1-1-2014

Summer Engineering Academies: Developing Participant Self-Efficacy in Engineering

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By

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A Dissertation
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
in Curriculum and Instruction
in the Department of Curriculum, Instruction, and Special Education

Mississippi State, Mississippi

December 2014

Summer engineering academies: Developing participant self-efficacy in engineering

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Title of Study: Summer engineering academies: Developing participant self-efficacy in engineering

Pages in Study: 150

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With the growing concern over the reduction of university students pursuing degrees in STEM fields, there are a number of entities sponsoring and implementing programs for young people in order to promote interest in and self-efficacy for these fields. Summer Engineering Academies (SEAs) are implemented in a variety of settings by stakeholders with a single purpose: to expose young people to the fields and work of engineers in the hope of recruiting them. This study is seeks to identify whether any positive changes to the self-efficacy of the participants occurs through the curricula of the program. This self-efficacy can be the driving force for many young people as they feel that they are both capable of success in addition to the desire to pursue a career in the field.

The SEAs in this study serve a variety of age groups and specialized demographic sub-groups; of greatest interest is the possible impact of these programs on traditionally under-represented groups. Each program hosts a specific demographic sub-group but they all share specific pedagogical practices in order to identify which may emerge as best practices in affecting change on the self-efficacy of the participants toward engineering.

A secondary purpose was to identify which, if any, practices had a positive impact on the participants' self-efficacy and presume those as best practices across demographics.

The programs were found to have a positive effect on the participants as identified through focus groups, journal entries, and personal interviews with the students. There were no identifiable differences in the impact of the practices between the subgroups. Each subgroup had gains in self-efficacy from each of the instructional practices which may allow for the distinction of best practice to be used in their description. These practices include: the use mentors or role models in face to face experiences; hands-on learning with tangible results; and recognizable real-world applications. Each practice yielded a positive result, but none of them appeared to be more successful with any group than the others. This allows them each to be considered a productive instructional strategy for the increase of self-efficacy of participants toward engineering.

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DEDICATION

The accomplishment of this effort would not have been possible on my own. It was only through the support of my amazing wife, Dr. April Heiselt and her constant reinforcement, encouragement, and inspiration that I was able to complete this effort. My entire family suffered through the process without flinching and added only positive encouragement for which I am grateful. To them, this work is dedicated as an example of perseverance and gratitude for the light they bring to my life.

ACKNOWLEDGEMENTS

I gratefully acknowledgement the many members of the Mississippi State University Faculty who made this study possible and supported the research. Chief among those are Dr. Sarah Rajala, Dr. Donna Reese, Dr. Royce Bowden, and Dr. James Warnock of the Bagley College of Engineering at Mississippi State University. Additional thanks to Dr. Jianzhong Xu and my entire doctoral committee for all of their patience and mentoring.

Finally, I would like to acknowledge the contribution of the young people who participated in this study and their willingness to share their views and ideas.

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CHAPTER I

INTRODUCTION

Introduction to the study

The role of engineering in the advancement of industry and society has been essential for the continued dominance of the United States in the global economy (American Association for the Advancement of Science (AAAS), 1993; National Academy of Sciences (NAS), National Academy of Engineering (NAE), & Institute of Medicine (IoM), 2007). There has been an increased concern on the part of both professional and educational groups dedicated to increasing the interest of young people in pursuing degrees and careers in the Science, Technology, Engineering and Math (STEM) fields; additionally, this call for attention is to be centered on STEM education improvement (Department of Education (DoEd), 2008; NAE, 2009; National Science Board (NSB), 2007). Enrollment in colleges of engineering has been dropping over the past 10 years (Becker, 2010; Lawanto, Santoso, & Liu, 2012). This drop is documented across gender and race (Field, 2004). In spite of the concerns and warnings of industry analysts over the past two decades, the number of engineering graduates continues to fall (Becker, 2010; Brown & Linden, 2008; Carroll, 2007; Yilmaz, Ren, Custer, & Coleman, 2010).

In response to the decreases in enrollment and program atrophy, many universities and industry partners conduct summertime experiences geared for young people to learn about the field of engineering in the hope to pique interest. This "widening of the pipeline" has occurred at many universities across the U.S. with special targets on traditionally underrepresented populations (Gordon & Silevitch, 2009; Knox, Moynihan & Markowitz, 2003; Winters, 2008). Many of these programs can claim only limited long-term success due to the difficulty of longitudinal tracking from the time of the program to the actual enrollment of the participants in university level engineering programs (Knox et al., 2003; Kuttan & Peters, 2006; Madeso & Tessema, 2009). Instead, the researchers designing these summer programs or interventions concentrate on whether a change in interest or self-efficacy occurs in an attempt to explain the success of these programs (Frehill, Brandi, Di Fabio, Keegan, & Hill, 2009; Kimmel & Rockland, 2002).

Purpose of the Study

The Summer Engineering Academies (SEAs) conducted by the College of Engineering (CoE) at a southeastern land grant university are the tools for this study. This study seeks to determine the effects, if any, that the SEAs may have on the self-efficacy of the participants in these programs. Additionally, this study seeks to differentiate the sought impact based on demographics of gender, age, and race.

There are five CoE SEA programs used in this study. Each of these SEAs, treated as case studies, are compared and an analysis of practices and curricula from each are examined for possible impact on the participants. The SEAs in this study include single gender, mixed gender, middle school, high school, open enrollment and a program specifically for minority students.

The aforementioned lack of comparative analysis of practices of these programs is important for the continued efforts of sponsoring universities and their industry partners or grantors. The funding for these programs is as variable as the designs used nationally. While some programs are funded through grants, university foundations, and industry giving, others are funded through tuition paid by participants. The question of impact is an important consideration as an investment (effort and financial) by a colleges of engineering. Funds expended to boost this understanding of the fields of engineering are baseless without a tool to increase enrollment at universities and colleges of engineering.

Questions Guiding the Study

Having identified the use of SEAs as a growing practice for early recruitment and outreach efforts by universities, the primary research question is:

> How does attendance at an SEA influence the participant to pursue a career in engineering through the increase of self-efficacy toward the study of engineering?

The second research question explores the levels of impact or influence differentiated through the peer demographic of the program. Within the K-12 realm of education there has long been debate about student grouping for maximum content learning – these grouping may be based on age, gender or racial background (Lent, Sheu, Gloster, & Wilkins, 2010). As there are distinct populations within each of the SEAs under study (gender – single or mixed; age – middle or high school; racial – mixed or single), the design of the programs may be enlightened and practice improved through comparisons. The following is the second research question:

Can specific design differences in instruction be identified as more effective to specific demographics of attendees based on their learning needs and practices within their schema of self-identification?

A third research question seeks to then ascertain the best practices of SEAs. Within previous studies of programs with a specific intended audience, there is a lack of comparison to develop this broad impact view of these programs. Within the K-12 realms of science and math education, extensive study of both formal and informal settings has developed a wealth of best practices (Windschitl, Thompson, Braaten, & Stroupe, 2012). Therefore, the third research question of this study states:

Are there identifiable best practices that become evident through comparison of programs designed specifically for a variety of intended audiences for generalization in practice?

There is great concern within the field of engineering over the need for a sustainable workforce. It is important for this workforce to be brought into focus prior to their entrance into the workforce or college. Within the study of engineering education, the identification of the aforementioned questions is imperative not only as a justification of funding K-12 engineering education but also in the grooming of future engineers for the workforce of the 21st- Century.

Definition of Terms

Rural geographic areas refer to rural and small towns and communities where public school funding and achievement test scores lag behind most suburban and urban areas in the state of residence (Felder, Mohr, Dietz & Baker-Ward, 1004). The majority of rural areas in this study are within the state of Mississippi.

Summer Engineering Academies are programs that are generally residential in nature that are used to expose participants to the fields of engineering and career options within those fields.

Underrepresented Groups are individuals who have been identified based on gender, race, and/or socio-economic background as being in the minority of those individuals involved. Felder et al. (1994) identified these groups as those who lack the basic advantages afforded members of the majority.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Across the United States there has been rising concern about the seeming lack of interest by young people in the secondary school level in pursuing degrees and careers in the STEM fields. This call for attention to be centered on STEM education improvement and recruitment has been led by professional and educational groups in seeking to increase student interest in STEM fields (AAAS, 1993; NAE, 2009; NSB, 2007; NAS, NAE, & IOM, 2007; DoEd, 2008). According to a study by the American Society for Quality conducted by Harris Interactive found that over 85% of students ages 8-17 are not interested in an engineering career and that only 20% of parents have or will encourage their children to consider an engineering career (Dubie, 2009). The number of high-school seniors who plan on careers in engineering has dropped almost 35% in the past 10 years, according to a survey by ACT, (the standardized-test provider) of students who took its college-entrance exam. Women now account for only 18% of prospective engineers, and minorities 22%, according to the ACT conducted 2002 survey (Field, 2004; Hewlett, Luce, Servon, Sherbin, Shiller, Sosnovich, & Sumberg, 2008). In more recent research conducted by Lacey and Wright (2009), the number of women holding degrees and employment in engineering and computer related fields has maintained at less than 20%.

Universities in the United States had 11% fewer engineering graduates in 2005 than in 1985 (Carroll, 2007; Becker, 2010) despite the fact that many high-tech companies in the US have been issuing warnings of engineer shortages for the past two decades (Brown & Linden, 2008). The NAE has also identified these problems and has sought to identify causes of this decline as well as seeking to identify ways to reverse the trend in their publication of *Changing the Conversation* (NAE, 2008).

Converse to the overall trend, more women are finding their way into engineering but in unremarkable numbers and in limited areas of concentration (Byko, 2007; Madsen & Tessema, 2009). Yilmaz et al. (2010) identified that the numbers of underrepresented minorities enrolled in engineering as well as all STEM fields has declined in the past 10 years as the majority select the social sciences fields. As one of the major methods in attempting to "widen the pipeline" or increase the recruitment pool of likely candidates, many universities and industries conduct summer learning experiences geared toward informing young people about the study and field of engineering in order to attract interest with a particular emphasis on recruiting students of color, women, and other traditionally underrepresented populations through these programs (Gordon & Silevitch, 2009; Knox et al., 2003; Winters, 2008). While some of these programs claim limited individual success at retaining the attendees' interest in the STEM fields, the original purpose of recruitment has been a difficult measure to attain by most (Knox et al., 2003; Kuttan & Peters, 2006; Madeso & Tessema, 2009). The importance of these efforts has not been questioned but the impact of the same is of concern and interest by those who host the experience as well as those stakeholders who are providing the funding for them (Eisenhart, 2008; Paulsen & Bransfield, 2009). Moreover, the few studies that are seeking to examine the statistical success markers have concentrated on examination on a single variable such as race or gender as served by a specific curriculum without using a comparative analysis leaving a gap in establishing an understanding of the best practices for the greatest desired impact (Fouad & Walker, 2005; Frehill et al., 2009; Hanson, 2004; Hewlett et al., 2008).

The central purpose of this study is to examine the possible effect outcomes, if any, on participating secondary level students who attend SEAs hosted by the CoE of a southeastern land grant university. The primary goal of this study is to ascertain whether any effect can be incurred through participation in a SEA on participants' perceptions of self-efficacy of the participant toward the field of engineering. The second purpose seeks to examine whether the delivery method of the program: single gender versus mixed gender, financial costs, and content had any measureable effect. The final purpose of this study is to identify the practices or methods of teaching that are perceived by the participants as those that caused the greatest influence on their self-efficacy in the work of engineers.

This literature review begins with a brief overview of the purpose and research legitimacy of content based short-term immersion programs or summer academies. This literature explains how these types of programs are designed and implemented with the specific learning goals as well as their use as recruitment tools for universities. This contextual understanding is vital to this research study as it frames the positive measurements that may occur as well as acknowledge limitations that are inherent within the process and implementation. Within this review of existing programs are brief descriptions of theoretical frameworks on which they are founded including situational learning and the use of mentors within the programs.

The other major body of literature reviewed relates to the development and role of self-efficacy for middle and high school aged students as they explore STEM fields with engineering as the central content. The themes of motivation and value expectancy based on Eccles' (1983, 1995, 2005, 2007) theories are also outlined.

Content Based Short-term Immersion Programs

COEs, as well as many other STEM associated programs of study, across the US have been struggling to attract qualified and academically confident domestic students into their programs for over a decade (National Research Council, 2011). Akram, Darwish and Green (2005) identified that enrollments in engineering programs have struggled to meet expected job growth needs in industry. They also share that overall, engineering college administrators work hard to increase enrollment, buoy retention rates, and improve the percentage of engineering students completing their courses of study. Felder and Brent (2005) agree that there is a decrease in interest in engineering across all demographics of high school students which leads to decreased enrollment. Outreach programs in secondary schools have been implemented in a many areas in an effort to elucidate students about engineering fields and careers with the belief that these efforts will lead to increased enrollment (Kimmel & Rockland, 2002; Mooney & Laubach, 2002; Sanoff, 2001; and Yilmaz et al., 2010).

One of the strategies being practiced across the nation to address the engineer shortage is the implementation of summer engineering academies (sometimes referred to as camps; Elam, Donham, & Solomon, 2012; Donham & Elam, 2010; Haller & Virkler, 1993). These programs are strategically designed to attract, motivate, stimulate and educate young people in the STEM fields, and for the purposes of this study specifically the field of engineering. Typically, these programs are targeted toward students with higher academic acumen or perceived potential (Yilmaz et al., 2010). Orsack (2003) refers to these programs as the red carpet for the "new frontier of engineering." There are a large number of informal education programs that promote math, science, and technology education across the United States with sponsors including non-profits, industry members and philanthropic organizations but engineering content programs are centered at universities which tends to skew the research as students who are already academically hesitant may not feel confident in this setting (Yilmaz et al., 2010). Bischoff, Castedndyk, Gallagher, Schaumloffle, and Labroo (2008) state that the poor performance and lack of motivation to student STEM careers and engineering specifically is "due at least in part, to a demonstrable lack of motivation to study science because of poor self-perceptions of their ability and a strong disconnect between school science experiences and the lecture and listen nature of the learning environment" (p. 132).

These SEAs and similar programs use methods that range from developing high school-level introductions to modern engineering content with hands-on activities to engineering-based robotics competitions such as BEST (Boosting Engineering Science and Technology) Robotics (Madsen & Tessema, 2009; Perna, 2002; Plant, Baylor, Doerr & Rosenberg-Kima, 2009; Schaaf & Welch, 2003). These competitions and similar activities are effective as precollege programs as they have been attracting students to pursue engineering disciplines. However, they may not give students the experience of the university residential setting, nor do they give them direct exposure to a variety of engineering projects and disciplines which can be a key strategy as an early recruitment strategy (Madsen & Tessema, 2009). Strategies using residential summer camps as a means to introduce potential students to STEM disciplines are one example of how universities can increase enrollment in these fields (Atwater, Colson, and Simpson, 1999; Bieber, Marchese & Engleberg, 2005; Robbins, Schoenfisch, Moore & Tolar, 2005; Streetman, 2007).

SEAs and similar programs focusing on various engineering fields can be conducted to deliver engineering design lessons from different branches of engineering. A basic internet search for this type of program commonly reveals programs for inner-city students; some are designated for specific grade levels or are gender-specific for girls only. Programs may be held for a few half-days or be residential for a week or longer (Byko, 2007; Dounay, 2006; Fields, 2009). A longitudinal research project by Simpkins, Davis-Kean, and Eccles (2006) sought to establish a correlation between a student's access to quality informal science activities and their sustained interest in the sciences. In their study, they followed elementary students who participated in a number of informal science content learning programs (including summer-based short-term immersion programs) and their later choices of enrollment in advanced science courses in their high school years. The resulting data confirmed that the quality and frequency of participation had a positive effect on their selection and interest in science topics. While longitudinal studies particular to engineering are not plentiful, there are some researchers currently working in this area. For example, Fantz, Siller and DeMiranda (2011), establish correlations between specific pre-college program participation as indicators of self-efficacy and persistence in the pursuit of engineering degrees. Throughout the emerging field of engineering education, the importance of informal and short-term immersion programs is being studied (Denson & Hill, 2010; Matusovich, Streveler & Miller, 2010; Purser, 2011). In their research on the impact of one such summer program, Hayden, Ouyang, Scindki, Olszewsi and Bielfeldt (2011) found that participation in a summer STEM based program presented an effect on Hispanic female participants' self-efficacy (used interchangeably with 'interest' by the author) in pursuing a STEM career. As a result of informal conversations correlated with learning journals, Hayden et al. found that as the young women interacted with instructors and the STEM curriculum many of the participants underwent a self-awareness change toward their own learning and personal value toward that learning.

Similarly, the iQuest program held annually at California State University San Marcos and is specifically designed to explore the relationship between participation and an increase in self-efficacy in the STEM fields (Hayden et al., 2011). Targeting students in middle level grades, the program used hands-on investigations and short term immersion into deeper curricula topics as a tool for student interaction with STEM curricula. Using two measures, one for interest in STEM topics and STEM careers and the other assessing student perceptions of efficacy in STEM, the researchers found that for their population under study, the program elements resulted in a positive increase in self-efficacy.

The research by Hayden et al. (2011) is specific to the Hispanic female middle school as the work of Thomas and Williams (2010) is specific to their population of academically advanced students at specialized STEM high schools. In their research, Thomas and Williams (2010) sought to establish that the efficacy that specialized schools (members of the National Consortium of Specialized Secondary Schools of Mathematics, Science and Technology) achieve in creating a lasting interest in the students as a result of intense STEM exposure could be replicated through subject specific summer programs. Part of that exposure included summer programs that allowed students to create individualized research. Within their longitudinal study that followed students who participated in these intense STEM learning experiences, the retention of these students within STEM careers was very high. The aforementioned authors posit that this deeper exposure to STEM curricula created a lasting interest through the development of greater self-efficacy in the topics and increased the retention within the fields (Thomas & Williams, 2010).

Despite a growing number of programs and initiatives focused on increasing the self-efficacy and sustained interest of young people in the engineering field, to date there are few research pieces with conclusive results. This lack of solid conclusions may be due to the difficulties of conducting research through similar programs simultaneously. The majority of research publications are program specific and few are included in peer-reviewed editing and journal publications (Bachman, Bischoff, Gallagher, Labroo, & Schamloff, 2008; Beer, LeBlanc & Miller, 2008; Hylton & Otoupal, 2009; Madsen & Tesseman, 2009).

Self-efficacy, Expectancy-Value and Motivation

An additional purpose of a SEAs is to create an increase in self-efficacy or desire for young students to pursue engineering as a course of study and future career. Although they may create a greater understanding of the engineering design process or the work of an engineer, can this learning be translated into the desire to become an engineer? This research lies in the theoretical frameworks of self-efficacy and agency as originally described by Bandura (1977) and later embedded by Bandura and others into the framework of social cognitive theory (1986) and the theory of personal agency (1997). Social cognitive theory asserts that the environment (e.g. peers) will impact the students' learning by simulating the cognitive, motivational and affective processes (Bandura, 2001). It is the level of confidence to which an individual believes they can organize and implement the actions needed to perform the task at hand adequately (Schunk, 1989). The theory of self-efficacy is used in a variety of fields but is most influential in the field of educational research in conjunction with academic motivations (Pajares, 1996).

According to Bandura's seminal 1977 work, there are four major informational sources that influence one's perception of self-efficacy:

> Personal performance and accomplishments – the pattern of past successes and failures.
>
> Vicarious learning – the comparing of one's performance to that of peers
>
> Social persuasion – the discouraging or encouraging feedback one receives from others
>
> Physiological states and reactions – the emotional and physical reactions that occur either pleasant or unpleasant. (page 195)

In Bandura's (1977) theory, these four sources act simultaneously and in conjunction with one another to create one's perception of self-efficacy. Bandura further explains that there are three behavior consequences that may then occur:

Approach versus avoidance – what will an individual do to stay away from an activity or situation and what an individual may be willing to try.

Persistence – the effort the individual is willing to dedicate to the completion of the task of goal.

Performance – demonstrated competence through assessment (pages 200-202)

Self-efficacy can be self-perpetuating; an individual with elevated self-efficacy might perform well on assessment, which can then lead to an increase in his or her perceived self-efficacy due to comparisons to their peers on the same assessment and the receipt of positive consequences (Fantz et al., 2011). The role of the SEA experience is under investigation in this development of self-efficacy. Bandura (1982) posited, "In causal tests, the higher the level of induced self-efficacy, the higher the performance accomplishments and the lower the emotional arousal" (p. 122). The role of self-efficacy has a definite effect in the decision making processes of the learner and has been researched significantly among undergraduate students studying engineering at the university level but there is little examination of the effect of earlier experiences on that same determination (Denson & Hill, 2010; Fantz et al., 2011).

This measure of self-efficacy is examined through one's belief that they are capable of performing the task and more importantly for this study; do they believe that they will find a sense of success in the task? The establishment of self-efficacy extends beyond that belief as documented by Hutchinson, Follman, Sumpter, and Bodner (2006) in their research of first-year engineering students at Purdue University. These researchers determined that the level of self-efficacy in the subject was tied both to the motivations of choice as well as the level of effort one feels willing to put forth to accomplish the goal. Moe and Zeiss (1982) have added to the knowledge base regarding self-efficacy on persistence through their studies of social interactions and perceived positive social stigma. They posit that one's security in social contexts can be increased as self-efficacy to perform or be positively recognized by peers or community members is increased. Academic motivation has been tied to self-efficacy in multiple studies and has been identified as one of the strongest influences that causes a student to persist and overcome obstacles they may encounter later (Graham & Weiner, 1996; Lent & Hackett, 1987; Lawson, Banks, & Logvin, 2007; Pintich & Schunk, 1996).

Schunk and Meece's (2006) study of self-efficacy development as tied to Piaget's stages of development seeks to define the optimal ages for educators and parents to provide opportunities for the building of self-efficacy beliefs. Additionally, Zimmerman and Cleary's (2006) work in the study of adolescent self-efficacy in the development of self-regulation and agency allows one a greater understanding of how the development of a sense of agency may occur. This sense of agency is important to this study because one's sense of agency aids in making the determinant factors for the accomplishment of goals and aspirations that may be influenced by participation in programs like the SEA (Bandura, 2001).

In examining the impact of pre-college programs such as SEAs, the work of Matusovich, Streveler, and Miller (2010) examined the theoretical frameworks of motivation theory and expectancy-value theory. Much of their findings linked high levels of engagement in learning to the development of self-efficacy regardless of their initial interest in the topic. Additionally, their work confirmed Eccles' (1995) expectancy theory as the expectation that if the topic was of interest, it became valuable to the subject. In the most basic form, the Eccles' expectancy-value is a reflection of Bandura's (1986) work. Eccles' (2005) work suggests that the choice to participate in activities or long-term goals is shaped by perceptions of competence and a value belief (Eccles, 2005, 2007; Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983). In applying this theory to this study, competence beliefs ask "CAN I accomplish the work of an engineer?" and the value belief asks the importance of that accomplishment, "Do I WANT to accomplish the work of an engineer?" (see Figure 1 as adapted from Matusovich et al. 2010). Eccles' (2007) work has a rich history in the field of career choice.

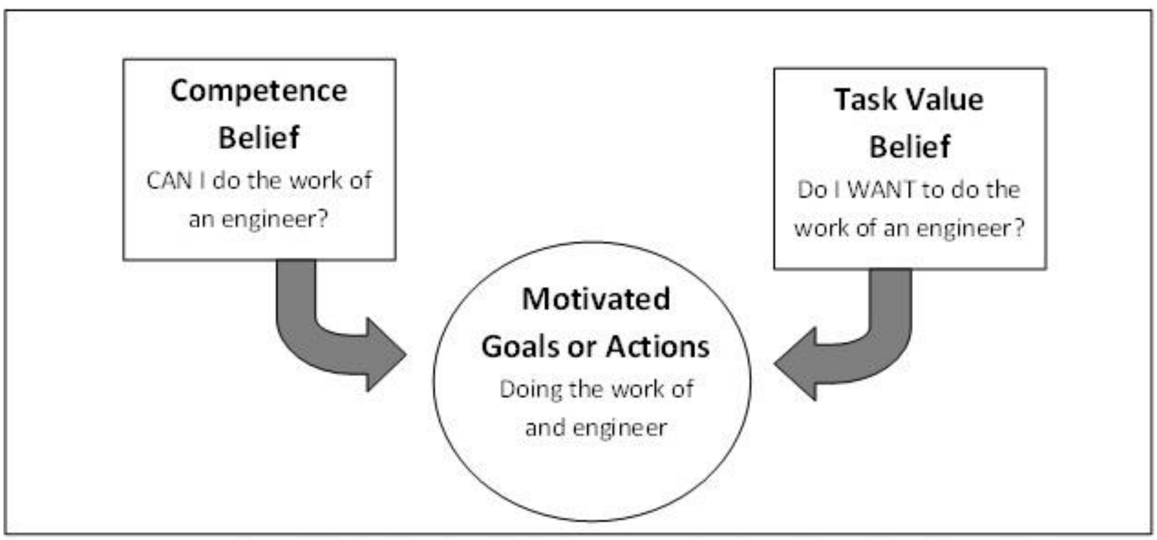

Figure 1. Simplified version of Eccles' expectancy-value theory.

Sheppard, Macatangay, Colby, and Sullivan (2009) support this research in their findings that the choice to study engineering is directly related to the perceptions of students at the secondary school level. Additionally, they advocate that most students' perceptions are poorly informed about engineering fields and without early exposure and the ability to develop an expectancy-value, these students may tend to avoid engineering and other STEM fields. Motivation theory holds that without this perceived task-value and feeling of competence, students who later begin to pursue a degree in engineering will fall prey to a lack of persistence in attaining that degree (Seymour & Hewitt, 1997). Early positive motivation is likely to assure persistence and result in completion of a degree (Lent, Brown, & Hackett, 1994; Sheppard et al., 2009).

Hayden et al. (2011) sought to identify the impact of participation in a summer based STEM program on the middle-school aged participants. The program: Investigating for Quality Understanding and Engagement for Students and Teachers (iQUEST) was a two part study with one section involving teacher training and the other solely for student participants in grades seven and eight. The researchers were basing their project on the concept of "widening the pipeline", that is to increase the number of young people who are interested in STEM careers and then encouraging them through the educational ranks to a STEM career. Participants in the study were introduced to a variety of STEM topics through hands-on and problem based activities. In order to measure self-efficacy, participants completed a narrowly edited version of the Test of Science Related Attitudes (TOSRA) as well as a similarly abbreviated version of the Information and Communication Technology Attitude (ICTA) survey. These researchers' findings indicate that at the conclusion of the program, participants had developed a higher level of interest in STEM content and that the students were more engaged in the content. This increase in self-efficacy and motivation to continue to pursue a greater understanding in STEM fields is attributed by these researchers to be a direct cause of their participation in the program.

As the level of motivation and self-efficacy are allowed to rise, the individual is more likely to persist in the face of obstacle as they strive for success (Purzer, 2011). This self-efficacy may prove to be a measurable outcome of the efforts and design of an SEA in order to ascertain the overall success of the program or identify need to change. The current research as outlined, does not lend toward specific examination of SEAs as they are currently implemented. Most of the research that is specific to SEA type programming are more often a reporting out to stakeholders rather than empirical research with the goal of a summative assessment or evaluation of success in affecting self-efficacy toward the content area.

Gender Motivations

Within the cadre of programs are those that are offered as a single gender programs (Women In Science and Engineering [WISE], Women In Action [WIA] and Becoming A Teen Mechanical Engineer [BATMEN]) and mixed gender programs (Mississippi Summer Transportation Institute [MSTI] and Engineering for Everyone [E4E]). There are content specific curricula presented (MSTI, BATMEN and WISE) and those that offer a broad view of engineering (E4E and WIA). Some programs are offered at a very low enrollment cost (MSTI) while others are significantly higher (WISE, WIA, E4E, and BATMEN). Finally, the other significant design difference lies in the ages that the programs are geared to – middle school students (WIA and BATMEN) or high school students (WISE, MSTI, and E4E). Although not being examined as part of this study, it is important to point out that E4E is intended for, but not limited to students of color.

It is therefore important to seek out the relevant research to gender and socio-economic theories as they apply to engineering. Self-efficacy is rooted in social psychology and has been well used in career choice research (Graham & Weiner, 1996). This self-efficacy is therefore an essential understanding for program designers seeking to target and encourage specific underrepresented groups (Streetman, 2007). Applying this to the field of engineering recruitment, past data indicates that the number of women entering the field of engineering is growing, but they still are an underrepresented group (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Jacobs, 2005). It is through the lens of self-efficacy that research into positive recruitment outcomes may be established and therefore better documented (Loftus, 2007). This is an important factor as skill level development has long been viewed as an essential cause of impact on the recruitment and retention of both women and students of color (Lent et al., 2005; Marra, Rogers, Shen, & Bogue, 2009; May & Chubin, 2003; Nauta & Epperson, 2003; O'Hare, 1995; Seymour, 1995; Vogt, Hocevar, Hagedorn, 2007; Zeldin & Pajares, 2000).

A lack of skills, including mathematic problem solving was examined in depth by Marra et al.'s (2009) study of the persistence of women in engineering. Marra's (2009) longitudinal study sought to establish the difference between the self-efficacy beliefs of the participants in comparison with their skill levels including mathematical reasoning, problem-solving and other academically based skills. In the course of the study, the researchers found that while the participants showed no lack or diminishing ability when it came to actual practical knowledge, their self-efficacy faded over time as they spent more time in the predominantly male discipline. These researchers therefore concluded that for the majority of those women who did not persist in the engineering course of study, the self-efficacy was the eliminating factor rather than their ability to accomplish the coursework (Marra et al., 2009). This is one of the supporting foundations for this study. Additionally, Vogt et al.'s (2007) findings found a positive relationship between self-efficacy and the experience of academic "integrative" experiences that create a sense of community and accomplishment are essential to the persistence and success of female undergraduate students.

Ponton et al.'s (2001) work discusses how sources of self-efficacy can be found for most underrepresented groups in the area of mastery experience, as described by Bandura (1977). These researchers explain that educators need to do a better job with female students in allowing them to process their experience and draw on the successes as well as identifying their areas of weakness as challenges to be addressed. In examining the interactions between self-efficacy theory (combined with motivation and value-expectancy theories) and basic feminist theory, the need for identifiable success is of primary importance as it is a driving force that is viewed by many researchers as a primary factor of success in any male dominated field (Du, 2006; Hutchinson-Green, Follman, & Bodner, 2008; Lord, Cashman, Eschenbach, & Waller, 2005; Pawley, Riley, Lord & Harding, 2009; Riley, Payley, Tucker, & Catalano, 2009).

Young women who have participated in programs designed to expose them to STEM fields such as architecture and construction management have reported that interacting in a short-term experience in the actual work environment have created deeper levels of self-efficacy in the field (Kisi, 2010). In Kisi's (2010) research, young women spent time learning about the STEM fields and then had opportunity to interact with professionals in the field and participate in a job shadowing experience. Using a mixed methods data sources, the researcher sought out the level of influence this experience had on the choices of the participants and found a strong correlation between the level of positive interaction and their change in their perception of their ability – or self-efficacy. These perceptions were found to be influenced and further research found that the interactions between young women in these types of programs can also be influenced by their relationships with other participants or peers within the program (Beer et al., 2008).

Peer relationships are a central issue of concern for the adolescent. The effect of peers on self-efficacy is of major import (Bandura, 1977; Bergvall, Sorby, & Worthen, 1994; Felder et al., 1995; Hanson, 2007; Quimby, Seyala & Wolfson, 2007; Rosser, 1995; Seymour, 1995). Hanson's (2007) research on African American young women and their interest in STEM fields found that although the family unit and school had a critical role on their choice to pursue STEM courses and develop a higher self-efficacy within these fields, the peer interactions and relationships have a high level of importance within the development of self-efficacy. Within the study, many of the young women were found to trade the influence of family on their self-efficacy to a reliance on peers and finally returning to reliance on the family unit as a late teen. This time when peer relationships is most paramount was identified by the researcher generally during the time frame from grades eight to ten (of which all are targeted by the SEAs used in this study). This supports this research study as the interactions between peers is a fundamental component of the SEA experience occurring in this same time frame. Quimby et al. (2007) determined in their study of high school students involved

Environmental Science summer programs that students from traditionally marginalized groups including students of color, rely more heavily on peer relationships within their development of self-efficacy in science fields. The researchers found a significant difference in this reliance between the ethnic majority (White) students and their minority peers as apparent through the interviews and surveys conducted in their study.

Paa and McWhirter (2000) conducted research in a small U.S. Midwestern city seeking to determine the influences that determined the career decisions of high school students. The 464 students (226 male and 238 female) in the study responded to survey questions regarding their perceptions of the factors around them that were like to affect their career pathway decisions. The analysis of these data revealed multiple factors having influence but the strongest influences among both genders were perceived ability, role models and peer perceptions of the career field. While researchers found that peers have a great deal of influence, they also reported that female students are only influenced by their female peers and male students by their male peers (Paa & McWhirter, 2000). The level of influence held by peers remains a viable factor in determining one's interest in a specific field of study.

Within Bandura's (1977) original assertions, vicarious learning and social persuasion have distinct impact on one's self-efficacy which places the aforementioned research in direct support of the original assertion that peers have an impact on learning and self-efficacy development. This impact is a valid part of this study as it may indicate importance to identifying whether the single gender programs create a different effect than those developed for a mixed-gender program. Interestingly, there is a void of examination of mixed-gender versus single gender short-term immersion programs in a comparative nature. Additionally, there is a lack of impact comparison studies based on age of implementation. There are a number of program reports for programs offered for young people of different ages but not in comparison to one another.

Summary

Throughout the course of the review of the current literature there are many programs that have been studied individually for effect. In the examination of the development of self-efficacy as a result of opportunities and experience there can be evidence of change or increase of this self-efficacy of both the ability to accomplish as well as the desire to accomplish. Based on the evidence of studies examining the effects of gender interactions and influences, there is a significant need to learn more about peer gender influence on the development of self-efficacy of both levels. This study seeks to examine the role of the SEA experience on both levels of self-efficacy in creating an interest in engineering and STEM as well as a desire to accomplish success in these areas as scaffolded by the theoretical frameworks. The addition of this study is to establish whether this same effect occurs in the variety of age, gender and race targeted programming and to compare the impact of the learning that may occur on participants in the five SEAs in the study. This comparison crosses the voids currently found in the literature. The majority of the literature seeks to identify an impact on the single group participating without a comparative analysis of against similar programs of significantly different participant populations whether gender-based, race-based or participation age. This is occurring as real-time data of multiple programs conducted with specified controls rather than a meta-analysis of broadly different programs with different variables – making conclusions difficult.

CHAPTER III

METHODOLOGY

Context

In order to allow for a better understanding of the data collected through this research, a level of context must be established. The contexts allow for a better illumination of the data as it is embedded into a relatable form (Morrow & Smith, 2000). The spheres of context rely upon one another in order to give the ful and deeper view of what is being seen in the data. To begin this process, I will review the basic context of the CoE Outreach efforts. Following this is a description of the SEAs examined in the study including the application process and the development of the program components. Aggregated data on the participants is shared in order to better understand the composite picture of those participants involved in the data gathering.

The Outreach Office of the College of Engineering

This study occurred at a named CoE at a southeastern land grant university's Summer Engineering Academies. In 1992, the College of Engineering took action to address the need for talented and creative students to enter the fields of Engineering by establishing the K-12 Outreach Office. The purpose of the K-12 Outreach Office is to develop and implement programs and curricula that engage K-12 students and allow them to explore the fields of engineering through hands-on, minds-on problem based learning activities. Additionally, professional development opportunities are provided for educators of all settings (public, private, charter, and home school educators) in a large variety of STEM-based programs with emphasis on the engineering strand.

The Outreach Office has been run by 5 different coordinators from 1996-2008. Each of these coordinators worked to increase the recruitment pool for the college through various activities and programs including some of those listed above. Often, the names for the programs have changed over time (Engineering for Everyone was first titled "University Familiarization Program for Minorities in Engineering" or UFPME). These changes in program names were for simplification or as a rebranding effort. In 2008, the Director position was created in order to increase the responsibilities of the office and to gather in K-12 programs that had been implemented in the various departments of the college under a single entity as a downsizing measure. The current programs within the Outreach Office include 3 robotics competitions (BEST, VEX and SeaPerch); the Region V State Science and Engineering Fair; Northern Mississippi Science Olympiad; Tours of the CoE research facilities for schools and educational groups; Summer Engineering Academies; and other early recruitment activities targeting students in Grades K-11. Each of these programs has the intent to educate K-12 students and their families across the state of Mississippi about the fields of engineering as well as the preparation needed to study engineering at the university level.

The SEAs have been a staple for the CoE as both and outreach effort and a tool for recruitment. Each SEA has a specific target audience based on specific demographics including age, gender, and racial background. In fulfilling its mission to increase the number of individuals from traditionally underrepresented groups, SEAs are designed for students from all backgrounds while meeting individual interests and questions. All programs include hands-on activities, field trips to research facilities, and presentations by college faculty and researchers. Each program concludes with a prototype project completed by the participants that ties in the content learning from the program.

SEAs are held on the university campus utilizing both classrooms and research centers within the CoE for instruction. Within the curricula design, the participants of the SEA interact with CoE faculty and staff members who conduct informational seminars and lead hands-on projects that tie into 'real-world' projects using a problem-based learning platform. Within this platform, students are presented engineering challenges for which they create proposed solutions based on their other learning activities and individual research.

Participants are housed on campus with access to campus amenities. Periodic excursions take place within each program that add to the understanding of the curricula or provide recreational outlets such as bowling and roller skating; each program also allows the students the opportunity to use the university Recreation and Sports center as a measure to allow the participants to experience as much "campus life" as possible (Riggs, 2009). Participants are monitored and led in activities by counselors who are current undergraduates primarily majoring in engineering fields. This interaction allows the participants to view successful engineering students who share similarities including race, gender, SES backgrounds and geographic ties. The selection of the counselors is a rigorous application process in order to assure that the SEA participants are allowed to view the counselors (with whom they spend a great deal of time) as mentors whom they can emulate (Denson & Hill, 2010; Marra, Rodger, Shen & Bogue, 2009). The SEA programs are promoted through a variety of media including state-wide print media, University Relations department, teacher networks that have been developed by the CoE Outreach Office staff as well as through direct mailings to past participants. Applications are judged for acceptance based on cumulative GPA (requirements differ based on the program), course completion via transcripts, multiple teacher and counselor letters of recommendation, a personal statement written by the applicant and ACT scores. Using an assessment rubric, applicants are assigned a score and if accepted, they received a letter of acceptance with additional forms for completion. Each program has a cap of thirty participants.

All applicants are required to submit a nominal application fee but in extreme circumstances, the director may elect to waive this. Scholarships are made available to all applicants with priority given to those families who demonstrate a significant need. As the costs to the CoE for each participant (including housing, meals, materials, etc.) can exceed $800.00, the availability of scholarships is very limited. In an effort to allow as many students to participate regardless of parental finances, each participant can request a letter from the CoE that confirms their acceptance and cost with a statement encouraging community support which can be used by the participant and their family for fundraising within their community.

Summary of Summer Engineering Academies

The Mississippi Summer Transportation Institute (MSTI) is an externally funded program that has been hosted the CoE Outreach Office in cooperation with the college's Department of Civil and Environmental Engineering since 2005. Each year through a grant from the Federal Highway Administration and the Mississippi Department of

Transportation, the CoE Outreach Office hosts 25-30 students entering Grades 9-11 for a 14-day residential program. The topics of the program are limited by the grantor to topics revolving around transportation and include road and highway planning, surveying, asphalt formulas (based on use), concrete formulas, safety, and intermodal shipping. Students also participate in leadership building activities, ACT test preparation activities, and sessions about college applications and preparation. In the three-year course of this study, 72 young people attended the program (please refer to appendix A for detailed demographics data).

For middle-school aged men (rising Grades 6-8), the Outreach Office hosts the BATMEN program. The central themes of this 1 week residential program are motors, vehicle design, gears, gear ratios, power, and machines. This program was started with internal funding to supplement a lower tuition in order to allow an economically diverse population in 2010. Prior to the inception of this program, there were no opportunities for young men in this age range offered which makes the placement of this program in the study an ideal opportunity to examine any excisable best practices. During the course of the study, 71 young men participated in the program over the three years (please refer to appendix A for detailed demographics data).

The WIA program is designed for young women entering Grades 7-9 as a 1-week residential program that exposes the participants to a variety of engineering fields and female practitioners within those fields. One of the essential pieces of this program is to allow the young women the opportunity to interact with engineering faculty, researchers and students in the hopes of inspiring the participants to pursue a career in engineering.

There were 29 young women attending the program for 2 years of the study (please refer to appendix A for detailed demographics data).

The WISE program has been a staple offering since 2003 and was started in cooperation with the Society of Women Engineers chapter at CoE and the Outreach Office. Each year, up to 20 young women participate in the week long residential experience exploring the fields of engineering with emphasis on one field such as cybersecurity or green engineering. Over the course of this study, this program was only held once with 16 attendees. This was due in part to other no cost programs being offered by the CoE for the same age group of women (please refer to appendix A for detailed demographics data).

E4E has been in existence since 2006 under a variety of names including the UFPME. The name was changed at the inception of this study (coincidentally) in order to facilitate greater diversity of applicants. This week-long residential program is co-ed and is general in topic. The 40 participants over two years of the program during the study participated in program (please refer to appendix A for detailed demographics data).

Table 1

Table of Programs with Cost to participant

Program Name	Target Audience	Content	Cost
Mississippi Summer Transportation Institute (MSTI) (14 days in duration)	Mississippi Residents entering 9-10 grade in the coming school year. This is a mixed gender program.	Intermodal transportation and the facets of engineering (primarily civil engineering) that affect/are affected by it. Leadership content and academic skills are also built into the curriculum.	Funding for the program comes from a Federal Highways Grant. Participants are only responsible for the application fee.
Women in Action (WIA) (7 days duration)	Middle School (entering grades 7-9 in the coming year) females.	Broad introduction to engineering with an annual 'grand challenge' from a specified field (rotated annually).	Application fee and tuition combine to $250.00 each.
Women in Science and Engineering (WISE) (7 days duration)	High School (entering grades 9-12 in the coming year) females.	Broad introduction to engineering with an annual 'grand challenge' from a specified field (rotated annually).	Application fee and tuition combine to $250.00 each.
Becoming A Teen Mechanical Engineer (BATMEN) (7 days duration)	Middle School (entering grades 7-9 in the coming year) males.	Primary focus is given to Mechanical Engineering with significant introduction to other fields as well.	Application fee and tuition combine to $250.00 each.
Engineering For Everyone (E4E) (7 days duration)	High school students (entering grades 9-12 in the coming year) with primary target audience of students of color.	Broad introduction to engineering with an annual 'grand challenge' from a specified field (rotated annually).	Application fee and tuition combine to $250.00 each.

There are many common methods of delivery used in the various programs. Each day is filled with seminars, laboratory visits, short hands-on activities and each day the participants have time to work on their summative activity related to their grand challenge for the program. In the course of this study, the grand challenges were as follows:

MSTI – Create a display outlining the history of your research topic (related to the curriculum, ie. Lock and Dam systems, Asphalt, Traffic patterns and planning, Air traffic management, Bridge span design), the seminal improvements and understanding and how engineers make improvements in the area. Final displays were presented at the closing ceremony for parents and visitors including faculty who had worked as mentors for the groups.

WIA – Examine the challenges of chemical engineers to develop cosmetics that have mass appeal to the target audience (tweens and teens) while assuring safety and cost limitations. The participants developed a new lip balm from an assortment of materials while maintaining the 'appeal' requirement. The participants developed a marketing and manufacturing plan as well. Final sales presentations were given at the closing ceremony for parents and visitors including faculty who had worked as mentors for the groups.

WISE – The curricula for this program was developed in conjunction with the T.K Martin Center for Adaptive Technologies also housed at the university. The participants were introduced to the work of the center in developing and engineering solutions for individuals with mobility challenges. Each group was then assigned a portfolio of an individual with specific challenges or handicaps. Based on the needs expressed by the individual in the portfolio and in spending time with the same challenges (eg. Using a wheelchair while shopping in a grocery store, traversing the university campus with severely limited eyesight, etc.) the participants engineered solutions. Prototypes and proposals were presented at the closing ceremony for parents, visitors and staff from the T.K. Martin Center as well as faculty who had worked as mentors for the groups.

BATMEN – Participants were introduced to a number of vehicle engineering and design challenges over the course of the program. The summative project was to develop a working rocket with limitations on size, materials and propulsion methods. Each team developed CAAD designs and physical models. Prototypes were presented at the closing ceremony and a brief flight competition was held for all attending to see the designs in action with the goal of greatest flight length and apogee height.

E4E – Create a solution to an environmental problem. Students chose a problem and then researched the issues, developed a possible solution and then proposed how they would engineer a solution. Project areas included: Roof-top gardens to reduce heat columns, Portable aquifers for low water quality communities to reclaim grey water, Water quality monitoring devices, and Solar powered homes. Projects were presented at the closing ceremony for parents and visitors including faculty who had worked as mentors for the groups.

Application Process

The application process for all of the programs is very basic. The application is posted on the Outreach website each January and promotional posters and postcards are sent to past participants, teachers, school counselors and school administrators across the state. Within the data collected for this study, students who were attending a program for a second time have been eliminated from focus groups and interviews in order to eliminate any 'bleed effect' in the data. Upon receiving the applications, they are reviewed to ensure that applicants meet the minimum requirements for the program including age, grade enrollment (homeschooled applicants are accepted based on age), and GPA as applicable. Secondary selections are based on response criteria including personal statement, interest in engineering, and teacher recommendations. In the case of co-ed programs, availability of gender based rooming assignments may have a role in final selections. A Likert rating scale is used in order to allow an objective application process. Keywords are identified to slide the score of the personal statement and teacher recommendation letters.

Acceptance letters are sent to those selected and non-acceptance letters to the others. Over the course of the study, the acceptance rate averaged at 78%. Although it is ideal to host each session/program every summer, there must be a minimum of 7 participants accepted in order to financially host the program. Once accepted, participants finalize tuition payment and submit required forms including photo release and liability forms. The data to be collected for this study are not discussed until participants arrive on the campus.

It is important from a research perspective to recognize that although the majority of the participants self-selected to apply and attend the SEA, not all of them expressed a blatant desire to become an engineer. On a small number of incidences, some participants revealed that parents had completed the applications without the participants' knowledge (even writing the personal statements) and were being force? to attend. Noting this initial resistance will be of importance as it may be an obstacle to any positive change in their self-efficacy.

Data Sources

All program participants arrive on campus at the housing location on the Sunday of the program. At that time, parents and participants were approached about participation in the study. They are made fully aware of their rights to end participation at any time as well as the types of data being collected. Signed forms are then collected for all those willing to participate. On Monday mornings' welcome session when the participants are briefed about the week's events, they use a 10-sided die to create a 4 digit personal identification code. In the event of a '10' being rolled, the participant records the roll as a '0'. Program staff unconnected with this research checks the number to assure no duplication among participants. Once verified, each participant records their number on their identification badge used throughout the program to assure that they record their submissions correctly. These numbers are written on journal entries and any written documents to assure anonymity. At the conclusion of the program, the journals and other documents are collected (with permission) from the participants.

Written surveys are administered on the Monday (or first day) of the program. Again, participants do not place their name on the survey – just their identification number. The initial page of the survey includes demographics of the participant. The additional pages are intended to identify areas of interests and perceptions about engineering and other STEM areas. Additional data is collected through the daily journals of the participants. Each participant received a single-subject spiral bound notebook. Each morning and afternoon, the participants responded to a prompt that either dealt with the topics of the day or a general topic about their views of engineering as a career and field of study.

On Wednesdays and Fridays, focus groups were pulled out of the general pool of participants. Each group was determined in part by level of active involvement in the classroom – A teams were the most involved, B teams were made up of those students who seemed to be the least vested in the program. These participants met with me in conference rooms that were near the classrooms being used. Sessions were recorded with an iPhone and an additional digital recorder that was placed across the room from each other.

The final source of data is the phone interviews with participants about 2-3 months after the closing of the program. Interview participants were selected from participants of the focus groups. Again, they were selected based on the observations I made during the program and the focus group discussions. For instance, participant 3693 (2011 WISE) was very assertive in the focus groups that she wanted to attend MSU and major in engineering during her first focus group. In fact she stated: "I have planned on this for a long time. Everyone in my family is a bulldog and I want to keep the tradition. I want to be an engineer because they really get to design stuff – not just fix it. This is so cool." Her body language was that of an eager participant – leaning forward and jumping in to answer questions. During the second focus group she had a definite change of attitude in both her body language and responses: "This is a lot harder than I thought. I don't think I am smart enough." She later added: "I don't know, I think if I really tried I could learn about this stuff but so much is boring." It was this type of participant that I felt should be interviewed as a follow-up participant. Another interviewed participant was 2641, a 2011 BATMEN participant who entered the program with skepticism. In the initial focus group he explained that attending the program was not his idea: "My grandmother filled out all of the papers. I did not even know she was doing it. Engineers are like, really you know, smart and do lots of math and sciencey [sic] stuff, right? I thought I was coming to a baseball camp so I don't really, like, think you, you know, that you really want me to answer your questions." His second group session was a little more hopeful when he stated: "It is like cool to, you know, build stuff and stuff. I like it, you know?" I was interested in seeing if that change of heart stuck after he left.

Frameworks and Paradigm

With the well-established need for domestic engineers, it is imperative that recruitment efforts focus on results rather than simply providing a momentary glimpse into the discipline of engineering. From an ideological standpoint, it would be of great import to establish whether participation in a Summer Engineering Academy (SEA) has the desired effect of creating high self-efficacy toward the engineering discipline and therefore a dedication toward the completion of a college degree in the field leading to work within the field. In the reality that encompasses these programs, the level of effect, if any, is the main focus. Additionally, the variation of the effect based on gender and age level at the time of exposure are the true measures sought.

In designing this study, a qualitative approach has been selected. While quantitative data is easily accessible and can be gathered with minimal effort thus giving a snapshot of effect, the process of self-efficacy development can only be seen through the use of qualitative data (Cartney, 2010; Merriam & Associates, 2002; Niaz, 2008; Strauss & Corbin, 1998). Using thorough data collection and analysis of qualitative data makes it desirable to implement a dual paradigm of social cognition's subjective paradigm and the social cognitive intersubjective paradigm. While these two pieces of data explore the same basic idea, they each hold key components which elucidate the data differently (Ickels & Dugosh, 2000; Ickels & Gonzalez, 1996, 1994). Kuhn (1970) first conceived the use of paradigms as broad-scope perspectives for organizing the process of research within a given area. Within Kuhn's vernacular, each paradigm is based on differing assumptions of the nature of the study and the methodology most appropriate for completion. Both of these paradigms are based in the work of social constructivism (Terwell, 2005; Vygotsky, 1978; Wells, 1999). The present study also relies on the qualitative use of the paradigms at the levels of ontology (multiple backgrounds of participants creating additional affect; Jackson, 1992), epistemology (interaction with rather than detachment from participants) and methodology (Cohen, Mannion, & Morrison, 2000; Guba & Lincoln, 1994). It is for this rationale that both social cognitive paradigms (subjective and intersubjective) are being used for this study. The basic premises of both these paradigms are briefly explained in the following paragraphs.

The Social Cognitive Subject Paradigm has been extensively used in both cognitive psychology and social psychology and has virtually defined the field of social cognition (Ickes, 2002). As outlined by its epistemological assumptions, it relies on individual testing of subject for studies where conceptual and statistical independence is desired by the researcher to assure that each subjects' cognitions and behaviors are seen separate from their peers within the study (Heller, 2007).

The Social Cognitive Intersubjective Paradigm combines methods that were designed for interpersonal relations and small groups research to examine the interaction processes between members of small groups (Ickes, 2000). In comparison with its sibling paradigm, this second paradigm is not as widely known and its epistemological assumptions are based on examining the effects of multiple members of a groups and their impact on one another's learning (Ickes & Gonzalez, 1994; Shawer, Kobrin, Packman, & Schmidt, 2009). In their study of changes in motivation, Shawer et al. (2009) examined the effect of their intervention through small group discussions in order to measure the presence of change. They found that the "addition" of the social context of data collection added to the depth of the data that were presented for analysis. This intersubjective paradigm allows the reactions of multiple individuals to their interactive experience and the shared constructive experience to be examined through their interactive behaviors and language (Ickes et al., 1988; Wegner, Giuliano, & Hetel, 1985). This study has been designed to allow the interdependence of the participants to be presented and these patterns can be examined as a body in addition to the individualized responses. Based on the evidence presented in the literature, these peer interactions and mentor interactions can be key in the formation of self-efficacy and may present a more detailed view of the process.

Through the inclusion of both of these qualitatively measured paradigms, the research design can be fully articulated as it allows the researcher to examine the effects of the SEA on the self-efficacy both in the context of the individual as well as the overarching group processes that occur over the course of the experience using a phenomenological approach.

In order to allow for the comparative portion of the research – seeking to find the commonalities of results between the various SEAs - case studies were used in the comparative portion. Yin (1994) explained that using case studies in qualitative research allows the researcher to investigate a concise specific occurrence within the confines within a multi-variable context otherwise known as normalcy in day to day life. In treating each SEA as a separate case study, the comparison of each is more readily accomplished. The comparison of individual case studies has allowed multiple research studies the opportunity to use the 'end-products' of field research to give a much more broad and rich analysis (Berg, 2009; Merriam, 1998; Merriam & Associates, 2002; Rubin & Rubin, 2005; Stake, 1995; Wolcott, 1994).

The use of case studies allows the researcher to compare the experiences and learning of the members of the programs within the study. The epistemological difference that may be present between the subject groups allows the researcher to create a more insightful view of the cognitive experiences as posited by the Social Cognitive Intersubjective Paradigm.

The foundation of these case studies lies within the focus group discussions with multiple focus groups from each SEA. Each SEA contained at least two unique focus groups. The use of focus groups allows the research to evolve into a richer and deeper understanding of the perceptions and efficacy beliefs of the participants. The focus groups were created as typical case sampling from willing participants within each SEA as a method of purposively sampling (Given, 2008). These typical case groups reflect Becker's work with medical students as he sought to study students who were more generalizable than others (Becker et al., 1961). During the course of the program, the groups met with the researcher and engage in an informal discussion with guiding questions that scaffolded and allowed for follow-up and clarifying questions. Focus groups are the selected procedure as they allow for greater revelatory depth of the intersubjective paradigm.

In an effort to create a comfortable environment for the group participants, the process was explained and the option to withdraw without prejudice was assured. The purpose and implementation of the audio recording of the session was also explained. Additionally, the participants were advised of their option to read through the transcripts upon completion if they have any concerns about their responses. The audio recordings were transcribed and then coded in order to ascertain identifiable trends in the data. The identified trends were then compared between the focus groups from the different SEA programs.

Focus group data was accompanied by participant journals. These journals were used by the participants as a forum for responding to prompts, brainstorming sessions for ideas, metacognitive documentation, and personal reflection. The use of these journals as artifacts has been well established as a method for exposing the internal beliefs and perceptions of study subjects in creating the deep and rich data mine (Berg, 2009; Hodder, 1994; Merriam, 2002). Journal writing allows the researcher the advantage of interacting with the experience of the subject in a non-judgment or non-confrontational manner as there is a lack of response by the researcher (Janesick, 1998).

The final supporting data to complete the required triangulation for this qualitative study are personal interviews with at least four participants from each SEA (average enrollment of 25) to complete the case study of each. This triangulation assists with concerns of trustworthiness and credibility (Shenton, 2004). These interviews were held as follow-up interactions with participants after the program was concluded. Interviewees were identified and invited to participate at a scheduled time in order accommodate the participants' schedule. Interviews occurred via telephone or internet (using Skype) and consisted of brief open-ended questions that allow for follow-up sub-topic clarifications and probes in order to continue the flow of dialogue as suggested by Rubin and Rubin's 2005 work on structured interviews.

By creating a summary of experience and perception changes, if any, through the triangulation of these three sources within each SEA, the composite product allows each SEA to emulsify into an individualized phenomenon that can be compared and contrasted and allow the similarities and differences to come to light for examination. This allows the research questions to be explored and be supported for trustworthiness concerns (Merriam, 1998; Yin, 1994). By exploring these questions in this manner, I was able to achieve a missing link in current research – the link that takes SEAs and pits them against each other to sift through the data and find what works across the board or for the specific demographics addressed.

Data Collection

The collection of data occurred through multiple tools as discussed earlier and include: focus group discussions, personal journals, and post-academy interviews for each SEA. Focus groups were made up of five to eight individuals purposely selected in an effort to meet the standards of Typical Case Sampling criteria (Given, 2008) from the pool of those who agreed (as well as their parents) to participate. Once selected, the group met in a conference room near their instructional classroom during the sixth day of their respective program. This day is selected in order to allow a significant amount of time and curriculum to be covered. The participants met with the researcher and after receiving verification to participate in this particular part of the research, the researcher explained the multiple recording devices being used (three placed around the conference room in order assure that all verbalizations are recorded) and the process of the questions, follow-ups and probes. Once this occurred a series of basic questions began with follow-up questions for clarification added as deemed necessary. Member checking was explained and offered to the focus group participants. The basic guiding questions for the group included:

- Can you share with me your understanding of the role of engineers in your life before you came to (name of the SEA) this week?
- What understandings will you take away from this experience?
- What are some of the things you will share with your friends and family when you leave after this week?
- Describe the attributes of a good engineer now? How do you think those attributes can be developed?
- Who has influenced you to: (a) attend this program? (b) consider engineering?
- What kind of student in your age groups should consider being an engineer?
- When you arrived at (name of SEA), why did you feel Engineering was a field you were interested in pursuing? How did (name of SEA) influence your view?
- How has attending (name of the SEA) affected your view of yourself as a person? As a future engineer?
- What are the things you wish we were doing as part of (name of the SEA) in order to help you understand engineering?
- Have you planned to attend college and what have you learned about attending college from (name of the SEA)?

At the conclusion of the focus group, the recordings were transcribed and member checking was once again been offered to participants with changes made as directed. The resulting transcripts were then be loaded into NVivo software and coded. Initial coding sought specific relevance to the research questions. Coding included terms or phrases such as:

- Want to be an engineer
- I am interested in . . .
- My favorite part was . . .
- I think I learned the most from . . .

Additional coding included data regarding the social interactions they may have had with other participants as well as group dynamics they comment about during the discussion.

This data were triangulated with the daily journal responses completed by the participants twice each day throughout the program. At the beginning of each day during the program, the participants were given a prompt to which they were asked to respond. Some prompts were a reflection of the previous days' activities while others were geared more toward ascertaining perceptions or opinions of the participants. These journals were copied (as per the participant agreement) and retained by the researcher with the original work being retained by the participant. Journal prompts pertaining to this study include (this is not a comprehensive list):

- What are the traits of a successful engineer you have met? Describe the traits you have.

- As an engineer, what problems would you like to conquer over your career and how will you start?
- Why do you think there are fewer (female engineers/engineers of color) currently in practice?
- If a classmate told you they could never be an engineer, what would you tell them?

The final piece serving to establish and support the data was follow-up interviews that were conducted via phone at the participants' convenience. These short interviews were conducted approximately 3 months after the conclusion of the program and consisted of brief, open ended questions to allow the participant to share their perceptions and beliefs that had now been subjected to time without the benefit of the regular interactions of the program, their peers enrolled in the program, and the program faculty. At least three to four participants from each program were purposively selected from participants in the original focus groups for this procedure and although the majority of the questions were general to the group, a small number of follow-up questions may be used as pertinent to focus group responses collected previously. The purposeful selection may be based on the level of participation or responsiveness to questions and interactions with the peers during the focus group activity. These brief interviews were scheduled ahead of time at the convenience of the participant. While the majority of the interview were largely unstructured but had specific follow-up questions based on the earlier focus group responses. Initial questions were based on the following scaffold:

- Describe the learning you feel influenced you the most.
- As you have shared what you learned, what kinds of response did you get from parents, peers, and teachers?
- Do you feel you could be and engineer and do you think you want to be an engineer?
- What should we do next year to help future participants learn about engineering and get them interested and confident?

Role of the Researcher

Within the SEA, I am a central figure as the initial designer and administrator of the SEAs. Although I interact with the content in the initial planning, the instructors create the individual lesson plans. Each SEA instructor is given relative autonomy in the selection of learning activities within the confines I have established concerning time and materials limitations as well as relying on their professional expertise on age appropriate learning. In order to limit the influence I have on the curriculum and content, once I approve the unit and lesson plans of the SEA I distance myself from the instructional process and limit my personal interactions with the participants to recreational activities.

As the administrator of the SEAs, there is a concern that the students may have approached the data collection methods from a standpoint of wanting to 'please the teacher' (or administrator in this case) and give responses they believe are more desirable. Based on the ages of the SEA participants, this may be a serious issue from a validity standpoint. For this reason, I have tried to design questions that have no obviously desired response other than informing the participants that I am seeking honest responses in the hopes of improving the programs. With the continued practice of interacting as little as possible with the participants in the academic portion and positioning myself as a more relaxed discreet presence during the evening recreational activities (including a few meals and off-site activities as a vehicle driver) I believe that I was able to be established in the minds of the participants as an allied outsider as advocated by Denson and Hill (2010) and Knox et al. (2003).

The final limitations that may exist in this study from my position are the fact that as a male studying the effects of program facets on female students; their responses may be guarded or nuanced in such a way that I may not fully grasp their meanings. Additionally, as a researcher from a hard science background, the use of qualitative research methodology may tend to create a challenge due to the lack of binary output. For both of these concerns, the task of creating a deep and rich description within the case studies becomes imperative.

As a researcher conducting a study within 'my own backyard', I followed a strict protocol of separating myself from influencing data collection through multiple recording devices to assure that all transcripts are complete. Multiple arguments both for and against this practice create a template of protocols supporting the use of this type of study as well as the assurances that need to be in place to avoid bias as much as possible.

Data Analysis

Analysis of the qualitative data collected was completed through a full transcription of the digital recordings and offered member checking. The information was then coded using a digital program (NVivo) to cross code and seek similar trends in the conversations and identifiers. NVivo was selected as it allowed me to identify specific trends and key words in a highly visual form. By identifying the commonalities among the various focus group discussions, the researcher can find areas for comparison and contrast in practice and result. These commonalities may include the practices or curricula that elicit positive responses or repeatedly identified negative responses. The same basic process was also used with the participant journal responses and individual interviews.

Additional analysis sought to identify the influence of the variable between the programs that may indicate a greater impact, if any, that race, age, or gender may have on participant reactions. The data collected from young women who attended a single gender program (WISE, BATMEN & WIA) was also specifically compared to the data from co-ed programs (E4E & MSTI). Similarly, reactions between the high school aged participants (E4E, WISE, & MSTI) were contrasted with the middle school level participants (BATMEN & WIA). Finally, the program specifically intended for students of color (E4E) were compared to the same age group programs that lack a racially specific target audience (MSTI & WISE).

The initial coding included some A priori codes but also included grounded codes as the process developed. I sought to identify key terms outlined in the following table as they may pertain to the research questions:

Additional coding occurred using descriptive coding and after the identification of chunks of content were identified as themes that had import or pique interest, these chunks were be grouped and labeled and developed into identified themes within each case study of the individual SEAs. Some of these larger chunks of data that were mined were those that reflect the Competence beliefs, task value beliefs as well as those interactions (conversations or joint learning) between subjects (Intersubjective Paradigm) and independent of peers (Subject Paradigm). After conceptual schemas were identified, an initial ven diagram (graphic organizer commonly used for comparative processes) was applied to initiate a comparative analysis and a more Analytic or theoretical coding process began. This allowed me to identify distinct similarities and differences without immense detail which can then be used to condense the significance that may be present and applies in a non-hierarchical coding form. Using this process from keywords to schemas from a constant comparison technique to the non-hierarchical coding method allowed me to interact with the data with a guided purpose and result in a more complete case study comparison process (Ryan & Bernard, 2003).

Table 2

Research Question Alignment

Research Question	Possible key terms/phrases
Does attendance at a SEA affect the self-efficacy of attendees toward the study of and career in engineering?	Want to be an engineer Decided/made me decide to . . . Changed my mind about . . . Studying engineering . . . I am interested in . . .
Does the influence of the peer group of the SEA (ie. Gender mix, age, racial makeup, content generalization) have a marked effect?	Drama New friends that are like me . . . No boys/girls made it . . . College is too far away . . . As I think about college . . .
Identification of presentation methods having greater influence.	My favorite part was . . . The most important thing . . . I really liked the time we . . . I think I learned the most from . . .

CHAPTER IV

RESULTS

Context

The SEAs were addressed early in the methodology section so I will not explain them at this point instead concentrating on a fuller view of the overall mission of the Outreach Office. Through the implementation of 15 programs (in addition to the SEAs) the Outreach Office seeks to implement its mission statewide. The Outreach Office is the host of the Mississippi Boosting Engineering, Science and Technology (BEST) Robotics program. BEST is a national program that began in 1992 by two Texas Instruments engineers who desired to encourage young people to investigate engineering as a career option. They knew that most students and schools could not afford the very expensive 'toy based' robotics kits and programs (ie. LEGO, VEX, etc.) and they also wanted to foster young people's interest in marketing, technical documentation and programming while building their self-efficacy towards those areas as they find success in their projects. Through tapping into the interest of the students and then providing the opportunity for successful implementation, self-efficacy could be constructed (as suggested by Eccles, 2005). The Outreach Office of the COE has been the lead host of the state level competition since 2006. As many as 450 students participate in school based teams annually.

In 2009, the Outreach Office introduced the SeaPerch Robotics program which is a much simpler program with an underwater remote operated vehicle (ROV) as the central build activity (www.SeaPerch.org). The target of SeaPerch is the middle level grades but high school teams are also encouraged. Each spring, the students build and engineering their ROV to complete an underwater task. The Outreach Office has been able to engage over 300 students in Grades 5-9 annually through this program.

The Outreach Office has been the sponsor and host for the Region Five Mississippi Science and Engineering Fair (MSEF) for almost 25 years. Students from the 16 counties around the university travel to the campus to compete for a place at the state level and international level. Over 2000 students in Grades 1-12 participate annually. Teacher training for student-centered research is a hallmark of the program as well. This program seeks to build awareness of Science and Engineering among the young participants as well as the opportunities that are available through attendance at the university. University students (undergrad and graduate) as well as faculty and research staff serve as judges as coordinated through the office.

In an effort to reach younger children and their families, the Outreach Office conducts Family Engineering Night (FEN) events for students in Grades K-6 and their parents. Held at the school site, the Outreach Office utilized open space to create a set of hands-on activities that encourage the children and their parents to interact with basic engineering, math, and science concepts in an environment similar to a children's exploratory museum. The 30 activities range from cantilever building with dominoes to sound proofing challenges, and three dimensional design activities. All of these activities generally take 3 to 5 minutes to complete. Families also participate in a 45-minute classroom activity that simulates the work of engineers. Some of these activities include the creation of a simple aquifer modeling the process of providing clean water; creation of a vehicle that required wind powered propulsion, and a mining ag activity requiring the participants to remove valuable 'ore' without much noticeable damage to the environment.

The Outreach Office is also actively engaged in providing resources for teachers in K-12 through teacher workshops and trainings. The majority of these programs are grant funded with very specifically focused intended outcomes. These programs include: Mission Eggcellence for Grades 1-5 which concentrated on crash safety through passenger restraints, impact reducing bumpers and barriers as explained through the use of active Newtonian physics concepts; Mission Intermodal for Grades 5-8 using a large variety of hands-on activities to explore the globalization of transportation of people and products giving participants an awareness of how people and products get from one place to the other through the lenses of safety, economics, and environmental impact; As the sole University Affiliate for the Project Lead the Way program in the state of Mississippi, the Outreach Office is the source of all teacher training for this nationally recognized curriculum for engineering in the middle school and high school classroom.

Within this section, each research question will be discussed with evidence gathered from the data sources from each program including participant journal entries, focus groups, and individual interviews. Brief introductions of each research question will allow the evidence to be better understood within the context for analysis. The contextual pieces are similar within each program allowing the data to be compared both within and between the various programs previously described.

The first section will identify the effects of the participation in the SEA directly on the self-efficacy of the young people in attendance. Using the journal entries, focus group discussions, and interviews the self-efficacy of the participants is examined for change. These changes may emerge through an increased comfort level with content or within the participants' belief that their access to success (self-efficacy) has improved after participation. The second section examined the data regarding the specific instructional practices for effect on the specific demographic subgroups. Each program used role model interactions, real-world applications, and hands-on projects to teach content. The participants within each subgroup contributed to the data pool in seeking to identify if any of these was of particular impact.

The final section then examines these same practices in the more generalized sense. Rather than looking at effect by demographic subgroup, the participant pool in its entirety is used as a sample. This section will address the impact of all of these instructional practices and the impact they had on the self-efficacy of the participants toward engineering.

Influence of SEA's on self-efficacy towards engineering

Keeping in mind that the purpose of this study is to identify any effects on self-efficacy toward engineering rather than content area understanding, I am seeking to identify what practices or paradigms influence any changes that may occur. These influences include the peer to peer interactions, role model to student interactions as well as the content explored through the program elements. These changes may be seen through the language used by the participants in each data source. Within each SEA, there are a series of identical journal prompts, focus groups with shared questions, and shared interview questions. It is through these data collections that I am seeking to identify any change in self-efficacy that may occur among the participants of the SEAs. In seeking to identify any influence on the self-efficacy of the participants, there are some indicators that are more readily identifiable including identification of common traits between practitioner and observer, ability to achieve an acceptable outcome predicated on expectations, and a sense of commitment that continues over time (Pajares & Usher, 2008). Over the course of the programs and beyond, I asked the participants to: (1) identify those traits that they recognized within the practitioner engineers with whom they interacted; (2) identify the some of the specific work they identified being done by the practitioner engineers; and (3) identify their long-term goals and how they (the participants) would overcome possible obstacles that may dissuade them from their intended career choices.

Using data from the participant journals, focus groups and individual interviews, I have laid out findings that indicate changes in perception or reinforcements of existing perceptions that may result from participation in the SEA programs. It seems relatively easy to see that the majority of participants gained a greater understanding of the traits of engineers (critical thinkers, creativity, questioning) but would this also translate into their own beliefs about themselves in that role? This is that gain in the self-efficacy of the participants that is being sought. These traits (or personal characteristics) are helpful in identifying self-efficacy measures as Bandura (1982) outlined them to be the cognitive identifiers within a students that can be translated as connections to others who have found success within the area of interest. Identifying these traits allows the SEA participants to relate to engineering beyond the academic knowledge to really cognitively identifying engineering as an area in which they feel they can succeed – or retain self-efficacy (Eccles, 1983; Kimmel & Rockland, 2002).

Many of the participants developed a portion of their self-efficacy after gaining a greater understanding of the work of engineers. This understanding is common among short-term immersion programs and is sought as a measureable output by many (Mooney & Lauback, 2002). The lack of operational definitions of the work of engineers and the skill set of the engineer that was the first obstacle to be overcome in developing the self-efficacy that will hopefully later develop. On the first classroom day of the program (usually Monday), participants were asked in journal prompts to describe their understandings of the field of engineering before they arrived at the SEA. There were a variety of responses with a few core beliefs including:

"Engineers do math and science all day. They mainly use computers and write programs for stuff," wrote 2012 MSTI Participant 1126.

"Engineers try to make things better and easier to use. They build things," stated a participant in the 2013 MSTI program.

"Engineering is constructing buildings and using math," was the view of a 2013 BATMEN participant.

"I really don't know what engineers do, my father is a Medical Engineer and all I know is that you have to do a lot of science," according to a 2011 WISE participant (4226).

"Engineering is about using Math and Science to help people like make a new Nintendo," according to BATMEN participant 2107 in 2011.

The common theme is the absence of content outside of mathematics and science. As we began the programs, the use of creativity and questioning were not mentioned by the participants. In referencing many of the application essays, many participants had listed themselves as being creative but at the beginnings of the programs this does not seem to be something they identify as a trait of an engineer. It was through the process of problem-solving during the activities that many of the m began to identify the need for these traits. These were also the moments when the connection of traits to their self-efficacy began to take place – the "Look what I did" epiphany seen in observation. As many documented in their journals, it was here that their pre-existing competencies in creativity were seen as part of the assets of an engineer. To identify their personal creativity as a part of them that is shared with the iconic engineer within their understanding allows their own self-efficacy as an engineer to be bolstered. For those who did not readily identify their creativity as an asset, it was important that they identify as many traits of a successful engineer as possible.

In searching for changes in understanding about engineering, and their self-efficacy, one of the most revealing prompts in the journals was given on the Thursday of each week asked the participants to respond to: 'What are the traits of a successful engineer that you have met? Describe the traits you have.' In asking participants to identify the traits they see in the practitioner engineers, I am seeking to see if they identify themselves as possessing those same traits as an indicator of their self-efficacy through their correlation. This use of trait can assist the participants is seeing beyond the engineering content to the possibility of emulating the individual with whom they are interacting (Akos, Lambie, Milson, & Gilbert, 2007). Once common traits between practitioner engineers and participants can be identified as commonality, the participants' self-efficacy is impacted. While the majority of responses centered on terms such as 'smart' and 'intelligent', a large number also mentioned that the engineers being described were 'hard workers'. A 2011 E4E attendee, 2048 spent almost six lines describing the level of effort an engineer may expend on a project: "When they start, they have to really understand the problem. Sometimes they have to ask lots and lots of questions. They have to be really creative too. The guy who talked to us about the car thing showed us that they have to try lots of ideas. They have to be creative. I think I can be pretty creative too. I love art and that is creative." This original identification of traits was carried over into the focus group discussion of the Focus group of 2011 WIA participants when I asked them to describe the attributes or traits of an engineer:

> 1118: "I used to think they really need to be smart and that was not me."
>
> 6666: "Why not? You did great on our last thing – the cantilever one"
>
> Nods of agreement around the table.
>
> 1118: "Yeah but, those people we talked to are, like, so freaking smart! That math stuff they were doing bout the wings and . . . you know, the thing . . ."
>
> 3333: "Lift?"
>
> 1118: "See? (laughing) I can't even remember the right words. But I think I could learn them – eventually."
>
> 6666: "But it is not like they memorize everything – that is why they have computers and books and stuff. So, like, it is more important that you can think about stuff and make a solution."

1118: “Yeah, okay, I guess so. It is just hard to imagine being that smart.”

6666: “But we can get that smart after we take the same classes. You know, like when we know that stuff too.”

Later in the discussion

2221: “You said about being smart” pointing to 1118. “I think we can all be that smart, we just need to see how we are just like them, you know, like, we are just a smart and we can ask questions and do the math.”

Participant 1118’s seeming reticence to self-identifying herself as capable was interesting as her peer, participant 6666, pointed out the inconsistency of the statements to her performance earlier. This helps identify the need to have peer recognition for some participants in building self-efficacy. Participant 1118 agrees with her peer’s point eventually. This recognition of creativity in conjunction with mathematical and scientific understanding was an interesting play that originated in the minds of the participants in this first year of the study. It seemed an important theme that began to emerge – the recognition of critical thinking skills fueled by creative solution seeking. Another source of gained self-efficacy was seen through the interaction with mentors and engineering practitioners. Although participants such as 1118 in the previous section identified the mentors as being ‘freaking smart’, the peer interactions allowed her to recognize her own ability to one day achieve a similar level of understanding. In her daily journal, participant 1403 from the 2011 WISE group, commented on a piece of advice she received during an interaction with a faculty member: “I learned that we should always ask questions and don’t be afraid to do so.” This new learning reflected another scaffold to her own self-efficacy toward the subject – that she felt an awareness and willingness to question and seek greater understanding. I followed up on this in an interview in August of 2011 and I asked her about this comment in addition to the basic set of interview questions. In her response, she mentioned that the statement meant a great deal to her as advice from an engineer whom she had begun to admire in their short interaction. The participant added:

> No one ever tells you to ask questions in school. They just want us to memorize the answers to the test. I like the idea of being able to always ask questions – if that is what engineers really get to do, that is what I want to do. Asking questions is easy. (2011 WISE participant 1403)

Through the trait identification and participant confidence in their own ability to refine or develop these same traits, the participants began to develop their own sense of identification between themselves and the practitioner engineers. As an individual identifies commonalities between themselves and the type of individual they are observing, the level of self-efficacy increases (Bandura, 2001). A 2012 BATMEN participant, 2107, agreed with this position in the course of a focus group session when he stated:

> Engineers have to ask lots of questions and it is okay. Everyone knows an engineer is just trying to solve the problem so it is okay to ask lots of questions. The hardest part is finding out the right questions to ask.

One of the fellow members of the focus group asked for clarification about this statement by asking: "what are the right questions?" This led to a discussion about learning how to question and is best summarized by 2107 when he stated: "that is what makes being an engineer so cool. There are no right questions, we just get to ask and ask." The use of questions in discovery appears regularly in journals and focus groups including statements such as:

"Engineers have to question reality and cannot accept no for an answer," 2013 BATMEN participant 1267 in focus group session.

"I love asking questions about stuff. I like books like 'How Stuff Works' and TV shows that teach you stuff. I think engineers are lucky because they get to ask lots of questions," 2012 E4E participant 2919 in daily journal entry.

"Engineers have to be creative but they also have to work hard and keep asking questions about their research so that they develop the best answer," journal of participant 2239 during 2013 MSTI.

WIA participant 7404 wrote in a journal entry that: "I learned that asking questions is important and good engineers ask lots of questions. I want to learn to ask these questions and then find the answers."

The ability to ask questions seems to be perceived as an important skill that many participants viewed as important and attainable. This is in direct opposition to perceptions that many of the participants brought with them to the program having been trained and immersed in the world of high-stakes testing as the key to academic success. Past experience in the modern high-stakes testing culture of schools may be influencing the participants who have been trained to simply memorize and regurgitate facts rather than using inquiry in their learning process (Trumbull, Serano, & Bonney, 2006). The original descriptions of engineers and their work were filled with a sense of constant success rather than identifying that an engineer seeks out a solution that may not be currently present. This is what 2013 BATMEN participant, 1448, articulated stating that an engineer "cannot accept no for an answer" while others commented that the answers the engineers sought were developed rather than known. The assertion by WIA participant 7404 that she wanted to learn to ask questions and get answers asserts her own belief that she can gain this ability – the desire is there already and the self-efficacy is also present within her learning.

There was one particular conversation during the second focus group with the 2011 WISE B group (B group was made up of students whose affect and physical mannerisms indicated a lack of interest and enthusiasm in the classroom setting). During the course of the discussion, the following interchange occurred between the participants:

> Researcher: "So, thinking back to Monday, I asked you to write what you thought engineers do. Please read over your answer and then tell me if you still agree with your answer".
>
> 7065: "Do you mean like, do I. like, still think that way or do you, you know, want us to tell you if our answer was right?"
>
> 3910: "Yeah, you mean did our answer change, right?"
>
> Researcher: "There is no right way to respond, I just want to hear your thoughts."
>
> 3693: (rolls eyes) "Ugh. I have learned so much this week, my brain is mush. I think I was right, that engineers build stuff and stuff. But, I think they do a lot of trial and error too. I don't think the (air quotes) 'EDP' always works though. I just kind thought they sit around and design stuff and then make it."

7065: (laughing) "You so crazy" pauses "He just wants to see if we still think the same, like, ideas, right?"

2200: "I think this has been pretty fun. I made new friends and everything. I still think engineering is really hard to do but I still think they do some cool stuff too. I wrote that they make new stuff, like computers, and inventions to make the world better. But, now I know they look at lots of ideas and have to ask lots of questions and try and try to get a good answer."

3693: (nodding in agreement) "But they do lots of little parts all the time. Some of it is super boring, I think. We did come up with cool stuff in the end. Like good solutions anyway. "

7065: "Yeah, I fell what you are saying but, I am sticking with my answer. I wrote that they do lots of math and build things."

2200: "Serious?" (pauses) "They do way more and you have think of new things, not just the same stuff again. Like that one lady said: You gotta think out the box."

7065: "Yep. And we can all do that. Like, you know, like we talked about. We can all be engineers if we want."

3910: "Like that one guy told us, we can do it. We just have to want to do and we can do anything. Just like with music and stuff. I think it is only boring if we don't care."

3693: "I didn't mean the stuff was boring, I just get tired of them talking to us instead of just letting us do the stuff. I guess the instructions were boring – and waiting for you slow groups to catch up." (Indicating another group member while smiling).

7065: "Yeah, okay, I can add that I can do the things that engineers do.. You want me to write that down?"

The evidence of self-efficacy occurs when the participants identify their desire (especially 3910) to perform the engineering. This desire to truly engage allows me to see that her desire is present even when her affect does not indicate such. The statements that engineering is difficult but that engineers do "cool stuff" indicates that participant 2200 has the self-efficacy to participate and a realistic understanding of the efforts involved – an essential part of Eccles supposition that a desire to perform is occurring (Eccles & Wigfield, 1995). As the participants seemed to place a high value on the knowledge or ability to complete the tasks, this value may have an effect on their interest in developing self-efficacy towards it (Eccles, 2007). Statements such as those of participants 2200 and 3693 indicate the importance of engagement into the task. By drawing them into the challenges and allowing them to question, apply creativity, and develop solutions, the individuals are able to develop a higher sense of efficacy as indicated in their later comments in the section. These changes are identified when they clarified their interest level had increased in spite of their original statements of 'boring' and 'engineering is really hard' and changed the terms to 'thinking out of the box' and 'cool stuff in the end'.

One of the challenges to the participants was developing the metacognitive understanding about their decisions. Meaning, how did the desire or self-efficacy develop in order to increase the retention of this view of themselves knowing that many of these participants will return home and may be influenced by new experiences that will affect their self-efficacy. Many of the participants' responses included an identification that gender had a definite role in the retention of self-efficacy in this area. Having identified that self-efficacy can come from a variety of influences; one may ask if females identify their gender as a liability to their self-efficacy in engineering.

In wanting to challenge them to think about their response to the learning experiences, I requested that they respond to a written prompt in their journals on the last day of the program that stated: If a friend told you they could never be an engineer, what would you tell them? Responses were varied but two common themes emerged with ties to gender.

"Lots of girls get scared of stuff like this because they don't see very many girl engineers. I would tell them to come to this program and they will meet some and see they are cool." 2011 WISE participant 1424

"I think that there are no really big women engineers so most don't see that it is something guys and girls can do. I would tell her that we can do it too. I just wish our teachers at school would talk more about it with the girls at my school." 2012 WIA participant 7940

"I would tell them don't be scared. It is hard but anyone can do it if they really want to. I learned that engineers are hard workers and I think that if you really want to do it, you should!!!!!![sic]" 2011 WIA participant, 1114

"I would tell them they are crazy to be scared. I mean, why not try. It is better than working at like, McDonalds or something." 2013 MSTI participant 1171

"I don't know. I guess I would tell them to not be scared of trying it. It can be cool and you learn lots of stuff that is pretty okay. I don't know if it is for everyone but it is okay." In a later conversation in a focus group setting, this participant stated, "I think now that being a girl should never keep you from wanting to be an engineer. I don't think I thought that before." 2012 E4E participant 2957

"Fine, don't do it. More money for me. No, serious, I think more people should do it. I think girls might have a hard time though because we learned that lots of boys are engineers but there are not many girls – it might be hard for them to make friends." 2013 BATMEN participant 2033

Reading the above excerpts that refer to the participants' past experience in their educational settings shows that their self-efficacy was not being built in the school setting but showed progress in the SEA setting.   In a brief interaction with this participant at the end of the program, he reported to me in a casual setting that three female members of his extended family were engineers – this was new information that his mother shared with him during the closing ceremony. I asked how he felt about that and his response included statements of excitement to know that he now knew of others in his family that he could emulate in his own life choices without regard to gender.

In comparing the two themes that emerged, it is interesting to read the number of responses that refer to a 'fear' of engineering or a career that might be difficult. This fear may be systemic toward perceptions of math and science difficulty but many of the responses also encouraged the friend to 'try engineering' rather than disregard. The second interesting theme was the number of assumptions that it would be a female friend who would make the prompt statement. The sources of self-efficacy by the participants outside of the program included teachers and role models. Within the programs, the participants repeatedly identified the information they were receiving, the role models, and opportunity for hands-on activities as scaffolds for their self-efficacy and that of their peers at home. Participant 2033 (2013 BATMEN) was participating in an all male program but identified that female peers may be reticent due to a lack of peers. During the interview stage, 2033 was asked this question again without referencing his original answer. His response did not seem to waver much:

> I think lots of kids think that engineers are, like, super dorky and have to be way smart. They might be worried they won't do well. I think that we all want to be good at our jobs so we will make good pay and like our jobs. I really think that if you try it and find new friends, you can do it. I did not think that lots of girls would want to be engineers. I mean, they might not like it because sometimes they are afraid of math as they get older and so if their friends are with them, they might do it really good.

While his response may not be politically correct, his message was likely appropriate based on his experience at school. I took the opportunity to ask a clarifying question, "Do you think women can be engineers even if they don't have friends who are engineers?" His response:

> Yeah. I mean, we met like, 5 teachers at the camp who were girls and they were super smart. I don't think it is any harder for a girl to be an engineer. It is just that all the girls at my school won't try anything unless their friends will do it. Maybe you should have a 'BATGIRL' camp for girls to come and meet other girls to be friend engineers? I am still friends with my roommate from camp and

we live in different states but it is nice to have someone who likes the same things. (2013 BATMAN participant 2033)

Unbeknownst to this young man, each program in this study had at least that number of female engineering practitioners presenting and working with the participants. His identification of these interactions as possibly enhancing the self-efficacy of others bears hi own value of these interactions to his self-efficacy.

In seeking to determine whether the participants had experienced a change in self-efficacy toward engineering, I was unsure as to the level of change that may or may not occur. Of the entire 232 participants who agreed to the study, 98 (42%)had clearly stated on their interest forms at check-in that they were not currently considering engineering as a possible future. The remaining 134 (58%) participants had indicated that they were interested in a future in engineering. Although the majority of the participants had self-selected to attend the program, there was an underlying question as to why one would attend a program about a topic that was a possible non-interest area.

In addressing this concern it became apparent that a clearly worded request for direct information is needed. Within each data collection technique (journals, interviews, and focus groups) the question, in different forms, was asked: How did the [SEA experience] program influence you to consider yourself capable of becoming an engineer?

The responses were varied and the challenge of identifying central themes was increased by the variance in age and initial beliefs. In reading the journals, I could see that the majority of participants gained a greater understanding of the traits of engineers (critical thinkers, creativity, questioning) but would this also translate into their own beliefs about themselves in that role? Eccles (2005) indicates that in creating interest that is followed by actions, self-efficacy is built. The journal responses allowed the individuals to respond without peer interaction. The prompt was given the day before each program ended. It did challenge some of them to think deeper than usual about their responses but there were some standard two sentence responses as well.

"I have been to lots of camps like this one. Mostly math camps. This one made me do more than math and it was a challenge. I didn't think engineering would be a good fit for me but I like that we used math to solve problems like the elevator project" journal of 2011 WISE participant, 1211.

"I had a great time this week making friends and doing stuff with girls like me (geeks unite!!). I love engineering even more now. I love that we learned how a math problem can be used to solve other problems. I know that the one professor told us there needs to be more engineers and I think there would be more if they saw the cool stuff you can do" journal of 2012 WIA participant, 9612.

"I think next year I will come back to this camp because I learned a lot about different types of engineering and designing stuff. The reason I want to keep learning about engineering is that most kids in my school hate math and science but here it is cool. I want to come back to learn more about Chemical Engineering (which is NOT chemistry!! LOL)" journal of 2012 E4E participant, 9082.

"I've learned that engineering is a great field and women should pursue just as much as men. Too many women are afraid of math but I learned that math is easier when you are engineering something. This camp has encouraged me to possibly pursue engineering later on in life" journal of 2011 E4E participant, 7658.

This first theme was repeated by young women primarily. It seems apparent that for many of the respondents, the programs allowed them to see engineering as a compliment to their interest in mathematics concepts, desire for creative outlets, and identification of models or mentors to follow. Additionally, the journal entries above show that interest was piqued thought the interaction with practitioner engineers and the program in which they were enrolled. The specific impact statements of "this camp has encouraged me", "I want to keep learning about engineering", and "I love engineering even more now" all suggest that program participation had a positive impact on their self-efficacy. Perhaps it is this new avenue of access to mentors and problem based learning experiences that has had an impact on their self-efficacy. This was also seen in many focus groups when there were only women present (WIA and WISE). The following conversation came from the 2012 WIA focus group A:

> 7128: "How did the camp make me feel about becoming an engineer? (pause) I guess, it is the same. I wanted to be an engineer already but I did learn that I do not want to be a chemical engineer. I thought they did, like, chemistry and mixing stuff but they don't. I think I really liked the mechanical engineering stuff more."
>
> 7404: "Yeah, I think so too. My mom is an engineer and I really want to do it to but I am always bad at math so I thought there was no way I could be an engineer. So, what I learned is that the stuff they teach us in math class at school is stupid. I learned so much more with our teachers here – they really showed us how to use math and not do math."

9612: (laughing) "Totally. Now we can (using air quotes) 'create math not just do math'."

7940: "I think I learned that I can do engineering because it lets us be creative, use math and science and make the world better."

7404: "I think that more people should know how engineers make the world better. I mean, the stuff they are designing at that place . . . where they design the wheelchairs and stuff. You know . . ."

Researcher: "The TK Martin Center?"

7404: "Yeah that, place. I mean, it is amazing. I really think I want to help people like that. That one guy was using physics to figure out the best steering wheel – that is awesome. It is, like, science and math had a baby and named it engineering."

This conversation allowed me to see that while the engineering design process and the concepts of engineering may have been new to the participants, they were discovering the relationships between their established schema and the could scaffold in the new concepts and practices. The comments of application of mathematics refer to a large number of activities completed during the program. This compared to the common practice in education referred to as 'plug and chug' or 'do all the even problems on page X', is seen as the direct application of learning in mathematics (Becker, 2010; Eccles, 2007). These relationships have direct impact on the self-efficacy of the participants. This adaptation of engineering into their lives was not unique to the female-only programs. There were similar conversations in other focus groups as well. One conversation that stuck out was during the second focus group session of the 2012 E4E B group:

> 1370: "I still don't want to be an engineer. I mean, it seems cool and stuff but I have always wanted to be a professional musician. This was cool and all but I still hate math."
>
> 9082: "I learned a lot and I think engineering might be a good thing. I like math class but this camp helped me see math as a real thing not just answering problem. You know? Doing the odds on page 40 is dumb to me now. I wish my teachers would really teach us how to use the math instead of stupid practice questions over and over."
>
> 2857: "I hate when they give us pages of problems for nothin'. So stupid."
>
> 1370: "See? This is why I don't want to be an engineer. That list that they gave us about the classes? There were like, a million of them."
>
> 8038: "But, my sister is here at college and she is majoring business and she has to take lots of math classes too. Doesn't everyone?" (asked to the researcher)
>
> Researcher: "I am not sure about the class requirements for each major. Will that have an effect on choosing your major?"
>
> 8038: "no"
>
> 1370: "Hell, yes. I am not doing any math after I graduate high school."
>
> 3978: "That is ignorant. Math is everywhere. You can either do it earning a good living as an engineer or making change at McDonalds."

1370: "No, at McDonalds the cash register tells you how much to give" (rolls eyes and crosses arms).

3978: "Whatever. My point is that math is important and engineers at least use it to accomplish something. I think I learned that I can be an engineer but I better take my classes at school more seriously."

Researcher: "3423, what do you think?"

3423: "Sorry, nothing. (pause) I was just thinking it would be cool if we could take an engineering class in high school that would also be a math class. I think the math we did here was easier to understand. But, maybe that is just me."

1370: "But you are already smart."

3978: "You are just making stuff up for drama. You did all the math for the elevator project we did."

1370: "That was easy though. You could see the gears and the ropes so you didn't just use numbers."

What makes this interaction interesting is the way the participants interacted in supporting the one member who is most vocal and most negative toward engineering as a field of study. It almost seemed that the peers sought to convince her that she was capable in spite of her own self-efficacy. It important to add that while these peer to peer encouragements were evident in the confines of the focus groups, there were a number of incidences observed casually during the programs where peer encouragements were a substantial encouragement to other members of the group toward completing the tasks. Additionally, within the theme, is the participant identification of applied mathematics rather than learning in the abstract. There are a number of incidences within each program where participants worked in small groups and conversations occurred in a casual setting. I wondered if this type of peer supported acquisition of self-efficacy.

> The girls in my group are really smart. I like having them around when we do stuff. They are nice to me and no feels like they should act dumb. I like math and I like engineering now more than ever. I hope we can stay friends after we leave too. (Journal entry of 2012 WIA Participant 9612)

This statement is an indicator of the value of peer interaction in learning activities. It is apparent that this type of interaction that occurred in focus groups also occurred in some of the informal interactions among the participants. Peer supported self-efficacy can have a very strong influence on choices.

Another theme that emerged was the importance of the broad survey of engineering rather than a single field in building the self-efficacy of the participants. There is significant diversity in the application of engineering concepts between the specific fields of engineering and more broad approach allowed the participants to find the niche that matched the self-efficacy they were developing. The MSTI program is the sole program that is narrowed to a single engineering topic – Civil Engineering – and that seemed to have an influence on participants of that program. From the journals and focus groups within MSTI this becomes a recurring topic.

"I liked the camp but I wanted to learn more about engineering. Not just building roads and bridges" (2011 MSTI participant 2309 journal entry)

> This was my second camp here. Last year we went and saw lots of cool things. This year we just did the civil engineering places and stuff. I learned that I do not

want to be a civil engineer. Do you do a camp just for rockets and planes? (2011 MSTI Participant 4260)

Everyone was really nice but asphalt is BORING [sic]. I liked when we learned about dams and locks. I liked when we made the cars with seatbelts. Why can't we do more like that? My brother came here before and he said they did lots of stuff. He is here learning mechanical engineering – that is what I want to do too. (2012 MSTI participant 8116)

These comments seem to indicate that the participants had a desire to learn about a more broad view of engineering. They seem to identify that this desire was not sated with the limited view they received. Instead, their self-efficacy may be in seeing various fields. It almost seems that in a survey will allow the participants to select an area within the fields and result in greater self-efficacy within one or more. Again, the choice and interest may be a key component to finding the roots of self-efficacy (Eccles, 2005). Vogt, Hocevar, and Hagedorn (2007) supported the belief that interest was the first step in building self-efficacy.

The 2013 MSTI focus group A also helped to shed some light on this theme as well.

7171: "I still want to be an engineer. My whole family are engineers."

6803: "I think that coming here helped me learn about engineering (or at least civil engineering). I just think we should have learned more about other kinds of engineering earlier in the camp. You waited until the last few days to have those people come talk to us. I learned lots from them about their kind of engineering and I liked that more."

1171: “Yeah, that computer lady was cool and her robot is really cool. I want to come back and make stuff like that.”

3425: “I thought I wanted to be an engineer but I thought they made motors and electrical stuff.”

6803: “Yeah, that is what I am sayin’ too. Engineers do lots of other stuff besides what we did. You need to show people all the other stuff too.”

3710: “But, we knew when we signed up that this was only about transportation stuff. So we shouldn’t complain. I don’t mean to offend but you should really mix this up more. I learned a lot and I liked all the stuff we learned but some was so boring.”

Researcher: “Okay, I think understand. Are you saying that if we did more activities with other areas of engineering that you think you would make you feel like you would want to be an engineer?”

3710: “Yeah.”

Researcher: “Can you help me understand why you think this would change your thinking?”

3710: “I don’t know. I guess because we already do so much boring stuff at school. We come here because we want something different. Just sitting there doing boring stuff will never make me want to be an engineer. I want to be inspired! (laughter)”

Researcher: “So how does coming to a camp like this help young people see engineering as a possible career? Or can it?”

1171: “I think it can help us decide to be an engineer. We just need to be able to see more stuff. Cause if we don’t like this kind of engineer, we might like another kind but we never saw it.”

7171: “I think some of us learned more and want to be engineers now. I know that we all learned a lot about engineers though. I know my roommate said that he thinks he can be an engineer now – that it is not impossible.”

The responses from the MSTI focus groups each year followed much of the same pattern as the above sample. Many students did not feel that the topics of the MSTI content (as prescribed by the grantor) had an effect on them. I felt in reading the transcript that they felt vested in giving feedback to help the researcher create a program that would yield a change in the lives of the participants. The most interesting part of these responses is the diametrically opposite direction of interest level. Other groups were very clear in expressing that the SEA program helped them feel that engineering careers are of interest and attainable while the MSTI feedback was more critical and the frustration level was higher. This may hearken back to some of the concerns previously mentioned about a single topic area which may not have been as well suited for the self-efficacy being built.

In examining the data gathered, there is a definite sense that participants did gain a sense of self-efficacy toward the study of engineering. There are points in journals and interviews specifically stating that there have been gains in both understanding as well as an increase in the desire to pursue and engineering career. In the process of checking out on the final day of the program, participants completed a final journal entry before they turned in their journals. The final prompt asked: if they felt they would pursue a degree in engineering now (regardless of their initial survey answer). Additionally, if someone tried to convince you not to be an engineer, what would you tell them?

Responses to the first question were generally a single word response of yes or no. There were a few non-respondents but of the 214 collected responses from the initial 232 participants, there were 146 (68%) responses that the participant did intend to pursue a career in engineering. Interestingly, there were an additional 27 responses of ‘not sure’, ‘I don’t know’, or ‘depends’ which accounted for roughly 13% undecided. Lastly, there remained 41 participants (19%) who indicated that they were not planning to pursue a career in engineering. Although the initial survey did not provide an option for ‘unsure’, there appears to be a small gain in the possible candidate pool as indicated in the table below. The greatest increases in affirmative responses were found in the WIA and WISE participants. This may be infer that the SEA participation has a greater impact on females’ self-efficacy.

Table 3

Responses to Question 1: Do you plan to pursue a career in engineering?

	Yes, or affirmative response	No, or negative response	Unsure response
Pre-program response	134	98	No option
Post-program response	146	41	27
Change	9% increase	23% decrease (10% decrease assuming unsure are negative)	

The responses to the second question were reviewed in the hopes of indicating sustainability of the influence of participation. This intent to retain this decision indicates a lasting effect of the participant's self-efficacy. Journal responses included:

"Lots of people just don't understand what engineers do. I will just explain it to them" (2011 WISE participant 2431).

"I will tell them to shut up" (2013 BATMEN participant 9243).

"I am not sure why they would say that except that they are stupid. Girls can do anything" (2012 E4E participant 1266).

"Anyone who tries to tell me I can't do this don't [sic] really understand what I can do as an engineer. I already told my parents and they are going to be supportive" (2013 MSTI participant 1562).

"I would explain what engineering does and they will change their minds" (2012 WIA participant 2531).

"I am not sure. I would ask them why they think I can't do it" (2011 E4E participant 2695).

In the interview process, I followed up with 2013 MSTI participant 1562 who had referenced her parent's support for her pursuit of engineering. I asked her if she still felt this strongly about her intended career choice. She replied:

My Mom is my best supporter and when I explained everything I was learning she got really excited. The only person who has been hard about it was my counselor at school when I tried to change math classes. She said I should take the transitions to algebra class but I told her I wanted to take Algebra 1. I already did the pre-algebra. I did not want to be one of the 11th graders in Algebra 1. My Mom had to yell at her but I got in. I have an A so far.

At the time of the interview, the mathematics course she mentioned, was in the second 9-week grading period. She attributed her strength to keep her conviction on the influence of her attendance of the MSTI program. She related that she now had a "map to be an engineer and what classes" she needs to take in high school.

Effective Instructional Practices between Identified Subgroups

Within the mission of the Outreach Office and the SEA programs is the goal to specifically target traditionally underrepresented groups including students of color and women. With this in mind, the WISE and WIA programs are limited to young women. The MSTI program recruitment targets rural populations of students but does not limit acceptance based on this factor. Additionally the MSTI program has a much lower GPA threshold (2.5 minimum versus a 3.0 minimum) in the application process and has a very low cost to the participant (grantor allowed a $50 processing fee for 2011 and 2012 but then rescinded the decision and disallowed any cost to the participant) while the other programs had a more significant cost (generally $250 - $425). This difference may have had an odd effect on the applicant pool that resulted on a much lower application rate of Caucasian and Asian students. The E4E program specifically targeted students of color but did not disallow any applicant but does maintain the higher tuition cost and minimum GPA requirement.

While there are a number of studies in content areas of science, math and technology that identify gender differences in approaching instructional practices, the use of race is less definitive than socio-economic status and rural student performance based on access within engineering (Pawley, Riley, Lord, & Harding, 2009; Sheppard et al., 2009; Stage & Hossler, 1989; Streetman, 2007). Race seems to have a lesser effect or appears as a lesser challenge than the socio-economic status of the participants. These studies repeatedly identified that socio-economic status is the greater impact on resistance to the influence that short term immersion programs, like the SEAs, may have on other students. Those programs involving rural students found similar barriers rose against this effect as well at a much higher rate than other indicator of resistance. Within the data of this study, there were a number of best or favored practices identified but these did not differentiate between the subgroups listed as expected. Among all groups the most commonly favored activities (and identified as building self-efficacy) were working with current practitioner engineers (including field trips to operating research facilities), participation in hands-on activities, and the use of 'real-world' or relatable problems in the context of developing solutions. Within the data collected from participants of all of the SEAs in the study, these all were mentioned or identified as having an impact on the self-efficacy in some way.

The only differences in responses between any subgroup were based solely on gender. Participants were asked to identify what engineers do at the beginning of the SEA and then again at the end of their program through journal prompt. The initial prompt resulted in a very bland result among the groups. Almost every participant response can be categorized under: (A) I am not really sure; or (B) They design and make things. There was no significant theme that emerged at that point. Within the journals of the participants of the WIA and WISE program at the end of the program, a unique theme emerged that was not seen from the participants of BATMEN (the sole male only program). That theme was the use of terms like: 'help people', 'healthier', 'safer', and 'environment' (referring to impacts like pollution). Seemingly, the ability to help others was a root in building their own self-efficacy or perhaps embedded in their prior belief that through assisting others, personal value is achieved. This may be due to the linkage provided during instruction and interactions that allowed the participants to see the work of engineers as beneficial and a desired outcome. The self-efficacy of the participants may have been bolstered by this connection as their personal desires to create a positive impact linked these pieces together.

Statements from journal entries include:

"Engineers make the planet better for everyone. They are solving problems like global warming and helping people with disabilities" 2012 WIA participant 7128.

"I want to be an engineer because we help people have a better life" 2011 WIA participant 2224.

"Without engineers there would be even less drinking water and more babies would die" 2011 WISE participant 1343.

"I have learned that engineers make medicines and health stuff that doctors can use to keep us healthier. They are also making food safer and easier to grow. I like that they do that and I want to find a way to make sure that kids stop dying of hunger and diseases and I can do that as an engineer" 2011 WISE participant 1403.

"Engineers make alternative energy easier to make and that is a good thing because we are using way too much oil and we need to RR&R" (note: reference is to Reduce, Reuse, & Recycle) 2012 WIA participant 7404.

In an interview with 2011 WISE participant 1343, we discussed her statement and she shared that this has been a concern of hers since the pastor of her church showed them photos of poor drinking water conditions in areas of the world. She shared, "I thought I would be able to help them on mission trips and stuff but now I know that as an engineer, I can do way more and make real differences not just temporary ones." I asked how she envisioned that difference. Her response was that as an engineer she could design whole systems for cleaner water instead of just a temporary fix and that she felt that is why God influenced her to learn about engineering.

Her self-efficacy in becoming an engineer has been bolstered by the combination of participation in the WISE program from which she gained greater insights to becoming the positive influence on the world around her that her faith had begun. It was through the exposure to the work of engineers that her self-efficacy grew. It seems that the combined effects of her religious or moral base in combination with learned engineering content has allowed her to visualize herself as a carrier of solutions. Her attribution of these knowledge gains to her participation in the SEA allowed me to see a definite impact on her self-efficacy in this area more clearly. In one of her final journal entries, this participant wrote about her 'testimony' of being 'called' to serve others and that God had put her on the path through this program.

In the 2012 WIA focus group A second session, one of the participants made the following statement:

> I think it was Ghandi who said to make the world better, we need to be the change in the world. Engineers do that all the time when they make a safer car, better engines that use less gas, and like, new heart valves and stuff. So, I learned that if

I grow up to be an engineer, I can make a difference and I like that. (2012 WIA participant 7128)

In a follow-up interview with this young lady, I had asked her about her future plans as an engineer and if she still felt strongly about becoming an engineer. She relayed that she was still using her original plan to be a pediatrician as a backup. She continued by stating that she thinks that "engineers that are making the world better" are her heroes. This is evidence that her participation in a SEA assisted in building her own self-efficacy toward engineering based on her realization that the work of an engineer creates a better world around her. Her self-efficacy is apparently rooted in her desire to do good for others.

Initially I wondered if this only occurred in the all-female programs because the statements were so overt among these programs. In reviewing the co-ed program data, I found a few statements from focus group interactions that indicate that the young women in other programs may have identified similarly:

"I learned that without engineers we would still be using really bad gas guzzling cars. It is important that we keep making better cars so that we don't totally ruin the world," 2012 E4E participant, 2014.

> Making the world better and helping people is the most important thing and engineer can do. I think engineers should come up with more cures for stuff. Like, that teacher who showed us how the diabetes pump was designed to help people with diabetes who can't control their sugars. (2011 E4E participant, 2695)

2011 MSTI participant 7536 mentioned environmental quality during my interview with her. She stated that "we only got one world and if we don't take care of it we will all die. I want to be an engineer and find ways of not polluting so much." She cited multiple ways that pollution could be decreased and while she could not give specific ways that engineers could solve them, she felt positive that as an engineer, she could be part of the solution.

While there were some references to 'making the world better' from male participants, they centered on designing faster vehicles rather than fuel efficient; creating stronger structures to survive disasters rather than for protection of inhabitants; and faster processing computers for gaming. There appears to be a definitive difference in how each gender defines 'making the world better'.

There is a distinct lack of differences in the opinions and perspectives of the participants between racial and socio-economic groups that could be identified from the data. The optimist part of me hopes that this is a reflection on their generation as a whole – that they are all hoping to make their world and society a better place. The realist side of me agrees that these young people are much more aware of the world at large around them than past generations and may see value in their contributions more than past generations.

Generally Effective Instructional Design Practices

As seen previously, there was a lack of significant differences in the effects of the practices on participants based on some of the demographic subgroups. The hope is then that these can be generalized as positive practices. Having seen positive evidence of gains in self-efficacy toward engineering through the eyes of so many participants the desire to identify the practices that made these gains possible need to be more thoroughly examined and identified as clearly as possible. One of the unique features of this study is the desire to identify instructional practices that are effective in a generalizable setting as well as those that are more effective for the learning of participants from specific demographic backgrounds. For instance, are there ways of presenting the materials that are more effective for one gender over the other? Specific journal prompts and focus group questions were used in order to attempt to gather data to assist this area of the research. Since I had already asked the participants to identify traits of a good engineer, I asked them to describe the kinds of students in their age group who should consider engineering as a career. By identifying the target age group, the participants give validity to the practice as appropriate. This identification is a portion of the metacognitive process for the participant as they identify it as effective upon themselves (Hayden et al., 2011). More importantly, do they see themselves within that group and do they derive self-efficacy through these interactions. This journal prompt was given in the hopes that participants would identify types of learning or strengths that should be considered in designing curriculum for an SEA.

"I think all students should try a program like this. Just because you are a jock or a outcast should not make you learn certain things" 2011 BATMEN participant 3498.

"Smart people should definitely be engineers" 2011 E4E participant 2510.

"Hard workers are the most important group. Anyone can learn the stuff but they have to really be able to work on it. Especially when it gets harder" 2012 MSTI participant 3812.

"People like me. I love doing things with my hands and mind. If they only want to read, this might be hard on them" 2012 WIA participant 4615.

"You must like to do math and science but you have to be creative too. Not everyone can do all of that" (2013 BATMEN participant 2696.

The theme that emerged over all was that there was no definitive type of person who should investigate being an engineer. This may be an indicator that marketing of SEA programs should cast a wide net. It also indicates that those in the early levels of engineering education need to be aware that there is still a great deal of mystery about the work of engineers. This marks that the participants see no barriers to their own self-efficacy being developed. The removal of any misconceptions of the ideal candidate to pursue a career as an engineer is seemingly dissolved as self-efficacy builds.

In taking a more direct approach, during focus groups I asked the participants in WIA, WISE, MSTI and E4E to share with me the reasons they think there are so few female engineers.

> "I think there are little female engineers because engineering is a dirty job and not all women are cut out for the job. We need more examples of what engineers do so more females can see what is really happening out there," 2011 WISE participant 7519.
>
> "One of the reasons is that 'back in the day' men did not think women were smart enough and some people still believe that" 2011 WISE participant 4641.
>
> "Society tells us that engineering is a men's profession," 2012 MSTI participant 2454.
>
> "Another reason is that a lot of women aren't strong in the math and science subjects which are needed in engineering," 2012 WIA participant 3842.

"There are no role models for us. I thought about my science and math classrooms and there are all kinds of posters with men like Einstein and stuff but no females," 2011 WISE participant 3747.

"Many companies used to pay women less even though they did the same work. Now some companies will pay us more because they need as many women as possible. I don't think most females know that change has happened," 2012 E4E participant 8038.

The apparent theme centered on a lack of role models or examples for the young women to exemplify. This appears to therefore be a significant influence on self-efficacy as identified by the above participants. To see oneself as similar to the ideal is a significant step toward self-efficacy. Noting this theme as a learning need, I wanted to follow up on these responses after the participants had met with multiple female faculty, researchers and students. In the focus groups, I asked this question again and invited them to review their initial responses from their journals. The 2012 E4E focus group A consisted of an even split of three males and three females and provided some enlightenment.

2201: "There aren't as many females because engineering is mainly a men's job."

3432: "Wait, that is not fair. We had, you know, 4 lady engineers talk to us this week. There were only 2 guys. So, you know, that is not really the problem."

2201: "That is just because we are at a college, right?" (looks to Researcher for affirmation)

Researcher: "I have some data you can look at if you are interested."

9311: "Oooh, burn! But is she right?"

Researcher: "There are fewer female engineers currently."

9311: "Well that is dumb. The girls at my school are smarter than most of my friends."

2201: "But being smarter is not enough. We need to make sure that more girls take engineering because they are all told that science, math and computers are for guys, you know?"

4426: "Part of the problem is that when we act smart, the boys get all rude and call us names. It is like they only date stupid girls and we get tired of acting."

2201: "I agree. It is good for a guy to be smart but at my school if a girl is smart, they tease her and call her names. They call her the pet and the other mean stuff. No one wants that so we don't try."

9311: "Well, that is just stupid. That is like, bullying or whatever. Just tell them to shut up."

2201: "Can we just move on?"

I identified this discussion because of the obvious conflict between the two genders. While the females identified with the consequences of being perceived as academically successful, the male did not seem to agree that the perception existed. While the male relied on his experience in the program (citing the gender and number of presenters), the females based their perceptions on their home life. These factors and perceptions that arrive with the participants may be an effective argument Obviously, 3432 gained an insight about gender through his recognition of a greater number of female practitioners who had gained his respect and admiration through their interaction with him. His self-efficacy may not have been effecte3d by those particular presentations but he believed that the self-efficacy of others should have been impacted in a positive manner. He was apparently correct as the self-efficacy of the female participants was bolstered through interaction with the guest speakers as successful practitioners. This was evidenced through other data points including the final journal entry of one of the young women (4426) in the same focus group when she wrote about how the female engineers she had met have helped her decide to pursue a career in engineering by "They helped me see that I can be an engineer because I am able, no matter what sex [gender] I am".

The 2011 WIA focus group A gave a somewhat different conversation since there was no male view present and the entire program was female only – making all interactions significantly unique. In this group, the use of guest speakers was beneficial to the participants' self-efficacy as a tool by empowerment as much as by example. Hearing from practitioners about external influences on their decisions, the participants are able to be more resistant to barriers to the attainment of self-efficacy.

> 3333: "Lots of females are told that math and science are for guys and we are supposed to like reading and art."
>
> 2221: "Yeah, I think that is part of it. But I also think we just need to see more women engineers and stuff. I mean, what if it was called 'Betty Nye the Science Girl'?"

1118: “But you know they would just make her dumb, pretty, and dress her in Hello Kitty.”

(Laughter among the group)

2221: “I hate Hello Kitty. But you are probably right.”

6666: “But why do so many girls buy it? I mean, if no one bought it, they would stop making it.”

2221: “Maybe. But look at commercials – there are never girls on a NERF or LEGO commercial.”

3333: “That is because boys like that stuff. We just don’t have toys to encourage girls to do science and math and stuff. I mean, that one woman, Ummmm, Dr. Whatever, said that women need to represent themselves and we need to set the example for younger girls.”

6666: “I really liked meeting her and the other professors. (Pauses to look to the others for reactions. Most are nodding in agreement.) They are all really smart and stuff. I just think it must be hard to be a woman engineer because you mostly work with boys. My mom used to work at an engineering college and she said only the secretaries were women and that the men were always rude to them. What woman would want that?”

2221: “Boys are stupid.”

(Laughter among the group)

The impact of the guest presenters as role models, had an obvious impact on these young women. It is interesting that participant 6666 identified a prior influence on her belief system based on her mother’s experience. Meanwhile, participant 3333 saw the influence of the female engineer as the central learning experience in building her self-efficacy. While the young women identify society pressures and commercial images, one did identify her enjoyment of meeting female engineers in the process and the others nodded in agreement. In an interview with 2011 WIA participant 2221, I asked her about the most influential part of the program. Her reply summarized this feeling when she identified the interactions with the female faculty and researchers as her favorite part of the program. She stated:

> I really liked talking to the women who are engineers. They made me feel like I could be an engineer. They were all so nice and one of them took me and our whole table group (during a lunch break) through her lab. It was really cool. Lots and lots of computers.

Therefore, the influence of interactions with role-model practitioners was positive toward her self-efficacy and can be identified an influential practice.

During the 2011 E4E focus group A's second session a similar outcome developed.

> 2695: "I think my favorite part of this week was getting to meet those professors."
>
> 2121: "Dude, we met, like, a million professors."
>
> 2695: "You know, the two black guys and that lady. The black lady."
>
> Researcher: "What made that your favorite part?"
>
> 2695: "I don't know, they were just cool and talked to us like we were smart. Like we belonged."

4256: "Yeah, that Dr. 'S' that designs cars and stuff, she was really interesting and took our questions seriously."

2695: "Even your dumb ones" (gesturing toward 2121).

(Laughter through the group)

2695: "Whatever. I mean it was like she thought we were smart. No one talks to me like that at school."

7428: "Did you know she has kids?"

2695: "Really?"

7428: "Remember she showed that picture in her speech? I thought that was cool. I guess I never thought about being and engineer and a mom. She must have a nanny or something."

2695: "That one skinny black guy, you know, he was talking about how he thought he was going to be a rapper back in the day. (laughs) I mean, he like really kept it all real but was really laid back and cool too."

2121: "I think he is my mom's cousin."

2695: "Man, you think everyone is your mom's cousin!"

The fact that the engineers being discussed were identified as 'being real', treating the participants as 'smart', and relating other areas of their lives as a mother and inspiring rapper seems to have affect these participants. Additionally, the fact that the participants specifically mentioned the race of the presenters allowed me to see that in this case, race mattered to them. The participants took the time to identify these speakers among the 15-18 who had presented to them as those who had influence –this influence may have been a form of social persuasion based on the perception of a peer relationship based on shared racial identity. It was these interactions that created a possible bond with the participants. I found this theme of 'being real' in interviews with other participants as well. In an interview with 2013 BATMEN participant 8530, he shared that his favorite experience was working with a particular researcher. When I asked what made that researcher his favorite, he mentioned that they came from the same small home town in rural Mississippi. This was an important commonality for this young man. To share the factor of race and background seems to have touched this young man in his quest for self-efficacy. I asked why having someone from his hometown was important, he responded that "no one from our town ever does anything cool like engineering. They are all just farmers." These role model experiences seem to have a distinct impact on these participants that may have only occurred due to participation in the SEA

In developing these lines of dialogue, I spent considerably more time in pursuing information about gender than race. The reader may question this practice as there was ample opportunity of access to students of color during the SEAs. My purpose was not to avoid the topic but rather to concentrate on the lack of female engineers. Race in the southeastern United States is still a very volatile subject and as a researcher, I did not feel as comfortable in asking the young people why there is a lack of representation of students of color in the field. It was my view that I had a better understanding of gender than race as a factor in developing self-esteem.

The use of hands-on activities to reinforce content learning has long been advocated in many content areas including science, mathematics and technology. In following this practice, there are many hands-on activities or 'builds' used in the SEA programs. These are activities where the participants may create prototypes of a designed solution in order to test the design. In most SEAs, these include the use of mechanical designs, electrical circuitry, delivery systems, or computer programs.

Journal responses to the questions about their favorite parts of the program often included the builds are favored activities which overlaps into the second purpose of this research. I identified favored practices as those that impacted the participant in a positive way of developing their self-efficacy. Participants using terms such as “I liked” or “I want to” create the self-efficacy markers of the positive practice. In identifying the particular data points within this theme, I sought the responses that gave particular reasons for the response. Journal responses included:

“I loved building the elevator. It was really hard but after our team failed twice, we decided to check our design. The third time it worked really well. I liked being a real engineer” 2011 E4E participant 2521.

> I never thought I would like building a car out of junk (did you get it out of the trash?) but it was cool! I liked making the stuff we designed. Usually we just learn stuff and watch a video or something. This camp lets us make stuff. (2011 BATMEN participant 2641)
>
> My favorite part of the week was all the times we made stuff. I like doing things with my hands and my brain. When we went to the field trips we saw the engineers build stuff too. We were doing stuff just like them. (2013 MSTI participant 7544)

“Making our wind turbine was superdy duper awesome! My group had so much fun. I want to make one at home after we leave. I bet it will be even better” 2011 WIA participant 2223.

Additional journal entries also mentioned the desire to recreate or adapt some of these builds at home. Many others also identified that seeing their work as similar to practitioner engineers was part of the reason they enjoyed the activities. One interesting subtheme that emerged in the data was the desire to spend more time revising their designs. Due to the time limits of SEAs that are a survey of fields is that the curriculum tends to drive at a pretty quick pace. Many of the journal entries indicated that participants wanted more time to complete a successful build.

Focus group data supported these themes as well. Of interest was the 2011 MSTI focus group B discussion during their second session. This group was one of the most disengaged groups of participants during the three years of this study. In the course of class and learning activities, these participants were more inclined to off-task behaviors. These included: texting, off-topic conversations, repeated trips to the restroom, and doodling on scrap paper. The conversation tended to lull quite often during each session. This seemingly lack of interest is what makes the following interchange so interesting.

1284: "My favorite part is when we get to just hang out at the dorm."

2142: (laughing) "Yeah. Mine too. (pause) Oh, and making that car things with the mouse trap."

1284: "Not me. I hated that. It never worked. It would get all jacked up."

3604: "Because you made it wrong. Your group was so stupid."

1284: "Shut up."

3604: "Whatevs. At least they let us make stuff. At school all they do is tests."

5914: "I liked the mousetrap car. It was better than the bridges that one lady made us make."

5102: "They were both okay. Like she said, (pointing to 3604) at least we are doing stuff. It is okay. I liked to watch the fools in your group (pointing to 1284) sittin' there just screwing it up over and over. Y'all dint even read the instructions or nothin'."

5951: (looking at ground, mumbling) "I liked it."

Researcher: "Can you explain what made you like it?"

5951: "I dunno."

(long lull)

5914: "I think we just like making stuff and trying it out. Like real engineers do."

5951: "Yeah, stuff like that is cool. I just tired of y'all talking to us all the time. Let us make stuff more."

While this discussion may not resound with positive energy and hope, it does enlighten the research that hands-on engagement is seen as significantly more interesting than the coursework the participants see in their usual academic setting. Again, this increased interest may lead to an increase in self-efficacy. The ability to successfully complete the physical tasks to indicate learning builds on the self-efficacy of the participants. The group's lack luster engagement level lends weight to the importance of these activities as this is the sole item deemed of interest to the group and therefore the sole source of self-efficacy development for them.

In an interview with 2012 E4E participant 5103, she shared that the parts of the program she enjoyed most were the builds – in part because she felt she was successful in their creation. As builds are successfully completed, the self-efficacy develops within the victory over perceived barriers. She stated:

> I like making the stuff for the building things. My favorite was the Rubert thing [Rube Goldberg machine] because we got to try lots of ideas. AND there were no guys in our group so we all got to talk and do it. Usually the guys just try to take over. I like building stuff. Even when the teacher had to show us how to use the drill (laughs) after we accidentally drilled a hole in the table thing. You should let the kids build more stuff.

Her statement that she could appreciate learning the skill of using a power drill safely through real use indicates that this was a new experience that resulted in a positive outcome. The fact that she also identified the lack of males in her build group gives an indication of gender interactions that may influence the learning that is occurring.

The last major theme that arose from the participants about the activities that had the greatest impact was along a different line. Rather than the actual activity, many participants made reference to the approach taken. Within each program, the curriculum was designed with problems that they students could relate to based on their experience and embedded within ‘real world’ problems. These may be adaptive design of tools and materials for use by people with physical restraints; design of recreational experiences such as amusement park rides; educational toy design; aquifers for clean water; and fuel cell development. Some participants mention these specific activities by name but the majority indicate that the simple use of this approach was significant.

In his interview, 2012 E4E participant 3131 spoke of this when he explained his future plans:

> I like that we talked about things that really happen. Lots of times at school they make up these writing assignments about, you know, what would you do stuff. But, at the camp you showed us the problem, like the sunken boat thing, and, you know, we had to really study out the problem and stuff. And like when you told us about the real sunken boat in, you know, where ever it was that had the radioactive waste that had to get out, we knew that this was real. I also liked when that guy talked about the problems with the port or marina or whatever with all the sunk boats that needed cleaned out. It was like we were really solving the problem with our little water robot thing.

He was referring to an activity where the students created Remote Operated Vehicles (ROVs) to descend to the bottom of a pool and recover items. I asked why this seemed real to him. He explained that "there are real things like this that happen and we had to use that stuff you taught us about buoying [buoyancy] and stuff to solve it."

Participant 2797 from the 2013 BATMEN group also referenced this as a positive impact in his interview. Although he was not a strong (less active than his peers) participant in his focus group, he had made a comment about enjoying the building process. I asked why the hands-on build was important for him he stated:

> I liked that I could prove that I know what I am talking about. Like the hydraulic arm thing we made. I mean, like, no one builds those in school. I made a real thing that really worked. That is cool – I wish I could have kept the whole thing

but my group made us all share parts. But that is a real think, you know, that a real engineer would build – not just a pretend crappy model from WalMart.

"I showed my Mom how we made the bucket things that cleaned the water," said 2011 WIA participant 1113 in her interview. "She thought it was cool and then she helped me show it to my Girl Scout group and we made them in case of, like, you know, a, like emergency like Katrina. We had no water for like, three days. Now we have something in case that happens again. It was a real thing that engineers do to help people and I taught others about it."

I asked how she felt about that. Her response was slow and deliberate:

> I never really thought about being an engineer but it was so cool to be able to teach my friends about a good thing. I really liked feeling like I could contribute. My mom wants me to show our mayor or someone too so that our whole town can have water in an emergency. I don't remember everything we did at camp but I really liked that part.

2013 MSTI participant 4685 was a little surprised about his level of learning when we spoke in his interview. I asked about his experience since leaving the academy and he remarked that he of thinks "I am going crazy" because he observes traffic patterns and signs now. I asked him to explain.

> You know, like, when we learned about traffic on our field to Jackson [Mississippi Department of Transportation planning center] and they showed us how they decide to put in lights and stop signs? Now I look at the roads and think that there should be a sign instead of a light because of the pattern of the cars. Who does that?! And I keep looking at the, you know, the things, crap, the lines

> on the road. I can totally tell where the paint is too old now and how the roads need asphalt and not just tar. I am totally weird now.

I asked, “So, does knowing that make you want to be an engineer now?” He laughed and said,

> I don’t know but I can never look at a train track again the same way because I keep thinking they are not built right. Like that guy showed us. I mean I know all this stuff about crap I never cared about before. I guess that is good though.

Within and between each demographic group, the practices that had the greatest impact on the participants’ self-efficacy were similar. On the broad examination, the use of mentors, hands-on work and authentic-based simulations were key to all groups across gender, racial identification, and socio-economic standing. As each of these practices had positive impact on the self-efficacy of the participants, they are easily identifiable and generalizable practices for success.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Overview of the Study

The use of Summer Engineering Academies (SEAs) as a tool for informing young people about engineering careers and fields as well as early recruitment for the hosting entity has been viewed through cost-benefit analysis individually but not comparatively. Existing research within SEA programs have centered on programs specific to a particular demographic without comparison to other programs nor programs intended for other demographics. The programs used within this particular study were selected because they had specific demographic traits including single genders, traditionally underrepresented groups, and specific age ranges. During the course of each program, specific best practices were employed in order to assess their combined impact on the self-efficacy of the participants. Data were then collected to seek an understanding of commonalities of best practices within and between these programs and their participants. The purpose of this study does not seek to measure content knowledge or gains. Instead, the participants' self-efficacy toward engineering content and practices were the central measure. This self-efficacy related to a belief of ability to accomplish as well as a desire to accomplish.

Using the qualitative data from participant journals, focus groups held during the program, and individual interviews held within three months after the program, this study seeks to examine any impact that participation in the SEAs had on the participants' self-efficacy toward pursuing a career in engineering. Data were collected over the course of three years of summer programming. SEA offerings and implementation were dependent on each program's application levels. Some programs were not held each year due to multiple SEAs being offered throughout the college creating a concern of 'cannibalism' between the programs. Each program was implemented at least once while two were held all three years. In total there were 246 SEA participants with 232 contributing data to this study. Within the sample there were 136 males and 96 females; 123 African Americans, 72 Caucasians, 27 Asians and 10 participants who identified themselves as 'other'. Participant ages were identified by the school grades they were entering the following fall. The largest group was entering the ninth grade with the smallest group comprising of rising twelfth graders.

Summary of Findings

This section will outline each finding with specific evidence and a brief interpretation of the data. The following sections summarize the practices that seem to elicit the greatest effects, the findings regarding sustainability of the intervention, and the misconceptions of levels of engagement as they pertain to the setting of the intervention.

Building of Self-Efficacy Toward Engineering

In the review of the data collected and analyzed, there is ample evidence to suggest that among the majority of SEA participants, there existed an increase of self-efficacy toward the content and fields of engineering. This was exemplified through the journals and focus group statements given that indicate a positive trend in their self-efficacy and belief that they both can and want to find success within the fields of engineering. By indicating that their views of themselves and their self-efficacy now include a possible career in engineering, the concern of so many industry leaders and researchers can be lessened. This is an important realization and impact of these programs as well as this study – by understanding the positive outcome on participant self-efficacy, an increase in these types of programs can result in a systemic change toward directing young people into these careers. Based on this evidence, the use of SEAs should be seen as a valuable tool for influencing the self-efficacy of young people toward engineering and will result in an increased number of prospective recruits to the field as well as colleges of engineering. Statements overtly claim that many of the participants now felt that the content was accessible to their understanding. Additionally, the instructional practices assisted in creating a sense of sustainable goals for the students.

It was exciting to read so many positive indicators from both young men and young women regarding the need for young women to seriously consider engineering as a career. This view of the need for women in engineering appeared as recommendations for young women to be confident and assertive in making the decision about pursuing a career in engineering. Additional comments encouraged young women to see themselves as candidates came from both female peers and male peers which may indicate the possibility of a shift in the social expectations norms held by participants after their attendance at an SEA. They also recognized the need for support for these young women from both academia and their peers. This support may need to extend beyond the advocacy for them to pursue a career in engineering to include academic support as well as a peer mentoring and role model interactions in an on-going setting. This recognition is evident through the peer-to-peer encouragements from both genders as well as the personal statements from many of the young women who had pre-armed themselves with responses to dissuaders they may encounter who may urge them to abandon their new self-efficacy to pursue a career as an engineer.

Best Practices

Within current research, there are many authors and researchers who have identified positive outcomes with the use of specific practices in settings similar to the SEAs in this study (Atwater et al., 1999; Beer et al., 2008; Byko, 2007; Denson & Hill, 2010; Elam, Donham, & Solomon, 2012). Those used within these SEAs were: the use of mentors in multiple settings who share demographic backgrounds similar to the participants; hands-on activities resulting in constructed models or prototypes; and the use of real-world problems as challenges within the learning process.

Within each SEA, all of the previously listed practices were used. Although previous research identified these practices (Robbins, Schoenfisch, Moore, & Tolar, 2005; Seymour, 1995; Usselman, 2004) as effective within particular demographics, this study found that all three had this effect on each of the programs without difference of variables of gender, age, or racial identity. Participants identified all of these practices as having a positive influence on their self-efficacy toward engineering. Participants from all programs and demographics identified that visiting with the mentors and role models inspired them to achieve but it was the way that these interactions allowed the participants to see engineering practitioner as 'real' people with similar backgrounds and challenges. The interactions were much more than a simple lecture and included times for questions, walking tours of the research facilities used by the role model, and casual conversations. Quite often it was the conversations that occurred during meals or break times that were mentioned by the participants. Whether it be the revelation that the role model came from a similarly sized town, had children of their own, or shared a common appreciation for a genre of music, the commonality was identified and celebrated. These interactions seem to be where the role model really became of interest to the young people.

The use of hands-on activities was expected to have an effect on the young males as assured by past research (Byars-Winston et al., 2010; Cho, Hudley, Lee, Barry & Kelly, 2008; Du, 2006; Pascarella, Pierson, Wolniak & Terenzini, 2004; Streetman, 2007). It was interesting to receive feedback from all of the groups that these activities built self-efficacy regardless of the variables of gender, age, and racial identity. Within the data collected from the participants of each program, individuals identified these activities as those that created self-efficacy through a tangible accomplishment. It would seem, from the data collected, that these activities allowed the participants to visualize themselves in a new light as someone who could accomplish a new task that exceeded their previous levels of self-efficacy toward engineering. The newly developed schema is supported by the scaffold support of this new realization of success.

The final practice used was that of presenting real-world solutions as challenges for the students to propose and design solutions. Using needs such as adaptive technology, water treatment for clean water access, and natural resource preservation, I received indications from all demographics as methods for the participants to envision a real future as a problem solver. The self-efficacy discovered supported the strand of self-efficacy of desiring to accomplish those things that they felt they can accomplish. Perhaps this can be paired with the development of a sense of purpose for engineers.

Sustainability of the Intervention

One of the greatest challenges of a short term immersion type of intervention is to determine the lasting changes that may occur. For many adolescents, living in the moment is their basic modus operandi. In order to attempt to assure a lasting effect, portions of the data gathered sought to identify the strategies the participants arm themselves with to maintain their self-efficacy. Many participants identified their self-efficacy (using terms like 'confidence', 'faith' and 'determination') as secure based on their learning experiences during the program. While this study is not a longitudinal look at possible effects of the intervention, the data indicates that the participants are aware that they will face detractors from their goals to pursue engineering and can be better armed to deflect those influences as evidenced by their responses to questions about possible detractors. Whether their planned response was to ignore those who discouraged their new goals or if they had already determined other responses, each seemed to have already thought the situations out in their minds.

Findings specific to the Questions Guiding the Study

Although the previous sections and subsections addressed some key findings, this section provides a summary of findings to the questions that guided the study.

1. How does attendance at an SEA influence the participant to pursue a career in engineering through the increase of self-efficacy toward the study of engineering? The evidence of positive movement within the self-

efficacy of the participants in both a desire and perceived ability toward engineering is present in every demographic present in each SEA program. The mechanisms for this change can be seen through the application of the aforementioned best practices of hands-on activities embedded in real-world challenges. The statements made by participants are indicative of a positive change in their self-efficacy included sentiments of feeling empowered, knowledgeable, and exposed to a reality in which they could identify themselves as capable of performing the work of engineers.

2. Can specific design differences in instruction be identified as more effective to specific demographics of attendees based on their learning needs and practices within their schema of self-identification? As stated in section 5.2.1, there was no notable difference in the effect of the selected practices between the variable demographics including age, gender, and racial identity. The lack of differentiation between demographics allows for the generalized application of these best practices across the spectrum of short term immersion programs similar to the SEAs in the study.
3. Are there identifiable best practices that become evident through comparison of programs designed specifically for a variety of intended audiences for generalization in practice? Based on the evidence gathered through this study, the three best practices implemented fully in all of the SEAs, are effective within all of the demographic groups identified.

Participants identified a positive impact on their self-efficacy through the hands-on activities, real-world applications, and interactions with mentors and role models across the demographic sub-groups in all of the SEA programs.

Discussion

The original intent of this research was to attempt to determine whether attendance at a Summer Engineering Academy for a weeklong immersion into the world and content of engineering assists young people in developing a sense of self-efficacy toward the field. This self-efficacy is an important factor in the identity of a young person as they face the decisions of college majors and careers (Madsen & Tessema, 2009; Matusovich, Streveler, & Miller, 2010). According to Lent, Sheu, Gloster, and Wilkins (2010), the lack of self-efficacy toward the field has an especially large impact on members of traditionally underrepresented groups within engineering. This study looked at demographics of student participants from a variety of racial and socio-economic backgrounds as well as gender.

The impact of attending an SEA like those in this study seems to have had a positive effect on the participants sampled from focus groups, interviews, and written daily journal entries. This creates an important view of the efforts toward increasing the number of young people entering the field of engineering nationwide through the recruitment efforts of universities. As Atwater et al. (2007) found, the number of young people who are actively seeking engineering programs pre-college, is shrinking drastically in the United States and without a more focused approach toward early recruitment, they expect the number of undergraduate enrollees to continue to decrease.

This is especially dire for those traditionally underrepresented groups who seem to be turning away from STEM related fields at an even higher rate than in the past (Cho et al., 2008; Hylton & Otoupal, 2009; Matusovich et al., 2010).

The data found in this study identified that the attendance at the SEAs did seem to build the self-efficacy for the participants which Bandura (1989) asserts will have great influence on the career choices of the participants. The benefits to the field of engineering as a whole can be seen through the addition of young people joining the profession – especially those who come from the traditionally underrepresented populations who will now create greater diversity within the ranks (Nauta & Epperson, 2003). This increase in diversity at the national or global level is an imperative and the findings of this study create at least one avenue of assured practice using SEAs and the identified best practices within.

Within the mission of many universities and colleges of engineering, the need for recruits is high (National Research Council, 2011). One of the greatest challenges that these institutions face is the dilemma of enrollment atrophy as students choose to change majors, drop-out, or stop-out of their programs of study (Eisenhart, 2008). Du (2006), found that one of the greatest challenges to completing a degree was found in a lack of self-efficacy toward their area of study. Based on the resulting data of this current study, the increased self-efficacy of the SEA participants should then result in an increased rate of completion of the programs of study. It may be recommended then for colleges and universities to use the SEA models as a tool for increasing the self-efficacy of young people and then working to retain them as recruits for eventual enrollment in the engineering programs and courses of study. This practice could reduce the atrophy and create a more streamlined road to graduation and career. Understanding this implication for practice extends the impact of this study for SEA program facilitators and those who seek to lower program atrophy. Seeing the impact of the SEA on self-efficacy can be seen as a promise for greater completion and retention rates. By increasing the self-efficacy of the individual through the practices, benefits can be measured for the individual, institution and industry.

Within this university, the use of the SEAs as a form of early recruitment would appear to be a wise use of resources based on the increase of self-efficacy among many of the participants. Among the young people within the various samples, the increase of self-efficacy fed into both of Bandura's (1989) and Eccles' (2005) theories that self-efficacy is two-fold (belief in ability to accomplish as well as a desire to accomplish) have appeared to grow. This greater self-efficacy results in a riper pool of candidates for recruitment who have a greater self-efficacy toward what can be a challenging field of study.

Within each demographic subgroup, gains in self-efficacy were present. By using the same basic principles of practice including mentor role models, real-world applications, and hands-on learning in a project based environment, the results were the same regardless of the audience. The significance of this allows curriculum developers of SEAs to plan the learning experiences with these three methodologies as true best practices for all learners. Other research (Denson & Hill, 2010; Dimitriu & O'Connor, 2006; Elam et al., 2012) have studied these practices individually with specific subgroups of students but the data from this study leads us to see these practices (using role models, recognizable real-world applications, and hands on learning) as beneficial to all learners in addition to those who had self-selected to participate in these SEAs. It is important to keep in mind though that May and Chubin (2003) advocated that the role models or mentors for these students be relatable. For this study, I sought out those practitioners, faculty and students with whom the students could relate on multiple levels including physical traits (ie. race, gender) as well as backgrounds (ie. Rural home towns, first generation college attendees) in order to maximize the opportunity. In this study, these practices were yoked together or used in combination with one another, to increase the impact of each. Through the unique combination approach used, the programs had a greater overall impact on the varied participants rather than hoping for a single approach to make a difference in the self-efficacies of a variety of participants. This is an important piece to program success where an increase in self-efficacy among a larger population is desired.

For the individual young person, this research creates the opportunity to find ways to develop self-efficacy toward engineering as well. As a young person self-selects to attend an SEA (as is the case for this study) and these identified best practices are implemented, there is a high probability that the experience may allow them to determine their dedication to the field of learning. For the SEAs of this current study, self-selection is a component as they are required to apply for entry including a personal statement. Although there was a minority of students who revealed (after arrival) that they had not completed the applications themselves, their attendance may have been parentally initiated. This is active enrollment rather than passive enrollment common in most educational systems. Plant et al.,(2009) stated that this level of personal investigation is a leading step toward the creation of self-efficacy. The personal investigation may also be defined as taking an active step in seeking to determine one's goals and future endeavors as outlined by Shawer et al. (2008) and Usselman (2004). As the step is nurtured and supported through the instructional practices used in this study, the individual can better identify whether participation builds the self-efficacy toward the field. This then allows the young person to better encapsulate their personal growth goals as Eccles and Wigfield (1995) advocate as a foundation of their self-efficacy. So many of the participants were surprised that their ideas were useable and often successful. This is a unique finding to this current study as many SEAs do not allow for this level of higher level free inquiry learning. It was this genuine surprise and accomplishment that seems to have fueled their self-efficacy the most. This assurance should also fuel initiatives for real assessments of evidentiary learning. In many of the curricula being used currently in the field, "cookie-cutter" laboratory experiments or builds are the status quo in exploration programs like the SEAs in this study as well as the classrooms of schools attended by these same participants (Beer et al., 2008; Hewlett et al., 2008). Based on the data of this study, allowing young people to express their learning in tangible ways may better fuel their self-efficacy than a standardized test of multiple choice answers. These tangible ways consist of hands-on and visible results rather than a percentage of correct answers on a multiple choice assessment. As part of the SEAs within this study, this practice was constantly present and measureable based on a binary success code of success or failure of design.

Participants' responses to questions also illuminated that through the instructional practices used there was an unexpected development of metacognitive processes of self-awareness about their self-efficacy. That is, many of the participants began to identify that they had learned something or developed a better understanding of the topic while identifying that the benefits were derived through participation in a particular activity. This gain was a benefit to their self-efficacy as learners as well as engineers. As Graham and Wiener (1996) identified, there are many frameworks available to educators for the development of the metacognitive process; there is little evidence to suggest that this occurs on a regular basis in the lives of most young people. Participation in the SEA seems to have allowed this to occur. This unique experience for participants allowed them the opportunity to view their learning and growth in an active rather than passive manner. They were aware of their learning and through the regular reflection and peer interaction. Within the fields sponsoring and supporting SEAs there is little if any mention of self-aware metacognition. This may be due to a gap between pedagogy and content but this study provides insight into the importance of bridging these two topics for the improvement of self-efficacy of the participants toward the field.

Recommendations

The findings of this study indicate some recommendations for programs similar the SEAs examined as well as some best practices that could be used in instruction of adolescents in other settings of engineering education. Since these young people were expressing their views about their self-efficacy in engineering based on this short-term immersion setting, they were given the opportunity to debrief in a way that may not be common in other learning settings for many of them. Taking that into account, there are recommendations for other settings as well. Additionally, taking into account the varied backgrounds of the participants, there are some particular recommendations for school counselors and parents in assisting their adolescents in building self-efficacy in engineering – which may be generalized into any STEM field.

Recommendations for Summer Engineering Academies

Given the recent emphasis on STEM programs for content understanding in young people across the nation similar in purpose to those used in this study (Zollman, 2012)., there are some recommendations for creating a positive effect on the self-efficacy of the participants toward engineering. In reviewing the findings from Chapter 4, all three of the best practices identified are recommended for use with all demographics of participants. Implementing hands-on activities with real-world applications are a seemingly obvious practice but it is important to recognize that the participants must understand the real-world challenge of the task. This becomes incumbent on the presenters to become as educated about the need as possible. For instance, when introducing the challenges of adaptive technology needs for individuals who face mobility challenges associated with the use of a wheelchair, the presenter should take a personal approach to discovering at least a portion of the difficulty faced by these individuals. One technique may be to invite the participants to use the current device as a mobility tool for a portion of time to recognize the reality of the situation. Another example is to present real water samples for physical interaction with the participants. This allows the young people to better understand the condition of water that many people around the world face daily. This tangible source of inspiration will allow the participants to better frame the need as they work to design and engineer a solution to the problem.

The use of mentors and role models with whom the participants can relate and identify commonalities is also recommended. For many young people, especially in rural areas, finding individuals who embody success in spite of perceived challenges is essential. Too often they fail to develop a self-efficacy of success due to the aforementioned lack of role models within their communities. They may wonder how they can achieve success if they cannot see an identifiable example. This study identifies the importance of role models for all demographics of young people and the that each subgroup finds benefit from interaction with individuals who can function as role models to increase the self-efficacy of the participants.

Recommendations for School Counselors, Educators, and Parents

Encouraging adolescents to make career choices based on limited experience and information is almost as damaging as failing to encourage career exploration and can result in frustration and resentment on all sides. It is important that young people have the opportunity to learn about a wide variety of careers – even those that the adults may find intimidating due to their own lack of self-efficacy toward the topics. Career interests develop through exploratory experiences and learning. Providing learning experiences with hands-on use of the tools of engineering, promoting problem-solving, decision making and independence promote career choices that may not be viewed as viable for all young people. When the adolescent is ready to make a decision about a career choice, they are more prepared to make informed decisions because of these experiences.

Parents and school personnel involvement are vital to the self-efficacy of all children. Parents are and should be the advocates for their children to explore technology applications and have opportunities for the children to interact with a variety of learning experiences. Rodrigues, Jindal-Snape, and Snape (2011) posit that parents and school personnel are the key to career exploration and have the greatest influence on the decisions made by young people. They often have an even stronger influence on young women (Novakovic & Fouad, 2013). By encouraging this exploration and then assisting in the metacognitive processes, educators partnering with parents become an essential component in the growth of self-efficacy in adolescents toward engineering and other careers.

As a final note, in speaking with the female participants of the study, many remarked that they are often unwilling to attempt new content or advancement in Math or Science due to a lack of tangible success in these areas in the past. Mothers have a great influence on their daughter's self-efficacy in mathematics and science and when they express to their reluctance towards these subjects, great damage can occur (Mireles-Rios & Romo, 2010). When a mother uses phrases such as "I am not good at math", the young woman may interpret that as a defining deterrent toward the effort. Rather than feed the lack of self-efficacy, it may be more advantageous to encourage and assist the young woman in finding a female role-model who may be able to assist at a greater level. Over the course of this study, there were notable comments by the participants regarding the female engineer practitioners and mentors who were now perceived as having similarities to the female participants. One young lady mentioned her surprise and admiration for one female faculty member who shared that she was the proud mother of two young children. Another participant was remarked her excitement at learning that one of the practitioners loved high fashion shoes just like the participant. Once these commonalities were established, the self-efficacy of both of these participants was built and they were able to visualize themselves in a positive light as engineers.

Suggestions for Further Research

As with any research, it is important to identify the limitations that may exist. For this study, the majority of the individuals used were self-selected to participate in the SEAs which may indicate an underlying desire to develop their self-efficacy through exploration. Sixty-nine percent (69%) of the participants indicated that they were planning to major in engineering prior to participating in the SEA. The role of peer or social influence may have had an effect within the study. Secondly, my role as a researcher in the study was a dual role as I also serve as the director of the programs. In this role I serve in an administrative capacity rather than as an instructor but the participants were very aware of my connection to the programs in which they were participating. This may have held influence on those participants who may be classified as ‘teacher-pleasers’ or wanting to perform for an individual in a perceived position of influence.

There are some definite areas worthy of further research. While the majority of the SEA participants did secure an increase in self-efficacy toward engineering from their participation, the use of multiple best practices should be studied more completely. Each of the three selected practices had a positive effect on self-efficacy but it would be of import to work to identify the level of impact between the practices. For instance, are role models more impactful to the development of self-efficacy than using hands-on tasks? There may, in fact, be a hierarchy of effectiveness between each of these practices.

A research project that looks at implementing these best practices in a longer-term setting would allow a measure of the impact on self-efficacy that extends beyond the short term immersion setting of this study. Perhaps implementing one or more of these methods within a semester-long course with periodic data assessments of self-efficacy would indicate the importance of immersion in the topic.

Research on the effect of this type of program on young people who do not self-select to attend an overtly engineering themed summer experience would provide a comparison as well. Measuring the impact of a short term immersion program within another content area on the self-efficacy of the participants' view of that content area may illustrate the impact of the immersion system on that change in self-efficacy. For instance, comparing the results of this study on a program that is based on the study of history or literature may yield an impact on the self-efficacy towards those subjects by the participants.

This analysis of "reluctant learners" toward engineering or STEM in general would also be of importance. As stated earlier, there were a small group of participants who did not truly self-select to attend the SEAs in this study. Over the course of the program they shared that parents had completed the application independently and then informed the participant that they were being sent to a summer program. Others were very explicit that they had no interest in engineering but liked the idea of a residential program at the university (interest based on fandom of the university football team or familial culture). It would be interesting to directly examine whether participation in an SEA using these instructional methods had the same impact as related to these young people.

Finally, although this study used interviews with individual participants three months after the conclusion of the program, there would be great worth in following the young people beyond that time. While sustainability across this relatively short term was established, many of the participants will not enroll at a university for as many as five years. Further study of the longer retention of these young people and their self-efficacy toward engineering is important. Within that concept is the use of 'return customers' or those young people who participate in multiple SEAs through middle and high school. Within this study were a few individuals who participated in consecutive years and may likely continue their annual immersions. To identify the impact of this annual shoring up of their self-efficacy may be enlightening to the research.

Conclusions

In the long process of this study, there have been many learning moments for me as a researcher, curriculum developer, and engineering education advocate. Self-efficacy is one of the greatest driving forces in humans and when it is present, the individual can achieve great success. The development of this essential trait is a complex scaffold that needs support structures that allow for sustainability over time. It is incumbent on educators and parents to work with young people to find those supports. The majority of the young people in the SEAs in this study seemed to experience a positive effect on their self-efficacy toward engineering. This experience may in turn, encourage them to seriously consider fields of study and careers that may be unfamiliar to them in their current environments.

The use of specified educational practices appears to have had a positive effect across the group without regard to the specific demographic with which they identified.

The impact of these practices on the self-efficacy of the individual did not appear to be effected by gender, racial identity, and age which allows for generalizability of these practices as effectual. These results suggest that they are good practices that should be used in learning environments.

The need for trained and creative engineers continues to grow across the nation. Each year, hundreds of young people enter the university setting determined to study engineering but a large number discontinue for a myriad of reasons but the prevailing thought is that their self-efficacy toward engineering waivers and when pressured, they seek those areas that are more comfortable for them. Diversity within the engineering practitioners is also of grave concern. Young people of all backgrounds and racial identities need to be encouraged to explore STEM fields and careers and programs such as the SEAs may hold the key to that encouragement.

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APPENDIX A

SEA PARTICIPANT DEMOGRAPHIC DATA

MSTI 2013						
Race	Black	White	Hispanic	Asian	Native Am	Other
	17	6	0	1	0	0
	71%	25%	0%	4%	0%	0%
Intended College	MSU	Other				
	19	5				
	79%	21%				
Intended Major	Engineering	Other				
	13	11				
	54%	46%				
Gender	Male	Female				
	12	12				
	50%	50%				
Grade	Grade 9	Grade 10				
	12	12				
	50%	50%				

MSTI 2012						
Race	Black	White	Hispanic	Asian	Native Am	Other
	14	5	0	3	0	0
	64%	23%	0%	14%	0%	0%
Intended College	MSU	Other				
	17	5				
	77%	23%				
Intended Major	Engineering	Other				
	12	10				
	55%	45%				
Gender	Male	Female				
	15	7				
	68%	32%				
Grade	Grade 9	Grade 10				
	6	13				
	27%	59%				

MSTI 2011						
Race	Black	White	Hispanic	Asian	Native Am	Other
	23	5	0	1	1	0
	77%	17%	0%	3%	3%	0%
Intended College	MSU	Other				
	20	10				
	67%	33%				
Intended Major	Engineering	Other				
	13	17				
	43%	57%				
Gender	Male	Female				
	22	8				
	73%	27%				
Grade	Grade 9	Grade 10				
	14	15				
	47%	50%				

BATMEN 2013						
Race	Black	White	Hispanic	Asian	Native Am	Other
	8	12	0	4	0	0
	31%	46%	0%	15%	0%	0%
Intended College	MSU	Other				
	16	10				
	62%	38%				
Intended Major	Engineering	Other				
	20	6				
	77%	23%				
Gender	Male	Female				
	26	0				
	100%	0%				
Grade	Grade 7	Grade 8	Grade 9			
	7	10	9			
	27%	38%	35%			

BATMEN 2012						
Race	Black	White	Hispanic	Asian	Native Am	Other
	7	8	0	4	0	0
	33%	38%	0%	19%	0%	0%
Intended College	MSU	Other				
	15	6				
	71%	29%				
Intended Major	Engineering	Other				
	17	4				
	81%	19%				
Gender	Male	Female				
	21	0				
	100%	0%				
Grade	Grade 7	Grade 8	Grade 9			
	5	13	3			
	24%	62%	14%			

BATMEN 2011						
Race	Black	White	Hispanic	Asian	Native Am	Other
	10	9	0	4	0	0
	42%	38%	0%	17%	0%	0%
Intended College	MSU	Other				
	16	8				
	67%	33%				
Intended Major	Engineering	Other				
	18	6				
	75%	25%				
Gender	Male	Female				
	24	0				
	100%	0%				
Grade	Grade 7	Grade 8	Grade 9			
	7	11	6			
	29%	46%	25%			

Women in Action (WIA) 2012						
Race	Black	White	Hispanic	Asian	Native Am	Other
	2	3	0	2	0	1
	25%	38%	0%	25%	0%	13%
Intended College	MSU	Other				
	5	3				
	63%	38%				
Intended Major	Engineering	Other				
	3	5				
	38%	63%				
Gender	Male	Female				
	0	8				
	0%	100%				
Grade	Grade 7	Grade 8	Grade 9			
	2	3	3			
	25%	38%	38%			

Women in Action (WIA) 2011						
Race	Black	White	Hispanic	Asian	Native Am	Other
	5	11	0	4	0	1
	24%	52%	0%	19%	0%	5%
Intended College	MSU	Other				
	12	9				
	57%	43%				
Intended Major	Engineering	Other				
	10	11				
	48%	52%				
Gender	Male	Female				
	0	21				
	0%	100%				
Grade	Grade 7	Grade 8	Grade 9			
	4	11	6			
	19%	52%	29%			

Engineering for Everyone (E4E) 2011						
Race	Black	White	Hispanic	Asian	Native Am	Other
	16	4	0	1	0	0
	76%	19%	0%	5%	0%	0%
Intended College	MSU	Other				
	17	4				
	81%	19%				
Intended Major	Engineering	Other				
	9	12				
	43%	57%				
Gender	Male	Female				
	9	12				
	38%	57%				
Grade	Grade 9	Grade 10	Grade 11	Grade 12		
	8	9	3	1		
	38%	43%	14%	5%		

Engineering for Everyone (E4E) 2012						
Race	Black	White	Hispanic	Asian	Native Am	Other
	17	1	0	0	0	1
	89%	5%	0%	0%	0%	5%
Intended College	MSU	Other				
	12	7				
	63%	37%				
Intended Major	Engineering	Other				
	10	9				
	53%	47%				
Gender	Male	Female				
	7	12				
	37%	63%				
Grade	Grade 9	Grade 10	Grade 11	Grade 12		
	6	7	6	0		
	32%	37%	32%	0%		

Women In Science and Engineering (WISE) 2011						
Race	Black	White	Hispanic	Asian	Native Am	Other
	4	8	0	3	0	1
	25%	50%	0%	19%	0%	6%
Intended College	MSU	Other				
	11	5				
	69%	31%				
Intended Major	Engineering	Other				
	9	7				
	56%	44%				
Gender	Male	Female				
	0	16				
	0%	100%				
Grade	Grade 9	Grade 10	Grade 11	Grade 12		
	3	8	3	2		
	19%	50%	19%	13%		