of documents, surveys, interviews, and focus groups, I explored the particulars of several ESSCs and investigated the co-curricular support offered at multiple engineering colleges. I also developed a logic model table and matrices that can be used to understand the function of co-curricular support from the administrator or student perspectives. In the following chapters, I discuss the analyses across cases and examples from within cases.

CHAPTER 4. Results

4.1. Introduction

The purpose of my study was to explore how the student interventions offered alongside engineering curricula influence the undergraduate experience. The overarching question that guided my work was: *How do engineering student support centers use student interventions to provide undergraduate engineering students with co-curricular support?* To address the purpose and answer my overarching question, I designed a multi-case study that employed multiple qualitative data collection methods to answer the following research questions:

RQ6. How are existing engineering student support centers typically configured?

RQ7. What outcomes and objectives do administrators aim to help students attain and achieve through student interventions?

RQ8. What outputs do administrators aim to produce through student interventions?

RQ9. What experiences do engineering students have with student interventions?

RQ10. How do student experiences align with the configurations, outcomes, and outputs? What gaps, if any, exist?

In this chapter, I present the results of my research based on the data analysis procedures described in Chapter 3. I begin this chapter with an overview of the Model of Co-curricular Support (MCCS), which is presented as a logic model table. Next, I explain each column of the MCCS, starting with the inputs (i.e., *Programs, Activities, and Services*) used to provide co-curricular support at the ESSCs included in this study (RQ1). Next, I present the outcomes/objectives guiding the ESSCs (RQ2). Then I describe the outputs that ESSC administrators aim to produce with the inputs to help students attain and achieve the outcomes/objectives (RQ3). Finally, I present the student experience with regard to the various ESSC configurations and outcomes/objectives (RQ4). I present the student experience using tables to visually demonstrate how the student experience aligns with ESSC configurations and ESSC administrative perspectives, respectively (RQ5). As a reminder, the data I report was self-reported and I did not collect actual performance data with regard to academic performance, student retention, or career attainment.

4.2. Model of Co-curricular Support (MCCS) Overview

The most important product of this study is the Model of Co-curricular Support (MCCS), shown in Figure 7. The MCCS is the most important product of my study because it visually depicts the general use of student interventions offered by ESSCs of varying classifications and structures. The model includes the following columns: (1) Inputs, (2) Outputs, (4) Short-term Outcomes, (5) Medium-term Outcomes, and (4) Long-term Objectives.

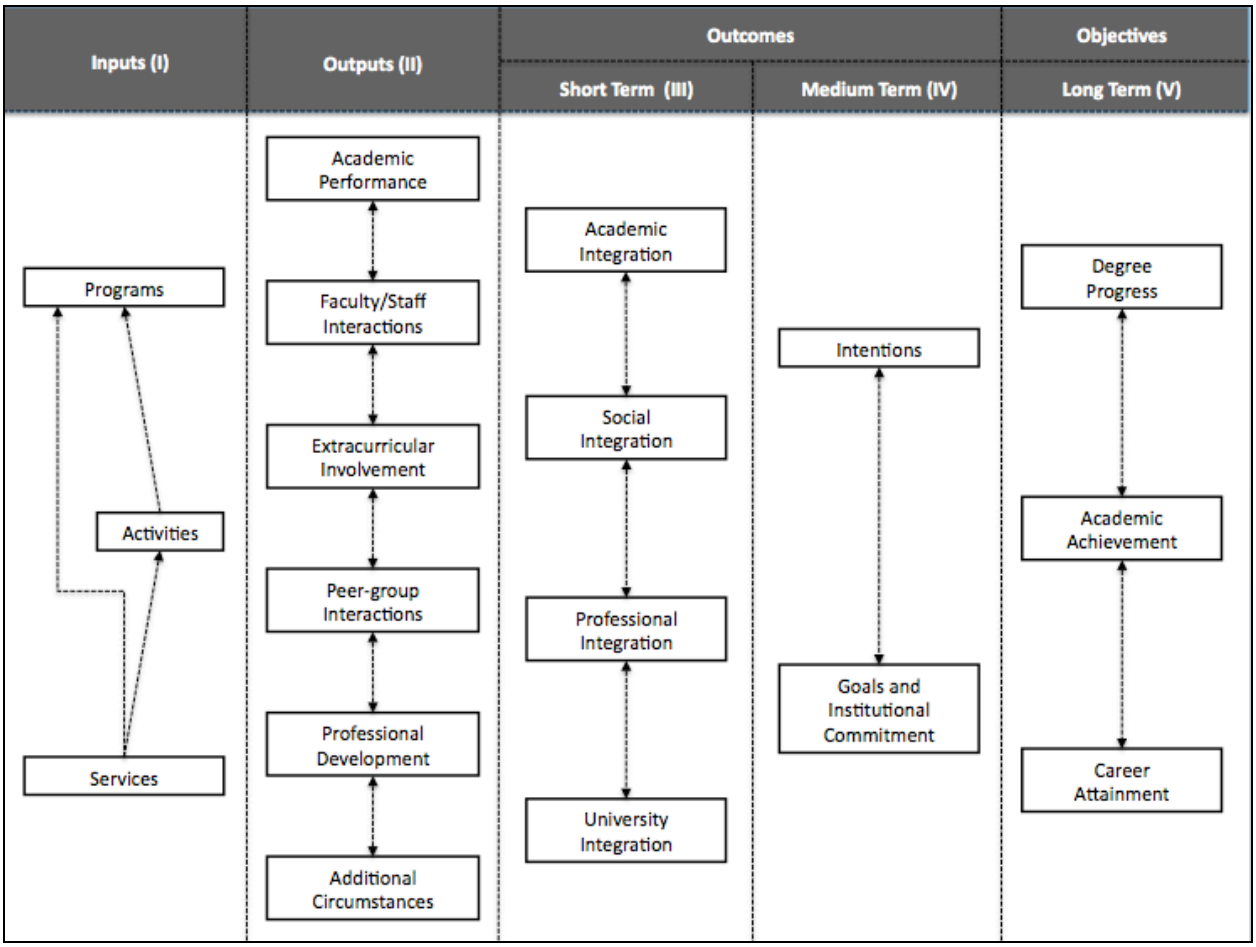


Figure 7 - Model of Co-curricular Support

Inputs (Column I) are the interventions provided by the ESSC administrators using the available resources: *Programs*, *Activities*, and *Services*. **Outputs (Column II)** are the areas of the institutional experience that ESSCs are intended to influence: *Academic Performance*, *Faculty/staff Interactions*, *Extracurricular Involvement*, *Peer-group Interactions*, *Professional*

Development, and *Additional Circumstances*. **Short-term Outcomes (Column III)** are the integration categories that ESSC administrators want students to attain from participating: *Academic Integration*, *Social Integration*, *Professional Integration*, and *University Integration*. **Medium-term Outcomes (Column IV)** are the *Intentions* and *Goals/commitments* that ESSC administrators want students to attain from participating. And **Long-term Objectives (Column V)** are the accomplishments that ESSC administrators want to prepare students to achieve: *Degree Progress*, *Academic Achievement*, and *Career Attainment*.

The MCCS is a repurposed version of Tinto's Model of Institutional Departure (described in Chapter 2; see Figure 2) and was adapted for co-curricular support within undergraduate engineering degree programs/colleges at large, public, four-year research universities. Based on the results of my study, I made several data-driven changes to the initial model. These additions, revisions, and withdrawals are summarized in Table 17. In short, Tinto's Model was modified to illustrate the process of students participating in Inputs to experience Outputs and attain Outcomes (short-term and then medium-term) so they can achieve Objectives. While the removed columns are still relevant to the model as a whole, they were not appropriate for this particular application; Tinto's Model represents the process of institutional departure at the institutional level, and the MCCS was developed to reflect this process in the context of undergraduate engineering as it directly relates to co-curricular support. These changes are explained in detail following the table and in subsequent sections.

Table 17 - Comparing MCCS to Tinto's Model of Institutional Departure

Tinto's Model (Columns)	Added	Modified	Withdrew
Pre-Entry Attributes	-	-	X
Goals/Commitments I	-	-	X
-	Inputs *Program* *Activities* *Services*	-	-
Institutional Experiences	*Professional Development* *Additional Circumstances*	Institutional Experiences » Outputs Extracurricular Activities » *Extracurricular Involvement*	-
Integration	*Professional Integration* *University Integration*	Integration » Short-term Outcomes	-
Goals/Commitments II	-	Goals/Commitments » Medium-term Outcomes	-
Outcomes	*Academic Achievement* *Career Attainment*	Outcomes » Long-Term Objectives Departure Decision » *Degree Progress*	-
Note: I made the shaded additions, modifications, and withdrawals at the column level, not the construct level.			

First, I withdrew the Pre-entry Attributes and Goals/Commitments I columns from Tinto's Model and added a column for Inputs. I made these revisions since student-support practitioners (e.g., ESSC administrators) are tasked with assisting a student as he or she arrives and, thus, I wanted the MCCS to focus solely on institutional action. While Pre-entry Attributes and Goals/Commitments can both impact the retention and persistence of engineering students, ESSC administrators do not decide who is admitted into a university; removing these columns allowed me to focus entirely on the actions that ESSC administrators can take to assist students directly; the addition of a column for Inputs represents these actions. Second, I modified the "extracurricular activities" construct from Tinto's Model. I changed the name of this construct to *Extracurricular Involvement* to minimize confusion since "activity" is a common term in ESSC practice that is used in my study to denote a specific intervention category. I also added the *Professional Development* and *Additional Circumstances* constructs to the Institutional Experiences column of Tinto's Model. I made this addition to reflect the intentions of ESSC administrators as they extended beyond *Academic Performance*, *Faculty/staff Interaction*, *Extracurricular Involvement*, and *Peer-group Interactions*. Third, I modified the Institutional

Experiences, Integration, Goals/Commitments II, and Outcomes columns in Tinto's Model. I changed the names of these columns to Outputs, Short-term Outcomes, Medium-term Outcomes, and Long-term Objectives, respectively, to align the longitudinal sequence of Tinto's Model with the naming convention of logic models. Lastly, I added constructs to Short-term Outcomes and Long-term Objectives to reflect the expanded outcomes and objectives that I identified through my dissertation. I added *Professional Integration* and *University Integration* to the integrations (i.e., Short-term Outcomes). I added *Academic Achievement* and *Career Attainment* to the outcome (i.e., Long-term Objectives). I also changed "departure decision" to *Degree Progress* to reflect the more encompassing objective that was articulate by ESSC administrators–which included enrollment, retention, and gradation. In the following sections, I will discuss these modifications in further detail and each column as it relates to my research questions.

4.3. Inputs (Column I)

My first research question was: *How are existing engineering student support centers typically configured?* As a reminder, **configuration** is the form of an ESSC that results from combining its classification and structure. **Classification** is the category of an ESSC based on the target populations. **Structure** is the arrangement of an ESSC with regard to the student interventions employed. In this section, I focus primarily on structure and how it compares across the classifications since the classifications themselves were defined in Chapter 3. Through data analysis, I identified 29 different intervention categories that were included in at least one of the six ESSCs. More specifically, I identified 9 *Programs*, 10 *Activities*, and 10 *Services*. While the student interventions are grouped by category and explained separately, it should be noted that they are not mutually exclusive. That is to say, many of the *Programs* contained elements of other *Programs*, *Activities*, and *Services*; and *Activities* sometimes included *Services* as well (see Figure 8). Consequently, I begin this section by discussing *Services* as the smallest unit of interventions, followed by *Activities* and then *Programs*. Lastly, I describe the resources that make providing these interventions possible.

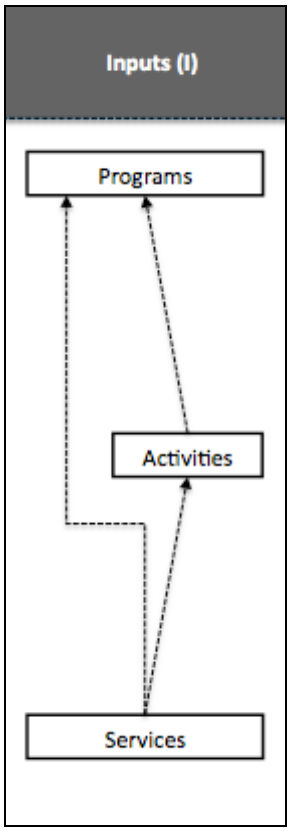


Figure 8 – Inputs (Column I)

4.3.1. Services

Each ESSC included at least two *Services*. As a reminder, **Service** refers to regularly available assistance or resources. In combination, ESSCs offered the following *Service* types:

- **Informal advising:** providing students with access to counseling or advising assistance.
- **Opportunity advertising:** distributing information to students about scholarships or opportunities from companies, organizations, etc.
- **Organizational support:** supporting engineering organizations such as the National Society of Black Engineers, Society of Hispanic Professional Engineers or Society of Women Engineers.
- **Tutoring**: coordinating students receiving active assistance via tutors.
- **Course clustering:** grouping students in classes together
- **Student lounge:** providing students with regular, sustained access to a physical space without active support/resources.
- **Study hall**: providing students with regular, temporary access to a reserved space with active support/resources to work on their academics.

- **Learning center**: providing students with regular, sustained access a physical space with active support/resources to work on their academics.
- **Test bank**: providing students access to old tests, exams, quizzes, or study guides.
- **Resource library:** providing students with access to resources in the manuscript format such as books and magazines.

Separately, each ESSC included a combination of *Services*. I provide an overview of the *Services* provides by each ESSC administration in Table 18. If we focus on the specifics within each ESSC, the descriptions in Table 18 show that ESSCs include many of the same *Services*, sometimes differently and sometimes similarly. For example, ESSC administrators personally provided informal advising at each ESSC that included the *Service*. Thus, informal advising illustrates a way that a *Service* could be provided similarly across structures. In contrast, each student lounge was distinct: DEP1 had a student lounge that included office space for student organizations; WEP2 and MEP2 were located in the same office and, thus, each ESSC included a student lounge that was jointly located; and MEP3 had a lounge that, while nearby, was jointly controlled by MEP2 and the student organizations that were directly connected to MEP3 through organizational support. Thus, student lounges illustrate a way that a *Service* could be provided very differently across structures. This result suggests that while ESSCs may offer similar *Services*, it does not mean that they are provided in the same exact way.

If we focus on the patterns across ESSCs, the data in Table 18 shows that the *Services* offered by ESSCs under different administration but at the same institution reflected each other more than they reflected the *Services* offered by the similarly classified ESSC at different university. For example, the *Services* offered at WEP2 were more similar to that of MEP2 than WEP3. This was also true for WEP3 and MEP3, which were located at the same institution as well, and reflected in the fact that DEP1 and DEP4 are also quite different from each other. This result suggests that while ESSCs are often discussed by classification, institutional context (such as to whom ESSC directors ultimately report, the university resources afforded to ESSCs, or institutional support provided elsewhere in the university) might impact the structure of *Services* provided by an ESSC more than how it is classified.

Table 18 - Service Descriptions

Service	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Informal Advising	Offered by DEP1 admin	Offered by WEP2 admin	Offered by MEP2 admin	Offered by WEP3 admin	Offered by MEP3 admin	-
Opportunity Advertising	Distributed using Facebook	Distributed using an electronic newsletter	Distributed using a mailing listserv	-	-	Distributed using a mailing listserv
Organizational Support	Administrative support to an umbrella organization	-	-	Administrative support to an umbrella organization	Advisory support to individual organizations	-
Tutoring	-	-	-	-	Free one-on-one or small-group tutoring sessions for basic-sequence and engineering courses	-
Course Clustering	Grouping of first-year women and URMs in basic sequence courses	-	-	-	-	-
Student Lounge	Includes office space for DEP1 student organizations	Includes resource library and is next to MEP2 lounge in shared space	Located next to WEP2 lounge in shared space	-	Controlled by MEP3 student organizations; under construction;	-
Study Hall	-	Open to the entire college and jointly hosted with MEP2	Open to the entire college and jointly hosted with WEP2	-	-	-
Learning Center	-	-	-	-	-	Includes supplemental instructions, tutoring, computers, white boards, and working space; open 24-hours
Test Bank	-	Shared w/ MEP2 and located in MEP2 lounge	Shared w/ WEP2 and located in lounge	-	-	-
Resource Library	-	Located in Student Lounge		-	-	-

4.3.2. Activities

Each ESSC provided at least one *Activity*, i.e., condensed experiences that do not require prolonged involvement from participants. In total, ESSCs offered the following *Activity* types:

- **Preview event:** centered on introducing prospective students (i.e., those who have been accepted already) to the college and university.
- **Professional Event**: centered on students interacting with traditional or non-traditional engineering professionals.
- **Leadership conference**: centered on the development of student leadership.
- **Event cluster:** collective groups of separate activities that are similarly purposed.
- **Banquet:** centered on students attending a formal meal.
- **Organizational showcase:** centered on exposing students to engineering organizations.
- **Orientation:** centered on familiarizing students with the college or university.
- **Semester kick-off**: centered on welcoming students at the beginning of a fall or spring semester.
- **Study sessions:** centered on preparing students for tests in engineering.
- **Workshop:** centered on students engaging in intensive discussion or action on a particular topic.

It should also be noted that while *Activity* types are mutually exclusive, many *Activities* also include components that are customary to the other *Activity* types. For example, an ESSC could host an organizational showcase at the beginning of a semester and, under these circumstances, the *Activity* could be considered an organizational showcase while working similar to a semester kick-off. In Table 19, I provide an overview of the *Activities* from each ESSC as well as the additional *Activity* components included within the intervention if applicable. If we focus on the specifics within each ESSC, the descriptions in Table 19 show that while ESSCs include many of the same *Activities*, the particulars of these *Activities* vary greatly across ESSCs. For example, preview events were offered by five of the six ESSCs and each ESSC offered it slightly different: DEP1 hosted a weekend event in the Spring for women; WEP2 hosted a one-day event in the fall for women; MEP2 hosted a weekend event in spring for URMs; WEP3 hosted the one-day event in the spring for women; and MEP3 hosted a one-day event in spring for students in general. Despite each *Activity* being classified the same, these events varied by duration, demographics, and semester across ESSCs. Variations similar to this were seen for each of the *Activities* that

were offered by multiple ESSCs. This result suggests that the *Activities* offered by ESSCs are essentially different across structures.

As with *Services*, if we focus on the patterns across ESSCs, the data in Table 19 shows that the *Activities* offered by MEPs and WEPs under different administration but at the same institution reflected each other more than they reflected the *Activities* offered by the similarly classified ESSC at different university – this time with regard to quantity as opposed to *Activity* type. For example, the number of *Activities* offered at WEP2 more closely aligned with that of MEP2 than WEP3. This was also true for WEP3 and MEP3. More specifically, WEP2 and MEP2 offered few *Activities* while WEP3 and MEP3 more regularly offered *Activities*. However, this trend was not reflected in the fact that DEP1 and DEP4 both offered few activities. This result suggests that while MEPs and WEPs are often discussed by classification, institutional context might impact the quantity of *Activities* provided by these classifications similarly to how it impacts the *Services* provided by an ESSC. However, it is unclear whether institutional context has the same impact on DEP.

Table 19 - Activity Descriptions

Activity	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Preview Event	Weekend in spring for women	One-day in fall for women	Weekend in spring for URMs	One-day in spring for women	One day in Spring for all students and parents	-
Professional Event	-	-	-	Focus on career paths; series of dinners	Focus on networking; mimics hospitality suites Focus on career development; competitions	-
Leadership Conference	-	-	-	One-day for student leaders across college; co-hosted	Two-days for officers in student organizations	-
Event Cluster	-	-	-	Designed for first-year women; fall and spring semester kick-offs and other events.	-	Open to all students; tutoring, mentoring, forums, banquet, et. Open to transfer students; orientation and some continued support throughout the year
Banquet	-	-	-	Networking event w/ company reps	Celebrations for MEP3 communities member	-
Organization Showcase	Fall semester kick-off for first-years affiliated w/ DEP1	-	-	-	-	-
Orientation	-	-	-	-	Start the process of incorporating URMs into MEPE3; includes first-years and transfer students	-
Semester Kick-off	-	-	-	-	Held first-week of Fall; also organizational showcase	-
Study Session	-	Led by mentors	-	-	-	-
Workshop	-	-	-	-	Career fair prep Graduate school prep	-

4.3.3. Programs

Each ESSC provided at least one *Program*. As a reminder, **Program** refers to interconnected sets of experiences that require prolonged involvement. Collectively, ESSCs offered the following *Program* types:

- **Mentoring program**: centered on paring students with mentors.
- **Learning community**: centered on students living in a single residential hall.
- **Summer bridge program:** centered on course preparation prior to the first semester.
- **First-year seminar:** centered on a course during the first year.
- **Professional seminar:** centered on a course geared towards professional development.
- **Undergraduate research program:** centered on conducting research.
- **Activity cluster:** centered on students participating in a grouping of activities.
- **Scholar program**: centered on a multiple-year participation commitment.
- **Student leaders:** centered on students serving in a leadership role to assist other students.

It should be noted that while *Program* types are mutually exclusive, many *Programs* encompass other *Program* components as well as components from *Activities* and *Services*. For example, an ESSC could offer a learning community that included a first-year seminar, mentoring program, semester kick-off, and opportunity advising. In Table 20, I provide an overview of the *Programs* from each ESSC as well as the additional components included within each intervention. If we focus on the specifics from each ESSC, the descriptions in Table 20 show that ESSCs include *Program* types have inherent similarities and programmatic differences. For example, mentoring programs tended to be student-to-student and focused on first-year students. However, the specifics of the mentoring programs varied slightly across each ESSC that offered this *Program* type. For example, DEP1 required student to sign-up for a mentor and allowed them to request a mentoring group specifically for women, Blacks, Hispanics, or students in general. In contrast, WEP2 enrolled students in the mentoring program automatically and placed every woman in an all-female mentoring program involuntarily (though they could decide not to participate.) This result suggests that while the *Program* type does provide a baseline understanding of what an intervention entails, there may be intentional differences with regard to participants, participant enrollment/selection, and duration across ESSCs.

As with *Services* and *Activities*, if we focus on the patterns across ESSCs, the data in Table 20 shows the *Programs* offered by the ESSCs under different administrations but at the same institution reflected each other more than they reflected the *Programs* offered by the similarly classified ESSC at different university. For example, the *Programs* offered at WEP2 more closely aligned with that of MEP2 than WEP3. This was also true for WEP3 and MEP3. More specifically, WEP2 and MEP2 each offered a mentoring program and summer bridge program while WEP3 and MEP3 each offered a first-year seminar, professional seminar, and undergraduate research program. This result suggests that while ESSCs are often discussed by classification, institutional context might impact the *Program* types provided by an ESSC similarly to how it impacts the *Services* and *Activities* provided by an ESSC. This finding is further supported by the fact that DEP1 (though similar to WEP2 and MEP2) did not offer any *Programs* that overlapped with DEP4.

Table 20 - Program Descriptions

Program	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Mentoring Program	Student-to-student; first-year; self-selected; entails sub-programs for women, Blacks, Hispanics, and anyone.	Student-to-student; first-year; women; automatic enrollment; entails student leaders and event clusters Students-to-professional OR prospective-to-current student; entails communication via email	Student-to-student; first-year; URMs; automatic enrollment	Student-to-student; first-year; automatic enrollment; includes event cluster	-	-
Learning Community	First-year women and men; sub-components include first-year seminars, events, student leaders, mentoring, study sessions, and lounges	Second-year women; includes study sessions and professional events.	-	First-year students; not much formal programming	-	-
Summer Bridge Program	Incoming students & incoming students wishing to transfer	Incoming women	Incoming URMs	-	-	-
First-Year Seminar	-	-	-	6 sections; take clustered courses and meet weekly w/ facilitator and mentor	4 sections; take clustered courses and meet weekly w/ facilitator, mentor, and tutor	-
Professional Seminar	-	-	-	Leadership Course	Leadership and Professional Development Course	-
Undergraduate Research Program	-	-	-	During Fall/Spring	During Fall/Spring During Summer	-
Activity Cluster	-	-	-	Second-year women		-
Scholar Program	-	-	-	-	-	2-year commitment; 40-50% URM/women; entails summer bridge program, staff/peer mentors, and events.
Student Leaders	-	-	-	-	Mentors, tutors, and office staff	-

4.3.4. Resources

It should be noted that each ESSC relied on a combination of resources to offer the respective student interventions. In Table 21, I provide an overview of the resources used by each ESSC administration. If we focus on the specifics within each ESSC, the descriptions in Table 21 show that each ESSC administration relied on financial support, physical resources, and people to offer the student interventions that they provided. If we focus on the patterns across ESSCs, the data in Table 21 shows that the source of these resources were commonly the college, university, faculty, students, or corporations. This result suggests that the financial, physical, and human resources that make ESSCs possible are typically provided by engineering colleges, universities, faculty volunteers, current engineering students, and corporations.

Table 21 - Resource Descriptions

Sources	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
College	Financial	Financial	Administrative Support (i.e., Dean/College)	-	-	Financial
University	Units such as Student affairs and Residential life	Units such as MEP3	Units such as WEP2 and the academic success center	Units such as MEP3 & General support	Units such as WEP3	Other colleges and units within the university
	Physical space & Housing	Physical space & Housing	Physical space	Physical space & Housing	Physical space & structure that allows experimentation and innovation	Physical space & Housing
Faculty	Volunteering	Volunteering	-	Advising	-	Volunteering
Students	Student leaders	Student leaders	Student leaders	Student leaders	Student leaders	Student leaders
	Graduate Teaching Assistants			Student volunteers		Student volunteers
Local Community	-	Churches, schools, fraternities, sororities, etc.	-	-	-	-
Corporations	Financial	Financial	Financial	Financial	Financial	Financial
				Partnerships	Partnerships	Partnerships
Donors	-	-	Financial	-	-	-
Departments	-	-	-	Partnerships	-	-
Government	-	-	-		-	Grants
Note: Site visit observations were also used to identify resources (e.g., student leaders, physical space, and housing)						

4.3.5. Summary of Inputs

In summary, ESSCs offer *Programs*, *Activities*, and *Services* in unique combinations within institutions and diverse combinations across classifications. While ESSCs are often discussed based on classification, it is important to acknowledge the structural differences as well as the impact institution can have on structure. The results from my study suggest that there are no conventional structures with regard to existing ESSCs (despite there being typical classifications) and imply that there will be structural similarities within institutions in the presence of multiple ESSCs under different administration. I present an overview of each ESSC structure in Table 22 below. The table is provided to present an overview of the intervention types employed across each ESSC and to illustrate the collective structures within universities as well as classifications. When reviewing the table, the following should be noted: (1) there are more similarities within institutional settings than within classification categories; (2) there is no ESSC that offers every interventions type but each ESSC offered at least one intervention from each category; and (3) there are no identical structures within institutions or classifications. In the following section, I discuss the Outcomes and Objectives behind these structures.

Table 22 - Intervention Summary

	Intervention	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Program	Mentoring Program	√	√	√	√		
	Learning Community	√	√		√		
	Summer Bridge Program	√	√	√			
	First-Year Seminar				√	√	
	Professional Seminar				√	√	
	Undergraduate Research Program				√	√	
	Activity Cluster				√		
	Scholar Program						√
	Student Leaders					√	
Activity	Preview Event	√	√	√	√	√	
	Professional Event				√	√	
	Leadership Conference				√	√	
	Event Cluster				√		√
	Banquet				√	√	
	Organization Showcase	√					
	Orientation					√	
	Semester Kick-off					√	
	Study Session		√				
	Workshop					√	
Service	Informal Advising	√	√	√	√	√	
	Opportunity Advertising	√	√	√			√
	Organizational Support	√			√	√	
	Tutoring					√	
	Course Clustering	√					
	Student Lounge	√	√	√		√	
	Study Hall		√	√			
	Learning Center						√
	Test Bank		√	√			
	Resource Library		√				

4.4. Outcomes and Objectives (Columns III-V)

The second research question was: *What outcomes and objectives do administrators aim to help students attain and achieve through student interventions?* As a reminder, **Outcomes** are the skills, knowledge, and behaviors that students attain through participation and **Objectives** are achievements that students are prepared to accomplish (long-term) through participation. Through data analysis, I identified four Short-term Outcomes (*Academic Integration*, *Social Integration*, *Professional Integration*, and *University Integration*), two Medium-term Outcomes (*Intentions* and *Goals/Institutional Commitment*) and three Long-term Objectives (*Degree Progress*, *Academic Achievement*, and *Career Attainment*). Collectively, these nine constructs (see Figure 9) encompass 11 aims that were revealed from analyzing the document artifacts and ESSC administrator interviews. Accordingly, I begin this section by discussing the aims guiding the ESSCs collectively. Next, I explain how the aims are incorporated in the MCCS as Outcomes and Objectives.

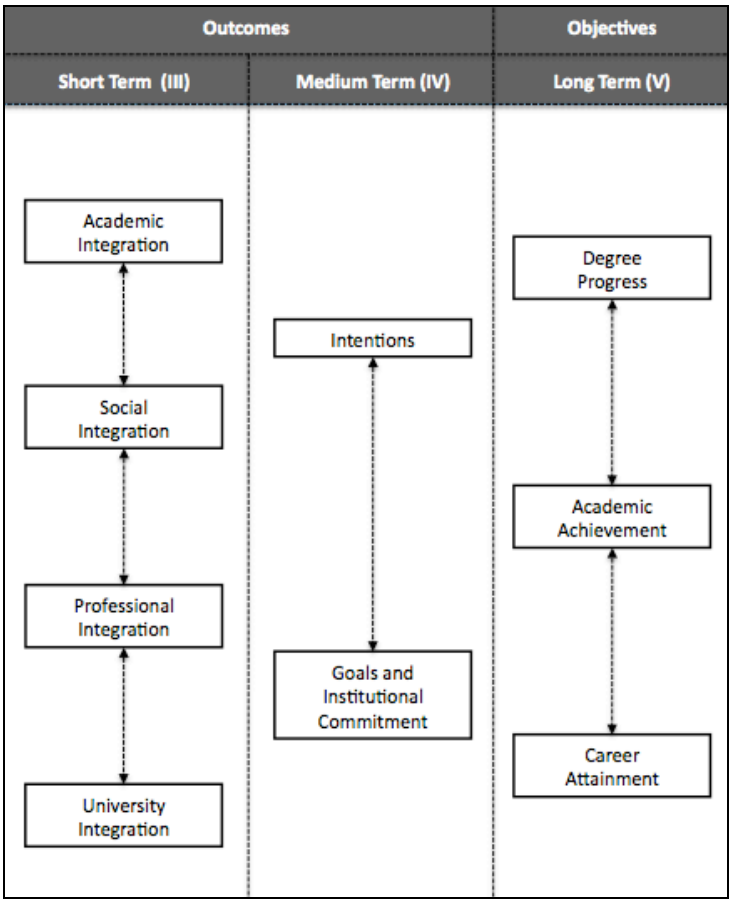


Figure 9 - Outcomes and Objectives

4.4.1. Aims (Practice)

Each ESSC administration had at least four aims. Overall, ESSCs were guided by the following:

- Improving the **graduation** rate and year-to-year **persistence** of engineering students.
- Improving the percentage of **diverse students** who accept their offers of admission.
- Improving the amount and/or quality of **support received** by engineering students.
- Improving the **motivation** of engineering students.
- Improving the **academic performance** of engineering students.
- Improving the post-graduate **career attainment** of engineering students.
- Improving the specific **characteristics** of engineering students.

In Table 23, I provide an overview of the aims from each ESSC. The descriptions in Table 23 show the different ways that ESSC administrators described aims that are perceptibly related. For example, the aim of improving the amount and/or quality of support received by engineering students was widely held yet represented distinctly at each ESSC. As an illustration, DEP4 wanted to create an environment where all students can respectfully interact, ensure students have access university resources, and support transfer students in all aspects; in comparison, DEP1 wanted to help students make the transition to college successful and ensure that URM students do not feel like they are completely isolated. This result suggests that while ESSCs have aims that are categorically similar, their interpretations of what it means in practice can vary.

If we focus on the patterns across ESSCs, the data in Table 23 suggests that the aims of ESSC administrators may fluctuate with classification. (The colors in Table 23 are a visual mapping to Figure 10, which is presented further in this section.) More specifically, WEPs (i.e., WEP2 and WEP3) and MEPs (i.e., MEP2 and MEP3) had less expansive aims when compared to DEPs (i.e., DEP1 and DEP4). In particular, none of the WEP administrators expressed an aim related to academic performance. Likewise, none of the MEP administrators expressed an aim related to career attainment. In comparison, DEP administrators expressed an aim in each category. These results suggest that the aims guiding an ESSC may differ across classifications. While it is unlikely that the WEP and MEP administrators did not care about academic performance or career attainment respectively, the prioritization of these areas may differ across classifications.

Table 23 - Aims vs. ESSCs

Aim	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Graduation & persistence	Improving graduation rates of URMs	Increasing retention/graduate rates of women	Increasing number of URMs graduating from university & engineering	Increasing retention/graduation rates of women	Increasing retention/graduation rates of URMS	Graduating a diverse pop. & increasing persistence
Diverse students	Increasing the diversity of students	Ensuring there is diversity	Increasing number of URMs	Increasing the percentage of women	Increasing the overall diversity	Attracting diverse students & recruiting diverse transfer students
Support received	Helping students successfully transitions to college	Supporting women	Helping students carry out academic plans	Helping students get connected to the college	-	Creating environment where all students can respectfully interact
		Making women feel more welcomed	Helping freshman adjust to university			
	Ensuring URMs do not feel like they are completely isolated	Ensuring there is inclusion within the college	Helping students decode academic environment			Ensuring student shave access university resources
		Educating women about opportunities	Helping students understand what it takes to be successful			Supporting transfer students in all aspects
Motivation	Increasing eagerness to learn and explore	Making women feel stronger (empowered)	-	Empowering women to benefit society	Helping students remain motivated, focused, and passionate	Increasing engagement of URMs in university activities
				Inspiring women to pursue opportunities		
Academic performance	Increasing GPAs	-	Helping Freshman Excel Academically	-	Promoting Academic Development & Excellence	Increasing GPAs
Career attainment	Increasing the rates of obtaining co-op, internship, and job offers	Preparing women to succeed in engineering careers	-	Increasing the number of women who pursue graduate study & academic careers	-	Increasing the rates of obtaining co-op, internship, and job offers
Characteristics	Desire to give back	-	-	Leadership	Leadership, professionalism, and community support	Cross-cultural competencies

4.4.2. Outcomes and Objectives (Theory)

Subsequent to identifying the aims, I used Tinto's Model to align them with theory. Aligning the aims with theory was important to connect the intentions of the ESSC administrators with theory on student retention. I visually represent the results of this alignment in the MCCS as Short-term Outcomes, Medium-term Outcomes, and Long-term Objectives. The combined Short-term Outcomes of ESSCs are increasing (1) *Academic Integration*, (2) *Social Integration*, (3) *Professional Integration*, and (4) *University Integration*; the Medium-term Outcomes are positively influencing (5) *Intentions* and (6) *Goals & Institutional Commitment*; and the Long-term Objectives are (7) *Degree Progress*, (8) *Academic Achievement*, and (9) *Career Attainment*. In this section, I explain how these constructs include each of the aims previously discussed.

I began the alignment process by dividing the constructs outlined in Tinto's Model into three categories based on the linear progression of the model with regard to time. As a reminder, Tinto's Model propositions that integration occurs before goals/commitments, which is followed by the departure decision. As a result, the following divisions were made with regard to Tinto's Model to enable it being aligned with the naming convention of a logic model. First, I designated the following constructs as Short-term Outcomes: *Social Integration* and *Academic Integration*. Second, I designated the following constructs as Medium-term Outcomes: *Intentions* and Goals *& Institutional Commitments*. Lastly, I designated the following construct as a Long-term Objective: *Departure Decision*.

After I aligned the longitudinal sequence of Tinto's Model with the naming convention of logic model, I divided the aims into two categories: Outcomes or Objectives. I classified aims that dealt with students attaining something <u>while</u> participating in interventions as Outcomes. I classified aims that dealt with students achieving something <u>as a result</u> of participating as Objectives. As a result of this process, I classified the following aims as Objectives: improving the academic performance of engineering students; improving the graduation rate and year-to-year persistence of engineering students; improving the number of diverse students who accept their offer of admissions into the university; and improving the post-graduate career attainment of engineering students. Accordingly, I classified the following aims as Outcomes: improving

the amount and/or quality of support received by engineering students; improving the motivation of engineering students; and improving the specific characteristics of engineering students.

Once aims were considered either an Outcome or Objective, I compared them to the constructs (originally from Tinto's Model) in their respective columns. I compared the aims that I categorized as Outcomes to the Short-term and Medium term Outcome constructs. And I compared the aims that I categorized as Objectives to the Long-term Objective constructs. In instances where the aims were not encompassed by the constructs in Tinto's Model, I added additional constructs to the MCCS. This process resulted in the addition of *Professional Integration* and *University Integration* as Short-term Outcomes and the addition of *Academic Achievement* and *Career Attainment* as Long-term Objectives. I also replaced the decision to depart with *Degree Progress*. I present a visual mapping of aims to constructs in Figure 10.

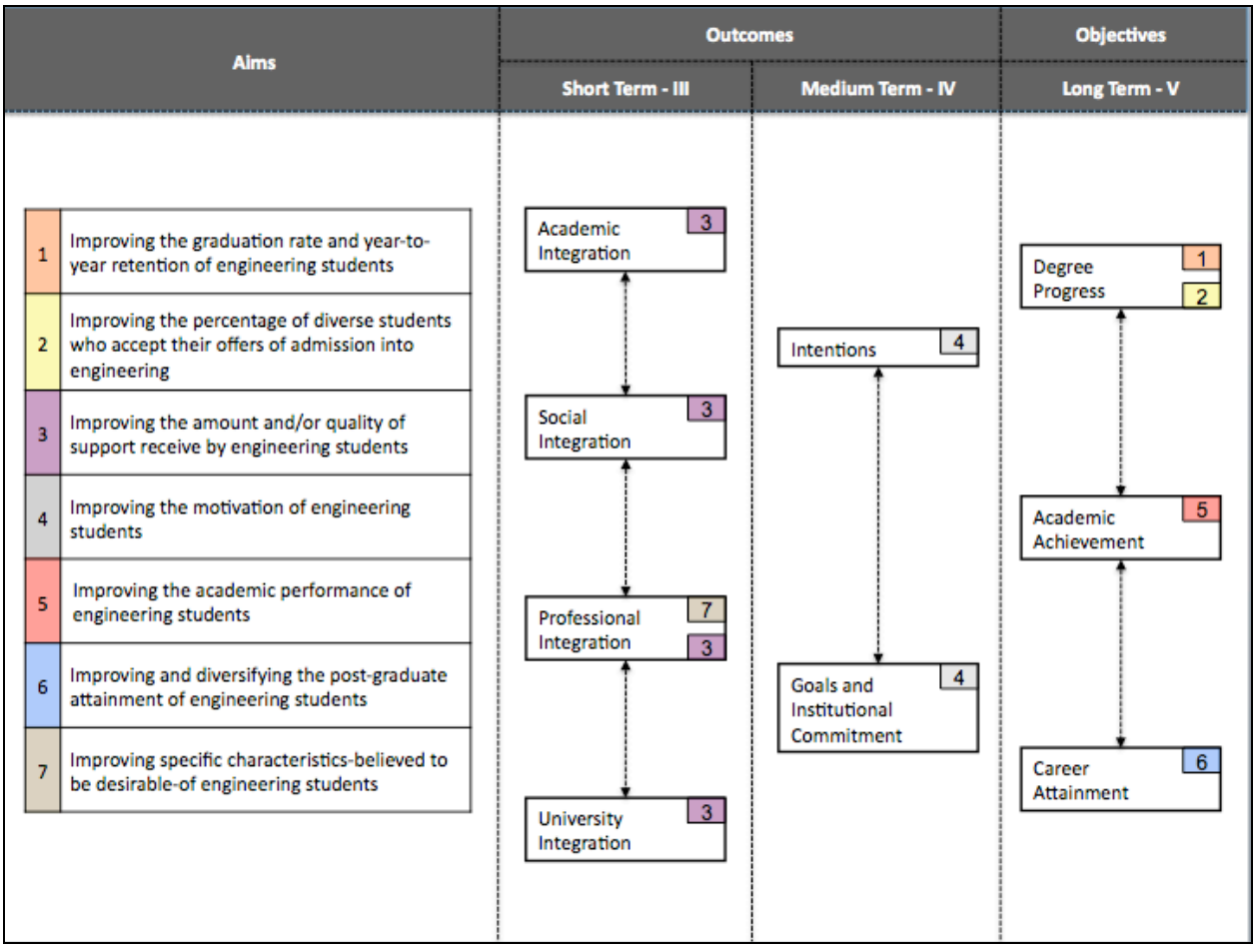


Figure 10 - Aims vs. Outcomes & Objectives

First, the aims to improve graduate rates and retention (#1) and the percentage of diverse students who accept their offer of admission (#2) are encompassed in *Academic Progress*. Therefore, I define progress as entering the system, progressing through the system, and, ultimately, leaving the system with an engineering degree. Second, the aim to improve the amount and/or quality of support received by engineering students from the college/university (#3) is encompassed in improving each of the four Short-term Outcomes. As a result, I define integration as having access and support in each respective area. In addition to access and support, *Professional Integration* also encompasses the aim of improving specific student characteristics (#7) since the characteristics (service-orientation, leadership, professionalism, and cultural-competency) were discussed in relation to their usefulness to the engineering profession. Third, the aim to improve the motivation of engineering students (#4) is encompassed in the Short-term Outcomes. Influencing the *Intentions* and Goals & *Institutional Commitment* a student has is related to impacting their motivation. Fourth, the aim to improve the academic performance of engineering students (#5) is encompassed in *Academic Achievement*. Lastly, the aim to improve/diversify the post-graduate attainment of engineering students (#6) is encompassed in *Career Attainment*. The results of this process suggest that the MCSS is encompassing of the aims revealed by each ESSC.

4.4.3. Summary of Outcomes and Objectives

In summary, ESSCs have common Outcomes and Objectives but some distinct variations existed across classifications. For Objectives, *Degree Progress* was common across all classifications while *Academic Achievement* was unique to MEPs and DEPs and *Career Attainment* was unique to WEPs and DEPs. For Medium-term Outcomes, *Intentions* and *Goals & Institutional Commitment* were represented across classifications, though not universally. For Short-term Outcomes, *Integration* was represented across classifications though the extent and nature of its representation varied. The results from my study suggest that ESSC administrations use student interventions to help students integrate in hopes of them attaining intentions, *g*oals, and commitments that align with engineering in a way that allows them to accomplish degree progress in addition to academic achievement and/or career attainment. I present an overview of

the Outcomes and Objectives (theory) for each ESSC in Table 24. In the next section, I discuss the Outputs intended to produce these Outcomes and Objectives.

Table 24 - Objectives Summary

	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Outcomes	U1	U2		U3		U4
Degree Progress	√	√	√	√	√	√
Academic Achievement	√	-	√	-	√	√
Career Attainment	√	√	-	√	-	√
Objectives						
Intentions	√	√	-	√	√	√
Goals and Institutional Commitment	√	√	-	√	√	√
Academic Integration	√	√	√	√	-	√
Social Integration	√	√	√	√	-	√
Professional Integration	√	√	√	√	-	√
University Integration	√	√	√	√	-	√

4.5. Output (Column II)

The third research question was: *What outputs do administrators aim to produce through student interventions?* **Outputs** are the immediate products that result from the internal operation of student interventions. Through data analysis, I identified six *output* areas: (1) *Academic Performance*, (2) *Faculty/staff Interactions*, (3) *Extracurricular Involvement*, (4) *Peer-group Interactions*, (5) *Professional Development*, and (6) *Additional Circumstances*. Collectively, these six *Output* areas encompassed 23 outcome categories (see Figure 11). These categories were revealed from analyzing the webpages and interviews ESSC administrator. In this section, I will discuss each Output area and category and provide examples from practice to demonstrate how they were produced at the ESSCs.

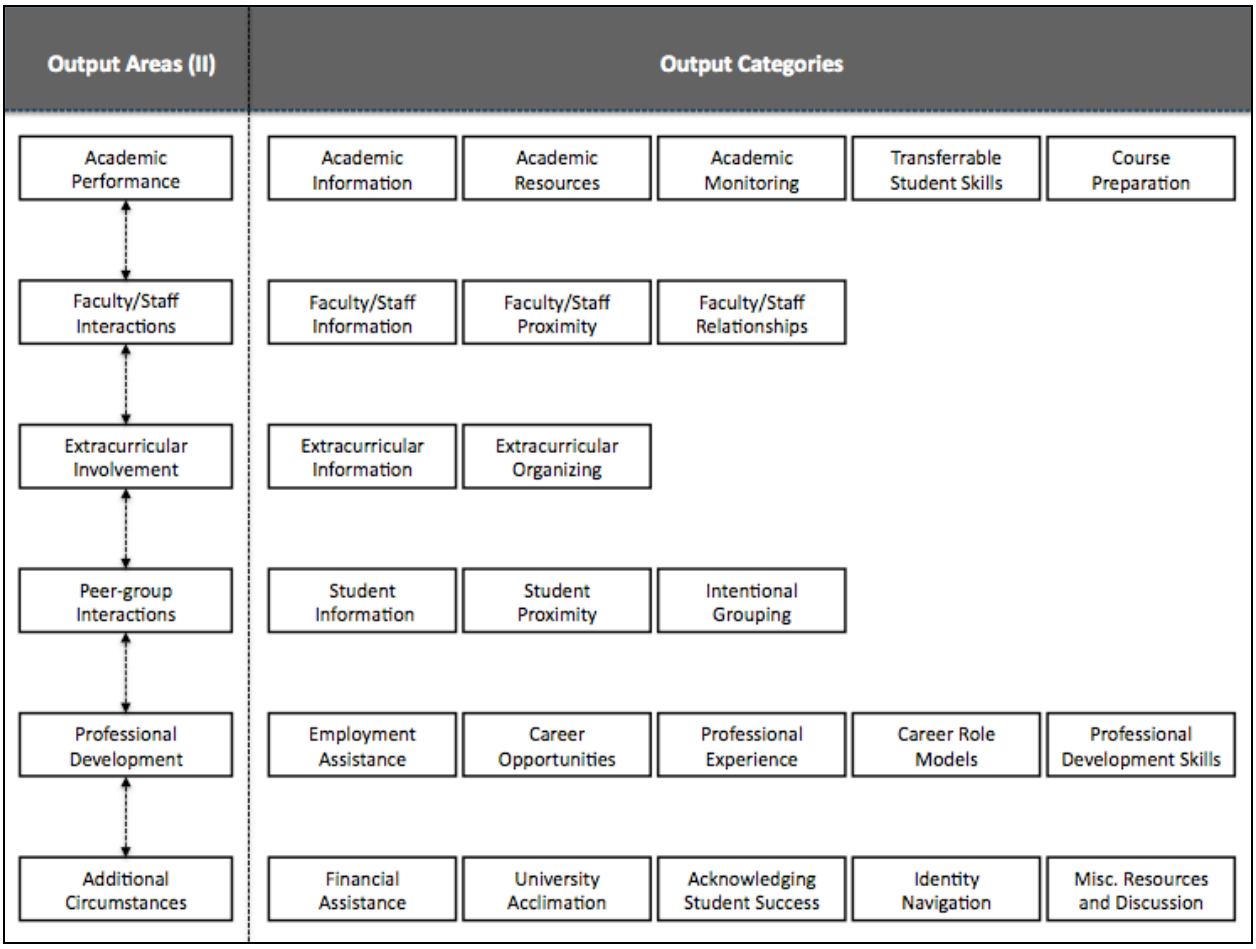


Figure 11 - Output Categories

4.5.1. Academic Performance

The first Output area is *Academic Performance*. In Table 25, I provide an overview of how each ESSC was intended to influence *Academic Performance*. In total, these results suggested that there are five categories:

- **Academic information:** disseminating information related to improving a student's academic performance or circumstances; this includes topics such scheduling courses, and classroom dynamics.
- **Academic resources:** providing students with access to resources that support their academic performance; this includes resources such as other students, physical space, or supplemental instruction.
- **Academic monitoring**: monitoring a student's academic performance or development; this includes individually discussing academic issues, tracking academic performance, enforcing GPA (i.e., academic performance) requirements, or acknowledging success.
- **Transferrable student skills**: contributing to the development of content-independent student skills that contribute to academic performance; this includes skills such as study techniques/habits, time management, critical thinking, learning strategies, etc.
- **Course preparation**: contributing to the development of content-dependent student skills that contribute to academic course preparation; this includes preparation prior to the first semester in chemistry, math (calculus or pre-calculus), engineering, physics, or computer programming.

In summary, *Academic Performance* refers to disseminating information related to improving academic performance or circumstances, providing access to resources that support academic performance, monitoring academic performance or development, and contributing to the development of content-independent and content-dependent skills that contribute to academic performance.

Table 25 - Academic Performance Categories

Academic Performance	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Academic Information	Encourage students to help each other with homework, form study groups, and develop study schedules.	Discuss which professors to take and which to avoid.	Explain how to read a syllabus, how credit hours work, and the expectations professors have for students.	Discuss places to study on campus; places to study on campus; ways for students to talk to their instructors about academics; how to balance leadership opportunities and academics; which classes to take and how to navigate the curriculum; and sources of academic support.	Encourage students to perform better academically.	Encourage students to attend supplement course instruction.
	Discuss topics such as the course request process and studying.					
	Notify students about academic opportunities.				Discuss course scheduling; academic performance as a requirement to be a student leader; and academic merit required to attend graduate school.	Discuss classroom dynamics.
	Refer students to sources of academic support.					
Academic Resources	Provide access to upper class students who help w/ hw and hold review sessions.	Provide access to upper class students who help with hw/tutor and lead study sessions, and a physical place to hold group meetings.	Provided a physical place to study, and access to upper class students who tutor.	Provide access to upper class students who can tutor.	Provide one-on-one and small group tutoring; a physical place to study; and review sessions before tests.	Provide a drop-in tutoring service; physical place to study that is open 24-hours; supplemental instruction for selected courses; and academic development workshops.
	Facilitate studying in groups and obtaining tutors.	Facilitate students having access to selection of study materials and old tests.	Facilitate students studying together, and having access to selection of study materials and old tests.	Facilitate course clustering for classes such as physics, chemistry, and calculus; forming study groups; and finding tutoring resources.	Facilitate students working together on class work.	

Table 25 (continued) - Academic Performance Categories

Academic Performance	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Academic Monitoring	Match students with instructors or academic coaches to discuss academic issues.	-	Position a university employee (MEP2 director) near students who can discuss academic issues.	Position a university employee (WEP3 admin) near students who can discuss academic issues and identify a plan of action to identify underlying issues.	Require students meet a minimum GPA requirement to be leaders in the affiliated student organizations.	Match students with a university employee (DEP4 admin) to monitor their academic progress, discuss academic issues, and help create a plan for success.
	Require students track their academic performance using Excel spreadsheets.				Recognize students who are performing well academically.	Require students retake calculus is they do not earn at least a B- in the course.
						Recognize students who are performing well academically.
Transferrable Student Skills	Discuss study habits and time management.	-	Assist students with study skills and time management.	Discuss time management, how to develop study skills, student success strategies, and learning styles.	Assist students with applying critical thinking skills to new situations; and with developing new learning strategies.	Teach students time management, study skills, and strategies for learning.
	Teach students the keys to academic success, study skills, and time management.				Teach students how to create study groups.	
	Require student practice proven success strategies.		Teach students how to learn collaboratively and time management		Discuss building effective study groups, strategies for identifying study partners, and time management.	Assist students in matters related to academic skills development.
Course Preparation	Teach students elements of chemistry, math, and engineering prior to their first semester	Teach students elements of chemistry, math, and physics prior to their first semester	Teach students pre-calculus or calculus prior to their first semester			Teach students elements of math, physics, chemistry, engineering, and computer programming prior to their first semester

4.5.2. Faculty/Staff Interactions

The second Output area is *Faculty/Staff Interactions*. In Table 26, I provide an overview of how each ESSC was intended to influence *Faculty/Staff Interactions*. In total, these results suggested that there are three categories:

- **Faculty/Staff Information:** disseminating information related to interacting with faculty/staff; this includes topics such communicating with faculty, interacting faculty, and addressing faculty when you have a problem.
- **Faculty/Staff Proximity:** increasing the quantity of interactions students have with faculty or staff; this includes hosting events for faculty to attend with students, inviting faculty to give workshops or seminars, introducing students to faculty members, or personally meeting with students yourself if you are faculty/staff.
- **Faculty/Staff Relationships:** helping student establish informal or formal relationships with faculty or staff; this includes reoccurring interactions between students and faculty/staff by involving faculty/staff in student interventions, facilitating students networking with faculty/staff, or personally meeting with students regularly and sometimes individually if you are faculty/staff.

In summary, *Faculty/Staff Interactions* refers to disseminating information related to interacting with faculty/staff, increasing the quantity of interactions students have with faculty or staff, and helping student establish informal or formal relationships with faculty or staff.

Table 26 - Faculty/Staff Interactions Categories

Faculty/Staff Interactions	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Faculty/Staff Information	Discuss creating connecting with faculty and why creating relationships is important.	Provide female students with a director of female faculty in engineering.	Discuss how to talk to professors and why it is important to talk to professors. Refer students to specific people who are campus resources when necessary. Help students with determine when they should go meet their academic advisor.	Discuss how student can address faculty member when they are having a problem. Encourage students to talk to faculty member and WEP3 administrators. Teach students how to go talk to their professors.	Encourage students to attend office hours, get to know faculty personally, and visit their faculty when they have a problem.	Encourage students to attend office hours.
	Encourage students to go meet their faculty.				Teach students how to interact with faculty and how to email faculty.	Teach students how and when to engage with faculty/staff to get what they need.
	Teach students how to approach their faculty.				Refer students to university employees as necessary.	Refer students to faculty/staff who can solve their problems.
Faculty/Staff Proximity	Host lunches and slushie hours for faculty member to attend with students.	Invite faculty to give workshops, seminars, information sessions, and attend events.	Invite faculty to attend events and give workshops or seminars.	Host dinners and lunches for faculty to attend with students.	Host a banquet that faculty/staff can attend with students.	Introduce students to faculty/staff from various departments at the university.
	Invite faculty/staff to give workshops or seminars and attend events.	Invite staff to come tell about the services offered by their respective offices.	Meet with students personally if you are faculty/staff.	Meet with students personally if you are faculty/staff.	Invite faculty/staff to attend activities and give workshops or seminars.	Invite faculty/staff to participate in events
	Facilitate prospective students meeting faculty.		Facilitate prospective students meeting faculty and students meeting graduate students.	Invite faculty/staff to participate in events and leader workshop sessions. Facilitate students networking with faculty/staff grad students in various departments; and student leaders networking with staff.	Meet with students personally if you are faculty/staff and attend events.	Facilitate students having informal access to faculty/staff.

Table 26 (continued) - Faculty/Staff Interactions Categories

Faculty/Staff Interactions	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Faculty/Staff Relationships	Meet with students regularly and sometimes individually if you are faculty/staff.	Meet with student individually if you are faculty/staff.	Meet with student regularly and sometimes individually if you are faculty/staff.	Meet with students regularly and sometimes individually if you are faculty/staff.	Meet with students regularly and sometimes individually if you are faculty/staff.	Meet with students regularly and sometimes individually if you are faculty/staff.
	Involve faculty/staff (or graduate students) as academic coaches.	Involve faculty as advisors for student organizations, mentors for students, and research internships sponsors.	Involve faculty in instructing students.	Facilitate students networking with faculty and graduate students in various departments.	Facilitate students meeting with graduate students and faculty weekly.	
	Support the engineering organizations.		Invite faculty to sponsor research internships.	Involve faculty in advising student organizations and mentoring students	Attend general body meetings and officer meetings of the student organizations.	Invite faculty to advisor student organizations, sponsor research internships, and instruct students.
					Involve faculty in sponsoring research internships and instructing students.	

4.5.3. Extracurricular Involvement

The third Output area is *Extracurricular Involvement*. In Table 27, I provide an overview of how each ESSC was intended to influence *Extracurricular Involvement*. In total, these results suggested that there are two categories:

- **Extracurricular Information**: disseminating information related to improving or increasing extracurricular involvement; this includes topics such as student organizations, studying abroad, undergraduate research, campus event, and design teams.
- **Extracurricular Organizing**: providing students with extracurricular opportunities; this includes opportunities such as events, design labs, intramural sports, student organizations, and undergraduate research.

In summary, *Extracurricular Involvement* refers to disseminating information related to improving or increasing extracurricular involvement and providing students with extracurricular opportunities.

Table 27 - Extracurricular Involvement Categories

Extracurricular Involvement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Extracurricular Information	Discuss involvement in student orgs.	Introduce students to research opportunities.	Facilitate prospecting students meeting w/ reps from opportunities on campus.	Discuss study abroad opportunities, student organizations, how to extend leadership experiences across the rest of college, how and where to get involved on campus, how to take on leadership positions, and what opportunities are available on campus.	Introduce students to engineering organizations.	Encourage students to attend participate in design teams, project teams, and undergraduate research.
			Introduce students to undergrad research.		Facilitate students inviting others to extracurricular activities.	Introduce students to the various design and project teams.
	Facilitate students meeting w/ leaders from engineering orgs.		Advertise campus events.	Encourage students to attend events, join engineering organizations, and get involved in non-engineering related activities.	Advertise programs and activities scheduled for the year and the benefits of participating.	Award participation in extracurriculars.
			Help students find opportunities that interest them.			Discuss extracurricular opportunities.
	Advertise study abroad opportunities.		Encourage students to participate in research and extracurriculars.		Teach students how to balance involvement in organizations with school and other commitments.	Advertise events.
Extracurricular Organizing	Organizing social, academic, professional, outreach, and service learning events.	Organize service, social, outreach, and professional events.	-	Organize outreach opportunities and hands-on projects.	Organize social events and a study abroad trip.	Organize events, trips, and lectures.
	Provide access to a design line that includes mentoring and financial support.			Support student organizations.	Support student organizations.	Support student organizations.
	Supporting student organizations.	Sponsor intramural sports teams		Partner with faculty to host undergrad research opportunities.	Partner with student organizations to host events.	Partner with other office on campus to host events.

4.5.4. Peer-Group Interaction

The fourth Output area is *Peer-Group Interaction*. In Table 28, I provide an overview of how each ESSC was intended to influence *Peer-Group Interaction*. In total, these results suggested that there are three categories:

- **Student Information:** disseminating information related to students interacting with other students; this includes topics such as interacting with peers, studying, communication, mentoring, teambuilding, and intergroup relations.
- **Student Proximity:** increasing the quantity of interactions that students have with other students outside of the classroom; this includes housing students together, grouping students together; organizing events for students to attend, providing a physical space for socializing, and supporting student organizations.
- **Intentional Grouping**: grouping students based on some part of their identity or academic circumstances; this includes within-group combinations of race, gender, academic year, role, and enrollment status plus across-group combinations of race, gender, academic year, and enrollment status.

In summary, *Peer-Group Interaction* refers to disseminating information related to students interacting with other students, increasing the quantity of interactions that students have with other students outside of the classroom, and grouping students based on some part of their identity or academic circumstances.

Table 28 - Peer-Group Interaction Categories

Peer-Group Interactions	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Student Information	-	-	Advise students on interacting with peer, particular majority peers.	Encourage students to communicate with each other	Train student leaders on how to mentor others.	Encourage students to take classes and live together.
			Encourage students to study together.	Discuss mentors befriending mentees, first-year students making friends, resolving peer conflict (particularly w/ males), relating to classmates, and working in a group setting effectively.	Teach student teambuilding.	Teach students about engaging in constructive and effective teamwork, functioning on teams, and intergroup relationships.
					Discuss being open and working in groups with other students.	
Student Proximity	House students in the same dorm.	House students in the same dorm.	Organize events and mentoring groups.	House students in the same dorm.	Support student-led organizations.	House students in the same dorm.
		Organize events.				
	Organize events and mentoring groups.	Provide physical space for meeting.	Provide physical space for meeting.	Organize events, mentoring groups, and seminars/courses.	Provide physical space for meeting.	Organize events and mentoring groups.
		Employ students to help other students.			Organize events and seminar/courses.	Provide physical space for meeting.
Intentional Grouping	Academic Year URM status Women	Academic Year Women Prospective	Academic Year URM status Prospective	Academic Year Women Student Leaders	Academic Year URM status Student Leaders	Academic Year URM status Women Transfers
	Lower x Upper Prospective x Current Women x Men	Lower x Upper Prospective x Current	Lower x Upper Prospective x Current	Lower x Upper Prospective x Current	Lower x Upper Prospective x Current	Lower x Upper Women x Men URM x Majority

4.5.5. Professional Development

The fifth Output area is *Professional Development*. In Table 29, I provide an overview of how each ESSC was intended to influence *Professional Development*. In total, these results suggested that there are five categories:

- **Employment Assistance**: developing industry-independent skills that contribute to obtaining employment of admittance; this includes skills such as writing cover letters, writing thank you notes, developing a resume, and navigating career fairs
- **Career Opportunities**: disseminating information related to career opportunities via an undergraduate degree in engineering; this includes disciplinary focuses, research areas, internships, co-ops, and full-time jobs.
- **Professional Experience**: providing work experience that contributes to the professional development of students via employment; this includes sponsoring undergraduate research experiences and hiring students as interns or student leaders.
- **Career Role Models**: providing access to role models along different career trajectories; this includes professional engineers, company representatives, business executives, etc.
- **Professional Skill Development**: developing industry-independent skills that contribute to successful professional performance; includes teamwork, communication, conflict resolution, etc.

In summary, *Professional Development* refers to developing industry-independent skills that contribute to obtaining employment of admittance; disseminating information related to career opportunities via an undergraduate degree in engineering; providing work experience that contributes to the professional development of students via employment; providing access to role models along different career trajectories; and developing industry-independent skills that contribute to successful professional performance. Unlike the other categories, this area was not originally part of Tinto's Model and emerged from my data.

Table 29 - Professional Development Categories

Professional Development	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Employment Assistance	Teach students how to write cover letters, write thank you notes, and create portfolios.	-	Host business etiquette dinner.	Teach students how to connect w/ industry, how to follow up with companies, and how to do a handshake.	Teach students about networking, resume building, dining etiquette, interviewing, public speaking, preparing handshakes, interacting with company reps, dressing appropriately, navigating career fairs, 30-second interviews, self-promotion, and graduate school preparation.	Help student develop resumes, secure internships, and secure undergraduate research.
	Require students to develop/update a resume.			Help students develop elevator speeches.	Help student write resumes.	
	Discuss preparing for career fairs.		Review statements of purpose.	Discuss resumes, career-fairs, social media and professional image, and dressing professionally.	Discuss preparing for grad school and whether it is a good choice; and searching for a job.	
	Help students prepare for career fairs.			Facilitate students having professional photographic taken for social media.	Facilitate students having mock interviews.	
	Review resumes.		Help w/ the job search process individually.	Encourage students to look for internships as early as possible.	Advise on interviewing, networking, and salary negotiating.	
	Host career fairs.					

Table 29 (continued) - Professional Development Categories

Professional Development	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Career Opportunities	Host seminar from various departments.	Introduce students to undergraduate research.	Host a seminar on undergraduate research.	Invite professionals to share their experiences and options after graduation; faculty to share their research.	Discuss non-engineering graduate school paths, whether or not graduate school is a good choice; engineering options w/ prospective students.	Encourage participation in undergraduate research.
	Discuss undergraduate research.	Host events that include company reps; and lab visits.	Advise students on career decisions and changing majors in necessary.	Facilities students attending research seminars.		
		Discuss majors within engineering.	Distribute information about research opportunities, jobs, and internships.	Discuss summer internships, co-ops, full-time opportunities, graduate school, undergrad research, and non-traditional career opportunities such as law, medicine, public policy, education, and non-profits.	Host employer information sessions.	Facilitate interacting with corporate sponsors to talk about careers and industry.
	Distribute information about internships, co-ops, and full-time jobs.	Distribute information with regard to what you can do with certain degrees; and internships and co-ops.	Discuss undergraduate research and internships.			
			Provide students with access to publications on engineering careers.			Discuss graduate school as an option.
Professional Experience	Hire students leaders	Hire interns and student leaders	Sponsor research experiences.	Sponsor research experiences.	Sponsor research experiences.	Hire interns.
			Hire student leaders.	Hire student leaders.	Hire student leaders, tutors, and mentors.	

Table 29 (continued) - Professional Development Categories

Professional Development	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Career Role Models	Provide opportunities to interact with diverse professional engineers.	Provide access to a database of alumni contacts and opportunities to interact with professional engineers.	Facilitate contacting alumni.	Provide opportunities to interact with female professional engineers.	Provide opportunities to interact with professional engineers such as company reps and alumni as well as graduate students.	Provide opportunities to interact w/ business executive and professional engineers.
				Host networking events.	Facilitate students attending professional conferences.	Host networking events, forums, and corporate sponsored discussions about engineering careers.
					Host networking events.	
Professional Development Skills	Host events intended to polish the non-academic skills such as working on teams, communicating effectively, dealing with conflict, and selling ideas.	Teach students about undergraduate research.	-	Teaching students MBA level course material related to topics such as leadership styles, vision, ethics, conflict resolution, mediation, communication styles, working in teams, and emotional intelligence.	Teach students about leadership, tutoring, mentoring, reviewing goals, evaluating programs, and developing new initiatives.	Invite companies to host forums. Teach students communication skills, how to interact w/ employers, and how to write a memo. Host professional workshops. Provide resources such as academic coaches.
	Teach students what companies expect of entry-level engineers.			Facilitate students working on presentation and communication skills; gaining practical research experiences; learning about the research profession; attending research meetings; and writing research papers.	Host professional sessions and research programs.	
	Invite companies to leadership sponsor workshops.	Train students in Six Sigma.		Help student assess their leadership and communication styles.	Discuss the transition to industry and leadership.	
				Teach students what companies expect from entry-level engineers.	Encourage students to attend workshops.	

4.5.6. Additional Circumstances

Lastly, the sixth Output area is *Additional Circumstances*. In Table 30, I provide an overview of how each ESSC was intended to influence *Additional Circumstances*. In total, these results suggested that there are five categories:

- **Financial Assistance**: facilitating access to financial assistance; this includes scholarships, stipends, or financial aid.
- **University Acclimation**: acclimating students into the university environment; this includes students adjusting to the university and surrounding city before their first semester or at the beginning of their first-year.
- **Acknowledging Student Success**: publically acknowledging the successes of students; this includes recognizing and celebrating.
- **Identity Navigation**: discussing life as an underrepresented engineering student; this includes addressing about what it is like to be a women or URM.
- **Miscellaneous Resources and Discussion**: providing students with miscellaneous resources and/or discussion.

In summary, *Additional Circumstance* refers to acclimating students into the university environment; facilitating access to financial assistance; publically acknowledging the successes of students; and discussing life as an underrepresented engineering student. Similar to *Professional Development*, this area was not originally part of Tinto's Model and emerged from my data.

Table 30 - Additional Circumstances Categories

Additional Circumstances	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Financial Assistance	Disseminating information about scholarships.	Disseminating information about scholarship opportunities.	Disseminating information about scholarships.	Disseminating information about scholarships.	Providing scholarships and stipends for undergraduate research.	Providing scholarships and stipends for participating in scholar program.
	Providing scholarships.	Providing scholarship.	Discussing financial situations such as paying rent off campus.	Providing scholarships.	Discussing financial support and management.	Helping students find financial aid.
	Helping students find financial aid.	Inviting the financial aid office to speak to prospective students.	Inviting financial aid to speak to prospective students.			
University Acclimation	Advising students on how to prepare for move-in day.	Facilitating campus and departmental exploration with prospective students.	Facilitating campus exploration with prospective students.	Introducing students to campus resources.	Answering questions about coming to the city where the university is located.	Introduce students to the campus and the available resources.
	Facilitating campus exploration before classes began or with prospective students.					
	Distributing a newsletter that introduced resources on campus.	Introducing students to the city where the university is located.	Distributing information about the resources available at the university.	Answering questions about the university, services provided by WEP3, and what to do after being admitted.	Distributing information about transitioning to the university.	
	Hosting seminars on resources and opportunities available on campus.					

Table 30 (continued) - Additional Circumstances Categories

Additional Circumstances	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Acknowledging Student Success	-	-	-	-	Recognizing students that excel academically, graduate seniors, outstanding members of student organizations, and students that participate in MEP3 programs.	Celebrate student successes individually and collectively for program participants. Recognize exceptional academic performance for top URM scholars.
Identity Navigation	-	-	-	Discuss life as a female engineering student.	Discuss the challenge associated with being the only minority in class and navigating that part of your identity.	-
Misc. Resources and Discussion	Offer personal support when students have non-academic problems.	Provide students with access to resource books and journals.	Provide students with a place to relax between classes; and access to computers and printers.	Refer students to the right person on campus when they have non-academic needs. Answer non-academic questions prospective students ask.	Discuss practical things such as moving off campus and sexual education. Advise students on non-academic problems if brought to your attention.	Offer personal support when students have non-academic problems.

4.5.7. Summary of Outputs

In summary, Outputs are very similar across ESSCs and each ESSC aims to produce experiences in at least two categories from each Output area (See Table 31). While the initial four categories were included in Tinto's Model of Institutional Departure, *Professional Development* and *Additional Circumstances* emerged from my data and are thus included in the MCCS.

Table 31 - Output Area Definitions

Output Area	Definition
Academic Performance	Outputs related to improving the academic performance, academic preparation, or academic skills of a student. This area refers to disseminating information related to improving academic performance or circumstances, providing access to resources that support academic performance, monitoring academic performance or development, and contributing to the development of content-independent and content-dependent skills that contribute to academic performance.
Faculty/staff Interactions	Outputs related to students interacting with faculty or staff outside of the classroom. This area refers to disseminating information related to interacting with faculty/staff, increasing the quantity of interactions students have with faculty or staff, and helping student establish informal or formal relationships with faculty or staff.
Extracurricular Involvement	Outputs related to student participation in activities not a required part of the engineering curriculum. This area refers to disseminating information related to improving or increasing extracurricular involvement and providing students with extracurricular opportunities.
Peer-group Interactions	Outputs related to students interacting with peers outside of the classroom. This area refers to disseminating information related to students interacting with other students, increasing the quantity of interactions that students have with other students outside of the classroom, and grouping students based on some part of their identity or academic circumstances.
Professional Development	Outputs related to improving the professional development of a student (industry or graduate school). This area refers to developing industry-independent skills that contribute to obtaining employment of admittance; disseminating information related to career opportunities via an undergraduate degree in engineering; providing work experience that contributes to the professional development of students via employment; providing access to role models along different career trajectories; and developing industry-independent skills that contribute to successful professional performance.
Additional Circumstances	Miscellaneous outputs not related to another category outlined in the MCCS. This area refers to acclimating students into the university environment; facilitating access to financial assistance; publically acknowledging the successes of students; and discussing life as an underrepresented engineering student.

The results of my study suggest that ESSC administrations use student interventions to help students acquire information, access resources, develop skills, prepare for courses, relate to faculty, adapt to the university, engage in extracurriculars, connect with students, explore opportunities, network with professional, obtain financial assistance, and receive recognition. I present an overview of the Output areas and categories for each ESSC in Table 32 below. The table is provided to present an overview of the Outputs produced by each ESSC. When reviewing the table, it should be noted that the categories represent intentions and not actual student experiences, which I discuss in the next sections.

Table 32 - Overview of Output Areas and Categories

Area	Category	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Academic Performance	Academic Information	√	√	√	√	√	√
	Academic Resources	√	√	√	√	√	√
	Academic Monitoring	√		√	√	√	√
	Transferable Student Skills	√		√	√	√	√
	Course Preparation	√	√	√			√
Faculty/Staff Interaction	Faculty/Staff Information	√	√	√	√	√	√
	Faculty/Staff Proximity	√	√	√	√	√	√
	Faculty/Staff Relationships	√	√	√	√	√	√
Extracurricular Involvement	Extracurricular Information	√	√	√	√	√	√
	Extracurricular Organizing	√	√	√	√	√	√
Peer-group Interaction	Student Information				√	√	√
	Student Proximity	√	√	√	√	√	√
	Intentional Grouping	√	√	√	√	√	√
Professional Development	Employment Assistance	√		√	√	√	√
	Career Opportunities	√	√	√	√	√	√
	Professional Experience	√	√	√	√	√	√
	Career Role Models	√	√	√	√	√	√
	Professional Development Skills	√	√		√	√	√
Additional Circumstances	Financial Assistance	√	√	√	√	√	√
	University Acclimation	√	√	√	√	√	√
	Acknowledging Student Success					√	√
	Identity Navigation				√	√	
	Misc. Resources and Discussion	√	√	√	√	√	√

4.6. Student Experiences

The fourth research question was: *What experiences do engineering students have with student interventions?* Through data analysis, I investigated the collective student experience using focus groups and isolated student experiences using open-ended surveys. Subsequently, the fifth research question was: *How do student experiences align with the configurations, outcomes, and outputs?* To identify the impact of configuration, I identified themes with regard to the collective student experience across cases. To validate the Outputs and Outcomes, I aligned the isolated experiences with the constructs outlined in the MCCS. I begin this section by discussing how the collective student experience aligns with the different classifications and structures. Lastly, I discuss the isolated student experiences as it pertains to the Outputs and Outcomes.

4.6.1. Classification, Structure, and the Student Experience

I used focus groups to investigate the collective student experience with regard to each ESSC. Through data analysis, I identified 18 different perspectives that contribute to the collective experiences. In Table 33, I provide an overview of each perspective and indicate its presence (or absence) at each ESSC. While the overall collective experience (i.e., combination of distinct perspectives) was different at each ESSC, there were similarities within and across classifications. If we focus on the patterns across ESSCs, the data in Table 33 suggests that classification is related to the positive perspectives students have with an ESSC. In particular, WEP2 and WEP3 were the only ESSCs that were perceived as a way to meet women and DEP1 and DEP4 were the only ESSCs that were perceived as safety nets. The data also suggests that certain perspectives are not bound by classifications. For example, five out of six ESSCs were perceived as support groups, indicating that this perception is usual for ESSCs in general. Lastly, these results suggest that negative perspectives exist across and within classifications. For example, students from DEP1, MEP3, and DEP4 (across classifications) perceived the time commitment of participation negatively, while WEP2 and WEP3 (within classification) perceived being isolated from males negatively. These results suggest that structure and classification impact how students collectively experience and perceive ESSCs, and indicate that students can have both positive and negative perceptions–though the positive impacts always outweighed the negative with regard to quantity. More specific details on how each ESSC was perceived can be found in Appendixes E.

Table 33 - Student Experiences vs. Configuration

Positive Perspectives	Descriptions	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
Support Group	Community of successful students at different academic levels who serve as support and provide proof that success in engineering is possible; ESSC admin who are willing to reach out and assist students.	+	+	+	+	+	
Safety Net	Method to "not fall behind" if students have a difficult transition.	+					+
Familiarity and Comfort	Personable support and physical space that is familiar and comfortable		+	+		+	+
Family Atmosphere	Places where students are welcomed and know people have their back.			+			+
Resource Access	Information and resources in a condensed manner that other students have to actively search for or do not have access to all.	+	+		+		
Opportunity Awareness	Exposure to opportunities and information spreading among students.	+		+			
Networking	Building networks and networking with diverse and/or older students				+	+	+
Way to Meet Women	Meeting other women, particularly peers.		+		+		
Adjusting to Minority Status	Places to adjust to minority status (URM) or address misconceptions about university demographics.	+		+			
Knowledge Expansion	Expanding knowledge or interests through outreach activities and interacting with students from other majors.		+		+		
Student Confidence	Developing a "go get it" attitude or coming "out of their shell"					+	+

Table 33 (continued) - Student Experiences vs. Configuration

Neutral Perspectives	**Description**	**DEP1**	**WEP2**	**MEP2**	**WEP3**	**MEP3**	**DEP4**
Perception of Engineers	Viewing students as "really nerdy" before joining programs (out-group) and more academically focused students after joining (in-group).	+/-					
Social Atmosphere	Social atmosphere that is friendly but can makes it hard to get work done sometimes.			+/-			
Negative Perspectives							
Time Commitment	Time commitment and the "amount of stuff" involved in participating.	-				-	-
Isolation of Women	Isolating female students from their male counterparts.		-		-		
Misperception of ESSC	Misconceptions and unawareness that uninvolved students have about an ESSC *(can prevent involvement)*		-				-
Cliquish Community	Community not welcoming non-engineering students or engineering students who are not currently involved.	-					
Always Engineering	Limiting oneself to the engineering community and engineering-related things.	-					

4.6.2. Outputs, Outcomes, and the Collective Experience

I used an open-ended survey that was tailored to each ESSC to investigate the breadth of isolated student experiences at each respective ESSC. As a reminder, each open-ended survey included questions that directly asked students about *Academic Performance*, *Faculty/staff Interactions*, *Extracurricular Involvement*, *Peer-group Interactions*, and *Professional Development*. I subsequently unitized the responses provided by students and developed a list of single-concept statements for each Output area. Through data analysis, I identified isolated student experiences (i.e., unitized responses) that aligned with each Output and Outcome from the MCCS except for *Additional Circumstances* or *University Integration*. (Since *Additional Circumstances* was not identified prior to the study, this Output area was not included in the student-survey and, thus, I do have not results for *Additional Circumstances* or *University Integration* with regard to the isolated student experience.) In this section, I represent the isolated student experiences as impact statements in Tables 34-42. Impact statements are the positive and negative responses provided by students after being unitized. As discussed in Chapter 3, student responses were self-categorized as positive, negative, or neutral. (Note that Tables 34-42 represent the breath of responses as opposed to the magnitude of the impact). I did not include neutral responses as impact statements because the respective reasons provided by students represented the absence of an impact as opposed to the presence of a positive or negative impact: the reasons for neutral responses typically cited were a student not being actively involved, not receiving support in that area while involved, or not being impacted by the support that was received.

Before reviewing the results in this section, it should also be noted that I used the MCCS and Tinto's Model to determine if an impact statement represented an Output or Outcome. As a reminder, **Outputs** are the immediate products that result from the internal operation of student intervention and **Outcomes** are the skills, knowledge, and behaviors that students attain through participation. While the open-ended survey was designed to solicit responses at the Output level, some students provided answers that had to be considered at the Outcome level and, thus, were handled accordingly. Impact statements that dealt with immediate products remained at the Output level and impact statements that dealt with skills, knowledge, or behaviors were moved to the Outcome level. For example, "I <u>received</u> help preparing for specifics courses I took" is an Output while "I <u>learned</u> how to manage my time better" is an Outcome. Furthermore, skills and knowledge were considered Short-term Outcome while behaviors were considered Medium-term

Outcomes since Integration was related to acquiring skills and knowledge and intentions/commitments had to do with actual behavior. For example, "I developed leadership skills" was considered a Short-term Outcome while "I started focusing on my future" was considered a Medium-term Outcome. Lastly, aligned with the theories, Short-term Output level responses from *Academic Performance* and *Faculty/Staff* were considered *Academic Integration*; Short-term Output level responses from *Extracurricular Involvement* and *Peer-group Interactions* were considered *Social Integration*; and Short-term Output level responses from *Professional Development* were considered *Professional Integration*. Since Medium-term Outcomes could theoretically result from any of the Output areas (according to Tinto's Model), impact statements that indicated a change in behavior were considered *Intention and Goals/Commitments*.

4.6.3. Outputs and Isolated Experiences

If we review Tables 34-38, we see that the student impact statements align with the intentions of ESSC administrators at the Output level. Table 34 includes impact statements for *Academic Performance*. Table 35 includes impact statements for *Faculty/Staff Interactions*. Table 36 includes impact statements for *Extracurricular Involvement*. Table 37 includes impact statements for *Peer-Group Interaction*. And Table 38 includes impact statements for *Professional Development*. Within each table, I provide the Output category to illustrate how the experiences of the students compared to the intentions of the ESSC administrators. For example, multiple students provided statement that, when unitized, stated, "I received information about the academic resources available to me on campus." This statement illustrates academic information being disseminated, which was a category within the *Academic Performance* Output category. These results suggest that the Output categories identified through the data collected from the ESCC administrator actually represent what occurs during student interventions from the student perspective. Additionally, several negative impact statements were identified at the Output level. For example, a student stated, "I was anxious and felt pressure to perform academically" in response to being aware that the faculty members she had developed relationships with were aware of how she was performing academically. These negative statements contain a minus sign (-) at the end of the impact statement in each of the tables.

Table 34 - Academic Performance Impacts

Output Category	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Academic Information	I was encouraged to ask for academic help when necessary (+)	+					
	I received guidance on scheduling courses and selecting professors (+)	+		+	+		
	I received information about the academic resources available to me on campus (+)		+		+	+	+
Academic Resources	I received financial assistance that allowed me to focus more on my academics (+)				+		
	I received academic assistance from tutors/mentors (+)	+	+	+		+	+
	I received academic assistance at the help sessions I attended (+)	+	+	+		+	+
	I had access to a physical place to study and work on academic assignments (+)	+	+	+		+	+
	I had access to physical resources such as old tests or academic books (+)		+	+		+	
	I had access to students whom I could ask for academic assistance (+)	+	+	+			+
	I had an easier time forming study groups and finding people to work with academically (+)	+	+	+	+	+	+
	I was around engineering student who were focused on their academics (+)	+					
	I learned from the experiences of upper-class engineering students (+)	+			+		
	I met engineering students who were passionate about earning an engineering degree (+)	+					
	I had access to a positive learning environment (+)	+				+	+
Academic Monitoring	I received help after an initial failure that allowed me to get back on track academically (+)					+	
	I was anxious and felt pressure to perform well academically (-)						-
Transferable Student Skills	I received advice on how to be academically successful (+)	+		+	+	+	+
	I received advice on how to manage my time better (+)	+					
	I received advice on how to positively interact with my professors (+)					+	
Course Prep.	I received help preparing for specific courses I took (+)	+					+

Table 35 - Faculty/Staff Interaction Impacts

Output Category	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Faculty/Staff Information	I received advice on which faculty to take classes with and which to avoid (+)		+				
	I received advice on how to positively interact with faculty (+)	+	+	+	+		
	I received advice on how to handle negative interactions with faculty (+)	+	+				
	I was encouraged to interact with engineering faculty (+)	+	+	+	+	+	
	I received advice on how to communicate with faculty/staff (+)	+				+	
	I was encouraged to attend office-hours (+)	+	+	+		+	+
Faculty/Staff Proximity	I had the opportunity to network with engineering faculty (+)	+	+	+	+	+	+
	I met engineering faculty in departments other than my own (+)		+		+		
	I met engineering faculty in my department (+)		+				
	I met women faculty in engineering (+)		+		+		
	I had the opportunity to work with engineering faculty (+)	+	+			+	+
	I had positive interactions with the people who work for the center (+)	+	+	+	+	+	+
	I had the opportunity to work with staff (+)	+		+	+		
	I have been introduced to administrators (higher-ups) in the college (+)	+					
	I had the opportunity to network with staff (+)	+	+		+	+	+
	I had negative interactions with people who work for the center (-)		-				
Faculty/Staff Relationships	I have become more familiar with engineering professors (+)	+	+		+	+	+
	I know university employees that care and want me to succeed (+)				+	+	
	I know university employees who are accessible and willing to help (+)	+	+	+	+	+	+

Table 36 - Extracurricular Involvement Impacts

Output Category	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Extracurricular Information	I was encouraged to become involved in the university community (+)	+	+		+	+	+
	I received notification about events that were occurring around the university (+)	+			+	+	
	I received information about organizations in which I could become involved (+)	+			+	+	
	I was more aware of the extracurricular opportunities at the university (+)	+		+	+		+
Extracurricular Organizing	I attended events and activities that the center sponsored/hosted (+)	+	+		+	+	+
	I had volunteer opportunities through the event the center organized (+)	+	+		+	+	
	I got involved in undergraduate research through a program sponsored by the center (+)				+		
	I had leadership opportunities through the programs the center sponsored (+)	+			+	+	
	I participated in a program that the center sponsored (+)	+	+		+	+	+
	I had the opportunity to be involved in many extracurricular activities (+)	+				+	
	I spent less time involved in extracurricular activities due to the commitment (-)	-					-
	I was involved in a professional organization that the center supported (+)	+			+	+	
	I joined an intramural team that the center sponsored (+)	+	+	+		+	

Table 37 - Peer-Group Interaction Impacts

Output Category	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Student Information	I was encouraged to make connections with my classmates (+)	+					+
	I received information on the importance of diversity (+)	+					
	I was introduced to an organization that allowed me to meet other engineering students (+)	+				+	
Student Proximity	I met a lot of engineering students (+)	+	+	+	+	+	+
	I was surrounded by engineering students (+)	+					
	I met engineering students that are now my friends (+)	+	+	+	+	+	+
	I knew engineering students as soon as I arrived on campus (+)	+		+	+	+	+
	I met like-minded individuals with whom I could relate (+)	+			+		
	I had a comfortable place to interact with engineering students (+)	+		+			+
	I had the opportunity to work/volunteer with other engineering students (+)	+			+	+	+
	I had the opportunity to meet other engineering students (+)	+	+	+	+	+	+
	I met engineering students that shared my interest (+)	+			+		
	I met engineering students that shared my goals (+)	+			+		
	I had the opportunity to develop social skills (+)				+	+	+
	I was unable to extend my social group beyond the students I work with academically (-)	-					
	I did not integrate with the cliques that were already established in the community (-)				-		
	I felt isolated from other engineering students due to dissimilar personalities (-)				-		
Intentional Grouping	I met a diverse group of engineering students (+)	+					+
	I met engineering students with whom I identified with based on gender (+)	+	+		+		
	I met engineering students with whom I identified with based on race/ethnicity (+)	+				+	
	I met engineering students whom I shared my major (+)	+	+		+	+	+
	I met engineering students with whom I did not share my major (+)	+	+		+		
	I met upper-class engineering students in my major (+)	+	+		+		
	I met engineering students who were experiencing struggles similar to those I experienced (+)	+			+		+
	I met engineering students that I could work with on academics (+)	+	+	+	+	+	+
	I met engineering students who joined college after me (+)	+	+	+	+	+	+
	I met engineering students within my academic classification (+)	+	+	+			
	I had access to an upper-class mentor (+)	+	+	+	+		+
	I had access to upper-class engineering students who served as role models (+)	+		+			
	I met upper-class engineering students as a freshman (+)	+		+	+		
	I met engineering students that come from a similar background as me (+)				+	+	
	I met a specific group of engineering students only and was isolated from everyone else (-)				-		

Table 38 - Professional Development Impacts

Output Category	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Employment Assistance	I was encouraged/required to attend a career fair (+)	+			+	+	+
	I received assistance with developing a resume (+)	+	+	+	+	+	+
	I received assistance with preparing for a career fair (+)	+	+	+	+	+	+
	I was encouraged to apply for internships and co-ops (+)				+		
	I received advice on what companies are looking for in an engineer (+)					+	+
	I received assistance preparing for interviews (+)	+	+	+	+		+
	I received assistance writing a cover letter (+)	+		+			
Career Opportunities	I received information about traditional career opportunities with engineering degrees (+)		+		+		+
	I received information about non-traditional career opportunities with engineering degrees (+)				+		
	I received information about internships and co-ops (+)	+		+	+	+	+
	I received information about undergraduate research (+)						+
	I talked to professional engineers about their career paths (+)					+	
	I visited corporations that hire engineers (+)					+	+
	I had the opportunity to network with faculty and discuss research opportunities (+)	+					
Professional Experience	I gained professional experience through being employed (+)	+					+
	I gained professional experience through volunteering (+)	+					
	I had things to put on my resume initially (+)					+	+
	I gained professional experience through undergraduate research (+)				+	+	
Career Role Models	I had opportunities to interact with professionals and network (+)	+	+	+	+	+	+
	I met professional engineers that I could identify with based on gender and/or ethnicity (+)		+				
	I met upper-class engineering students and learned from their professional experiences (+)	+			+		
Professional Development Skills	I receive professional guidance/advice (+)	+	+	+	+	+	+
	I received information about professional development opportunities/events (+)	+	+			+	+
	I joined a professional organizations for engineers that is supported by the center (+)	+					+
	I attended professional development events/workshops that the center sponsored (+)	+	+	+	+	+	+

4.6.4. Outcomes and Isolated Student Experiences

Table 39 includes impact statements for *Academic Integration*. When the impact statements from this table are considered collectively, they describe academically integrated students:

- Students know how to approach engineering programs;
- Students know how to manage his or her academics in an organized manner;
- Students know how to effectively prepare for exams;
- Students how to manage their time;
- Students understand the importance of working with other students on academics;
- Students are comfortable asking others for academic help;
- Students know how to collaborate with other students academically;
- Students know the dynamics of the student-teacher relationship;
- Students are not afraid or intimidated by engineering faculty/staff;
- Students know the importance of getting to know engineering faculty;
- Students know about the careers of engineering faculty;
- Students know how to positively interact with engineering faculty; and
- Students know how to communicate with engineering faculty.

The results of this table demonstrate (via isolated student experiences) how ESSCs can positively impact *Academic Integration* through co-curricular support in the Output areas of *Academic Performance* and *Faculty/staff Interactions*.

Table 40 includes impact statements for *Social Integration*. When the impact statements from this table are considered collectively, they describe socially integrated students:

- Students know how to actively participate in student organizations;
- Students know how to balance their academics and extracurricular involvement;
- Students understand the importance of extracurriculars;
- Students know how to interact with other engineering students;
- Should know the importance of working in groups;
- Students know how to network with other engineering students; and
- Students know how to work in groups.

The results of this table demonstrate (via isolated student experiences) how ESSCs can positively impact *Social Integration* through co-curricular support in the areas of *Extracurricular Involvement* and *Peer-Group Interactions*.

Table 41 includes impact statements for *Professional Integration*. When the impact statements from this table are considered collectively, they describe professionally integrated students:

- Students know how to communicate in a professional manner;
- Students understand the professional environment;
- Students have leadership skills;
- Students have technical skills that will be useful as an engineer;
- Students know how to network professionally;
- Students have personal characteristics that are attractive to companies;
- Students are confident/comfortable in a professional settings;
- Students know how to interact with others in a professional manner; and
- Students understand the importance of networking professionally.

The results of this table demonstrate (via isolated student experiences) how ESSCs can positively impact *Professional Integration* through co-curricular support in the areas of Professional Integration.

Table 42 includes impact statements for *Intentions, Goals, and Commitments*. When the impact statements from this table are considered collectively, they describe students who have positive intentions, goals, and commitments:

- Students are focused on their academics;
- Students are motivated to perform well academically;
- Students are focused on their future;
- Students are motivated to become more professional; and
- Students are motivated to seek professional opportunities.

The results of this table demonstrate (via isolated student experiences) how ESSCs can impact *Goals/Commitments* through co-curricular support in the areas of *Academic Performance* and *Professional Development*.

Table 39 - Academic Integration Impacts

Output Area	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Academic Performance	I learned how to better approach engineering problems (+)	+					
	I learned how to manage my academics and became more organized (+)	+					
	I learned how to study and prepare for exams more effectively (+)	+	+	+	+		
	I learned how to manage my time better (+)	+	+				
	I learned the importance of working with other engineering students on academics (+)	+					
	I became more comfortable asking others for academic help (+)	+					
	I learned how to collaborate with other students academically (+)						+
Faculty/Staff Interactions	I learned about the dynamics of the student-teacher relationship (+)				+		
	I realized that I should not be afraid or intimidated by faculty/staff (+)	+		+	+	+	+
	I learned the importance of getting to know engineering faculty (+)	+		+	+	+	+
	I learned about the careers of engineering faculty/staff (+)	+	+		+		
	I learned how to positively interact with engineering faculty (+)	+		+			+
	I learned how to communicate with engineering faculty/staff (+)	+	+	+	+		+

Table 40 - Social Integration Impacts

Output Area	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Extracurricular Involvement	I learned how to actively participate in a student organization (+)				+		
	I learned how to balance my academics and extracurricular involvement (+)	+					
	I learned how important extracurricular activities are (+)	+				+	
Peer-group Interaction	I learned how to interact with other engineering students better (+)	+					
	I learned the importance of working in groups (+)	+		+			
	I learned how to network with other engineering students (+)	+					
	I learned how to work in groups (+)	+			+	+	+

Table 41 - Professional Integration Impacts

Output Area	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Professional Development	I learned how to communicate in a professional manner (+)	+	+				+
	I learned about the professional environment (+)	+					
	I developed leadership skills (+)	+				+	
	I developed technical skills that will be useful as an engineer (+)		+				
	I learned how to network professionally (+)				+	+	+
	I gained characteristics that are attractive to companies (+)	+				+	+
	I became more comfortable/confident in professional settings (+)	+			+	+	+
	I learned how to interact with people in a professional manner (+)	+		+	+	+	+
	I learned the importance of networking professionally (+)					+	

Table 42 - Intentions and Goals/Commitments Impacts

Output Area	Impact Statement	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
		U1	U2		U3		U4
Academic Performance	I was more focused on my academics (+)	+			+	+	+
	I was motivated to perform well academically (+)	+	+		+	+	+
Professional Development	I started focusing on my future (+)	+	+	+			
	I was motivated to become more professional (+)					+	
	I was motivated to seek professional opportunities (+)	+			+		

4.6.5. Summary of Student Experiences

In summary, the results of my study suggest that students in general perceive ESSCs as having a positive impact on their experiences but can be impacted negatively on occasion. Additionally, isolated student experiences align with the intentions of the ESSC administrators at the Outputs and Outcomes level, and the collective student experience is impacted by classification and structure when the entire ESSC is considered.

4.7. Summary of Results

The purpose of my research was to answer the following question: *How do engineering student support centers use student interventions to provide undergraduate engineering students with co-curricular support?* The MCCS demonstrates the breadth of institutional support that can be provided by way of co-curricular student interventions that prioritize undergraduate engineering students. The results presented in this chapter also demonstrate the alignment between the experiences of students and the intentions of ESSC administrators, as well as some pros and cons associated with various classifications and configurations. Based on the data collected from the ESSC administrator perspective, (1) there are no typical structures with regard to existing ESSCs (despite there being common classifications); (2) ESSC administrations use student interventions to help students integrate in a way that facilitates the students in attaining intentions, goals, and commitments that align with engineering in a way that allows them to accomplish degree progress in addition to academic achievement and/or career attainment; and (3) ESSC administrations use student interventions to help students acquire information, access resources, develop skills, prepare for courses, relate to faculty, adapt to the university, engage in extracurriculars, connect with students, explore opportunities, gain work experience, network with professional, obtain financial assistance, and get recognition. Based on the data from the student perspective, students in general perceive ESSCs as having a positive impact on their experiences but can be impacted negatively on occasion. For example, an ESSC could positively function as a support group or negatively function as an additional time commitment. Additionally, the student experiences align with the intentions of the ESSC administrators at the Outputs and Outcomes levels, and student experiences are impacted by classification and structure when the entire ESSC is considered. For example, WEPs were commonly viewed as a way to meet other women in engineering but also as a source of female isolation while neither

DEPs or MEPs were discussed in this manner. Collectively, these findings suggest that the MCCS is an appropriate representation of how co-curricular support functions in engineering and is broad enough to capture the nuances that occur as a result of structure and classification. The next chapter discusses these findings in relation to existing literature and provides recommendations for implementing the results.

CHAPTER 5. Discussion and Conclusions

5.1. Introduction

The purpose of this study was to explore how the student interventions offered alongside engineering curricula influence the undergraduate experience. I addressed this purpose by conducting a multi-case study to qualitatively investigate the particulars of six ESSCs from the perspective of ESSC administrators and undergraduate engineering students. Through this in-depth inquiry, I was able to contribute to our understanding of ESSCs with regard to the following areas: (1) the outputs, outcomes, and objectives behind ESSCs of multiple configurations; and (2) how the co-curricular support provided by ESSCs functions alongside engineering curricula. In this chapter, I interpret the results presented in Chapter 4 in relation to the literature. I also propose some implications of these contributions with regard to research and practice. I then provide recommendations for future work that will allow us to continue advancing the practice and scholarship of co-curricular support in engineering education. Finally, I present the conclusions from this research concerning ESSCs and co-curricular support.

5.2. Discussion of Results

Through this study, I created the MCCS using data collected from six ESSCs. The multi-phased process I used to develop this model resulted in theoretical and practical contributions to our understanding of co-curricular support in engineering education. In this section, I will discuss how my contributions are consistent with and expand the literature. The following sections are organized around two outcome categories: theory and practice. I begin this section by discussing the MCCS and the resulting theoretical contributions. Next, I discuss ESSC configuration and the practical contributions that resulted from investigating the particulars of six ESSCs.

5.2.1. Model of Co-curricular Support

Currently, there is a disconnect between student-retention theory and student-support practice. While the current theories on student retention traditionally focus on attrition at the institutional level (e.g., Bean & Metzner, 1985; Tinto, 1994), the efforts to address this problem within engineering education are commonly implemented through student-support practice at the college level (e.g., Allen, 1999; Dickerson et al., 2014; Lee & Cross, 2013). If researchers and practitioners are to work in collaboration to advance the diversity and retention efforts in the

engineering education community, this disconnect is undesirable because it inhibits communication: researchers and practitioners are not using the same language or similarly scoped. According to Jamieson and Lohmann (2009), communication between researchers and practitioners is imperative to facilitating the direct connection and continual flow between educational research and educational practice that is needed for engineering education innovations to be impactful. Through my dissertation, I addressed this disconnect between research and practice by developing a practice-oriented student-retention model that focuses on student attrition in engineering at the college level. Specifically, the results of my study allowed me to develop the primary result of this research, the Model of Co-curricular Support (MCCS). The MCCS is a repurposed version of Tinto's Model of Institutional Departure. Whereas Tinto's Model (1994) represents a student's institutional experience as the academic and social systems within an institution, the MCCS represents a student's institutional experience as the academic, social, and professional systems within a college as well as the surrounding university system. Whereas Tinto's Model explains how a student's interactions with the academic and social systems could influence student retention, the MCCS explains how a student's positive or negative interaction with the academic, social, and professional systems could influence the success a student has in an undergraduate engineering program with regards to academic performance, degree progress, and career attainment. In total, the MCCS was adjusted to focus on college-level interactions, expanded to include the professional systems, and broadened to consider multiple forms of success in addition to student retention. Due to Tinto acknowledging the need for models that "help institutions address practical issues of persistence" (Tinto, 2006), I believe adapting his model in this manner was not only appropriate but in alignment with how he intended for his research to be used.

While I cannot prove the explanatory power of the MCCS due to the exploratory nature of my study, I developed the model in a way that advances our understanding of student retention in engineering specifically. Based on the findings of my study, I used Tinto's Model to create the modified theoretical framework presented in Figure 12; I highlighted the main changes to the model to assist the reader with visually identifying the modifications/additions that were necessary due to the change in purpose. I expanded Tinto's Model to encompass the mechanisms used by ESSC administrators as well as their intentions/goals. In particular, the MCCS includes

the *Programs*, *Activities*, and *Services* offered by ESSC administrators to provide co-curricular support. I also expanded the model to include *Degree Progress* more broadly (i.e., enrollment and graduation) as well as *Academic Achievement* and *Career Attainment* since ESSC administrators do not consider student retention in isolation. As mentioned in Chapter 4 (section 4.4), *Degree Progress* was common across all classifications while *Academic Achievement* was unique to MEPs and DEPs and *Career Attainment* was unique to WEPs and DEPs. While the data suggests that *Academic Achievement* is not an Objective of WEPs and *Career Attainment* is not an Objective of MEPs, it is unlikely that the WEP and MEP administrators do not care about academic performance or career attainment, respectively. However, the prioritization of these areas may fluctuate across classifications as a result of the barriers that are unique to these populations. That is to say, it is possible that the presence of occupational stereotypes when considering gender (Ambrose et al., 1998) results in WEPs prioritizing *Career Attainment* while the presence of ethnic stereotypes and discrimination when considering race/ethnicity (Brown et al., 2005) results in MEPs prioritizing *Academic Achievement*. Lastly, I included *Professional Development*, *Additional Circumstances*, *Professional Integration,* and *University Integration* to reflect the broadened intentions that accompanied the additional Objectives.

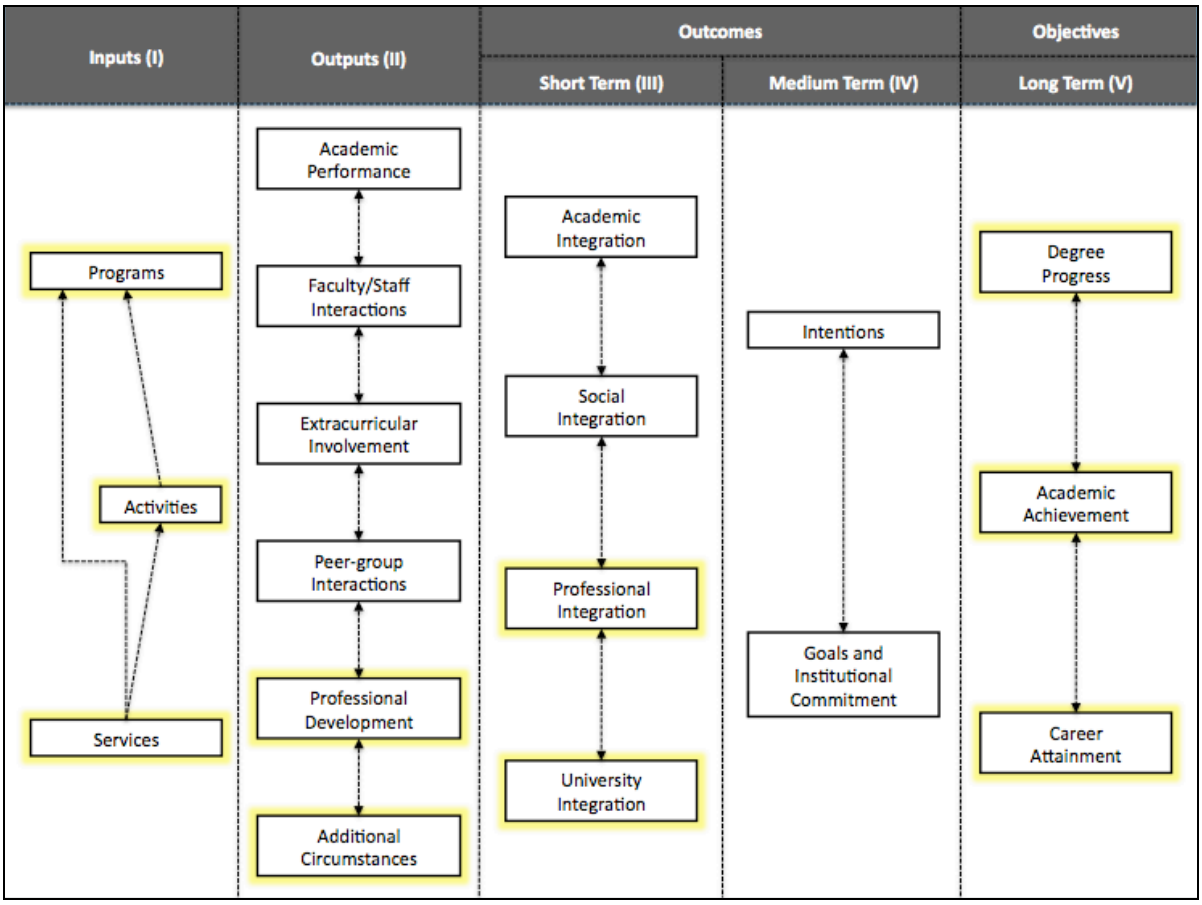


Figure 12 - Modified Theoretical Framework

In this research, I did find that the constructs in Tinto's original framework were still appropriate when the focus was at the level of the college of engineering specifically, a context where student retention is still prioritized. Consequently, I did not remove any constructs from the model other than those that were beyond the influence of the college such as pre-entry attributes. However, I did add constructs that focused on the profession of engineering and the institution in which the college was located. The additions of *Professional Development* and *Professional Integration* are not surprising since there is a strong emphasis on engineering programs addressing the development of professional skills with regard to accreditation (Shuman, Besterfield-Sacre, & McGourty, 2005); this emphasis means that in order to maintain accreditation, engineering degree programs must include skills such as communication, teamwork, and professionalism. As a result, there is a stronger focus on what it means to be an engineer and to engage in engineering practice. This focus may result in student-support practitioners assisting students in these areas as well, despite ESSCs not being directly linked to

the accreditation process. The additions of *Additional Circumstances* and *University Integration* are not surprising since the MCCS was scoped to the college level and each engineering college represented in my study was housed inside a larger institution, thus adding a contextual layer that needed to be considered. For example, student-support practitioners may be concerned with helping students acclimate to the university or secure financial assistance despite these Outputs not pertaining to engineering per se. In total, my additions resulted in a model that focuses on student success more broadly while paying attention to the student experience more locally: specifically, Tinto's Model focuses on student-retention at the institutional level and the MCCS focuses on degree progress, academic achievement, and career attainment at the college level. While more work is needed to determine explanatory power (i.e., usefulness) of the constructs in the MCCS with regard to the Long-term Objectives that were revealed, my research indicates that these constructs are considered important from the perspective of ESSC administrators.

In addition to developing the MCCS, I used the particulars from six ESSCs to operationalize the constructs in a way that could be interpreted by practitioners. In particular, I identified practice-informed categories within each Outputs area (see Figure 13). Since frameworks alone do not provide practitioners with an understanding of the theoretical process represented in the model, it was important that I partition the Output areas into categories that would make sense to practitioners. Discussed in Chapter 4, each category in Figure 13 emerged from the data. The Output categories in Figure 13 are consistent with and expand the retention strategies in the literature. In particular, Hermond (1995) synthesized existing literature on MEPs and identified the existence of seven common strategies: (1) matriculation, (2) orientation, (3) academic advising, (4) student organizations, (5) tutoring and academic workshops, (6) personal counseling, and (7) financial aid. My findings are consistent with Hermond's study but expand upon it by identifying additional strategies. For example, Hermond defined matriculation as interventions done with students between the time they are admitted and their first semester of enrollment; this strategy is shown in Figure 13 under *Academic Performance*, listed as course preparation. In the same way, orientation is shown under *Additional Circumstances* as of university acclimation. Academic advising and personal counseling are shown under *Faculty/Staff Interaction* and *Additional Circumstance* as faculty/staff relationship and misc. discussions. Student organizations are shown under *Extracurricular Activities* as extracurricular

organizing. Tutoring and academic workshops are shown under *Academic Performance* as academic resources. And financial aid is under *Additional Circumstances* as Financial Assistance. In addition to these strategies, the MCCS also included a number of strategies that were not included. In total, the output categories listed in Figure 13 are consistent with the MEP strategies identified by Hermond (1995) and expands the literature to incorporate strategies common across ESSC classification.

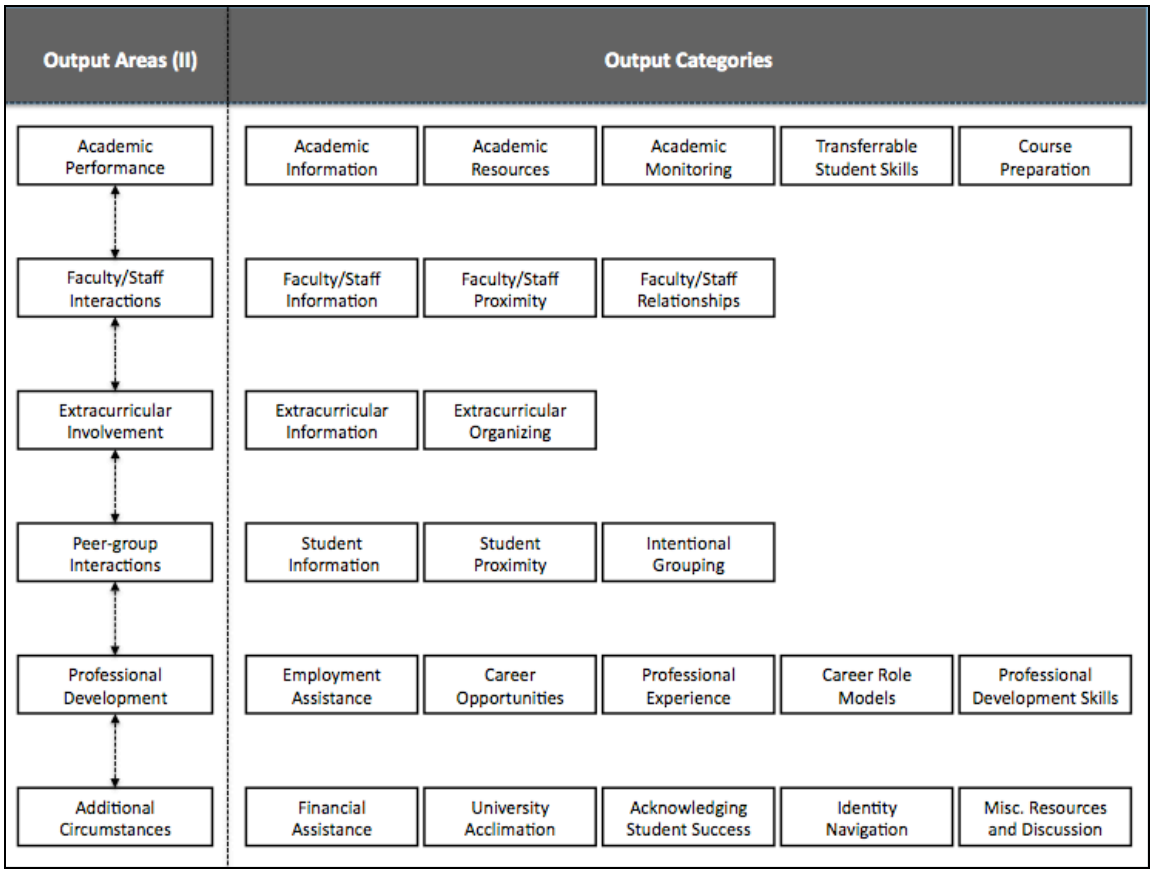


Figure 13 – Operationalized Outputs

The operationalized Outputs also expand the current literature with regard to student-retention theories because many existing theories do not directly account for the numerous barriers in engineering that students from different backgrounds potentially encounter. By developing the MCCS using the perspectives of student-support practitioners, I was able to explicitly account for each of these barriers in a way that these theories do not. For example, Tinto's Model does not include *Professional Development*, *Additional Circumstances*, or any of the Output

Categories included in the MCCS. To illustrate this contribution with regard to barriers, Table 43 includes a mapping of the barriers mentioned in Table 1 (Chapter 2) to the individual Output area and category that most directly addresses it. In the first column of Table 43, each of the barriers in engineering previously discussed is listed. In the second column, the Output area that most directly accounts for this barrier is listed followed by the specific category within that area. For example, *Academic Performance* can specifically address students having difficulties with the curriculum through course preparation and *Professional Development* can specifically address occupational stereotypes through career role models.

Table 43 - MCCS vs. Barriers in Engineering

Barriers in Engineering	Output Area	Output Category
Difficulties with the curriculum	Academic Performance	Course Preparation
Competitive and unsupportive culture	Peer-group Interaction	Intentional Pairing
Perception of a "weed-out" tradition	Faculty-staff Interaction	Faculty/Staff Relationships
Difficulties with instructors	Faculty-staff Interaction	Faculty/Staff Information
Losing interest in the original major	Extracurricular Involvement	Extracurricular Organizing
Occupational stereotypes	Professional Development	Career Role Models
Sexism (harassment)	Additional Circumstance	Identity Navigation
Racism (stereotypes, discrimination)	Additional Circumstance	Identity Navigation

Lastly, I was also able to operationalize integration in way that makes the construct more understandable. According to Tinto, integration occurs when a student has a positive perception of institutional fit and sufficient interactions within the system (Tinto, 1994). While the concept of Integration is understood in abstraction, researchers have interpreted it numerous ways, relying on measures of their own choice to measure it (e.g., Barnett, 2011; Bers & Smith, 1991; Rienties, Beausaert, Grohnert, Niemantsverdriet, & Kommers, 2012). For example, Barnett (2011) measured *Academic Integration* by identifying and adapting existing scales for quantifying a student's competency and membership with regard to the college environment. In contrast, Rienties et al. (2012) measured *Academic Integration* using an existing survey for quantifying a student's academic adjustment, social adjustment, personal-emotional adjustment, and attachment. Consequently, it is challenging to synthesize the literature on Integration and the measurement of this construct needed to improve (Barnett, 2011; Braxton, 2000).

My findings expand our current understanding of Integration because I can describe this construct in context, specifically for researchers who wish to measure the construct within engineering:

- **Academic Integration** refers to a student having a positive perception with regard to intellectual fit (i.e., access and support) and sufficient interactions within the formal and informal academic systems of an engineering college and is most directly impacted by their academic performance and faculty/staff interactions.
- **Social Integration** refers to a student having a positive perception with regard to social fit (i.e., access and support) and sufficient interactions within the formal and informal social systems of an engineering college and is most directly impacted by their extracurricular involvement and peer-group interactions.
- **Professional Integration** refers to a student having a positive perception with regard to professional fit (i.e., access, support, and characteristics) and sufficient interactions within the formal and informal professional systems of an engineering college and is most directly impacted by their professional development.
- **University Integration** refers to a student having a positive perception with regard to institutional fit (i.e., access, support) and sufficient interactions within the formal and informal university systems surrounding an engineering college and is most directly impacted by their personal and financial experiences at the university level.

In Table 44, I provide a list of impact statements that can potentially be used to measure *Academic, Social, Professional, and University Integration*. The ability to measure each of these constructs is important because it will (1) facilitate determining the explanatory power of the MCCS and (2) assist researchers and student-support practitioners with monitoring the impact the institutional support has on students. While I did not develop reliable instruments to measure these constructs during my dissertation, the impact statements presented in Table 44 can be used to develop such instruments.

Table 44 - Academic, Social, Professional, and University Integration

Integration	Impact Statement
Academic	I can effectively approach engineering problems.
	I can manage the academic workload.
	I can effectively prepare for engineering exams.
	I can effectively manage my time.
	I understand the importance of working with other students on academics.
	I am comfortable asking others for academic help.
	I can collaborate with other students academically.
	I understand the dynamics of the student-teacher relationship.
	I am not afraid or intimidated by engineering faculty or staff.
	I understand the importance of getting to know engineering faculty.
	I know about the careers of engineering faculty.
	I can positively interact with engineering faculty.
	I can communicate with engineering faculty and staff.
	*I have access to resources that can help me academically.
	*I have access to engineering faculty/staff.
	*I am supported academically.
Social	I can actively participate in a student organization.
	I can balance my academics and extracurricular involvement.
	I understand the importance of extracurricular activities.
	I can positively interact with other engineering students.
	I understand the importance of working in groups.
	I can network with other engineering students.
	I can work in groups with other engineering students.
	*I have access to other engineering students.
	*I have access to extracurricular activities.
	*I am supported socially.
Professional	I can communicate in a professional manner.
	I can function in a professional environment as an engineer.
	I have leadership skills that will be useful as an engineer.
	I have technical skills that will be useful as an engineer.
	I can network professionally.
	I have traits that are attractive to companies that hire engineers.
	I am comfortable in professional setting.
	I am confident in professional setting.
	I can interact with people in a professional manner.
	I understand the importance of networking professionally.
	*I have access to resources that can help me professionally.
	*I am supported professionally.
University	*I can afford to attend this university.
	*I am comfortable at this university.
	*I feel welcomed at this university.
	*I successfully transitioned to this university.
	*I have acclimated to the university environment.
	*I have adjusted to the city where the university is located.
	*I have access to university resources.
	*I am supported personally.
* =*Statement was generated using ESSC administrator intentions as opposed to student experiences*	

5.2.2. ESSC Configurations

The current conversations concerning ESSCs are typically centered on MEPs or WEPs (e.g., Hackett & Martin, 1998; Knight & Cunningham, 2004), despite the presence of additional classifications (Lee & Matusovich, 2013). Additionally, these conversations seldom, if ever, overlap. For example, Hackett and Martin (1998), focused on faculty support for MEPS while Knight and Cunningham (2004) focused the structure of WEPs. Though infrequent, conversations generally focus on ESSCs by classification when they do occur. Through my dissertation, I expand the literature and address the disconnect between the conversations by including multiple classifications–MEPs, WEPs, and DEPs–in my dissertation and examining them using the same framework.

To determine which ESSCs I should include in my study, my first task was identifying the types of ESSCs that existed. While the literature typically only discusses two classifications (i.e., MEPs and WEPs), I was personally aware of different alternatives and, thus, knew that I needed to develop a better understanding of the ESSC landscape before I could conduct a multi-case study and effectively recruit and select cases. The results of this search were presented in Chapter 3 with my research methods. In Table 45, I have provided a description of each ESSC classification. This result expands current literature because definitions for ESSCs classification had not previously existed. In previous literature, researchers assumed that readers knew what an MEP or WEP was and a further description was not necessary. As I identified additional classifications, the need for definitions that ESSC administrators identified with and could agree on became apparent: I realized that the terminology in the literature was insufficient because it did not permit me accurately describing the new classifications or explaining exactly what the traditional classifications were. For example, I was aware of DEPs but did not have the terminology needed to explain what the difference was between a DEP and MEP. I was unsure how to describe an MEP from the perspective of the student-support practitioners involved in the administration of such ESSCs. The definitions presented in Table 45 facilitate such explanations and comparisons.

Table 45 - ESSC Classifications Defined

Classification	Definition
Engineering Student Support Center (ESSC)	ESSC is a mechanism established by an institution to provide interventions (programs, services, and activities) that prioritize engineering students with the aim of positively influencing their success.
Minority or Multicultural Engineering Program (MEP)	ESSC that focuses on race/ethnicity (as demonstrated by the federal guidelines) with less focus on gender while aiming to address the factors for underrepresentation of certain populations in engineering, specifically domestic students that are African-American, Hispanic, and Native American.
Women in Engineering Program (WEP)	ESSC that focuses on gender parity and underrepresentation in engineering with some focus on addressing the unique issues for women of color.
Women & Minority Engineering Program (WMEP)	ESSC that includes a MEP and WEP separately but under common administration (see previous definitions)
Diversity in Engineering Program (DEP)	ESSC that focuses on students in general and attempts to identify and address the unique needs of underrepresented populations in effort to broaden participation and improve diversity.
General Engineering support Program (GEP)	ESSC that focuses on engineering students in general without a specific focus on broadening participation or diversity.

While I was able to identify five classifications, I was unable to recruit a partner site from each classification for my study. In particular, I did not include a WMEP or GEP (see Figure 14). Consequently, I was not able to provide any additional information about WMEPs or GEPs other than documenting the fact that these additional classifications exist and should be considered. Clearly this is an area for future research.

Figure 14 - Missing Classifications

Nonetheless, I was able to develop a comprehensive list of the mechanisms used by ESSC to support students by examining the student interventions employed across six ESSCs from the classification I did include in my study. In Table 46, I provide the category and classification (i.e., name) of each student intervention. I also provide a brief description of the focus implied by

the name selected. For example, a mentoring program is an intervention within the *Program* category that focuses on grouping students with mentors. These findings are consistent with and expand the literature. In particular, the strategies listed in Table 46 are consistent with the retention strategies previously suggested (Landis, 2005). Often viewed as the "father" of MEPs in the United States, Landis–in conjunction with the National Action Council for Minorities in Engineering (NACME)–republished a monograph originally published in 1991 on establishing an MEP. In this report, Landis suggests that four programmatic structures be in place to establish the collaborative learning environment needed to support URMs: (1) clustering of students in common sections, (2) a freshman orientation course; (3) a student study center; and (4) structured study groups. The findings from my study incorporate these structures. In Table 45, for example, clustering of students in common sections is represented as *course clustering*; a freshman orientation course is represented as a *first-year seminar*; a study center is represented as a *student lounge* or *learning center*; and structured study groups is represented as *study sessions*. My study also expands the literature by describing additional forms of support in a single location; such descriptions did not previously exist.

The findings from my study also expand our understanding of ESSC structure and the impact that institutional context has on what interventions are offered by ESSC administrators. Prior to my study, we knew that engineering faculty could view student interventions offered by MEPs that physically segregated students less favorably (Hackett & Martin, 1998), we knew that which student intervention were offered by WEP administrators could be impacted by the resources available to them and the number of students they could reach (Knight & Cunningham, 2004), and we knew that how students perceived an MEP could be impacted by the respective mission, physical space, and personnel (Shehab et al., 2012). My dissertation expands these results by offering insight about ESSCs in general. For example, my results show that there are no typical structures for ESSC despite the existence of standard classification and suggests that there will be structural similarities between ESSCs that are classified differently but housed at the same institutions.

Table 46 - Intervention Alternatives

Classification		Focus
Program	Mentoring Program	Grouping students with mentors
	Learning Community	Grouping students in a single residential hall
	Summer Bridge Program	Coordinating course preparation prior to the first semester
	First-Year Seminar	Offering a seminar during the first year for freshman
	Professional Seminar	Offering a course geared towards professional development
	Undergraduate Research Program	Coordinating student participation in undergraduate research
	Activity Cluster	Organizing a grouping of activities
	Scholar Program	Coordinating multiple-years of participation
	Student Leaders	Employing students to serve in leadership roles and assist others
Activity	Preview Event	Introducing prospective students to the college and university
	Professional Event	Facilitating interaction between students and professionals
	Leadership Conference	Developing student leadership skills
	Event Cluster	Organizing separate activities that are similarly purposed
	Banquet	Hosting a formal meal for students to attend
	Organization Showcase	Exposing students to engineering organizations
	Orientation	Familiarizing students with the college or university
	Semester Kick-off	Welcoming students at the beginning of fall or spring semester
	Study Session	Preparing students for tests in engineering
	Workshop	Organizing discussion or action on a particular topic
Service	Informal Advising	Offering students counseling or advising assistance
	Opportunity Advertising	Distributing information to about scholarships and opportunities
	Organizational Support	Supporting student organizations with similar missions
	Tutoring	Coordinating students receiving active assistance via tutors
	Course Clustering	Grouping students in classes together
	Student Lounge	Providing a physical space to assemble
	Study Hall	Providing regular, temporary access to a reserved space
	Learning Center	Providing regular, sustained access a physical space w/ support
	Test Bank	Providing access to old tests, exams, quizzes, or study guides
	Resource Library	Providing access to resources in manuscript format

Lastly, I identified the impact ESSC configuration can have on student experiences by simplifying the results from Chapter 4 (section 4.6.1; Table 33): I only considered the perspectives that students agreed were positive or negative, discarding that which was considered neutral. I present these consequences as pros (positives) and cons (negatives) in Table 47. I also show how often the pro or con showed up in each classification–denoted by 0, 1, or 2. For example, the 2 under the column labeled DEPs represent the pro or con showing up at both DEP1 and DEP4. The presence of a consequence at both ESSCs under a given classification is indicative of a trend, which suggests the following:

- DEPs commonly provide students with a safety net but require a time commitment.

- WEPs commonly provide students with a support group, access to resources, a way to meet women, and a way to expand knowledge but isolate them from men.
- MEPs commonly provide students with a support group, and a familiar and comfortable place to receive personable support.

In addition to these trends that appeared for each classification, we should also consider consequences that showed up at only one case under a classification since these pros and cons may be present at ESSCs as well. For example, a DEP could also lend itself as a support group though the data suggests that this is not common to all DEPs. The results in Table 47 are consistent with the literature and expand it as well. For example, the concept of female isolation as a negative consequence of WEPs is consistent with the literature. In particular, previous studies have shown that spotlighting, which refers to singling out women in a way that makes them feel uncomfortable, can occur even when our intention is to help them (McLoughlin, 2005). Furthermore, McLoughlin asserts that WEPs in general are the source of the "brightest gender spotlight in the engineering education environment" and women are not always comfortable with the premise of having an ESSC designed specifically for them. While female isolation also referred to the consequence of not interacting with their male counterparts and establishing those relationships, women also talked about the negative impact of women being singled out. On a positive side, the notion of providing students with a family atmosphere was also consistent with the literature. In particular, a previous study suggests that providing engineering students with fictive kin ("like family") who help them feel like they belong in engineering could be an effective way to support students, particularly First-Generation College (FGC) Students (Simmons & Martin, 2014). In addition to helping FGC students develop a sense of belonging, Simmons also suggests that fictive-kin may help students develop engineering-related networks and social capital. Moreover, many other positive consequences in Table 47 also relate to social capital, which has also been shown to be important for undergraduate engineering students and underrepresented engineering students in particular (Daily, Eugene, & Prewitt, 2007; Martin, Simmons, & Yu, 2013; Miller, Martin, & Orr, 2014). In particular, support group, opportunity awareness, and networking each relates to social capital; this suggests that social, academic, and professional integration may include developing social capital in each of these domains. Lastly, these results expand the literature by identifying the positive and negative consequences associated with each configuration included in my dissertation.

Table 47 - Pros and Cons by Classification

Pros	Descriptions	DEPs	WEPs	MEPs
Support Group	Students at different academic levels that provides support and proof that success is possible and ESSC administrators who are willing to reach out and help.	1	2	2
Safety Net	Method to "not fall behind" if students have a difficult transition.	2	0	0
Familiarity and Comfort	Personable support and physical space that is familiar and comfortable	1	1	2
Family Atmosphere	Places where students are welcomed and know people have their back.	1	0	1
Resource Access	Information and resources in a condensed manner that other students have to actively search for or do not have access too all.	1	2	0
Opportunity Awareness	Exposure to opportunities and information spreading among students.	1	0	1
Networking	Building networks and networking with diverse and/or older students	1	1	1
Way to Meet Women	Meeting other women, particularly peers.	0	2	0
Adjusting to Minority Status	Places to adjust to minority status (URM) or address misconceptions about university demographics.	1	0	1
Knowledge Expansion	Expanding knowledge or interests through outreach activities and interacting with students from other majors.	0	2	0
Student Confidence	Developing a "go get it" attitude or coming "out of their shell"	1	0	1
Cons				
Time Commitment	Time commitment and the "amount of stuff" involved in participating.	2	0	1
Isolation of Women	Isolating female student from their male counterparts.	0	2	0
Misperception of ESSC	Misconceptions and unawareness that uninvolved students have about an ESSC.	1	1	0
Cliquish Community	Community not welcoming non-engineering students or engineering students who are not currently involved.	1	0	0
Always Engineering	Limiting oneself to the engineering community and engineering-related things.	1	0	0

5.2.3. Summary of Contributions

In summary, I contributed six distinct outcomes through my dissertation and discussed each above. I summarize these outcomes and their contribution to theory and practice in Table 48.

Table 48 - Contributions

Outcomes	Contribution
Theoretical Model	Addressed the disconnect between student-retention theory and student support practice by developing a model that prioritizes college-level retention
Output Categories	Operationalized variables included in the theoretical model in a way that could be interpreted by practitioners.
Integrations	Operationalize *Integration* in way that made the abstract constructs more understandable and facilitates the development of measurement instruments.
ESSC Classifications	Developed definitions for five existing ESSC classifications, three of which had not been previously discussed in the literature.
List of Interventions	Developed a comprehensive list of the mechanism employed across these settings, including category, classification, and focus
Pros and Cons	Identified the positive and negative consequences associated with each configuration included in my dissertation

5.3. Implications

Student diversity and retention have been persistent issues in engineering education (Chubin et al., 2005; National Science Foundation & National Center for Science and Engineering Statistics, 2013; Ohland et al., 2008; Seymour & Hewitt, 1997) and the efforts taken to address these problems for currently enrolled undergraduate engineering students are generally taken at the college level as opposed to the institutional level (e.g., Knight & Cunningham, 2004; Lee & Cross, 2013; Lee et al., 2014b; Samuelson et al., 2014). In that regard, the results of my research have implications for educational research and student support practice in engineering education. Implications for research involve the use of the MCCS for further study of co-curricular support and student success in undergraduate engineering programs. Implications for practice include using the MCCS to analyze and develop co-curricular student interventions that provide underrepresented students with comprehensive support.

5.3.1. Implications for Research

The research presented in my dissertation has general implications for research on diversity and retention. To support these college-driven diversity and retention efforts, research should be conducted using frameworks that adequately reflect the challenges associated with retaining a student in a particular college as opposed to university. If the issues within engineering are addressed using local solutions, it may require research using theoretical lenses that account for this reality. The MCCS could be used in future studies. I also suggest that researchers consider the four systems identified through my study when investigating the undergraduate experience of engineering students: (1) social, (2) academic, (3) professional, and (4) university. By incorporating each of these systems when examining the undergraduate experience in engineering, future research can incorporate the student experience more holistically and paint a complete picture of the realities of being a student in an undergraduate engineering program. The combination of these four systems can account for a student not only needing to integrate into the academic, social, and professional system associated with a particular college, but also within the university in which the college is imbedded. Examining each of these systems allows the researcher to investigate each system individually as well as the impact each has on the other. In summary, researchers conducting educational research focused primarily on the engineering discipline could use frameworks that effectively account for the scope of an individual discipline (as opposed to an entire university) and consider the social, academic and professional experiences students have as well as those with the university more broadly.

5.3.2. Implications for Practice

The research presented in my dissertation also has general implications for practice in the areas of diversity and retention. In Chapter 1, I identified four stakeholders: ESSC administrators, engineering colleges, engineering students, and society. In this section, I provide specific implications for ESSC administrators, engineering colleges and engineering students. For ESSC administrators, it is important to consider each of the Output areas when constructing co-curricular student interventions. It is equally as important that you consider which Outputs are of particular importance for the specific students you are serving. If this is done, the multifaceted needs of the students will be the driving force behind the experiences you create, especially in situations where resource limitations prevent you from providing interventions that cover each of

the identified Output categories. Broadly speaking, ESSC administrators should use the Output categories found in this study and make those the focus of student intervention design. For engineering colleges, it is important that you consider the system of support provided at your university in entirety and pay close attention to the level of support received by students at different academic levels, in different majors, and from different backgrounds. While this study focused specifically on ESSCs, the needs identified are likely to be important to a student regardless of where they are addressed. If we are to ensure that students in general are supported, we should take the additional effort required to determine if the support revealed through this study as Output categories is being provided to students more broadly. If not, we should identify current efforts that we can direct these students towards or create attention forms of support to address any gaps that may exist. Broadly speaking, engineering colleges should use the framework in this study to assess the sources and level of support received by their undergraduate students. Lastly, engineering students could reflect on the Output categories revealed through this study to determine if there are unmet areas of needs within their own experience. While this study focused on institutional action, the Output categories provide students with a roadmap that can assist them with seeking help within an academic setting and verbalizing areas of unmet needs to university employees who can point them in the right direction. Broadly speaking, students should reflect on how well supported they are and seek out additional assistance when necessary. In summary, the Output areas revealed through this study should be used to evaluate the current level of support received and provided within engineering college and can be beneficial to ESSC administrators, engineering colleges, and students themselves.

5.3.3. Summary of Implications

In summary, the results of my dissertation have implications in the areas of research and practice. Each of these implications is a direct result of the intentional connection between student support practice and student-retention theory used in this study.

5.4. Future Work

While my dissertation advances our understanding of co-curricular support, it is imperative that additional work be carried out if we (i.e., the engineering education community) are to create environments that address our retention and diversity problems by providing undergraduate engineering students with comprehensive support. In particular, I suggest nine areas of future work. I discuss each of these suggestions below.

We could broaden the sample of ESSCs in this work to include Women & Minority Engineering Programs (WMEPs), General Engineering Program (GEPs), and ESSC housed in different institutional contexts. This would address the limitations of not including each of the ESSC classification identified, and expand or confirm the results of my dissertation beyond the scope of large, four-year, research-intensive universities.

We could use the items I created in this study as a starting point to develop reliable instruments to measure Outputs (*Academic Performance*, *Faculty/staff Interactions*, *Extracurricular Activities*, *Professional Development*, and *Additional circumstances*) and Short-term Outcomes (*Social*, *Academic*, *Professional*, and *University Integration*). This would provide the engineering education research and practice community with the instruments necessary to quantitatively analyze co-curricular delivery and impact. It is my hope that an operationalized definition of these constructs would also facilitate comparing results across studies.

We could expand the scope of this study to investigate the level of co-support received more broadly (i.e., from other university entities as opposed to just from ESSCs) by undergraduate engineering students with diverse genders, race/ethnicity, academic levels, majors, and institutions. This would allow us to investigate how co-curricular needs differ across various student populations and expand the results of my dissertation beyond how ESSCs function.

We could pursue a longitudinal study of the co-curricular support needs of underrepresented undergraduate engineering students with diverse genders, race/ethnicity, academic levels, majors, and institutions. In particular, we could include students from private institutions, minority serving institutions, and teaching-focused institutions. This would expand the results of

my dissertation by investigating how co-curricular needs are addressed (or not addressed) over time and the subsequent impact on performance variables.

We could analyze the interviews conducted for this study to identify the assumptions ESSC administrators made about the students they were targeting and impact of their interactions. While I used theory to connect the Outputs, Outcomes, and Objectives in my dissertation, ESSC administrators expressed their personal beliefs about who their students are and how their interventions impact students during the interviews as well. Analyzing the interviews to identify these assumptions would allow us to better understand the intentions of ESSC administrators and investigate whether or not the information they are using to guide their practices is supported by research.

We could investigate the quantitative relationship between the Outputs, Outcomes, and Objectives. In particular, quantitative data is needed to determine the explanatory power of the MCCS. This would expand the results of my dissertation and assist ESSC administrators with prioritizing Outputs for individual student interventions and ESSCs collectively.

We could investigate the quantitative relationship between the academic, social, professional, and university integration and the professional choices of recent graduates. This would allow us to investigate the impact integration (particularly, academic and professional integration) has on the career choices students make after earning an engineering degree.

We could develop a network/database of ESSC administrators (and student-support practitioners more broadly). To date, there is no central location to disseminate information to the practitioners tasked with supporting undergraduate engineering students. This would facilitate best-practice sharing and collaborations between researchers and practitioners in the areas of co-curricular support.

We could develop a scaffold to assist with the development of co-curricular student interventions. While the MCCS was designed to directly connect student-retention theory with student-support practice, practitioners could benefit from having a tool designed specifically to

assist them with developing student interventions based on their available resources and the needs of their students. This would facilitate the results of this dissertation being of practical use to practitioners who provide co-curricular support and facilitate best-practice sharing by providing a means of standardizing the language used to describe co-curricular student interventions.

We could provide *Activities* that specifically focus on women of color. This would allow students with multiple dimensions of identities that are underrepresented in engineering to have a place where they can freely express the intersection of those multiple dimensions. Neither ESSC included in this study provided such an intervention.

We could provide more *Activities* that specifically focus on the development of majority students with regards to their interactions with women and URMs in engineering. This would contribute towards creating a more inclusive culture within engineering colleges in conjunction with helping unrepresented student navigate the majority culture.

Collectively, the suggested work above could expand the findings in Chapter 4 through confirmation or revision, address the limitations discussed in Chapter 3, expand the scope outlined in Chapter 1, and help advance our efforts (research and practice) to support undergraduate students from diverse backgrounds.

5.5. Conclusions

I developed this research study with the aspiration of better understanding the approaches applied by university employees tasked with supporting underrepresented engineering students. My intention was to combine student-retention theory with student-support practice in a way that could facilitate future collaborations among educational researchers and student-support practitioners. Accordingly, I used Tinto's Model of Institutional Departure to closely examine the holistic nature of six distinct ESSCs from the perspective of both ESSC administrators and students with full intentions of modifying the framework. Prior to my dissertation, previous work had examined the *practice* of providing students with co-curricular support by investigating individual interventions at a micro level. However, the *theory* of co-curricular support had not

been as thoroughly examined by investigating the system of support ESSCs provide as a whole. It was my intention to fill this gap. Based on the results of my work, ESSCs function in various ways and support students in a range of capacities. I am confident that the Model of Co-curricular Support herein effectively captures the many functions of ESSC in a way that is useful to both research and practice. Furthermore, I believe the MCCS will facilitate future work towards the purpose of addressing the diversity and retention issues in engineering. It is my plan to carry out this work and to continue advancing the scholarship of co-curricular support. It is my hope that other educational researchers and student-support practitioners will join me on this quest.

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APPENDIX A. Survey 1 (Administrator Survey)

Based on the Engineering Student Support Center (ESSC) you are directly involved with, please provide the following:

1. Name of the center:

2. University:

3. Link to website (if applicable):

4. Target population of engineering students (select multiple if necessary):
    a. Female students
    b. Black or African-American students
    c. Hispanic or Latino students
    d. Native-American students
    e. First-Generation College (FGC) students
    f. Students from under-resourced high schools
    g. All students
    h. Other:

5. Academic levels included in your target population of engineering students (select multiple if necessary):
    a. Freshmen
    b. Sophomores
    c. Juniors
    d. Seniors
    e. Graduate Students

6. Do you offer any programs or services targeting transfer students or students not admitted directly into engineering?

7. Approximate size of your target population:

8. How many full-time staff members are employed by your center?

9. How many graduate students/assistants are employed by your center?

10. What is your job title (i.e., director, assistant director, etc.)?

11. Who does the director of your center report to at your university (i.e., dean of engineering, university president, etc.)?

12. Center Classifications: The following 5 classifications were developed through a preliminary Internet search of 50 universities from multiple regions of the United States to gauge the commonness and variety of student support centers in engineering. In the following section,

please indicate whether you agree or disagree with each of the classifications as well as the associated definition: the definitions are meant to be general and not about a specific institution. If you disagree, please suggest how you would modify them.

- Minority (or Multicultural) Engineering Program: Student support center that focuses on ethnic diversity in engineering without a specific focus on gender diversity
    a. I agree with the classification
    b. I disagree for the following reasons:
    c. I am unfamiliar with this type of ESSC

- Women in Engineering Program: Student support center focused on gender diversity in engineering without a specific focus on ethnic diversity
    a. I agree with the classification
    b. I disagree for the following reasons:
    c. I am unfamiliar with this type of ESSC

- Women & Minority Engineering Program: Student support center that separately focuses on ethnic diversity and gender diversity in engineering but under common administration.
    a. I agree with the classification
    b. I disagree for the following reasons:
    c. I am unfamiliar with this type of ESSC

- Diversity in Engineering Program: Student support center that focuses on engineering students in general while targeting underrepresented populations; this includes centers that focus on broadening participation by targeting students from underrepresented populations or under-resourced high schools communally
    a. I agree with the classification
    b. I disagree for the following reasons:
    c. I am unfamiliar with this type of ESSC

- General Engineering support Program (GES): student support center that focuses on engineering students in general without a specific focus on broadening participation or diversity
    a. I agree with the classification
    b. I disagree for the following reasons:
    c. I am unfamiliar with this type of ESSC

13. Are any classifications missing from this list? If so, please describe them below:
    a. No, there are not any classifications missing
    b. Yes, there are classifications missing: [text box]

14. Based on your definitions, how would you classify your respective ESSC?
    a. Minority/Multicultural Engineering Program
    b. Women in Engineering Program
    c. Women & Minority Engineering Program
    d. Diversity in Engineering Program

e. General Engineering Support Program
f. Other:

15. Which of the following programs does your ESSC offer/sponsor/facilitate:
    a. Engineering Residential Community
    b. Mentoring Programs (student-to-student)
    c. Summer Bridge Program
    d. New Student Orientation
    e. Preview Weekend for Prospective Students
    f. Other:

16. Which of the following activities does your ESSC offer/sponsor/facilitate:
    a. Student Organizations (i.e. SWE, NSBE, SHPE, etc.)
    b. Design Competitions
    c. Student-faculty Organized Meetings (i.e. dinners, lunches, etc.)
    d. Faculty Panel Discussions
    e. Student Panel Discussions
    f. Study Retreats
    g. Other:

17. Which of the following services does your ESSC offer/sponsor/facilitate:
    a. Academic Advising
    b. Tutoring
    c. Personal Counseling
    d. Financial Assistance
    e. Student Lounge or Study Center
    f. Listserv
    g. Block Scheduling or Clustering
    h. Other:

18. How is engineering faculty involved with your ESSC?
    a. Attend activities
    b. Give workshops/seminars
    c. Help plan programs
    d. Advise student organizations
    e. Serve on an advisory board
    f. Mentor students
    g. Sponsor research internships
    h. Other:

19. How would you summarize the goal/purpose of your ESSC with regard to current engineering students (i.e. between being a prospective student and graduation)?

20. If your ESSC has a mission statement, please provide it here:

21. In what ways is your ESSC hindered in reaching its goals and achieving its mission? This includes barriers from faculty, students, the university, etc.

22. In what ways is your ESSC supported in reaching its goals and achieving its mission? This includes support received from faculty, students, the university, etc.

The next phase of this study will entail exploring several student support centers more closely. Participation entails: participation in interview(s) from administrators (i.e. director, assistant director, etc.), distributing an open-ended survey to the students you serve, and assisting with the organization of an on-campus focus group with interested students. A summary of the results of the study will be provided to those who participate at the conclusion of the study.

23. If you would like to be contacted about the possibility of your center participating in the subsequent phase of this study, please provide your name and email address:

APPENDIX B. Survey 2 (Student Survey)

1. Have you participated in any programs or activities in particular?
    a. List of programs and activities offered by [ESSC]
    b. Other:

2. Have you been involved with or supported by [ESSC] in any other ways? If so, please describe these:

Next, I am going to ask you to reflect on specific types of experiences and think about how [ESSC] has impacted them.

3. With regard to the interactions you have with engineering faculty and staff, which of the following statements do you agree with:
    a. [ESSC] has positively influenced my interactions with engineering faculty/staff
    b. [ESSC] has not influenced my interactions with engineering faculty/staff
    c. [ESSC] has negatively influenced my interactions with engineering faculty/staff

Please explain your answer to the previous question, providing specific examples if possible.

4. With regard to the interactions you have with other students, which of the following statements do you agree with:
    a. [ESSC] has positively influenced my interactions with other students
    b. [ESSC] has not influenced my interactions with other students
    c. [ESSC] has negatively influenced my interactions with other students

Please explain your answer to the previous question, providing specific examples if possible.

5. With regard to your academic performance, which of the following statements do you agree with:
    a. [ESSC] has positively influenced my academic performance
    b. [ESSC] has not influenced my academic performance
    c. [ESSC] has negatively influenced my academic performance

Please explain your answer to the previous question, providing specific examples if possible.

6. With regard to your participation in extracurricular activities, which of the following statements do you agree with:
    a. [ESSC] has positively influenced my participation in extracurricular activities
    b. [ESSC] has not influenced my participation in extracurricular activities
    c. [ESSC] has negatively influenced my participation in extracurricular activities

7. With regard to your professional development, which of the following statements do you agree with:
    a. [ESSC] has positively influenced my professional development
    b. [ESSC] has not influenced my professional development
    c. [ESSC] has negatively influenced my professional development

Please explain your answer to the previous question, providing specific examples if possible.

8. Are there other influences [ESSC] has had on your college experience that you would like to mention? If so, please provide specific examples.

9. How would you describe [ESSC] to an incoming freshman?

10. Has [ESSC] helped you deal with any particular problems? If so, what sorts of problems has [ESSC] helped you deal with and how? (For example, students can have difficulty with the engineering curriculum or find the engineering culture unsupportive).

11. Indicate your sex:
    a. Male
    b. Female

12. Which of these racial/ethnic groups do you most closely identify with:
    a. White
    b. African-American
    c. Hispanic, Latino or Spanish origin
    d. Asian-Pacific Islander
    e. Native American or Alaska Native
    f. Other: _____

13. Indicate your current academic level:
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
    e. Graduate Student

14. Which engineering department are you currently in? (Choose the one you identify with the most if more than one)
    a. [List major options]

15. If you would like to be considered for the raffle at the conclusion of the study, please provide your name and email address below:

The next phase of this study will include focus group interviews (sometime during the remainder of the academic year) to further discuss how [ESSC] functions alongside the engineering curriculum and to identify ways engineering colleges can better help students. Each student selected to participate in a focus-group interview receive a $10 gift card.

16. If you would like to be contacted about the possibility of participating in a focus-group interview, please provide your name and email address:

APPENDIX C. Interview 1 (Administrator Interview)

1. How long have you been working with [ESSC]?
    a. What is your role? What does this entail?
    b. Do you work with any programs in particular?
    c. Could you provide a brief overview of the individual program and services provided by [ESSC]? [Bring a list of the programs and services with you to interview]

2. How would you describe [ESSC] to a prospective student or parent?

3. Focusing on current engineering students (that is to say from the time they are prospective students/accepted to the time they graduate), what purpose do you think [ESSC] serves within the college?
    a. Who is the intended client for the center (i.e., what types of students do you target)?
    b. What problems or issues do [ESSC] intend to address for students?
    c. Has the intended client for [ESSC] or the mission of [ESSC] changed over time?

4. With the purpose in mind, what programs, activities, and services are most critical to [ESSC] achieving its mission? Why?
    a. Which interventions do you believe have the greatest impact for current students? (Note: may discuss greatest impact in regard to the number of students impacted, the significance of the impact, or the per student cost)

5. What advantages do you believe a student experiences if they participate in the programs offered through your center?
    a. Do you believe there are any disadvantages to participating in any of the programs?

6. What do you think students perceive as being the advantages of participating in the programs?
    a. Do you believe there are any perceived disadvantages to participating in any of the programs from the student perspective?

7. How do you measure the success of these programs and activities?
    a. Individually? For the center as a whole?

8. Do you believe the experiences of students who choose to be involved with [ESSC] are different than those who choose to not be involved?

9. Do you think the students who participate have different experiences with regard to their _____?
    a. Interactions with faculty/staff
    b. Interactions with their peers
    c. Performance academically
    d. Involvement in extracurricular activities
    e. Professional development

10. In what ways are you efforts supported, or made easier, by your college and other units within the university?
    a. Do you receive any external support?
    b. In what ways are your efforts made more difficult?
    c. What resources make it possible for you to offer the programs and services that you are able to provide?
    d. Are there any programs or services you think you should provide or wish you could provide but don't? If so, why?

----- Activity Below -----

11. Next, I'm going to give you a table that lists the common barriers student face in engineering. To complete this activity, you will identify whether addressing each barrier is within the scope of [ESSC], and, if so, which sorts of student interventions have been created (or can be created) to facilitate student experiences that help address each barrier. The intervention categories are listed in the last five rows, but I'm going to go through them to make sure we're on the same page.

Faculty/staff interaction:
- Interventions geared towards facilitating student interactions with faculty and staff outside of the classroom

Academic preparation/skills:
- Interventions geared towards directly improving a student's academic performance through preparation or providing them with academic strategies or tips.

Peer-group interactions:
- Interventions geared towards facilitating student interactions with other students outside of the classroom

Extra-curricular activities:
- Interventions geared towards directly getting students involved in activities that fall outside the realm of the normal curriculum

Note: I am interested in engineering and non-engineering experiences. That is to say, if interacting with faculty outside of engineering is facilitated to address a particular barrier, I would like to hear about this as well. That goes for academic preparation/skills, peer group interactions, and extracurricular activities as well.

----- Task Starts Here -----

Now we are going to move on to the task. Please verbally walk me through what you're thinking about while completing this activity.

First, for the different barriers listed in the table, please describe what each of the barriers means to you. [Complete first task]

Second, please indicate if addressing each barrier is within the scope of the center. If addressing the barrier is within the scope, check "yes." If the barrier is somewhat within the scope, check "maybe." And if the barrier is outside of the scope, check "no." [Complete first task]

Next, for the barriers that have "yes" or "maybe" checked, please indicate which types of interventions you have created (or believe can be created) to address each barrier? [Complete second task]

----- Switch focus -----

12. Now we are going to focus on the list of barriers in the first column again. Do the students you work with experience any of these barriers? If so, which of the barriers do they face and how regularly would you say these barriers are brought to your attention?

13. Are there any other barriers they face that are not listed? [Proceed to blank table]
    a. Is addressing these barriers within the scope of your center?
    b. If so, what sorts of interventions have you created (or can you create) to address them?

14. Of the barriers we've discussed thus far, which ones do you think have the greatest impact on whether or not a student stays in engineering?

15. Is there anything else that you would like to add to what we have discussed, or anything that we have not discussed that you believe is important to understanding the purpose/function of [ESSC]?

Please read the list of barriers in the first row. For each barrier listed, please indicate if the barrier is within the scope of the purpose the center serves (check yes), somewhat within the scope of the purpose the center serves (check maybe), or is outside the scope of the purpose the center serves (check no).

Barriers in Engineering	**Within the scope?**			**If yes or maybe, which type of intervention(s) can address this barrier?**				
Difficulties with the curriculum	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
Competitive and unsupportive culture	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
Perception of a "weed-out" tradition	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
Losing interest in engineering	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
Occupational Stereotypes	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
Sexism (i.e. harassment)	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
Racism (i.e. stereotypes or discrimination)	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other

Faculty/staff interaction: Interventions geared towards student interactions with faculty and staff outside of the classroom
Academic preparation/skills: Interventions geared directly towards improving academic performance
Peer-group interactions: Interventions geared towards student interactions with other students outside of the classroom
Extra-curricular activities: Interventions geared towards participation in activities outside the realm of the normal curriculum

Please read the list of barriers in the first row. For each barrier listed, please indicate if the barrier is within the scope of the purpose the center serves (check yes), somewhat within the scope of the purpose the center serves (check maybe), or is outside the scope of the purpose the center serves (check no).

Barriers in Engineering	Within the scope?			If yes or maybe, which type of intervention(s) can address this barrier?				
	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other
	Yes	Maybe	No	Faculty/Staff Interaction	Academic Preparation/Skills	Peer-Group Interaction	Extracurricular Activities	Other

Faculty/staff interaction: Interventions geared towards student interactions with faculty and staff outside of the classroom
Academic preparation/skills: Interventions geared directly towards improving academic performance
Peer-group interactions: Interventions geared towards student interactions with other students outside of the classroom
Extra-curricular activities: Interventions geared towards participation in activities outside the realm of the normal curriculum

APPENDIX D. Interview 2 (Student Focus Group)

We are focusing on student experiences with the center located at this university. While you can mention personal experiences, we are focusing on the experiences of students in general. First, I am going to define some terms to make sure we're using the same language during the interview:

- Center: university office established to enhance the undergraduate experience, retention, or diversity of undergraduate engineering students.
- Program: experiences that require prolonged involvement such as mentoring programs.
- Activity: condensed experience that does not require prolonged involvement from participants such as orientation activities and guest speakers.
- Service: assistance or resources such as opportunity mailings or study lounges.

Before we begin, does anyone have any questions?

-----Interview Starts Here ----

1. How would you describe [ESSC] to incoming students or their parents?

2. In what ways do you believe the existence of [ESSC] impacts the experiences of the engineering students who are involved?
    a. Do you think the experiences of students who participate in [ESSC] are different than the experiences of student who choose to not be involved?

3. Next, we're going to talk about each of the programs offered by [ESSC] individually. For each program, I'm interested in how you would describe the program as well as what you see as the impact it has on the students who participate? [List interventions].

4. What sorts of problems or challenges does [ESSC] help students deal with or avoid?

5. What do you think students, both involved and not involved, see as the advantages and disadvantages of being involved with [ESSC]?

6. Are there any problems [ESSC] does <u>not</u> help students deal with that you believe they should? If so, please describe these and how you think students could be helped. .

7. Are there any programs, activities, or services that are provided that you believe should <u>not</u> be?

8. Is there anything else that you would like to add to what we have discussed, or anything that we have not discussed that you believe is important to understanding the purpose/function of [ESSC]?

APPENDIX E. Collective Student Experience Details

This appendix includes specific details on how each perspective (see Table E1) manifested at each ESSC.

Table 49 - Student Perspectives

Perspectives	DEP1	WEP2	MEP2	WEP3	MEP3	DEP4
	U1	U2		U3		U4
Support Group	+	+	+	+	+	
Safety Net	+					+
Familiarity and Comfort		+	+		+	+
Family Atmosphere			+			+
Resource Access	+	+		+		
Opportunity Awareness	+		+			
Networking				+	+	+
Way to Meet Women		+		+		
Adjusting to Minority Status	+		+			
Knowledge Expansion		+		+		
Student Confidence					+	+
Perception of Engineers	+/-					
Social Atmosphere			+/-			
Time Commitment	-				-	-
Female Isolation		-		-		
Misperception of ESSC		-				-
Cliquish Community	-					
Always Engineering	-					

Section 1. DEP1 – Collective Student Experiences

This section includes details on how each DEP1 student perspective (see Table E2).

Table 50 - DEP1 Student Perspectives

Perspectives	DEP1
	U1
Support Group	+
Safety Net	+
Resource Access	+
Opportunity Awareness	+
Adjusting to Minority Status	+
Perception of Engineers	+/-
Time Commitment	-
Cliquish Community	-
Always Engineering	-

The demographics for the focus groups used to identify these perspectives are presented in Table E3.

Table 51 - DEP1 Focus Group Demographics

Group	Gender	Race/Ethnicity	Major	Year
1	Male	Black	Mechanical Engineering	Senior
	Female	Black	Engineering Science & Mechanics	Senior
	Female	Black	Industrial & Systems Engineering	Junior
	Female	White	Industrial & Systems Engineering	Junior
2	Male	White	Ocean Engineering	Freshman
	Male	White	General Engineering	Sophomore
	Female	White/Native-American	Computer Science	Sophomore
	Female	Asian	Industrial & Systems Engineering	Junior
	Male	Asian	Industrial & Systems Engineering	Senior
	Male	Black	Industrial & Systems Engineering	Freshman
	Female	Black	General Engineering	Freshman
3	Male	Hispanic	General Engineering	Freshman
	Female	Hispanic	General Engineering	Junior
	Male	White	Industrial & Systems Engineering	Freshman
	Male	Black	General Engineering	Freshman
4	Male	Middle Eastern	General Engineering	Junior
	Male	White	Industrial & Systems Engineering	Senior
	Female	Asian	Civil Engineering	Freshman
	Male	Asian	General Engineering	Sophomore
5	Female	White	Industrial & Systems Engineering	Senior

Support Group (Source: Focus Group 1 – 5) – One of the perceived advantages of being involved with DEP1 is having access to a network/community of engineering students at "different places academically" (i.e., at different levels academically and with regard to preparation) who serve as support and provide proof that success in engineering is possible. Explaining how the student network is advantageous, a student who participated in the learning community stated, "I feel like it was just a big support group because everybody understood how everybody else felt about everything that was going on, academically speaking." Other students expressed how knowing people removed the intimidation of walking into a large lecture hall. For example, a past participant of the summer bridge program stated, "I'm in a big lecture just like that, 200 people, and I wasn't in a group and then I saw two people that I knew from [the summer bridge program] and I was like, 'Perfect. I got a group.'" In addition to the academic support provided by the network, students can also benefit socially. A student who self-identified as introverted explained this benefit by saying, "If it weren't for [the summer bridge program], I probably wouldn't have any friends." She explained this statement by discussing how it takes her a long time to get comfortable with most people but somehow participating in the summer bridge program made her more comfortable than usual and "allowed [her] to branch out in like other aspects of [her] life because [she] knew if push comes to shove, [she had] something to retract to where [she feels] comfortable" – the network she established during the summer bridge program. Another student, who used the mentoring portion of learning community in a similar way, echoed this sentiment when she stated, "there's a mentoring program the first semester that I found to be one of the most helpful things ever because that's how I really go to start knowing people - through those girls - and then I just kept on expanding until I found my friends." Additionally, DEP1 provided students with access to faculty/staff. A

past the summer bridge program participant explained this by stating, "I probably wouldn't talk to [the DEP1 director] if I had not gone to [the summer bridge program]. I would not feel comfortable asking her for advice, like I sometimes do." Ultimately, DEP1 gave students access to other people and, as one student stated it, "DEP1 is just a great community… it's really nice getting to know so many people and having so many connections."

Safety Net (Source: Focus Group 1 – 4) – One of the perceived advantages of being involved with DEP1 is having a safety net to minimize the likelihood of a "disastrous first semester freshmen," whether it be through the summer bridge program and learning from the "practice round" or the learning community or mentoring program and having readily available help during the academic year. A past summer bridge program participant explained this stating, "The impact was I more or less knew what college was going in. And I know people who dropped the ball first semester, their first semester, and that didn't happen to me and one of the reasons why is because I dropped the ball in [the summer bridge program], multiple times, but I knew like, 'Hey, I gotta watch out for this.' It was a good learning experience so I knew what to expect." Summarizing how DEP1 serves as a safety net, another student describes it as follow: "If you want to succeed academically and you're serious, it's really, really, easy to do it because they just put all of the resources in your face, constantly. And so you have to try very hard, you have to specifically go out of your way, not to do anything." Additionally, another student described DEP1 as "not necessarily as a way to get ahead, but more so as a way to not fall behind," especially during the first couple of weeks for first-year students. In the event that someone does fall behind, DEP1 is still there to help him or her. While discussing the programs and challenges DEP1 helps student deal with, one student stated, "Grade challenges: Like, if you're struggling grade wise or academic wise, [DEP1] is definitely there to help you bring back your grades and academically focus on whatever you need help with. Like there's always someone to help you."

Resource Access (Source: Focus Group 1 – 4) – One of the perceived advantages of being involved with DEP1 is conveniently having access to resources, including other engineering students, that other students either have to actively search for or do not have access too all together. While students who are not involved can still find many of the resources, they have to look a little further than those involved in DEP1 (particularly the learning-community where students could simply walk down the hall at anytime during the day and have access to a design studio or the minority-serving engineering societies which provide students with a "condensed" version of many of the resources offered throughout the campus in a more comfortable setting, where they do not have to feel like the "odd-person-out"). One student summarized it by saying, "it's just convenience, really, through living in the dorm; being able to go down the hall to say 'Hi' to someone or to get homework help." This sentiment was corroborated by the following statement from a student who was not involved in DEP1 when he stated, "I feel like I'm out there on my own kind of and I feel like they're with a community in a sense. So they are being helped along whereas, this might sound too negative for me but it's not that negative, whereas I'm trying to make my resume by myself; learn how to interact with people by myself; things like that. But it's not that negative." One student expressed her regret for not joining a program as follows: "I'm not in [the learning community] but I have a lot of friends who are in [the learning community] so I'm always in [the residence hall], and from an outside perspective I really wish I had joined [the learning community] because it's definitely more focused. I go there to study with friends and stuff and it seems like you just have access to everything and anyone you need around you at anytime of the day. And I think that's a really important thing to have, especially as an engineer. You'll be like coding and then you'll get stuck and you can just go to your neighbor and be like, 'Hey, help me.' And that's just there for you." Additionally, participants believed that some students who were not involved viewed this convenience negatively, as a way that DEP1 "[gives] the minorities and women all of the short cuts to academic

success" or gives participants "a short cut to the front of the line," while another student (who participated in the summer bridge program but not the learning community) viewed these as advantage of attending the university in general, and felt like "there's a lot of help if you're in engineering" regardless of where they lived.

Opportunity Awareness (Source: Focus Group 1 – 4) – One of the perceived advantages of being involved with DEP1 is being exposed to "the knowledge of those opportunities that are out there." In particular, students talked about employment opportunities, professional conferences, career fairs, learning community events, and information about scholarships. One student believed DEP1 (minority-serving engineering societies in particular) brought opportunities to underrepresented students and stated, "So I know a lot of them – [minority-serving engineering societies] - actually do open some doors, which hopefully evens out a lot of the doors that are closed because you're a minority or female or whatever." In a subsequent focus group, a student added to the benefit of being exposed to opportunities by discussing how he believed students involved in DEP1 are "more likely to get involved in other things outside of the DEP1 office, such as design teams and other groups, because you're around a lot of other people who are also a part of those." Another student echoed this sentiment when he discussed how "most of [his friends] are engineers" so he got to hear about all of the stuff available at the university that they were involved in. Explaining what types of opportunities DEP1 helps students find, another student states, "All kinds of opportunities: volunteering opportunities, networking opportunities, job opportunities, academic opportunities… every possible type of opportunities."

Adjusting to Minority Status (Source: Focus Group 1 & 5) – According to students in multiple focus groups, one of the perceived advantages (i.e., positive impacts) of being involved with DEP1 is it helps underrepresented students adjust to being underrepresented. In particular, DEP1 helps female engineering students avoid "the gender challenge" during the first-semester by surrounding them with many other female engineers and it helps minorities by providing them with places where they are not as underrepresented as they are in the general population. (DEP1 also exposes majority students to these populations so they do not think the university is "made out of White dudes.") A student explains this positive impact by stating, "I think it makes the school more attractive to diverse people because nobody wants to be that fish that's taken from the pond and thrown in the tank. You have to be put in the little bag of water and sit in there and then adjust." While this support does dwindle down after the first-semester and students start venturing off in different directions, DEP1 is initially able to serve as "the little bag of water" for underrepresented students, allowing them to feel a little less underrepresented initially.

Perception of Engineers (Source: Focus Group 2, 3, and 5) – One of the perceived disadvantages of being involved with DEP1 is the perception students often initially have of other engineering students: students tended to believe "everyone was going to be really nerdy" and they would not "fit in." This perception can result in students being apprehensive about living in the learning community and may even prevent them from applying all together. A student who chose not to apply to live in the community summarizes this disadvantage in the following statement: "Before I came here, a bunch of non-engineers told me, 'Don't do it because it's going to be a bunch of nerdy people.' So I didn't, but I regret that so it's just like a misconception of the [learning] community." On the contrary, multiple students who participated in the programs had a more positive stereotype concerning the type of engineers who participated. For example, one student stated, "Well, I mean, we're around more engineer. Where as if you're not involved in programs like [the summer bridge program] or [the learning community], you're probably going to be less likely to hang out with other engineers… or at least not high-minded, high-goaled engineers." Another students who participated in both the summer bridge program and the learning community summarized her perception of participants as follows: "I feel like the people who go

to [the learning community] and who seek out these sort of programs tend to do better because I think they care more about their school work. So I at least felt like the [learning community] kids, or even the [summer bridge program] kids… you know they're the smart kids in the class because they're going to go out and try to seek help and try to understand it." A student who was not initially involved with DEP1 echoed these opinions and expressed how she noticed the difference once she "became more closer to the DEP1 community" and experienced the "positive vibe" that impacts your grades and social life.

Time Commitment (Source: Focus Group 1 – 5) – One of the perceived disadvantages of being involved with DEP1 is the time commitment required to participate in the programs, though everyone did not see this as a disadvantage and one student expressed that since DEP1 teaches you time management skills, "it basically balances everything back out to an equilibrium point." Whether it was giving up 5-weeks during the summer or fulfilling community requirements during the academic year, the level of commitment required to participate was seen as a disadvantage by some students and expressed by students who have participated as well as those who were on the outside looking in without much information. Even when students acknowledged the usefulness of participating, they still acknowledge the amount of time required to participate. Explaining the commitment, a student states, "I mean you could make an argument for it. But definitely when you're in it you're like, 'This is dumb. I don't know why I did this.' I totally thought, while I was in it, 'I don't know why I chose to do this. Like this is stupid.' But looking back on it, I'm like, 'Ok, ok. This was a good decision. Good job. Good job choosing [the learning community].'" As a result of not necessarily seeing the benefits immediately, participating in these programs can initially look like "extra time that you have to work into your schedule. And when you're just looking at a time block, you don't really see the positive impacts. So that's what a lot of people are hesitant about."

Cliquish Community (Source: Focus Group 2 – 5) – One of the perceived disadvantages (i.e. negative perceptions) of being involved with DEP1 is the notion that the community is "cliquish" and everyone is not welcome – this included non-engineering students and engineering students who are not currently involved. This is manifested through the community that forms prior to the semester as a result of [he summer bridge program and the community that forms during the year as a result of the learning community. One student explains this possibility by stating, "I only know engineers. I don't know any non-engineers. I know where at an engineering school but I feel like I should've met someone else other than engineers… and that's partially because of [DEP1]; and not that that's a bad thing, it just it is what it is." Additionally, multiple students shared this sentiment; for example, another student stated, "I don't really know that many people outside of [the learning community], or [DEP1] for that matter." A third student summarizes this phenomenon with the following statement: "…there are still engineering students who aren't a part of these programs – or who aren't even engineering students – and we kind of like forget about those rather than like trying to network regardless of what their major is… so that's a disadvantage." In addition to students who were never involved being forgotten, one student expressed a similar feeling despite having been a member of the learning community during her freshmen year. She states, "This semester I've been in classes where the kids who still live in [the learning community] have like study sessions in one of the studies, so it's like… I was a part of it but now it's still like a little club, and because I chose not to live in the dorms again it's like I can't get into it or something like that." Students did not always share opinions with regard to whether or not this was the reality or a problem, but there was agreement that this is how it can look from the outside. A student explains this when she states, "Like it definitely looks that way from the outside looking in, so I can see how from an outsiders perspective we can seem kind of stand offish because we're just so involved in what we're doing that those are just the friends that we accumulate." Similar sentiments were expressed by a student who did not participate in the summer bridge program but befriended people who did participate; she agreed that

the misconception existed but felt like the students were very welcoming once you got past the notion of them already having a community formed which you were not initially apart of. Additionally, a student who did participate in the summer bridge program expressed regret that she did not "branch out enough" because she already had a group of friend.

Always Engineering (Source: Focus Group 1 and 3 – 4) – One of the perceived disadvantages of being involved with DEP1 is the notion that students will limit themselves to the engineering community and things will be "constantly always about engineering." For example, a student may only make friends with other students in the program or only get involved with engineering-related activities. However, students did not always feel like this was a negative impact. For example, one student felt that "because you're surrounded by so many scientific and like science based and engineering pursuits that you can do," it really helped if you wanted to go "really deep" into engineering. He felt like DEP1 presented opportunities in the following manner: "Look at all of this cool stuff you can do… as an engineer though!" Explaining how this was a positive impact in her situation, one student stated, "DEP1 has pretty much made it so most of my friends are engineers, which kind of ties me more tightly with engineering. Because as much as it sucks right now, I'm sure that in a few years, once I graduate, I'm going to be very happy that I have an engineering degree. And it's like, if I didn't have all of these ties… like I feel like I'm duct taped to engineering at this point. I can't escape: Like all my friends are engineering." Another student in a different focus group echoed this phenomenon as well: "Since everyone else is doing engineering, people stay in engineering. And even if they really shouldn't, they still do because there's just that pressure from the whole community to do that. And whether that's a good thing or a bad thing, that's what I see is happening." While the student who were involved generally expressed the positive influence of being immersed in engineering (one student described it as having a "more integrative" social and academic life), the perception of being "constantly always about engineering" was viewed, according to focus group participants, as a possible deterrent to students who were not involved as well as parents.

Section 2. WEP2 – Collective Student Experiences

This section includes details on how each WEP2 student perspective (see Table E4).

Table 52 - WEP2 Student Perspectives

Perspectives	**WEP 2**
	U2
Support Group	+
Familiarity and Comfort	+
Resource Access	+
Way to Meet Women	+
Knowledge Expansion	+
Female Isolation	-
Misperception of ESSC	-

The demographics for the focus groups used to identify these perspectives are presented in Table E5.

Table 53 - WEP2 Focus Group Demographics

Group	Gender	Race/Ethnicity	Major	Year
1	Female	White	Civil Engineering	Senior
	Female	White	Electrical Engineering	Senior
	Female	White	Mechanical Engineering	Sophomore
	Female	Hispanic	Bioengineering	Senior
2	Female	White	Environmental Engineering	Sophomore
	Female	White	Chemical Engineering	Junior
	Female	White	Bioengineering	Junior
	Female	White	Physics	Sophomore
	Female	White	Mechanical Engineering	Sophomore
	Female	White	Civil Engineering	Sophomore
	Female	White	Biosystems Engineering	Senior
	Female	White	Environmental Engineering	Senior
	Female	White	Chemistry	Junior
	Female	White	Civil Engineering	Junior
	Female	Asian	Bioengineering	Senior

Support Group (Source: Focus Group 1-2) – One of the perceived advantages is having a place to go for various kinds of support; students in both focus groups described this benefit. Support included personal (emotional), technical (curriculum), and professional (college systems, future employment). Explaining the benefit of having support available, one student states, "It's comforting to have, as a freshman, someone who always has time for you; like, you know that you can go to them and they're going to find time to like help you no matter what you need." In particular, students felt like WEP2 was a safe space to get emotional support: "It's a place to find that home center where… you can go to talk about anything even if you just need to vent to somebody for a few minutes." Another student echoed this sentiment when discussing a bad experience she had with a lab partner. She stated, "At the very least, [WEP2] is a safe place to vent" and recalls a time when she went to the director for emotional support: "I was so upset and I went to [the director] and was like in tears like, 'I don't know how to deal with this person' and she just gave me the support that I needed. And I've had the same issue with professors, especially in electrical. They're all very conservative, old men. And so I feel like I don't feel very supported in my major sometimes so I have to go to [WEP2]." Supporting the sentiment that this support made WEP2 feel like a family to some students, one student stated, "I went through a lot through my college career, and I don't know that I would've even stayed in college if it hadn't been for [WEP2]. I just… it was my second home. I just kept coming back every time something got me down." Additionally, students felt supported academically by WEP2. Discussing the problems WEP2 helps students avoid, a student stated the following: "I think one of the big things is succeeding in classes, so avoiding failures. Through our study sessions, and I don't know about the other [mentors], but my office hours are usually specifically devoted to, 'I know you have a homework due in a couple of days and you may not know how to do it. Come to me and, I've already done that homework before. We can sit down and figure out what's confusing you.' And so it's ensuring that if my [mentees] wants to be a chemical engineer, she can get through that class with the knowledge that she needs to go on and succeed." Ultimately, WEP2 supports students in various ways. As one student stated: "I think [the director] is a really good resource. Just because she seems to know everyone on campus and she will help you with whatever issue it is, just like point you in the right direction. And then you said support, and I think it's

different types of support too. Like not only do you get the academic support like tutoring and the study sessions, but also social and mental support. Like just today, I had a horrible day so I'd go into the [WEP2] office and get that emotional support."

Familiarity and Comfort (Source: Focus Group 1 – 2) – One of the perceived advantages of being involved is having a place to seek solutions to the problems – personal, professional, and academic problems – that arise during college: "Sometimes it's intimidating to talk to a professor, especially if you're in a class and there's like over 100 kids in it. It can get hard to go and talk to them, so it was really great having someone else I can go to." WEP2 mentors serve as an initial point of contact for many freshmen with regard to solving problems. One student describes this advantage as follows: "I like to use it for the mentoring. Like if I have any questions, it's the first place I go and they normally help me out with like how to start figuring out the solution." Another student, who is serving as a mentor, describes WEP2 as "a safe place for them to come talk too and get answers to questions they might have." Summarizing this need for freshman to have questions answered and the benefits, one student stated: "You're not sure where things are. People don't know how to pick up football tickets. They don't know what they should do about this or if they should withdraw form a class or drop something… and I just feel like having a [mentor] is a good way to ask those questions and try to bring down that feeling of so many emotions and being so overwhelmed." Another student explains how WEP2 helps students deal with conflict. She states, "[WEP2] has been a really great way for me to find professional ways to deal with conflict. And I think that's a really great thing. Because you're going to have, when you graduate… in the professional, world that's a part of life. You're not always going to get along with your co-workers. Whether you have different ideas about the project you're working on or just about life, and I think [WEP2] does a good job of helping you acquire the skills to deal with that." WEP2 also helps students avoid academic conflicts with classes. One mentor felt like she was a "second academic advisor" to her mentees since they rarely met with their advisors and the students "have better insight as far as what classes to take and all that kind of stuff." Ultimately, the mentoring program "goes beyond academic and social and professional. It's someone who has actually experienced the things that these freshmen girls are going through and can help them deal with their problems."

Resource Access (Source: Focus Group 1 – 2) – One of the perceived advantages of being involved is being able to access resources: "It's the access to all of the resources. Whether you're a freshmen to a senior – there's just so many different things that can help you and give you a leg up in the world, whether it's … against men or other women. I think that's the biggest thing. It gives you a leg up." Students discussed having access to a test bank, seminars, review sessions, and each other. With regard to the test bank, one student stated, "I think the test bank is a huge thing. When you come into college, you're not used to… the way things are set up; it's pretty different from most testing you're use to. So I love the test bank. Like coming in, getting to see the old exams from multiple years. Being like, 'Alright, this is how this professor works. This is what I should focus on.'" A further testament to the benefit of having access to resources, one student describes WEP2 in the following way: "It's also a good academic resource. There's a lot of tutoring available and a test bank and it's not just for finding your niche. It's also for getting academic help and keeping your grades up and doing what you're supposed to do in college, which is learn." While students did not use WEP2 purely for academic purposes, the usefulness of the center in this regard was evident in the discussions. Additionally, having access to these resources strengthened some students' confidence in their ability to success. "It gives you a higher level of confidence. You come in concerned that you're not like everybody else, you know? It's mostly guys, and when you have all this different support system and tutoring… you just feel like you can do better; you feel like you can succeed."

Way to Meet Women (Source: Focus Group 1 – 2) – One of the perceived advantages of being involved with is being able to meet other women in engineering, particularly peers - "I think that the greatest thing that WEP2 does is help girls meet other girls with the same interest as them. So it helps you to not feel quit as isolated or as alone." In particular, women in each focus group expressed the benefits of meeting other students if they were new to the area (i.e., out-of-state students). For example, one student stated, "I think another benefit, at least my freshman year, I came from out of state and I didn't know a single person when I got here. And having a [mentor] who could not only be a friend but help me find other friends and make me feel like I fit in here and feel at home at [the university] really helped me to adapt and stay at [the university] rather than transferring out." Echoing this sentiment, another student states, "I came from out of state and it was really nice to have [WEP2] to help me really start to meet people." Another student expressed a similar sentiment due to being a commuter: "I wasn't out of state, but I lived at home so I knew like, commuting, I was going to have to go out of my way to meet people because I wasn't going to have like hall mates or a roommate or anything. So I remember when… our [mentor] freshman year, contacted me I was like, 'Ok, this could be that thing that I like get involved with to keep me on campus besides classes and labs.' WEP2 also provides students with opportunities to meet women outside of their major and learn about a wide variety of things. Summarizing this advantage, a student states: "It's not just people who I see everyday. It's people who have different opinions and, because they're from a different major, I can ask a question to like get help if I need something from like mechanical… or… anything like that. Before, I was very limited to just what I could find in bioengineering, and it's been nice seeing it like broaden." Students were also able to meet older students, which provided them with someone to ask questions and role models. One student stated, "I know being an underclassman and working for WEP2, I really like being around so many upperclassmen because it's kind of like I see that, 'Oh, they made it through most of their undergrad so I can do it too!' And I know… I actually got to know some more seniors and juniors that are in mechanical engineering. They've really helped me out." It is also "really great having someone closer in age answer your questions. Because there are certain things you want to ask and you're like, 'I can't ask an adult that.'" A transfer student also expressed the benefit of meeting other people: "I know, for me as a transfer student coming in, it was hard to get involved. But the people that I did meet and did keep in touch with, those people are still really good friends now. …College is really hard and people get lost in a big college like this. So it's nice to have someway to not get lost." Despite being a transfer student and coming in after "everybody's kind of got their friends [and] everybody has figured out where they're suppose to be," WEP2 was able to provide her with an environment where she felt comfortable coming and getting involved. In addition to meeting other students, WEP2 also allows students to meet professors. Reflecting on a volunteering experience, a student recalls the following example: "I met a professor in electrical engineering that I've gotten to have a really strong relationship with off of working with middle school students." Through involvement with WEP2, "You can make a lot of different networks and connections with other women, even professors, not just students and the people in the WEP2 office. It's a really good tool to keep everyone connected. A student summarized the benefit of meeting people when she states, "I enjoy people. I like the relationships you are able to build there."

Knowledge Expansion (Source: Focus Group 2) – One of the perceived advantages of being involved is the opportunity to learn things outside of the classroom, particularly through participating in outreach activities and interacting with students from other majors. A student explains the benefit of participating in outreach activities as follows: "I've learned more about majors. More recently we did an event at a local middle school… and we learned a lot about physics just because that day focused on physics." She did not believe she would have "gotten that experience without [WEP2]" and classified this as a "good learning experience, not only for the middle schoolers but also for us." A different student shared a similar experience when she described her participation in a different outreach activity: "I've actually

found myself learning a lot… and that the projects they do are pretty cool. Like we were programming robots this past time and it was cool to see the platforms that they have for teaching middle schoolers about programming." In addition to learning things related to various engineering, students are also exposed to the opportunities in various disciplines. A student summarized this benefit as follows: "I also think that students that get involved with [WEP2] have a greater understanding of the opportunities available to them, in their field and outside of it. I know I've found that I have become very knowledgeable about a wide variety of things besides just bioengineering. I know about mechanical engineering, I know about civil engineering and math, and things like that also… So by interacting with students in other majors and also attending professional development presentations by different companies, just to see different company dynamics, even if it's not in my field, the atmospheres that are available to you to work in." Ultimately, the students were actively involved in WEP2 (particularly those serving as mentors) also expressed the advantage of learning things about engineering they would not have otherwise been exposed, specifically related to the various majors and what options each major afforded to different students.

Female Isolation (Source: Focus Group 1) – One of the perceived disadvantages of being involved is that there are not any interactions with their male counterparts. Explaining this disadvantage, one student stated: **"**the female-male interaction isn't dealt with as much… just because we're in classes, and we're going to be in groups, and our careers surrounded by men all the time. So we need to learn how to work with men." Students in one focus group expressed the concern that being too involved in WEP2 would result in them not engaging with the men in engineering as much as they should. Explaining why she was not as involved with WEP2 recently, one student stated, "I've always been like friends with everybody and I needed that. And I felt like being part of [WEP2], I just got so caught up in everything. It was all girls but when I went to my classes it was 5 girls and then the rest were guys and I still felt lost even though I had that little group. So that's one of the reasons I'm kind of not as involved as I was last year." Even though WEP2 provided her with a group of friends, she felt like this group was not inclusive enough once she returned to the classroom where they only made up a very small fraction of the student overall. A transfer student expressed a similar concern when she discussed living off campus and never having a dorm experience: "So when you're a transfer, you're living with girls off campus, and then if you're too involved with [WEP2], you don't have that experience to meet any guys unless you talk to them in class… But I think, even in classes, you don't build the relationships that you do in extracurricular activities. So forcing myself to do more things that were co-ed was better for me." Ultimately, students did appreciate having the women-only space where they could go to meet/be around other women in engineering but felt like only being around women could be a disadvantage is the student was not connecting with male engineering students in some manner.

Misperception of ESSC (Source: Focus Group 1 – 2) – One of the perceived disadvantages of being involved is the misperception of what WEP2 does, which results in uninvolved students perceiving WEP2 as a "feminist" organization or sorority. When asked why the women who were not involved in WEP2 decided to not be involved, the misperception was commonly cited and agreed upon during both focus groups. With regard to the feminist label, one student sated the following: "They think we're all just like huge feminist and are just like anti-men and whatever." Since WEP2 focuses primarily on women, some students view this negatively. Explaining this perception, a student stated the following: "I think the women that aren't involved in WEP2… one of the main reasons that they aren't involved is they kind of see it as an isolating factor as well, because we are in an organization that is specifically for women. Some women in the college of engineering and science see it as we can't stand on our own. Like women, me as a person, I can't stand on my own. I can't function without somebody else. So that's one disadvantages that there seems to be a lot of miscommunications about what we are striving to do."

Students also discussed how outsiders often "don't want to join that because they're trying to be a sorority," which students attributed to the fact that the mentors are often called "Bigs" and the mentees "Littles," similar to the family set up of a Greek organization. Echoing this misperception, one student sated, "I guess there are some people that perceive it to be a sorority… And so that kind of turns some people that are not interested in being in Greek organizations of any kind. I have heard of people [saying], 'Oh, I don't want to be in [WEP2]. I'm not like a sorority girl.' And it's like, 'I'm not either and I'm in [WEP2]'. So there are some, I guess, preconceived notions about what we do." Ultimately, the preconception student held of other women-only activities seems to influence whether or not they are interested in being involved with WEP2 and those involved believed this misperception influenced student involvement since everyone was not exactly clear regarding the purpose of WEP2.

Section 3. MEP2 – Collective Student Experiences

This section includes details on how each MEP2 student perspective (see Table E6).

Table 54 - MEP2 Student Perspectives

Perspectives	MEP 2
	U2
Support Group	+
Familiarity and Comfort	+
Family Atmosphere	+
Opportunity Awareness	+
Adjusting to Minority Status	+
Social Atmosphere	+/-

The demographics for the focus groups used to identify these perspectives are presented in Table E7.

Table 55 - MEP2 Focus Group Demographics

Group	Gender	Race/Ethnicity	Major	Year
1	Male	Hispanic	Mechanical Engineering	Senior
	Female	Hispanic	Biomedical Engineering	Sophomore
	Male	Hispanic	Electrical Engineering	Senior
	Female	Black	Electrical Engineering	Senior
	Female	Black	Bioengineering	Senior
	Male	Black/White	Mechanical Engineering	Junior
	Female	Black	Electrical Engineering	Senior

Support Group I (Source: Focus Group 1) – One of the perceived advantages of being involved with MEP2 is having successful surroundings (i.e., being exposed to successful upperclassmen). A student explains how he personally benefited in this area in the following statement: "I got to meet my mentor. She was a senior, real smart, she had like a real strong resume, [and] she'd done a lot of stuff. That inspired me, so she was like the one that really got me on track and made me want to co-op and intern and really get hands on experience. If I hadn't went to those meetings, I don't know what… I probably still would've had a good college career, but I don't know what kind of track I would've been on compared to where I am now. That allows me to also be that to my mentees now; tell them about interning, and co-ops, and keep your grades up, and all that kind of stuff." Multiple students corroborated this advantage. One

student stated, "seeing successful people makes you want to be more successful" and another stated, "being around a whole bunch of successful people just makes you want to be successful as well and take your academics and everything to the next level." Students felt like MEP2 facilitated that happening. Explaining how it happened, one student provided the following explanation: "And something important to note is how MEP2 chooses the people that it sets as role models… so mentors and tutors. I think she does a good job of selecting the right people. You know, like us, our group, and we can be those role models for like freshman and incoming. I think that's a key part, like that selection process, and she will actually sit there and interview you; ask you a few questions; and have some kind of GPA requirement. So, I think if it wasn't for that, it wouldn't even be as successful. You have to put the right people in the right position." Ultimately, MEP2 facilitates those right people being in the right position and provides students with successful surroundings so they can experience having those role models.

Support Group II (Source: Focus Group 1): One of the perceived advantages of being involved with MEP2 is the relationship the director has with the students. Multiple students expressed how she was able to assist them with personal and academic problems. Summarizing her influence, a student stated: "it's not just like her job to help you. But like she actually cares. That's nice to feel that it's not just her job." The problems students discussed her assisting with ranged from dealing with a parent having cancer to recovering from a low test-score. A mentor offered the following example to illustrate the type of relationship she has with the students: "Sitting down with [the director] actually helped me put my life into perspective because I did a lot and my GPA started suffering because of it. So, just having her as a go-to person to talk to and to advise me, that really helped me, I think, make better decisions than I would have had it just been me solely depending on what I thought was right; getting that second opinion, the experienced opinion, really helped me." Even when students were not in trouble, they believed the director could help them make the most of their college experience. Explaining how the director's influence extended beyond academics, a students stated: "I remember my first semester freshman year… the only thing I did was study and study… and then I kind of started like meeting with [the director] and like she was like, 'Oh, you should starting doing this! You should start doing that! Not just for your resume, but it's a good experience.'" Students also felt like she was strongly connected throughout the university and could assist them with almost any problems – "she can say, 'Go down this way. Talk to this person. Go over here. Use this resource.'" Despite not being an academic advisor, students stated that it "seems like she knows pretty much what you should do or who you should talk to." Ultimately, the students believed having a relationship with the director gave them access to her network. A student summarized the benefit by stating, "[Director] is like a link to the outside world. I feel like she has the biggest network. Like she can get to anybody. If you ever have some kind of problem, some kind of issue, you can always come to her and she'll know where to guide you or at least who to contact. She's really willing to help. I know a lot of people have came into her office with all kinds of problems and they'll walk out with some kind of solution."

Familiarity and Comfort (Source: Focus Group 1) – One of the perceived advantages of MEP2 is the physical space. Students discussed the lounge providing them with a place to nap, socialize, and come for snacks during exam week. Expressing her appreciation for the resources available in the lounge, a student states, "Oh my gosh. It's like heaven. It's like Wal-Mart." Additionally, students outside of the normal population benefit as a student states: "not even just [MEP2] students, everyone comes in here during exams for snacks. Everyone benefits form it." Students also discussed how everyone comes into the office for the test bank. A student summarized the benefits of the physical space as follows: "This office right here is like really good. So, I don't know if we ever touched on like the value of this [MEP2] office and how it's really like a congregating spot and [MEP2] minus this probably wouldn't be what [MEP2] is because people can just come here and take naps and just sit here and talk about whatever is going on in

their day. So I don't know where this fits at in that whole discussion, but this office is actually a very critical part of [MEP2]. Just having that physical spot where people can come."

Family Atmosphere (Source: Focus Group 1) – One of the perceived advantages of being involved with MEP2 is having the family atmosphere. Describing the family atmosphere, a student offers the following descriptions: "I mean [MEP2] is just a great social thing, because it really is a family. If you leave your engineering STEM major, you're still a part of [MEP2]. If you're failing your classes, you're still a part of [MEP2]. So there's like no kind of rejection." Another student echoed this acceptance with the following statement: "And the thing that I love about [MEP2] is that no matter what, even if you did neglect it, even if you did ignore your mentor, no matter what it's still here. You can always come back." Multiple students spoke about the familial nature of MEP2 and how it could make being a minority student at a white majority school less overwhelming since "Because of PEER, you're family," which can help students get over an initial sense of not belonging. A student also spoke about how having this family kept her from leaving: "I would say that problems [MEP2] helps students deal with would be like that homesick factor. Cause I know if it wasn't for participating in like [the preview weekend] or [summer bridge program], I would not be here. I was gonna leave spring semester of my freshmen year. But just seeing them and how they dealt with it, it made we just want to stick it out even more. Because I didn't want to like leave some people here." Ultimately, "[MEP2]: It's good people. It's just good people because [the director] knows everything. There's good people around. There's good mentors, as we all know. There's good friends everywhere. It's just good people."

Opportunity Awareness (Source: Focus Group 1) – One of the perceived advantages of being involved is information spreading among the students. A mentor describes this process in the following statement: "We take information from our weekly meetings [with the director] back to our mentees and they range from things such as how to study for math to how to budget… it's really broad. They learn not only about academic life, but about life in general. And I think the impact that it has on student is preparing them for when they are on their own. So we'll always be their mentors, but they'll always know that they have some… that ground to back to. 'Oh, my mentor told me this.' And you know, they can help their peers." In addition to the mentees helping other students with the information they were provided by their mentor, students also discussed how the summer bridge program benefited non-participants through information sharing. Discussing those who participated in the summer bridge program, a student stated the following: "And I know, from being a [summer bridge program] counselor and I have some of them as my mentees, because they know so much and they're so far ahead of the game… that affects the other mentees. So, if they go to [the gym], and the other mentees have never been, they know everybody, they can get to meet new people, they can help them out. And then it just… [the MEP2] network, once again." Ultimately, MEP2 serves as a mechanism for getting information into the student population and the MEP2 network results in it getting to students indirectly as well.

Adjusting to Minority Status (Source: Focus Group 1) – One of the perceived advantages of being involved with is addressing misconceptions students have coming into the university, particularly through the preview weekend. Multiple students discussed having the opportunity to see what the university was like before officially enrolling and the experience helping them decide whether or not they wanted to attend once admitted. One student described the impact as follows: "So you get a real good flavor of [the university] before you get here. And like, kind of like the mystery and the unknown parts about college life are cleared up for you as a freshmen, incoming freshmen. And also, you know you whether you want to come to [the university] or not. If you believe that [the university] is majority black, that kind of goes out the window: you see that that's not true." Another student echoed his sentiment but spoke to the opposite scenario: "The flip side of something that he mentioned, if you think that [the university] is too

white for you, but you get to come here and be hosted by a minority, you're around minorities basically the whole weekend because of the social events… I think that turns the tide for a lot of people in their decision making." The preview weekend also allowed students to talk to current students about "how you feel being a minority here at a all-white campus" and one student stated that the experience "gave me more insight into what I should expect once I got here in the fall." Ultimately, participating in MEP2, particularly the preview weekend, provided students with the opportunity to personally see what it would be like attending the university and address any misconceptions they had about the demographics. As one student stated in regard to participating in the preview weekend, "I never expected to see so many minorities in one area at once. And then, going to class, you don't see as many, but you still know they're there and that's the difference."

Social Atmosphere (Source: Focus Group 1) – Students mentioned advantage/disadvantages when discussing the realities of study hall. Addressing the benefits of study hall, a student stated: "It's a lifesaver… I didn't use it freshmen year that much, like first semester, because I was not involved with [MEP2]. But like just after I started going and like getting help, you don't have to spend 3-hours trying to go to SI for math, SI for calculus, SI for… I mean chemistry and like different subjects, you can get all of your answer at once. It's like perfect." Another student echoed this convenience and mentioned no longer having to attend multiple Supplemental Instruction sessions to get help: "I can get the same stuff that I can get from all these random places in one spot." On the contrary, students also felt like study hall was only beneficial if a student knew exactly what they needed help with and would not recommend it for someone who just needed to study or get work done in general. A student summarizes this disadvantage as follows: "Unless you have a purpose, it's not useful. You go in saying, 'Ok, I need to get this homework done for these three questions,' you can find a tutor that's going to help you out. But if you go in saying, 'I'm just going to go because I need to get some work done,' and unless you're like sitting there listening to music, it's not going to get done." She expressed the need to be listening to music due to the fact that students believed the "social nature of [MEP2] in itself" results in people talking to one another. "Because when you get all of those people in the room, usually all these people are friends…. So it's not just like you're going to sit there and do work; you're going to talk." Ultimately, "if you're more specific, you're going to get your work done. You have that avenue to get these questions answered if you're stuck. But if you're aimless you're going to be aimless."

Section 4. WEP3 – Collective Student Experiences

This section includes details on how each WEP3 student perspective (see Table E8).

Table 56 - WEP3 Student Perspectives

Perspectives	**WEP 3**
	U3
Support Group	+
Resource Access	+
Networking	+
Way to Meet Women	+
Knowledge Expansion	+
Female Isolation	-

The demographics for the focus groups used to identify these perspectives are presented in Table E9.

Table 57 - WEP3 Focus Group Demographics

Group	Gender	Race/Ethnicity	Major	Year
1	Female	White	Mechanical Engineering	Junior
	Female	White	Mechanical Engineering	Freshman
	Female	Hispanic	Electrical Engineering	Freshman
	Female	Asian	Aerospace Engineering	Junior
	Female	Asian	Electrical Engineering	Junior
	Female	White	Engineering Undeclared	Sophomore
2	Female	Asian	Mechanical Engineering	Junior
	Female	White	Civil Engineering	Senior
	Female	Asian	Electrical and Computer Engineering	Sophomore
3	Female	White	Biomedical Engineering	Senior
	Female	White	Electrical Engineering	Freshman
	Female	White	Mechanical Engineering	Freshman
	Female	Asian	Biomedical Engineering	Sophomore
	Female	Asian	Chemical Engineering	Senior

Support Group (Source: Focus Group 1-3) – One perceived advantage of WEP3 is the supportive nature of the center and the willingness of administrators to reach out and assist students: "They're very supportive of females. They're a community that's always going to be there to back you up." In particular, students discussed the willingness of the WEP3 administrators to assist with any concern. To illustrate such support, a student discussed a time when she expressed concern losing a major-specific scholarship if she switched to what she believed was a more suitable engineering major. According to the student, WEP3 responded, "If you want to switch, we'll cover that scholarship for you." Following up this example, she continued, "I don't even talk to them that much but whenever I see them I feel like they recognize me or at least act like it and are very friendly." Several students echoed this sentiment and felt like the WEP3 administrators went out of their way to assist the students who needed help. As one student stated, "I think, personally, that the women who work in that office make this department… or make this program. I think without them this [center] wouldn't be nearly as great as it is at this school…. They're very dedicated. They're always happy and willing to help everybody. And I see students come in who have never talked to them before and they will be very personal with them and they'll try to remember them; they'll put in effort to people they don't know. They will basically be very equal." Students also believed that the administration was willing to help them even in situations where they could not personally assist the students: "For the most part. I would say also just the staff and the actual office is like incredible knowledge so it's a great way for freshmen to come in and if you have a question about anything on campus, they somehow know… and they can direct you to where you need to go and help you out and they, a lot of time, will try to push forward… you'd basically would be getting to the right person." Students also found having access to mentors to be helpful and mentioned support from the upperclassman as well, though this was not heavily emphasized. Ultimately, WEP3 provides some students with a place to for help: "Just in general, you know they're there if you need them. So, it's like you don't feel quit as isolated and helpless."

Resource Access (Source: Focus Group 1-2) – Students discussed having access to information/resources in a condensed manner as one of the advantages of WEP3. A student summarizes

this advantage as follows: "I found the most useful part was, as an incoming freshman, kind of the information they organized and had all in one place. I was not extensively involved in WEP3 after I started my freshman year, but prior to that it was a really good way to get an idea of what the resources available at [the college] were." Another students echoed this advantage by saying, "Most of the resources available through WEP3 seem to be available through the general engineering; you just maybe have to look a little harder. While students often expressed the idea that the resources offered by WEP3 were also available elsewhere within the college, they did view having the resources in one place as an advantage. Ultimately, WEP3 brings the resources to the women who are involved and advertises the resources elsewhere so the students are aware they exist. In the words of a student, "I feel like someone who is involved in [WEP3] is exposed to more resources available and so they're just more aware of what they have there for them as opposed to someone who's not in [WEP3]. I guess they still form communities but it's not as emphasized as when you are in [WEP3]… and you're not as exposed to the resources that they lay out in front of you."

Networking (Source: Focus Group 1-3) – One of the perceived advantages of WEP3 is the ability to network with other students and fine-tune your networking skills. WEP3 allows students to network with other students as well as corporate representatives. With regard to having both types of opportunities, a student stated: "I enjoy making friends and doing the student things too, not just the networking with corporate people." As a testament to WEP3 facilitating this process, a student stated, "Meeting other people right at the beginning of freshman semester was really easy through [WEP3]." When asked why students choose to get involved with WEP3, one student stated, "I think they get involved because they want to meet other engineering students, because I feel like, especially as an electrical engineering major, there aren't a lot of females in my classes. And it's also good to meet people from different majors, so it's not always just about school or talking about classes." Through WEP3 events, students are also able to me professional engineers: "You get to meet people who have gone the route you want to go in. So you get to hear about their experiences and maybe about how they did it, so that'll help you make choices as well. So it's like you actually meet a real life person who has been there rather than here through someone else." In addition to meeting people, students also discussed developing networking skills as an advantage. A student describes this advantage as follows: "My best friend is also a woman in engineering, but she doesn't really go to any [WEP3] events and I've had a lot more opportunities to network and fine tune my networking skills and more opportunities to get out there and do more interactive things than she had just because she chose not to participate." On the contrary, another student expressed disagreement with the following statement: "I'm not fully involved in [WEP3] and I would say I like go through other engineering organizations and can reach out and meet other people that way. Like I do agree, [WEP3] does help a lot. Especially, it would've been nice at the beginning, helping facilitate just being able to meet people early on. I think as you progress through your college career you can, on your own, be able to find your path." Ultimately, networking and developing networking skills is an advantage of participating in WEP3, though it is possible to network using other avenues within the college of engineering.

Way to Meet Women + Female Isolation (Source: Focus Group 1 and 3) – One of the disadvantages discussed by students was the isolation they believe occurs by participating in women-only initiatives. Students discussed philosophical problems with isolating women as well as actual consequences they experienced. Providing an example of the disadvantage of participating in a WEP3 first-year seminar, a student stated the following: "After my first year, I knew all of the women in the mechanical engineering department that were my year and that was awesome. But we had also sectioned ourselves off from all of the guys, very quickly and very noticeably, and it's taken me up until last semester to actually meet other people for study groups… everything else you do as an engineer." Echoing this sentiment, a student who

participated in a non-WEP3 first-year seminar (the college offered first-year seminars as well) made the following statement: "I wasn't in any [WEP3 first-year seminar] and I didn't really hear about them until just recently… but what I would see with other girls in my majors that were in [first-year seminars], they did seem to be more close knit and knew each other really well. But I found myself was able to mingle more with other engineers they didn't necessarily know. So you do get sectioned off a bit." The segregating factor of WEP3 almost resulted in one student no-longer participating, but she ended up staying involved because she eventually realized that she needed girls around. She summarized the experience as follows: "I almost didn't stay involved because I was like, 'too much estrogen'. I didn't want to be around just girls all of the time. But then I kind of like… I have four sisters, and so all of a sudden I found myself without any girls around me and was like, 'What do I do now?' So that's why I ended up staying involved, but I think that can be a reason for a lot of girls who don't stay involved. 'Oh, it's just other girls. Not interesting.'" Additionally, the segregating factor does allow some students to realize that they do belong in engineering. A student summarizes her positive experience with WEP3 as follows: "I know for me, the first thing I experiences when I came to UT was like, 'Wow, I've never done engineering before. All of these guys have worked on cars with their dads before and like build bikes that I've never done.' And so, in my FIG, I met other girls who were interested in like fashion design and cooking and all this stuff that I like to do. And so that made me feel like I fit in: just because I hadn't grown up building cars I wasn't like expelled from being in engineering." In addition to the actual experience of finding themselves isolated from male students, students also disagreed with the message they believed WEP3 was sending by targeting women; this message was particularly relayed by one student in particular who did not agree with having support specifically for women in engineering. The expressed her disagreement in the following statement: "One of the things that I don't like about the program is, relatively early in the year, they kind of sent out an email that was something to the effect of, 'If you're a women, and you're in engineering, you're in the WEP3 program, period, technically because you fit into the category.' And I don't agree with that personally." This student felt like WEP3 drew a "big pink circle" around women and was "almost a little sexist." Though her opinion was not widely held, other students did express similar feelings about men being excluded. A student who was actively involved in WEP3 offered a similar story about how focusing on women made her feel: "It was a disadvantage to me right at first because I felt like I wasn't supposed to be an engineer if I needed this much support. And why weren't other people getting this kind of support? I felt handicapped. And this, like… I had a really big conversation with my dad about it and he was like, 'Hey, it's a resource there for you to use. Don't over think it.'" Another student felt like "even though it was suppose to empower women, it still perpetuates the stereotype that women are somehow inherently less capable of doing engineering." Ultimately, students had mixed feelings about being segregated. Summarizing the views, a student ended one of the discussions with the following statement: "So, what I wanted to say was I know there was a lot of negatively said about WEP3, but overall, like, if someone would ask me if WEP3 would be something you would want for UT to maintain, I would say, 'Yes' because it did open my eyes personally to a lot of resources but make it known that it's not something that you necessarily have to tie yourself down to forever. I mean its there if you need it but don't necessarily make your life of it because then you might just feel segregated or trapped or not necessarily enjoy your fill experience."

Knowledge Expansion (Source: Focus Group 3) – One advantage of WEP3 is discovering what you are really interested in doing with your engineering degree. In particularly, students expressed this occurring through emails, personal conversations with WEP3 staff, and the professional networking event/dinner. A summarizes this benefit in the following statement: "I think another thing to add to that is the importance of the [professional networking] dinners and stuff like that. I have some upper class friends who are freaking out because they're realizing they don't want to be engineers but it's too late for them to switch majors without having to start over completely. And so, they're like, 'I don't know what I'm going to do.

I want to go into music or something else but I don't know how I would ever get around to do that.' And I feel like because of [WEP3] I have a resource that would help me figure out how to use my engineering degree for something else, whereas those upperclassmen who are guys don't necessary have that option." Students also provided examples of WEP3 admin sending them emails with particular opportunities they knew they would find interesting, and pushing girls who have expressed interest in various activities towards different organizations. Ultimately, WEP3 can help students who are not 100% sure what they would like to do with their engineering degree discover opportunities: "I remember my first and second year I had no idea what I was going to do with engineering and I went to some of the [professional networking] dinners, and it was nice to see there are so many different opportunities for us."

Other - Choice Among Other Choices (Source: Focus Group 1-2) – Another theme from the focus groups was that there were multiple options for receiving the assistance within the college of engineering, alternatives to WEP3. In particular, students discussed the difference between WEP3 first-year seminars and non-WEP3 first-year seminars: some students felt like the non-WEP3 first-year seminars were more academically focused since major divided them whereas the WEP3 first-year seminars (those that contained multiple majors) were more social. Whether this was viewed as an advantage or disadvantage depended on the student. A student who participated in a WEP3 first-year seminar viewed having students from other majors as an advantage and stated, "personally my [first-year seminar] experience was pretty good because that was how I really got to meet people outside of my own major." Alternatively, a student who participated in both a non-WEP3 and WEP3 first-year seminar (one during the fall, and the other during the spring) expressed a dissimilar opinion: "My first semester, I did a [first-year seminar] with… it was an electrical engineering [first-year seminar] and so it was mostly guys actually; I think there were like three girls. And my second semester I did a [WEP3 first-year seminar], and I actually preferred the electrical engineering [first-year seminar] because I felt like it was more study oriented, more academic oriented, and so we were meeting up to get into study groups because we were in the same classes so we were seeing each other and I felt like it was more of a closely knit community. Whereas the [WEP3 first-year seminar] was comprised of people of all different majors so… it was still informative but it was more about like general resources and it wasn't as in-depth and it was a little bit more relaxed." Further elaborating on this notion of WEP3 being less-academic than some of the other options for student support, a student explains why this is not a problem: "They don't have a lot of tutoring type things, but… There's other programs at [the university] that focus on that and so I don't know that it's necessarily like [WEP3's] job to do that. There is specific engineering tutoring that you can go to; there's not specific women in engineering tutoring but I don't really feel like that's necessary. That's the only thing that I feel like it doesn't have. It has the social and professional aspects and less of the specifically academic." Students also discussed the ability to receive professional and academic support from other units with the college of engineering. Adamant on expressing her belief that the information provided by WEP3 was available elsewhere, one student consistently brought up the alterative ways students could receive assistance provided by WEP3. For example, in response to students discussing undergraduate research and the WEP3 undergraduate research program, she stated, "It's probably worth mentioning that there are other programs throughout the university that allow undergraduates to do research. It's not exclusive to [WEP3]." Ultimately, students felt like WEP3 was a useful resource but did not view it as the only option for receiving help within the college. Summarizing the existence of options, a student stated the following: "I feel like it's a matter of choice. There are other programs that aren't related to [WEP3] and it's a matter of choice of which ones you want to be involved in. So, it's also you taking a personal initiative but the programs that WEP3 organizes are good; I'm not saying they're not, but it's what you choose to do."

Section 5. MEP3 – Collective Student Experiences

This section includes details on how each MEP3 student perspective (see Table E10).

Table 58 - MEP3 Student Perspectives

Perspectives	MEP 3
	U3
Support Group	+
Familiarity and Comfort	+
Networking	+
Student Confidence	+
Time Commitment	-

The demographics for the focus groups used to identify these perspectives are presented in Table E11.

Table 59 - MEP3 Focus Group Demographics

Group	Gender	Race/Ethnicity	Major	Year
1	Female	Hispanic	Chemical Engineering	Junior
	Female	Hispanic	Architectural Engineering	Senior
	Male	Hispanic	Civil Engineering	Junior
	Female	Hispanic	Electrical Engineering	Junior
	Male	Hispanic	Civil Engineering	Junior
2	Male	Hispanic	Chemical Engineering	Freshman
	Male	Hispanic	Mechanical Engineering	Sophomore

Support Group (Source: Focus Group 1-2) – One advantage of MEP3 discussed by the students is having someone to support them: "Yeah, everyone is very welcoming. They're very friendly. They make you feel like they have your back, which they do." Students believe this support was there for personal as well as academic situations. Summarizing this advantage, a student provided the following statement: "I think [MEP3] is a good choice, as I would say to the students and their parents, because it's a center that kind of has your back. So, your freshman year especially, you have no idea what you're doing and they are always there, their doors are always open to talk to you, and they'll like walk you form office to office if you need help getting something done… which is really convenient because you're completely on your own your freshman year and they're just someone who is going to guide you in that right way." As a testament to the academic support MEP3 is willing to help, a student in the initial focus group stated, "They help you a lot with challenges of just getting back on your feet, especially if you had a rough semester. You're at your low and you're like, 'I just don't know what I'm going to do anymore.' They'll sit down with you and, 'Ok, we're going to put you in one-on-one tutoring. And he's who you need to talk to.' And they help you plan out what you're going to do and get you to the right people. So it's like… at some point you feel like you're sinking and they're the one's who are going to help pull you up, which is really helpful." As a testament to the personal support MEP3 is willing to help, another student in the initial focus group stated: "I feel like they've always been there, even when I had a personal crisis; they were the ones I went to to get help… all of the supervisors and coordinators." A student in the second focus group felt like this extended to the MEP3 staff as well as the organizational officers: "Any of the [MEP3] staff… officers in [the minority serving organizations]. They're always willing to help you with

anything… Maybe you've gone through something hard that has happened back home, maybe here, and someone else has already gone through that so they may be able to help you anyways they can." Ultimately, several students expressed the belief that MEP3 was a place they could go to for help whether they had academic or personal problems. While discussing the benefits of MEP3, a student offered the following explanation: "I would've just said it helps you avoid giving up… I guess. You don't give up on engineering and you don't give up on your classes because you've got all of these people supporting you."

Familiarity and Comfort (Source: Focus Group 1) – Another benefit of MEP3 is the familiarity and comfort afforded by the center: "You get to recognize the community." In particular, students felt like MEP3 allowed them to become familiar/comfortable with company representatives and tutors. With regard to company representative and MEP3 activities that include them, a student made the following statement: "It makes you remember they're just people like you… not like scary monsters or something." Echoing this sentiment, another student made a similar statement: "I think it's definitely a confidence booster in how to talk to corporate reps in general. You feel a lot more comfortable knowing you can do it. They're real people." With regard to academic tutors, a student made the following statement: "I think academically it improves the students overall academic ability because they offer free tutoring - like one or two hours a week - and that's really beneficially because tutoring can be expensive. And some people are kind of shy too to go to the tutoring table but through [MEP3] you're going to be tutored by someone through one of the orgs or somebody you're already more comfortable with so I think it's a good experience... being tutored by someone you already know as opposed to, I guess, a stranger kind of." Echoing this sentiment, a second student offers the following statement about the tutors as well: "you tend to know a lot of the people, especially if you're already integrated in [MEP3], so you're more comfortable with them; you're more comfortable to ask those questions you're scared to ask in class or you think people might think you're stupid." Ultimately, students expressed the belief that MEP3 allowed them to become more comfortable with company recruiters and receive academic assistance from people who are familiar.

Networking (Source: - Focus Group 1-2) – Building your network is another advantage of MEP3 that students discussed; this advantaged manifested in various forms that included developing friendships, finding students to study with, meeting students from other majors, and developing networking skills in general. As an example of developing friendships, a student made the following statement about MEP3: "It introduced me to my future friends that I hang out with now and pretty much paved the way to friendships and connections and all that stuff." As a testament to the impact of finding students to study with, another student offered the following example with regard to the first-year seminar program: "And it kind of helps you know people you can study with because you have at least one class together with all of those kids. And then you can start working on making study groups and learning good study habits and just make some good friendships and go on from there." Students also provided examples concerning the benefit of meeting students from other majors: "It also gives you access to other majors because I'm a chemical engineer and technically I mean I would hang out just in the chemical engineering building… but now I see Aerospace and Mechanical and others, Civil engineering, Architectural. I can really like talk to them as engineers. But me, even though I'm a chemical, it broadens my perspective." Additionally, students believed that being involved with MEP3 allowed them to be "exposed to a lot more situations than someone who may not be as involved," such as the networking events, the engineering organizations, as well as the first-year seminars – hall of which they felt made them better at networking in general. Ultimately, MEP3 was a way for students to build networks and they perceived the opportunity to form these relationships and learn how to form them as a positive impact of participating. As one student stated, "I think that was the biggest one for me too; just the fact that back home I had a bunch of friends

and I came here and I had nobody. So it's just the fact that you get to meet other people, I think that's the biggest one."

Student Confidence (Source: Focus Group 1-2) – One advantage of MEP3 is helping students get out of their shell. Explaining this impact, a student provided the following example: "I think it really impacted me in leadership and just making us be more assertive; it helped me come out of my shell a lot. Because coming in freshman year I was also just staying to myself; I didn't want to talk to anyone. I joined a [first-year seminar], and the first-semester I was like, 'I don't really know you guys; I can't really speak up.' Second semester got a lot better: I met my future roommates and all of that so it was great. And through all of the events that we do that we talk to corporate people or just like others, where we're forced to kind of talk to others, I felt it helped like just pulled me and others. I've seen it in others too, where it just pulls them out of their shell and they just show you how to be a good leader and how to step up your game." Echoing this experience, another student offered a similar example: "It was a dread to come to school. I would even doubt myself; I would question if I was even going to make it. And then it wasn't until that second semester that I started getting involved; I started talking to my [first-year seminar classmates] more often, and then so we started hanging out. I joined [two of the organizations]. I started meeting more people, so that feeling of lonesomeness faded. And then I started studying with a group and it had a tremendous impact on my academics. And then after that, not only that, but after I got involved in [an organization] I gained leadership roles and it helped build my leadership. And so now I actually like college." Ultimately, multiple students described instances where MEP3 could help you come "out of your shell" overtime and increase their confidence and believed this was a positive impact.

Time Commitment (Source: Focus Group 1-2) – The only disadvantage students discussed was the time involved in participating in MEP3 activities. For example, a student made the following statement: "I think one disadvantage would be that since you are so heavily involved maybe you don't give as much time to your academics as other people do who aren't involved. But I just think it's a balance that you have to find." As a follow up, another student stated, "I'd say that's probably what people think as well when they hear that you're going to all of these meetings and dinner and all that. It's like, 'When are you studying?'" In the other focus group, time was similarly mentioned: "Yeah, it would be the time commitment; some things might take a little too much. But if you're able to manage your time well or sacrifice sleep or studying then you can get things done, you can do that." Ultimately, while students mentioned the time commitment as the only possible disadvantage, the statements were made lightheartedly as the students who commented seem to realize that there was a balance they needed to find; they did however acknowledge the potential disadvantage if a student was unable to do so. As another student stated, "I may regret it but I always end up making time for studying… sometimes sacrificing sleep. But it's always good to hangout, take a little break from your classes and stuff, and actually meet new people."

Other, Supports for Minority Serving Engineering Organizations (Source: Focus Group 1) – Students discussed the organizational support provided by MEP3 and its benefit in one focus group. Explaining the importance of this support, a student made the following statement, "I think it's important because it really keeps us in check and keeps the unity between the organizations… because if we didn't have that, it would be easy for an organization to be like, 'Alright, we're just going to start taking this path' and you just start diverging. Whereas [Student Leadership Conference] brings you back, 'Ok, what are you doing?' You talk it out and it's understanding; they don't tell us what to do, we talk it out and see what's best for all of the organizations." Another student echoed this sentiment and believed MEP3 was a "good way to unite all of the three orgs…. instead of competing as three individual organizations." Lastly, a student who served as an officer in one of the orgs believes that the support provided by MEP3 was

very helpful: "it helps us see what [the three organizations] are doing at the same time so we can all work together and we don't overlap on certain dates, on events, on meeting. So they kind of help us synchronize all of the three orgs better. They provide us with support if we ever need it. Any events that we need help with they're there, so I feel like that's the most helpful." Ultimately, several students agreed that the support provided to the organizations by MEP3 was a positive impact of the center.

Section 6. DEP4 – Collective Student Experiences

This section includes details on how each DEP4 student perspective (see Table E12).

Table 60 - DEP4 Student Perspectives

Perspectives	DEP4
	U4
Safety Net	+
Familiarity and Comfort	+
Family Atmosphere	+
Networking	+
Student Confidence	+
Time Commitment	-
Misperception of ESSC	-

The demographics for the focus groups used to identify these perspectives are presented in Table E13.

Table 61 - DEP4 Focus Group Demographics

Group	Gender	Race/Ethnicity	Major	Year
1	Male	White	Electrical Engineering	Sophomore
	Male	Asian	Industrial Engineering	Graduate Student
2	Male	White	Mechanical Engineering	Sophomore
	Female	Black	Civil Engineering	Senior

Safety Net (Source: Focus Group 1-2) – One of the advantages of involving yourself with DEP4 is being provided with a safety net: "you know that there is some organization to fall back on… some place where they can go get some clarity of things that [you] are not sure of." In the initial focus group, a student describes this benefit as follows: "I think they provide pretty good guidance in general. I know for M-STEM we have academic coaches and if we have a problem - or if we have a dilemma like, 'What should I do in this situation?' – you can go to your academic coach and they will give you pretty good advice on what to do in that situation, what would be most beneficial, because they do have a lot of experience with it." The student also made the following statement, further expressing his belief that DEP4 provided students with a safety net: "I think one of the big advantages is that they provide you with a safety net. If you start to fall behind in everything and you're not really sure what to do, you can always just turn back to your academic coach or [a learning center] tutor and they can just provide you with a good direction to go with from there; and they'll kind of give you guidance on how to fix the problem that you're having and make a turn around. Or if you have a mentor, you can go to them; they'll give you good advice on what to do." This sentiment was echoed in the second focus group as well, with one student making the following statement about the impact of DEP4, particularly the scholar program: "It keeps you in college. That first semester when things get kind of rough, there's always someone to talk to

and make sure you stay in engineering… and you work out things, if it's financial, if it's personal problems, if it's just a bad course." Ultimately, student felt like DEP4 was a place to offer them support if they lost control of a situation, providing them with a college safety net.

Student Confidence (Source: Focus Group 1-2) – Another impact of DEP4 is it provides students with a "Go get it" attitude - "It makes the bridge easier for going from being a student to be a fully involved student on campus." Each of the undergraduate students who participated in a focus group provided an example of this occurring. In the first focus group, a student explains this benefit with the following statement: "I think students who participate in [DEP4] programs, at least from my experiences, look at a lot of the situations that they're put in differently. They might see this dilemma and a [DEP4] student would say, 'Oh, well I can just go do this.' I don't know. It's kind of hard to explain. I just feel like [DEP4]… I'm just trying to speak from my experiences… kind of provided me with a more go-get-it attitude. More motivated, I guess." In the second focus group, both students provide similar testimonies of DEP4 influencing their attitude and initiative. Reflecting on the difference between involved students and those who aren't involved (particularly in the scholar program), a student made the following statement: "My friends talk to me about trying to get internships and interviews and things like that. And I'm like, 'Well, you just go to career fair. I've done it for the last four times, you know.' I've talked to many companies and this is their first time going to career fairs as like a junior, and I've already had like four years of experience with it." The other student in the focus group expounded on this impact and how it benefits non-participants as well: "[Scholar Program] students tend to clue other students in on what's going on around campus. Like [Scholar Program] students are the one's who have already done the research; they've already gotten their internship; and they've already done the resume before normal students even realize there is a career fair going on." Ultimately, students expressed the belief that participating in DEP4 (i.e., the Scholar Program) led to students taking more initiative. The following statement by a student explains how this may occur: "another thing that [DEP4] in general just really emphasizes is being prepared for life after college and not just going through college itself. Because in both [Scholar Program] and my training for my summer job, I received a lot advice and critiquing on professionalism and how to better yourself professionally and prepare yourself for going out on the job market and finding a job and succeeding professionally."

Family Atmosphere + Familiarity & Comfort (Source: Focus Group 2) - Students viewed receiving personable help as a benefit of participating in DEP4, particularly the scholar program. Summarizing this advantage, a student made the following statement: "I would say that [DEP4] provides a family atmosphere, so it's more personal help instead of kind of going to the career services every time you need something. It's more of that person know your name, that person knows where you're going, that person advocates for you when you're not even around. So I feel like it's more of a personal, family-oriented atmosphere for you to blossom at the university." Students appreciated the fact that the DEP4 admin "make a point to know all of their students' names" and "if you're in there and you need to talk to them they'll set aside an hour… They'll just stop what they're doing and help you out." Additional examples of DEP4 providing personal help included assistance as small lending a student a calculator to more involved tasks such as ensuring students who work in undergraduate researcher are paired with "good professors who have a track record of working with [Scholar Program] students and providing them with good resources." Ultimately, students in the second focus group believed the DEP4 administrators who worked with the scholar program provided them with a more intimate form of help than they received elsewhere. A student summarized the assistance provided by DEP4 with the following statement: "I think if it comes up they'll help you deal with it."

Networking (Source: Focus Group 2) – Networking with other students is another benefit of participating in DEP4. In particular, students provided examples of talking to upperclassmen and becoming friends with other students in their cohort. Since the scholar program is multi-year program, participants can interact with members of previous cohorts. To describe the benefit of networking with upperclassman, one student stated, "It allows you to talk to people who you would never talk to, so seniors who are about to graduate; people in your shoes who you need to talk to about classes that you haven't taken yet." Students can also benefit from interacting with members of their own cohort. With regard to meeting people in their cohort, a student made the following statement: "I like what you said about getting to meet people that you otherwise would've never gotten to meet, because though [Scholar Program] you get to meet 59 other engineering students [and] they can be all different majors." The student believed meeting other students was advantageous because "It kind of gives different insight on different things and you build connections that maybe… maybe these connections will help [you] out later." Additionally, since the scholar program is very diverse, a student also commented on how the friends you make through the program are also diverse: "There's like such a diverse group of people in [Scholar Program], it's like insane. I've never been with a more diverse group of people and for like six weeks at a time. And you become friends with all of them so… it's just pretty amazing." The scholar program also forms a network of students that extends beyond those who participate in the program as one student explains. While discussing students who are not involved in the program but friends with people who are involved, she states, "they've realized they've kind of become friends with one person who is in [Scholar Program], but they basically got a whole network of other people who are also resources. And I feel like that is a testament to how much it gives you." In addition to the scholar program, students almost mentioned the learning center as a place for networking. In particular, a female student stated the following about the learning center: "It's become a space where students of color usually hang out [and] that's probably the only place I can go and I can meet like half of the black people on campus - I'm kidding, but I'm not. And you know there's groups like NSBE and SHPE - National Society of Black Engineering and the Society of Hispanic Professional Engineers - those groups usually meet with each other or something in there. So it's easy…." Ultimately, students felt like participating in DEP4 gave them access to a network of people they would have otherwise not had access too.

Time Commitment and Other, Source of Stress (Source: Focus Groups 1-2) – While students generally felt positive about the scholar program, they also believed there was a downside to participating – particularly "the amount of stuff you have to do" in the program. A student explained how the expectations placed on the student negatively impacted him in the following statement: "I think for me one of the, not really disadvantages, one of the things that had a slightly negative effect would be a lot of the stress that [Scholar Program] put on me. Because I know like over the summer, taking all of those classes and we had a lot of stuff packed into our schedule, it can get very stressful at times. And then… during the year we had to maintain a certain GPA or we would be put on academic probation within the program. And that definitely put a lot of stress on top of everything. Like, 'Ok, not only do I have to pass this class but I have to have this GPA, and I can't get below a B in math otherwise I have to retake the class.' And it was just a lot of built up extra stuff. But it definitely helped to motivate but at the time it didn't seem like…. it was just kind of like, 'Oh, man. I have to do all of this stuff.'" While each Scholar Program participant did not share a similar story, the negative effect of having to commit so much time was a common view held among the three Scholar Program students who participated in a focus group. Students also discussed how previous students "freaked out when they heard [Scholar Program] was originally made for students that were predicted to perform less than average." Ultimately, students felt positive about the program though they did view the time commitment as a somewhat negative effect and were not always 100% sure how they were selected to participate in the program.

Misperception of ESSC (Source: Focus Group #2): In the second focus group, participated discussed how students generally "don't really know much about DEP4." A student who was knowledgeable with regard to DEP4 efforts attempted to summarize the program with the following statement: "I feel like they don't really know that much about DEP4, and a lot of the students in DEP4 are the only people they get to talk to about it." Despite DEP4 offering activities open to all students, she felt like there was a distinct group of "students in DEP4' and the other students were unaware. She attributed this to the fact that there is "not a lot of exposure" and believed, referencing ScholarPOWER, "If it was advertised to everybody, but DEP4 students were kind of the force behind it, I think a lot more students would be more involved in DEP4 things." Echoing this notion of students being unaware, a second students provided the following statement in support of the initial claim: "Yeah, because some of my friends, they'll be like sitting in the Chrysler Center, which is the area right outside of the ELC, and they'll be like sitting there doing homework or something and then I'll come up and say 'What's up?' and talk to them for a little bit. And then I'll be like, 'All right, see you guys later.' And then I'll go into the ELC, which is like right next to the Chrysler Center. Like I'll walk 10 feet, but I'll just like be in there and they'll never come in there so… I don't know." Ultimately, while DEP4 offered initiatives to all students, only "students in DEP4" seem to be taking advantage of them, according to the students in the focus group.