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PROJECT ICAN: A STEM LEARNING AND PERSISTENCE MODEL FOR
POSTSECONDARY STUDENTS WITH DISABILITIES

by

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A dissertation submitted in partial fulfillment of the requirements
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ABSTRACT

Education and work in Science, Technology, Engineering, & Math (STEM) are of utmost importance in a post-modern society. Yet American performance in the STEM disciplines has waned over recent years. In order to recapture a global advantage in STEM, efforts are being made by educators and policy makers to compile and implement instructional supports. Of particular interest to this study are post-secondary students with disabilities (SWDs) who persist and learn in STEM degree paths. This population is an “untapped resource” with limitless potential for contribution to the collective fields of STEM (Leddy, 2010, p. 3; Alston, Hampton, Bell, & Strauss, 1998, p. 5). The National Science Foundation (NSF) has funded Project Interdisciplinary Coaching as a Nexus for Transforming How Institutions Support Undergraduates in STEM (Project iCAN) at Landmark College as a model to develop a successful STEM support model. Post hoc interview data from students and staff at Landmark revealed themes pertaining to educational and vocational-training supports that may generalize to larger, urban institutions of higher education for further development of STEM persistence and learning models.

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Interdisciplinary Coaching As a Nexus for transforming how institutions support undergraduates in STEM (iCAN)



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LIST OF ACRONYMS

BLS	Bureau of Labor Statistics
CBT	Cognitive Behavioral Therapy
CPS	Current Population Survey
DOL	Department of Labor
EF	Executive Functioning
iCAN	Interdisciplinary Coaching as a Nexus for Transforming How Institutions Support Undergraduates in STEM
IOA	Interobserver Agreement
IWD	Individual with Disability
iPEDs	Integrated Post-Secondary Education Data System
LC	Landmark College
LD	Learning Disability
NSF	National Science Foundation
ODEP	Office of Disability Employment Policy
PFC	Pre-Frontal Cortex
PI	Principal Investigator
SLD	Specific Learning Disability
STEM	Science, Technology, Engineering, & Mathematics
SWD	Student with Disability
UDL	Universal Design for Learning

CHAPTER ONE: INTRODUCTION

The success and welfare of our global society in the 21st century is incumbent upon expertise and execution in science and technology. As members of society we are an interdependent world of people that survive and thrive on a collective understanding of Science, Technology, Engineering & Mathematics (STEM). Military intelligence, aerospace, social science, meteorology, agriculture, and computer science are merely a few careers of many that rely heavily on the STEM disciplines. Much of the health and wealth we enjoy as a post-modern American society is owed to STEM education. Alarming, American dominance has transitioned to that of a global international workforce (CEOSE, 2014; McComas, 2014; PCAST, 2012). Numerous reasons can be attributed to these downward trends including academic achievement scores, STEM pipeline persistence, educational quality and supports, vocational opportunity and mentoring, and international competition.

U.S. Labor Force in STEM

A robust workforce supplied with able U.S. workers is necessary for precision in STEM. According to the Bureau of Labor Statistics (BLS, 2014), STEM careers are among the fastest growing occupations projected for the foreseeable future (years 2014-2024). From wind turbine service technicians to statisticians, and with various amounts of education required, there has never been a better time to pursue a career in STEM. Further, the majority of careers in STEM fields have better median salaries than those of non-STEM fields (BLS, 2014). Various sources have even projected an impending shortage of STEM-related jobs at 1-3 million openings

(iPEDs, 2016; Lacey & Wright, 2009; PCAST, 2012). Individuals with disabilities (IWDs) are some of the most promising future workers for this labor force.

Individuals with Disability (IWDs) at Work

According to the U.S. Department of Labor's (DOL) Office of Disability Employment Policy (ODEP), people with disabilities comprise 20.5% of the labor force whereas people without disabilities comprise 68.4%. From 2010-2012, a third of individuals with a disability (IWDs) maintained employment as compared to two-thirds of individuals without disabilities. Of employed IWDs, self-employed careers and part-time work are most common. IWDs are most likely to be employed part-time (34%). Of eligible (i.e., non-institutionalized) individuals with a disability, 31.4% have some level of college completed, and 13.7% have a BA or higher (BLS, 2014).

The American Community Survey (ACS) from the Census Bureau (2014) recently estimated unemployment for IWDs at 13.2%, as compared to 7.1% of individuals with no disability. Some figures vary slightly, with the Office of Disability Employment Policy (ODEP) citing the unemployment rate for IWDs at 9.7% and 4.3% for individuals without a disability. Although unemployment rates for men and women with disabilities are nearly similar, African-Americans and Latinos with a disability have higher unemployment figures than their white or Asian counterparts.

The ACS found that 34% of employed IWDs earn less than \$15,000 annually. Higher levels of education increased the likelihood of employment, but not as compared to people without a disability. Despite decades of underrepresentation in the labor force, the career outlook for IWDs is bright (DOL, 2014). It's especially bright within STEM fields (National Math &

Science Initiative, 2015) as median salaries rise, computers ameliorate workplace disadvantages for IWDs (DOL, 2014), and better STEM learning models proliferate.

STEM Education

In response to these trends, the National Science Foundation (NSF) continues to actively fund research and programs promoting STEM learning and persistence in the U.S. A resulting impact of these and other external funding sources is an extant body of research that has taken shape on models and methods for workforce preparation in STEM. Of particular importance to the present study are educational and institutional supports for STEM persistence and learning models in post-secondary students with disabilities. Interdisciplinary Coaching As a Nexus for transforming how institutions support undergraduates in STEM (iCAN) is an NSF-funded, two-year exploratory study with collaborators from Landmark College (LC) seeking to develop a comprehensive STEM learning and persistence support model for larger, urban institutions, such as the University of Central Florida (UCF).

One data point from this exploratory study includes a body of semi-structured interviews with Landmark students and staff inquiring into their impressions of successful supports from their program. Post hoc transcript data revealed multiple themes on successful evidence-based supports in STEM learning and persistence for SWDs. Recommendations from the interview data include the implementation of academic coaching models that favor teaching executive functioning (EF) skills such as self-efficacy in students.

Significance of the Problem

A highly skilled STEM workforce is contingent upon a highly effective STEM educational system. Unfortunately, American student achievement scores on standardized science and math tests have dropped in international rankings (Kena et al., 2015; NCES, 2012; PCAST, 2010). Further, students cite a lack of vocational inspiration and scarcity of interesting learning opportunities as their primary reasons for declining to enter the STEM Pipeline (Dunn, Rabren, Taylor, & Dotson, 2012; Seymour & Hewitt, 1997). Although these trends concerning the general public and STEM are somewhat disconcerting, IWDs have even less representation and opportunity within the STEM pipeline.

SWDs have potential to offer significant advances to STEM. The untold successes of many SWDs in STEM may reveal answers to some of the broader problems afflicting these vocational and academic trends. All students who pursue STEM, including students with disabilities, can plan to derive benefit from doing so (Basham & Marino, 2013). SWDs can thrive both academically and vocationally in STEM (Leddy, 2010). Much of one's success in their STEM career can be explained by the quality of the supports offered to the student with a disability. Perhaps one of the most powerful contemporary supports is Universal Design for Learning (UDL). UDL concerns the removal of barriers in academic content in order to make learning as accessible as possible for all learners (Hitchcock, Meyer, Rose, & Jackson, 2002; Rose, 2000; Story, Mueller, & Mace, 1998). UDL is prevalent in the educational sphere and continues to garner funding, policy, and implementation.

Another promising practice is academic coaching. Academic coaching develops certain essential skills (Bellman, Burgstahler, & Hinke, 2015) in students that cannot be addressed by

traditional academic processes. Scholars have noted that a combination of factors contribute to matters of attrition in undergraduate careers (including social, emotional, and academic) (Gerdes & Mallinckrodt, 1994). Specifically, we know that coaching students to become more aware of their mental processes (i.e., metacognition), is an important strategy for increased learning gains (Daley, Hillaire, & Sutherland, 2014). This cognitive-behavioral process becomes the pathway by which students can access a plethora of assistive technologies, supports, and strategies for learning and persistence in STEM.

The merger of UDL with academic coaching can be witnessed in the *BreakThru* theory of change model (Gregg, Chang, & Todd, 2012). This STEM-learning model was developed as a customizable system to help students achieve persistence and fulfillment on their STEM path. There is an emphasis on electronic mentoring (e-mentoring), social networking, and a personalized virtual learning environment within this model that uses existing, familiar technologies to help students in their academic careers. The coaching element to the *BreakThru* model and other similar models emphasizes the acquisition of executive functioning (EF) skills. EF skills help individuals persist and learn due to marked gains in self-confidence, motivation, and determination (Bellman et al., 2015).

The literature is beginning to grow with examples of academic coaching and EF skills acquisition for STEM. EF skills training has been used with multiple populations, across post-secondary institutions with great success (Bellman et al., 2015; Weiss & Rohland, 2015). Typically, this service model is found at smaller, private institutions with lower ratios of staff to students. Affordability is a common concern to access for the larger population. As such,

generalizability of this service to larger domains remains challenging given the dearth of proficient academic coaches at colleges and universities (Bellman et al., 2015).

Purpose

This qualitative research project examined interview data from a larger NSF-funded exploratory project. The purpose of this study was to identify the essential elements of a successful STEM-support model at Landmark College in order to further generalize knowledge and services to a larger urban university (i.e., the University of Central Florida). Semi-structured interviews were conducted to harvest factors related to student persistence and learning in STEM. Post hoc analysis of interview transcripts derived themes from these data and provided recommendations for learning and persistence strategies toward STEM degrees and careers.

Research Question

The purpose of this study was to examine and identify the essential elements of a successful STEM-support model at Landmark College in order to generalize knowledge and services to larger models such as the University of Central Florida. The research question was as follows: What are the essential attributes of an undergraduate support model for STEM learning and persistence in students with disabilities (SWDs)?

CHAPTER TWO: REVIEW OF LITERATURE

This literature review canvasses multiple aspects to STEM education, post-secondary challenges, and persistence and learning models. This chapter is organized into the following sections: (1) an overview of STEM and STEM as it relates specifically to students with disabilities, including past and present challenges; (2) post-secondary STEM training; and, (3) innovative solutions for retention, persistence, and learning in STEM, with specialized application toward students with disabilities.

STEM: A Definition & Rationale

STEM is an acronym encompassing the collective fields of Science, Technology, Engineering, and Math (STEM). The well-being of our post-modern society and our very “health and welfare” (PCAST, 2010, p. 1) are incumbent on educational and vocational preparation in the STEM field (Lee, 2011). STEM disciplines include the life and biological sciences, computers, the environment, finance, and architecture, to name only a few. According to the STEM Education Coalition (SEO, 2016), the STEM fields are interrelated to the point of being symbiotic. For example, scientific advancements in the field of engineering will inform corresponding principles in the field of physics, and vice versa. As interdependent members of society, we advance forward cooperatively when any field reaches a breakthrough milestone.

Collectively, we rely on an advanced, educated STEM workforce that generates economic gains, makes advancements in numerous fields, and derives common applications for increased quality of life (Alston et al., 1998). Recently, the SEO (2016) branded the pursuit of STEM a “national priority” owing to the urgency of our situation (p. 3). To wit, America is no

longer a global leader in STEM education, vocational placement, or discovery. In fact, we have been slipping from our reign for quite some time now (CEOSE, 2014; PCAST, 2012). President Barack Obama has championed the case for STEM stating, “Whether it’s improving our health or harnessing clean energy, protecting our security or succeeding in the global economy, our future depends on reaffirming America’s role as the world’s engine of scientific discovery and technological innovation” (White House, 2010).

In our history of industrialized nations, the story of the United States’ growth in the STEM disciplines is one of progress and success. Examples of achievement are numerous and impressive; they include putting men and women on the moon, curing diseases, building life-saving infrastructures and systems, sending and receiving vast sums of information around the world in an instant, mechanizing agriculture to feed the masses, and actualizing environmental awareness and conservation. STEM education and vocational training was, is, and always will be a priority as we seek expansion, opportunity, infrastructure, safety, economy, health and prosperity for our world.

Economic incentive. There is overwhelming economic incentive for the relentless pursuit of a world-class STEM workforce. America’s role as an unrivaled superpower in finance, defense, manufacturing, global commerce, medical technologies (amongst many domains) can be attributed to a superior education in STEM-related fields. Historically, since the industrial revolution, and especially after World War II, America has reigned as a global leader in education and employment of STEM workers (Dunn et al., 2012). For example, the ensuing baby boom of the 1950’s compelled major industries such as housing, medicine, manufacturing, education, and technology that required highly skilled workers in STEM fields. As our economy

swelled with competent workers equipped with STEM-related degrees, so did our ability to educate, hire, and retain the most qualified workers in the world.

Job projections. The Bureau of Labor Statistics (BLS) continues to project a healthy number of jobs in STEM for the foreseeable future. According to the BLS (2015), STEM employment will likely add over 1 million new jobs to the economy by the year 2022. Other entities have corroborated these projections (iPEDs, 2016; PCAST, 2012), and some agencies even foresee as many as 3 million new jobs within this timeline (Lacey & Wright, 2009). This growth is assumed to occur at a rate greater than the average of other occupations, with the median income of STEM workers being twice that of their counterparts in other fields (BLS, 2015). Further, the unemployment rate for STEM-related careers tends to be lower than average. In 2012, unemployment in STEM-related jobs capped at 5.5%, whereas general employment was nearly double that at around 10% (U.S. Joint Economic Committee, 2012). Some sources even suggest STEM-related unemployment to be under 3.5% (iPEDS, 2016).

Despite optimistic figures, scholars' warnings to improve STEM employment figures have grown increasingly shrill with time. Data from 1990 stated that the "pool" of eligible workers "is rapidly shrinking" (Alston et al., 1998, p. 263). Over 25 years later, the numbers are even sharper. This is good news for job seekers. A college degree in STEM will complement healthy job projections, especially in the technology sector. Careers in computer science, specifically jobs in computer design and service, are projected to grow by 45% between 2008-2018 (National Math & Science Initiative, 2015). Naturally, a celebrated workforce with strong projections for future growth requires an equally impressive educational system that equips all students for these careers.

After matching Census Bureau data with BLS projections for 2012-2022, three key trends emerged: (1) There is chronic underemployment and under-representation of IWDs in the workforce; (2) IWDs tend toward lower-paying jobs, especially IWDs who are underrepresented minorities or less educated; (3) Projections are good for higher-paying jobs for IWDs (DOL, 2014). Secretaries, carpenters, and bookkeepers are the top projected jobs for IWDs without a college degree. With the rise of computers in the workplace, most occupations have streamlined their ability to accommodate more workers with disabilities. Increasingly, the traditional limitations of IWDs (e.g., a psychomotor disability) are being sidestepped with the aid of computers.

STEM Education

Test scores in STEM. The United States' competitive edge as a global leader in STEM academics has been slipping, especially in the last couple decades (CEOSE, 2014; Dunn et al., 2012; PCAST, 2010). Our students' test scores on internationally-ranked achievement tests have yielded disappointing results. According to the U.S. Department of Education (DOE, 2016), K-12 U.S. students recently scored 29th in math and 22nd in science on a list of top international competitors. Math and science achievement results from the Program in International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) report declining scores over the last decade (Kena et al., 2015; McComas, 2014; NCES, 2012; PCAST, 2010).

The Nation's Report Card in Science, as funded through the National Assessment of Educational Progress (NAEP) at the DOE, shows similar data to corroborate these trends of

declining test values in STEM disciplines. The science portion of the NAEP is comprised of a framework of three content areas including physical science, life science, and earth and space sciences, and has reported some of the lowest numbers compared to international competitors (National Center for Education Statistics, 2012). All of these assessments are undeniably linked to the education that is offered to our students in STEM. The quality, quantity, and scope of relevant STEM curricula are the responsibility of the education system and best represented in the coursework offered to our STEM-seeking students.

STEM coursework. STEM coursework can be defined as the requisite classes in elementary, secondary, and post-secondary education that lead to mastery in STEM concepts. STEM courses are undeniably difficult; they require more cognitive load bearing than normal (Goldstein, Naglieri, Princiotta, & Otero, 2014). To further complicate issues, STEM coursework has seen its share of funding cutbacks, contributing to declining vocational interest and population numbers in the STEM pipeline. Of the STEM disciplines, science has been a decreasing priority in K-12 public curricula across the nation in the past decade due to increased emphasis on high stakes testing in verbal and mathematics scores.

The STEM FOR ALL Initiative (Basham, Israel, & Maynard, 2010) undergirds the importance of UDL for SWDs in STEM. The authors propose a framework to manage the multiple, varied theories for practice in STEM education for SWDs. This framework is informed with an ecological model based upon Bronfenbrenner's (1977) theory. According to Marino & Basham (2010), an effective STEM education is about curricular engineering via an "iterative process" (p. 14). Each successive re-design customizes the learning platform to a better fit for the learner's needs and abilities, thereby furthering their progress. The UDL guidelines are an

excellent resource for consideration when designing content for STEM and SWDs (CAST, 2011).

SWDs struggle to attain access to STEM coursework even more so than their peers without a disability. The DOE's Office of Civil Rights Data Collection (CRDC, 2012) compiled college and career readiness data to show that a basic high school STEM course catalog offering (i.e., algebra, geometry, calculus, biology, chemistry, and physics) was available to only 63% of students with a confirmed disability and 65% of limited English proficient (LEP) students.

Interestingly, scholars who have sifted through complex data sets in the National Longitudinal Transition Study-2 (NLTS-2) have determined that students with disabilities elect to pursue STEM coursework and degrees with greater frequency than their peers without a disability (Lee, 2011).

STEM content reform. An education in STEM provides acquisition of complex skill sets necessary in this post-modern era. Yet only 16% of high school seniors show interest and proficiency in these fields; And of college majors who earn a STEM degree, only 50% choose to work in a STEM career (Chen, 2013). Alarmed by the anemic numbers of students interested in STEM, the SEO (2016) seeks to lobby for the priority of STEM education via legislative channels. PCAST's (2010) report to President Obama concluded that lack of interest in STEM is a larger problem than lack of competency in STEM. The report proposed recommendations for a STEM education that inspires and prepares students for a post-modern world full of intricacies in these fields. Surely, opportunity and encouragement in a career is as important as preparation of technical skills in that field. Figures like these convince educators, legislators, and lobbyists to

improve services and supports for students as they embark upon the collegiate experience in pursuit of a STEM degree.

Marginalized Populations in STEM

Ethnic minorities. Individuals from ethnic or cultural backgrounds that differ from the national majority are some of the most disenfranchised groups in STEM education. Although certain figures for overall enrollment of minority students has increased steadily over the last couple decades, the number of actually entering STEM degree tracks is still quite low (Mooney & Foley, 2011; Wladis, Hachey, & Conway, 2015). In fact, diversity in the STEM fields is so lacking that current percentages of ethnic minorities would need to triple in order to equal the majority population (National Academy of Sciences, 2011). Retention and persistence in undergraduate STEM programs can be improved with certain highly targeted programs such as summer bridge initiatives, but overall degree completion rates are still in jeopardy (Tomasko, Ridgway, Waller, & Olesik, 2016). Even online courses at community colleges, assumed to be more accessible for individuals from ethnic minorities, show the lowest proportions of Black and Hispanic students (Wladis, Hachey, & Conway, 2015).

Women. Women are notoriously underrepresented in STEM (NCES, 2012). Even in light of the contemporary workforce surge into careers in technology, women still have disproportionate numbers into the STEM pipeline. Reports from higher education reveal declining trends in women's attainment of STEM degrees. According to the U.S. Department of Education's Integrated Post-Secondary Education Data System (iPEDS, 2016) women earned 40% of STEM degrees in 2001 and only 22% of STEM degrees in 2012. According to the New York Times' bestseller *Lab Girl*, sexism is rampant in post-secondary and graduate STEM

education as well as the STEM workforce (Jahren, 2016). Such accounts from successful and respected female scientists offer awareness to the public and encouragement to younger girls, setting the ball in motion for greater equality and access to everyone, especially marginalized groups. Although women have had, and continue to have, their share of discrimination and denied opportunities in STEM, students with disabilities (SWDs) often have the most challenging time entering the STEM pipeline.

Individuals with disabilities (IWDs). Before the year 2000, scholars predicted that the impending shortage of STEM workers would bode well for a surplus of STEM-workers with a disability (Alston et al., 1998). Despite reported trends that show increasing numbers in the field, however, SWDs are still an underrepresented minority (Dunn et al., 2012; Burgstahler & Chang, 2014; Alston et al., 1998; NSF, 2013). Individuals with disabilities (IWDs) comprise merely 5%–6% of the workforce (Burrelli, 2007; Leddy, 2010). Some sources estimate numbers of people in the U.S. with a disability at 19% of the general population (Leddy, 2010; Burrelli, 2007). Other figures remain more conservative, with confirmation of disability at 10% (Odom, Horner, & Snell, 2009). Regardless, SWDs comprising a mere 5-6% of the STEM field warrants discussion and change. As cited previously, IWDs are an “untapped resource” (Leddy, 2010, p. 3; Alston et al., 1998, p. 5) that can, and will, do manifold things for STEM fields.

Post-Secondary STEM

The literature is clear that SWDs undergo more intense struggles during college and are less likely to graduate than their peers without disability (Burrelli, 2007). STEM retention is especially low for SWDs (White, 2013). According to data from the NSF, of the SWDs who attempt a bachelor’s degree, less than half actually persist to completion (Burrelli, 2007).

Fortunately, these numbers are much higher for graduate students with a disability, at over two-thirds of this population earning their degree. 28% of non-disabled students declare a STEM major, with biological/life sciences being the most popular choice. Math and physical sciences were least preferred, enlisting on 2-3% of students (Chen, 2013). A whopping 48% of these students who intended to earn a STEM degree actually changed their major or dropped out altogether (Chen, 2013).

The college experience is a time of transition for all students--perhaps even more so for SWDs--given the enormous responsibility required and less structure involving individualized supports (Parker & Boutelle, 2009; Estrada, Dupoux, & Wolman, 2006). It is well documented that students with a learning disability (LD) have a more pronounced struggle during their transition to post-secondary education as compared to their non-disabled peers (Hanafin, Shevlin, Kenny, and Neela, 2007; Weyandt & DuPaul, 2008; Collins, Hedrick, & Stumbo, 2007). Fortunately, post-secondary students identified with a disability have shown increased enrollment numbers over the years (Rath & Royer, 2002). By far the overwhelming percentage of these students are those who classify as having a high incidence disability (Hamilton, 1992). Of these students, those who actually graduate are considerably low (Cowles & Keim, 1995).

It is no surprise that STEM enrollment at college is on the decline (CEOSE, 2014). Lee (2011) looked at data from the National Longitudinal Transition Study-2 (NLTS-2) and the Educational Longitudinal Study (2002) to more fully understand the enrollment differences of students with and without disabilities in their pursuit of a STEM degree. The conclusions from these data were surprising. Women are still a minority in STEM degree paths. More

interestingly, however, SWDs enrolled in STEM degrees at a higher rate than students without a disability, and at a much higher rate at 2-year colleges than previously expected (Lee, 2011).

The struggle is real for SWDs in pursuit of a STEM degree (Lee, 2011; Moon, Todd, Morton, & Ivey, 2012). Academic, vocational, social, and emotional challenges are numerous and intense. Academically speaking, there is a lack of consensus for what constitutes the processes around learning STEM (Lamb, Akmal, & Petrie, 2015), although scholars believe it likely revolves around a blend of cognition, affect, and critical application of content (Houseal, Abd-El-Khalick, & Destefano, 2014). This places undue burden on the already challenging academic journey that is a STEM discipline. In addition to learning processes, there is a lack of access to STEM courses in college and career readiness (i.e., secondary) levels (CRDC, 2012).

The academic pursuit of STEM degrees also contributes to a lack of significant representation by SWDs in the field. A barrier to entry seen in SWDs includes an inferior range of customizable academic supports that could compensate for the student's greater needs and improve their access to the content (Dunn et al., 2012). Their entrance into the field can also be effected by secondary math achievement scores, their intent, their self-efficacy, and their exposure to STEM in important phases of college (Wang, 2013). Furthermore, the skills, resources, and follow-through of their teachers and supporting staff are maxed out (Bargerhuff, Cowan, & Kirch, 2010). Educators need comprehensive instructional design (Langley-Turnbaugh, Wilson, & Lovewell, 2009) and frameworks such as Universal Design for Learning (UDL) to help SWDs access the content in a successful and individualized manner.

Reports and evidence for these reasons have been varied and broad regarding vocational struggles. According to Burgstahler and Chang (2014), a lower amount of females to males in the field can impede entry from this unbalanced atmosphere of genders. Low expectations for performance and outcome of the SWD are also a contributing factor (Dunn et al., 2012) in their lack of entry to the field. As would follow, this environment contributes to an attitude of low aspiration for and from SWDs (Rath & Royer, 2002). Career mentors and experiences are important to access and success in a field, yet SWDs are traditionally in deficit for both of these (Dunn et al., 2012). SWDs typically find barriers to entry in their chosen career if/when they make it this far. This may cause underemployment in the field with issues working against them such as the attitudes of their employer, their own work ethic, habit, and skills; recidivism, and challenges related to transition into an independent lifestyle (Leddy, 2010).

Burgstahler & Chang (2014) compared samples of SWDs and concluded that programs to encourage STEM career goals, mindsets, and experiences increased student interest to pursue STEM. Of the different research groups, students who self-selected as being interested in STEM weighted their decision more heavily in favor of financial incentives in a STEM-related career, as well as a propensity to use technology regularly and show interest in learning outcomes associated with these disciplines.

Nature of Disability: Executive Functioning (EF)

The most prevalent disability category for SWDs is the specific learning disability (SLD), accounting for half the eligible population (Bargerhuff, 2013; Burrelli, 2007). According to Goldstein, Naglieri, Princiotta, and Otero (2014), executive functioning (EF) of the brain is an operationalized construct believed to be responsible for the following functions: Planning,

working memory, attention, inhibition, self-monitoring, self-regulation, and initiation. Although these symptoms could be housed under numerous high incidence disability categories [e.g., dyslexia, ADHD, and/or specific learning disability (SLD)], for the purposes of this research EF will be considered the primary disability designation. Scholars note that EF is a “multidimensional construct” of cognitive activity involving academic, emotional, and behavioral abilities (Vriezen & Pigott, 2002, p. 296).

The origins of EF disabilities were originally believed to be the direct result of a sustained injury to the Pre-Frontal Cortex (PFC). The PFC is the brain region responsible for executing the tasks of these functions and abilities (Barkley, 2001; Goldstein, Naglieri, Princiotta, & Otero, 2014). Given the increased cognitive demands of STEM coursework, it is imperative that students have EF skills, or learn to cultivate EF skills, for STEM persistence and learning (Bellman et al., 2015). Unfortunately, the students who most require extra support and attention toward in learning are often those least likely to seek out the requisite help (Roll, Alevan, McLaren, & Koedinger, 2011). UDL designers and online curricular designers have always understood the irony that is unused online support features (Stahl & Bromme, 2009). Finding an academic coaching model that accounts for this tendency is therefore the goal of this research project.

Degrees & careers. According to Cortiella & Horowitz (2014), the National Center for Learning Disabilities (NCLD) reports that 41% of the student population with a disability typically graduates with a degree, as opposed to 52% of the general population. Pingry O'Neill, Markward, & French (2012) looked at the graduation records of 1289 students with disabilities from three public universities and discovered that 74.2% of SWDs graduated. The authors

determined that disability type greatly impacted graduation rate. Students with intellectual disabilities yielded only half as many graduates as those with physical disabilities and students with psychiatric disabilities were only as third as likely to graduate. Although physical disabilities are not as common in the general population, high incidence disabilities involving executive functioning tend to be the most prevalent form of disability to present challenges for students seeking degree attainment.

For post-graduates seeking an advanced degree in a STEM discipline, the numbers are truncated much further. The Committee on Equal Opportunities in Science and Engineering (CEOSE, 2014) found that in the year 2012, a mere six Latinas were awarded PhDs in computer engineering and no PhDs were awarded to Native Americans in the field of math. Minorities comprised only 3% of all awarded PhDs. Women earned a third or less of all PhDs in STEM disciplines in 2012. Students with disabilities, women, and minorities, participated in the following careers the least: engineering, math, computer sciences, and physical sciences. Broken down by discipline, physical sciences are the lowest represented field followed by life-sciences, then engineering, then computer and math sciences (Burrelli, 2007). According to the BLS (2012), STEM workers earn a median salary that is double that of their counterparts in other fields. Legislative efforts in STEM have worked to empower equality, opportunity, and success for our students.

Federal policy & legislation in STEM. Numerous initiatives and bodies of legislation have shaped STEM policy in education and the workforce. The National Science and Technology Policy, Organization, and Priorities Act of 1976 birthed, among many initiatives, the The Office of Science and Technology Policy (OSTP). The Office of Science and Technology

Policy (OSTP) is an inter-agency task force represented by elite members of numerous STEM fields including: energy, aerospace, climate, oceanography, climate, water, biosecurity, cybersecurity, education and learning science, behavioral science, nanotechnology, and telecommunications. The list of careers on this committee is exhaustive given that there are multiple players at stake regarding STEM policy at a federal level. The OSTP's role is advisory to executive office, like the President's Council of Advisors on Science and Technology (PCAST), who report directly to President Obama on all matters STEM.

In recent years, the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science COMPETES Act (2007) was created "to invest in innovation through research and development, and to improve the competitiveness of the United States" (America COMPETES Act, 2007, p. 2). The America COMPETES Reauthorization Act of 2010 hardened the resolve of the previous house resolution and administration, and permitted greater funding for STEM career supports infrastructure. This legislation created the Committee on Science, Technology, Engineering, and Math Education (CoSTEM) in 2011 to make timely reports, recommendations, and assessments for the development of 5-year strategic plans that offer federal oversight of STEM education, workforce training, and lifelong learning. These legislative actions are by no means comprehensive of the greater body of legislative work that promote STEM awareness, education, and vocational placement. Ideally, these legislative acts support the equality and access of all populations to the world of STEM.

The National Science Foundation (NSF) is one such organization that has contributed sizably to the future of STEM (Elliot et al., 2009; NETP, 2016) in an ongoing effort to support STEM learning for all populations. The NSF was one of the original adopters of the STEM

acronym, in fact. According to the CEOSE (2014), NSF's annual budget for STEM-related investing is around \$7 billion. Every two years NSF (2015) produces the *Women, Minorities, and Persons with Disabilities in Science and Engineering Report* with facts and figures related to enrollment, education, and employment figures and descriptors of STEM related workers. The Committee on Equal Opportunities in Science in Engineering's (CEOSE) newest report (2014) to Congress also works in an effort to help marginalized groups who are underrepresented in STEM (namely women, minorities, and SWDs). The report proposes a "holistic" approach that includes all people, values cooperation and collaboration, uses goal setting, and includes data monitoring for long-term evaluation and change (CEOSE, 2014, p.1). Ideally, the spirit in the law serves to protect all individuals equally and with due process. Ultimately, increasing access to all populations, especially those most marginalized, is the goal of these laws.

Solutions for STEM: Learning & Persistence

An astounding 1.5 million of the 3 million undergraduate students who enter into a STEM major each year ultimately drop out (PCAST, 2012). Yet despite discouraging figures such as these, there is a bounty of evidence-based practices to encourage growth in learning and persistence models. Psycho-education, specifically the practice of academic counseling, has a unique ability to address some of the pitfalls inherent to learners with disabilities. Gerdes and Mallinckrodt (1994) claim that "proactive" counseling programs at universities that encourage early and ongoing adoption of counseling services greatly increases the likelihood of student satisfaction and retention (p. 286). The student's decision to access these services, and to become sufficient and more independent, can be seen in the construct of self-efficacy.

Theoretical perspectives. Bandura's (1977) renowned social cognitive theory (SCT) sought to explain the psychological mechanism for a belief in one's self to handle a given situation via the construct of self-efficacy. Bandura's definition of self-efficacy is, "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1977, p. 191). The motivation needed to persist in a STEM education and career is explained through self-efficacy (Meyerhoff, 2013) and directly informs the underpinnings of a successful STEM psycho-education. Bandura (1977) wrote that the personal efficacy of an individual would determine how successful she would be via coping behaviors, how long and hard she would persist, and to what degree she would attain mastery over aversive influences.

Lent, Brown, and Hackett (1994) authored the social cognitive career theory (SCCT) that sought to explain how occupational interests in a given discipline are cultivated, how choices are made regarding the discipline, and how overall performance might be effected in this discipline. Wang (2013) conducted research with the SCCT to better discern factors that compel a student toward majoring in STEM. The data revealed compelling factors including: the intention to major, high school math performance, and exposure to STEM during pivotal years of education. Recommendations for future STEM support models are implicit within these data.

Bandura called the culmination of historical events—and one's perception of them—*mastery experiences* (Bandura, 1994). Bandura further defined *social persuasion* as the perception of one's ability, as communicated through another person. Zeldin, Britner, and Pajares (2008) conducted a study concentrated on men's and women's self-efficacy in STEM. The data determined that there was no relative difference in aptitude between men and women in

given content areas, but that women had largely diminished perceptions of their ability, at least much more so than their male counterparts. Self-efficacy in men was most prominent when the individual was full of mastery experiences. Such was not the case for women, however. Social persuasions were found to be the most potent predictor of self-efficacy in women. Implications for STEM education and training are evident in these results. Men and women have varying needs to succeed in STEM, as do other populations.

Cardoso and colleagues (2013) looked at underrepresented minority SWDs interested in STEM and their relative level of goal persistence. The social cognitive career theory (SCCT) framework identified predictors for their continued STEM interest and goal persistence including gender, father's education level, and advanced placement (AP) classes. With respect to the first two predictors, these results appear to be categorical, immutable factors that our students can't change about themselves. A call to better representation, cultural awareness, academic supports, and access to AP classes would leverage the SCCT framework to the student's advantage.

Meyerhoff (2013) reported that undergraduate STEM students received less mentorship and research experience due to faculty wary of their inexperience in complicated labs. Meyerhoff (2013) constructed a STEM Persistence Framework comprised of a learning dimension and a professional identification dimension as two keys to achieving persistence in STEM. In order to increase confidence and motivation (the constructs exercised with the two dimensions), the framework cites three activities as essential: (a) early research experiences, (b) active learning, and (c) participation in learning communities.

Evidence-Based Practices for STEM Persistence & Learning

Much data have been compiled that indicate STEM enrollment and academic performance are down. Much less data have been gathered to understand factors related to persistence in a STEM career, however (Maltese & Tai, 2011). A guiding philosophy in much of the NSF's mission is STEM access for SWDs by way of Universal Design for Learning (UDL).

Universal Design for Learning (UDL). In the 1990's the Center for Applied Special Technology (CAST) founded the notion of Universal Design for Learning (UDL), inspired from the decades-old architectural principle of Universal Design (Rose, 2000; Hitchcock et al., 2002; Story et al., 1998). The architectural purpose of Universal Design was for construction of facilities and infrastructure to ease the physical challenges of individuals with disabilities (Rose, 2000; Story et al., 1998). Most typically, old ramps and elevators were retrofitted to an existing building or structure. The application for education is evident in the three guiding principles of UDL.

The UDL model benefits all types of learners, not just SWDs (Rappolt-Schlichtmann, Daley, & Rose, 2012; CAST, 2016; Alston, Bell, & Hampton; 2002; Schunk, 1989) In an effort to make learning educational content accessible for everyone, UDL framework is founded on the following guiding principles: (1) Provide multiple means of representation (correspond with recognition networks, the “what” of learning); including perception, language, expressions, and symbols; (2) Provide multiple means of action and expression (correspond with strategic networks, the how of learning); including physical action, expression and communication, executive function; and (3) Provide multiple means of engagement (correspond with affective

networks, the why of learning); including recruiting interest, sustaining efforts and persistence, self-regulation (CAST, 2011).

A common misunderstanding of UDL is the belief that “universal” means a “one size-fits-all solution” (Rose, 2000, p. 67). In fact, universal suggests that multiple, varying modes and methods for learning be offered given the diverse learning of multiple, varying people. The notion that the student had too many learning needs for a common curriculum was supplanted with the concept that perhaps the curriculum itself was studded with too many barriers for all learners to access the content (Hitchcock et al., 2002; Rose & Meyer, 2002). Interventions & supports aimed at improving access and persistence for SWDs are also effective for other underrepresented populations such as women and minorities (Marino, Black, Hayes, Beecher, 2010).

According to Rose, Hasselbring, Stahl, and Zabala (2005) there are two distinct but complementary forces charged with similar missions in bringing about effective technology into the classroom for SWDs: Specifically, the National Assistive Technology Research Institute (NATRI) at the University of Kentucky (for AT) and The National Center on Accessing the General Curriculum (NCAC) at CAST (for UDL) (Rose, Hasselbring, Stahl, & Zabala, 2005). Assistive technology (AT) is a well-established term in education circles, often regarded as the low-tech cousin to the sleeker, high tech UDL. AT employees various methods to embed technology into the classroom experience for students to better access and appreciate learning. UDL is a more recent addition to education, though has been used for decades in architectural design and construction.

Both AT and UDL share the same goal of fostering greater learning for students, but are different in their processes for accomplishing this. AT is the actual technology tool that individuals implement to defeat objects in school and life. UDL uses technology to make school less challenging and more user-friendly (Rose, Hasselbring, Stahl, & Zabala, 2005). The fact remains that the merger between technology and our work space is less obvious all the time. Customizable features and personalization abound for educators and students alike. Examples include digital libraries, remote tutoring, and remote collaboration (Manzo, 2010). Scholars have noted this construct as personalized learning. End-users will likely agree that the ability to be flexible, accessing learning anytime or anywhere, and constantly re-define the role of a teacher and learner for a user-driven experience is key (Wolf, 2010). By personalizing student learning, the individual is able to gain skills and knowledge in a given career set through a comprehensive network or “ecosystem of support” much like the Bronfenbrenner model (1979).

Academic counseling. Academic counselors play a pivotal role in teaching and coaching these pro-active persistence and learning strategies. Academic coaching continues to show promise for developing certain essential skills such as executive functioning (Bellman et al., 2015; Weiss & Rohland, 2015). Before there was a contemporary awareness of EF skills regarding STEM training models, there was a prevailing trend in certain cognitive behavioral approaches to a psycho-education. Self-efficacy and positive psychology are such constructs within the established approach, suitable for use within a support-model framework of counselors, coaches, tutors, mentors, and faculty (Hanafin et al., 2007). Seligman (2007) defines positive psychology as “the study of positive emotion, of engagement, and of meaning, the three aspects that make sense out of the scientifically unwieldy notion of happiness” (p. 266). Self-

efficacy has been defined as a person's belief in his or her abilities (Bandura, 1997). Self-efficacy and positive psychology both seek to evoke human strengths such as optimism, perseverance, and interpersonal skills (Seligman & Csikszentmihalyi, 2000). A primary goal of STEM support models is to encourage this perseverance and self-efficacy in order to engage the STEM pipeline successfully. Coaching nurtures "personal development skills" like self-determination and self-advocacy (Dunn et al., 2012), which have corresponding definitions to self-efficacy and positive psychology.

According to Bandura's (1977) theoretical framework on self-efficacy, individuals will increase their feelings of self-worth and thereby reinforce further effective behavior by virtue of engaging in psychological exercises aimed at behavior change. Through gradual accomplishment (i.e., mastery), a learner will incrementally gain higher levels of self-efficacy while also becoming more effective at the intended behavior. CAST (2011) calls on the UDL-embedded skillset known as self-regulation to "effectively manage (your) own engagement and affect." The implication supplied here from the CAST think tank is that social-emotional learning is an actual behavior to be taught. The best academic coaching models have taken the guesswork out of these soft skills and put them into a tangible learning format.

We know that teaching and coaching students to become more aware of their strengths and weaknesses, and more aware of their mental processes (i.e., "metacognition"), is an important strategy for increased learning gains (Daley et al., 2014). This cognitive-behavioral awareness becomes the pathway by which students can access a plethora of assistive technologies, supports, and strategies for learning and persistence in STEM. In addition to effective counseling of cognitive-behavioral strategies such as self-efficacy, counselors are also

recommended to be effective at teaching STEM persistence and learning by shaping a student's self-perception of his or her self.

One such responsibility is toward crafting realistic and positive student perception. The manner in which a counselor encourages the goodness-of-fit or perception of his student toward an intended career is of utmost importance for student identity. Alston et al. (1998) surveyed rehabilitation counselors' perceptions of SWDs in science and engineering and concluded that attitudes and perceptions were governed via three variables: (1) human and system barriers; (2) student aptitude; and (3) teacher influence. Awareness of these factors can imply training to overcome challenges and reward strengths. Alston et al.'s (1998) research concluded that an effective counselor was not only aware of their perceptual guidance, but also well-versed in the ins and outs of a given field prior to educating the student on it; and versed in technology germane to learning and progress in the field. An active learning model in a STEM learning community would encourage students and staff alike to engage in new learning about relevant STEM concepts. This would further bolster their relational abilities and feed a positive learning cycle.

Interest in STEM at an early age is an indicator of latter success and persistence in the field (Cardoso et al., 2013) Achievement in STEM-related coursework is also a predictor (Wang, 2013). Students tend to gravitate toward subject matter they find reinforcing of their skill sets and abilities. If students aren't made to be successful, or even feel successful, they will likely shy away from this content. Typically speaking, by the time a student has reached junior high, she will have been well-acquainted with STEM content and can readily tell you if she is interested in

pursuing secondary or post-secondary STEM-related content. It is crucial that educators do more to cultivate interest in the content.

It is imperative that higher education also do more to encourage a nascent STEM workforce. Unfortunately, many students don't see STEM careers in a positive light. Upon entering college, students commonly take issue with the lack of inspiration they derive from introductory STEM coursework (Seymour & Hewitt, 1997). As STEM faculty busy themselves with the system's stressors of tenure, grant-writing, and research, it is the under-developed Teaching Assistants (TAs) who serve as the primary point of contact for undergraduate students. The job of inspiring today's students to be tomorrow's STEM-workers often falls on their contemporaries. Although peer mentoring has been shown to be effective, the intended model for this research emphasizes the relational process of student and staff via academic coaching.

The EF skills derived from the academic coaching models assessed thus far are powerful for their practice of UDL-inspired design plus the knowledge of all the theory and structure of the past decades. The *AccessSTEM* academic coaching pilot offered this model via weekly coaching sessions that sought to bolster executive functioning skills. *AccessSTEM* emphasized skills in time management, prioritization, and productivity; how to study, write, and take notes; and how to combat stress and be an advocate for one's self.

Cost effectiveness is very much a concern for implementation of this best practice. Typically, academic coaching services are provided to SWDs with the means to afford the support. Large scale adoption of this support has not yet been achieved for the masses (Bellman et al., 2015). There is tremendous promise, however, with the growing influence of well-designed, customizable technology into the coaching model. As seen in the *BreakThru* model,

examples of these technologies include e-mentoring and virtual learning training (Dunn, et al., 2012). As these technologies become more accessible (i.e., affordable), larger institutions will be able to implement these exciting practices into effect for much greater numbers of their students.

CHAPTER THREE: METHODS

The purpose of this study was to examine the essential elements of a successful STEM-support model at an undergraduate institution in order to generalize knowledge and services to a larger university. The research question guiding this study included: What are the essential attributes of a STEM learning and STEM persistence model for SWDs at a small college?

Setting & Participants

Landmark College (LC) is a small, private college in southeastern Vermont that is well-reputed for their support model for students with disabilities. EF skills training is a prize-winning service in their academic coaching model included in the tuition (Parker & Boutelle, 2009). LC is noted for being the first undergraduate institution to fully accommodate and support students with dyslexia. Decades later, they are developing and implementing programs that cooperatively foster academic, social, and emotional excellence in their students. There are numerous stories from Landmark that consist of disabilities being overcome through the institution's innovation and supports. Landmark College agreed to share their students and faculty with the principal investigators (PIs) of this study in an effort to gather results for analysis and publication.

Landmark College enrollment data from 2014 reported an overall student body of 494 students, divided into 73% male and 27% female students. The vast majority (93%) of these students originated from out of state with 5% from the state of Vermont and 2% from international locations. Race and ethnicity of the students comprised 69% white, 7% black or African American, 3% with two or more races, 1% Asian, 3% Hispanic/Latino, 2% non-resident

alien, and no American Indians, Alaskan Natives, Native Hawaiians, or Pacific Islanders (Landmark College, 2015).

The interview sample comprised both students and staff from Landmark College. 30 individuals participated in total, including 20 undergraduate STEM majors who reported having EF deficits comorbid with their disability; five academic coaches, and five academic advisors (see Tables 1-2). The researchers elected to conduct purposive sampling of the participants to maximize access to the richest information possible across age range, gender, and ethnic background. Use of purposive sampling permitted selection of a broad range of students.

Table 1: Landmark College Student Participant Demographics, Age & Gender

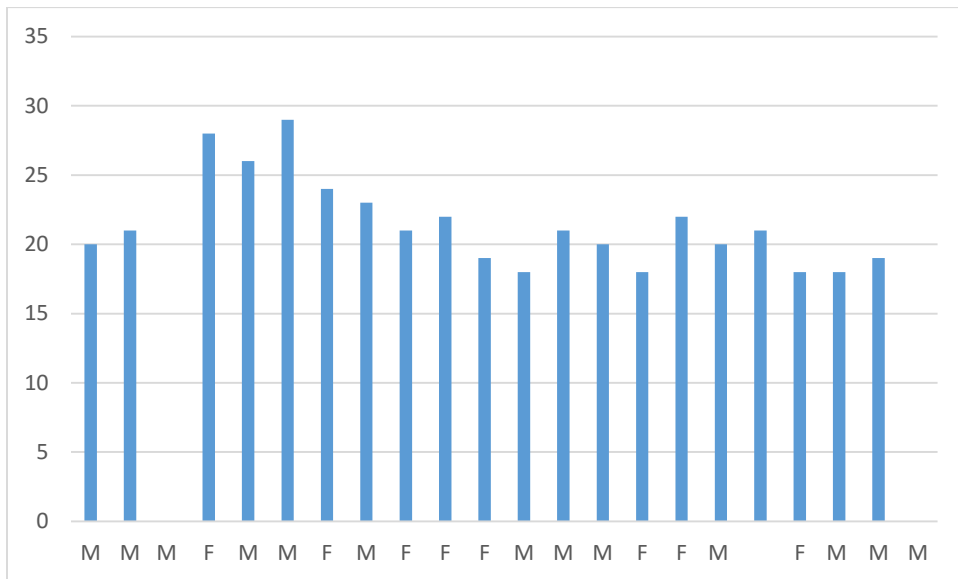
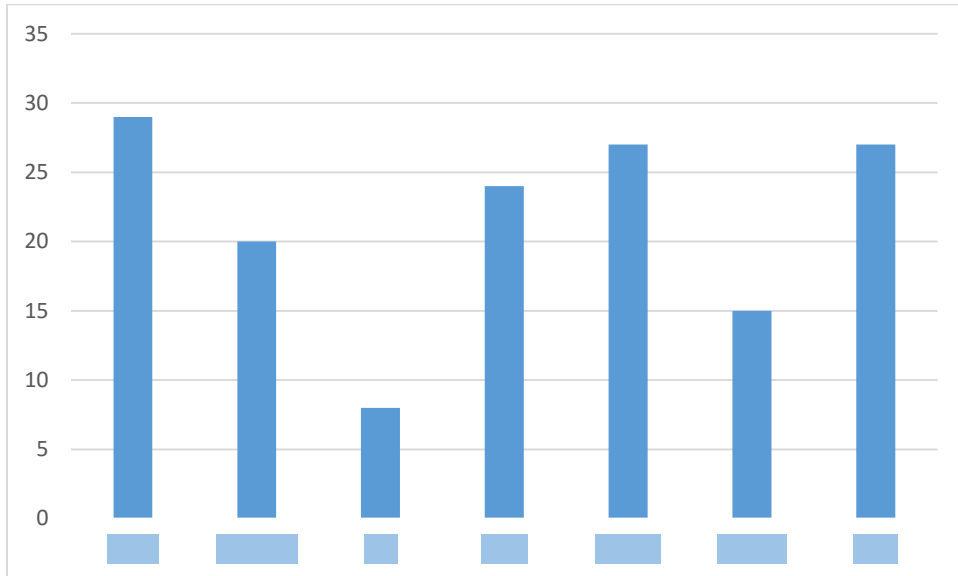


Table 2: Landmark College Advisors' Years of Experience



Design

The purpose of this study was to harvest the most crucial factors essential to STEM persistence and STEM learning models at an undergraduate institution with a successful track record for support. A qualitative research design was implemented to examine faculty and student perspectives via semi-structured interviews. Semi-structured interviews are the primary source of data for many qualitative research studies (DiCicco-Bloom & Crabtree, 2006; Kvale, 1983; 2007) and were implemented in this study to extrapolate themes most indicative of a successful STEM coaching model. The interview protocol is a popular style of experimentation (Turner, 2010) that accesses themes or categories that emerge and are common to all participating interviewees (Kvale, 2007).

According to Miles & Huberman (1984), implementation of a qualitative research design is all about “detection” (p. 309). This involves a degree of skill in observation of the data, as it is

being gathered, for future analysis. Practiced interviewers have a naturalized intuition about their work. They are, as Gall, Gall, & Borg (2003) noted, "...entirely on the spontaneous generation of questions in a natural interaction, typically one that occurs as part of ongoing participant observation fieldwork" (p. 239). Once detection is underway, the researcher should derive an index of categories (Pope, Ziebland, & Mays, 2000) by systematically refining the data. Based upon assumptions from grounded theory, a constant comparative method (Glaser & Strauss, 1967) was utilized to ascertain categories and themes most pertinent to the research questions.

In these semi-structured interviews (see Appendix A), the general line of inquiry oriented around academic coaching, technology, virtual coaching, and strengths and weaknesses of the current Landmark College model. These interviews were conducted by the principal investigator and co-principal investigator of the larger NSF grant study. Interviewers led the direction of the interview process, with the occasional re-directing prompt for thematic inquiry. "Sequential analysis" occurred during collection of data with the interview participants (Pope, Ziebland, & Mays, 2000, p. 114), so that as data was being collected, the line of inquiry was also being refined and coordinated by the interviewers with better clarity and potency. The interviews were recorded with audio and video, yielding more data for further examination. Interviews were transcribed by an independent contractor with proven reliability figures. The transcriptions are not isolated to words alone but sometimes included pauses, facial expressions, and tone of voice.

Procedures

Table 3: NVivo Coding Protocol: An Iterative Data Analysis System

<u>Step</u>
1.) Familiarization (Miles & Huberman, 1984): Doctoral researcher read one transcript at a time for familiarity and comprehension. No notations or interpretations were rendered. The goal was general understanding and exposure.
2.) Construction of a thematic framework (Miles & Huberman, 1984) which is “not an automatic or mechanical process, but involves both logical and intuitive thinking” (p. 314). Re-read transcripts a second and third time and identify emerging themes (Glaser & Strauss, 1967; Stemler, 2001) as they present themselves. Begin by highlighting passages of transcription text and assign a preliminary label or “node.”
3.) Injection of a search query. Based upon reading these passages, amass 2-3 search “terms” from each node. Run independent search query to search for other passages that may have been overlooked (i.e., double-check for missed instances.) Code additional data accordingly. Nodes visualized with “word tree” diagramming.
4.) Formalization of themes and codes: Propose a priority label checklist (Haney, Russell, Gulek, & Fierros, 1998; Stemler; 2001). Re-read a 4 th and 5 th time with coding and re-coding process.
5.) Draft ongoing memo to record insights, with “sequential analysis” (Pope, Ziebland, & Mays, 2000, p. 114) as guidepost for iterative analysis.

Data Analysis

A qualitative research software program named NVivo (version 11.2.1) was used to process, analyze, and interpret the interview transcripts. Although software such as NVivo should never be seen as a “shortcut” to data analysis (Pope, Ziebland, & Mays, 2000, p. 114),

NVivo is an excellent tool for management and categorization of large bodies of data (i.e., interview transcription). Typical qualitative designs neglect to represent the data with statistical means. Oftentimes frequency counts are utilized as a reference point but the truest expression of these data are often indices (i.e., an index) that yield a hierarchy of categories (Pope, Ziebland, & Mays, 2000).

NVivo works to systematically highlight main themes (or “nodes”) as the reviewer “codes” the interview transcripts. Each node nests other subcategories beneath it for further examination. Tools for further inquiry (e.g., “cases”) provide further cross-cutting and analysis of the transcript data. NVivo’s process of coding at nodes, nesting, and driving case inquiry is an ideal tool for transcript analysis in order to implement the constant comparative method. According to the developers and practitioners of NVivo, the best qualitative data analysis is approached iteratively (QSR, 2015). That is, numerous readings of a given transcript afford the most refinement of themes and categories pertinent to the objective. According to scholars (Haney et al., 1998; Stemler, 2001; Miles & Huberman, 1984), this iterative process is consistent with the emergent coding process in qualitative literature. Numerous readings, codings, and re-codings provided refinement and clarification of themes sought in this research design, consistent with the constant comparative and emergent coding processes (Glaser & Strauss, 1967).

Interobserver Agreement (IOA) and Member Checking

NVivo provides experimental rigor via total transparency across all data sources. A team of inter-observers (i.e., coders) may mutually agree to an experimental protocol and then proceed

with their coding autonomously. In process and in retrospect, the software provides comprehensive oversight of the coders decisions. Frequency, comparisons, contrast, and nature of the content may be scrutinized for reliability of a given construct or theme. Discrepancies can be visualized accordingly and steps to re-adjust protocols may be implemented as necessary.

This research project was conducted by a solo practitioner, the author, and no IOA or alternate codings were conducted at this time. Given that these data are post hoc from a larger study, the practitioner's codings may be used for further comparison with other codings. Member checking was implemented by the co-authors of the larger NSF grant, however, to verify the veracity of the conclusions drawn from the codings. Drs. Marino & Vasquez presented the results of the analyzed interview transcripts to students and staff of Landmark College in an effort to corroborate the findings. Overwhelmingly, the feedback and results were positive and accurate, with no discrepancy reported in the outcomes from the data.

CHAPTER FOUR: RESULTS

The purpose of this study was to examine and identify the essential elements of a successful STEM-support model at Landmark College. The research question was: What are the essential attributes of an undergraduate support model for STEM learning and persistence in students with disabilities (SWDs)?

The essential attributes to Landmark’s STEM-support model have been identified as corresponding themes that emerged from the interview data. Themes were assigned as nodes within the analysis software (Table 2). As these nodes withstood multiple iterations of coding and assessment, larger findings began to emerge. Upon further iterations of coding the data, three key findings surfaced as over-arching themes. These include: (1) Academic counseling is the core support. Technology facilitates, not supplements, this relationship; (2) Persistence comes through self-efficacy; and (3) Learning comes through metacognition.

Table 4: Key Findings and Themes in Landmark’s STEM-Support Model

<p><u>Key findings</u></p> <ol style="list-style-type: none">1.) Academic counseling is the core support. Technology facilitates, not supplements, this relationship.2.) Persistence comes through self-efficacy.3.) Learning comes through metacognition. <p><u>Themes or “nodes”</u></p> <p>Advisors</p> <ul style="list-style-type: none">Access<ul style="list-style-type: none">Academic Support CenterLibraryOffice hoursPM support sessionsPsychologistAccountability

Acct-activating
 Acct-balance
 Dialectic
 Weekly meeting
 Challenges
 Diagnosis, label
 Families
 Goals
 Big picture
 Weekly
 Learning differences
 Metacognition
 Persistence
 Professional Development
 Relationship with student
 Care
 Coaching
 Self-efficacy
 Strength-centered approach
 Tech Supports
 Apps
 AT
 Flipped classrooms
 Mobility
 Social media
 Students
 Access
 Academic Support Center
 Office hours
 Psychologist
 Support system
 Accountability
 Weekly meeting
 Diagnosis, label
 Families
 Goals
 Big picture
 Weekly
 Learning differences
 Metacognition
 Learning about learning
 Peer support
 Relationship with staff

Talk to profs_questioning
Self-efficacy
Promote SE_push student
STEM persistence
Time management_productivity
Job_school balance
Note taking
Prioritization skill
Stress, assignments
Tech Supports
Apps
AT
Flipped classrooms
Mobility
Social media

Although the nodes are the most salient points to extract from the data, NVivo's analysis engine provides search queries in keyword frequency. Quantifying keyword frequency can be a valuable added dimension for data interpretation. Table 3 highlights selected words from the list of the 1000 most common keywords derived in the interview data. The selected words were appropriate to the nodes in all instances, and provide further understanding of the value of this learning and persistence model. Note the frequency of terms related to metacognition (i.e., knows, thinking, helps, using, learns, support). The academic coaching theme was pervasive throughout this query as well, evidenced by words such as: coaching, advisor, teacher, understand, successful, and disability. This word frequency analysis tool was a welcome corroboration to the thematic analysis, providing a more specific lens of awareness into the content of the data. The word frequency data can be visualized in the form of a word cloud with NVivo's analysis software (Figure 1).

Table 5: Selected Words & Frequencies, 1000 Most Common Words in Interview Data

<u>Word</u>	<u>Count</u>	<u>Weighted %</u>	<u>Similar Words</u>
knows	1397	2.44%	know, knowing, knows
students	987	1.72%	student, students, students'
thinking	537	0.94%	think, thinking, thinks
helps	309	0.54%	help, helped, helpful, helping, helps
using	309	0.54%	use, used, useful, uses, using
learns	235	0.41%	learn, learned, learning, learns
support	190	0.33%	support, supported, supporting, supportive
talk	189	0.33%	talk, talked, talking
coaching	174	0.30%	coach, coaches, coaching
advisor	128	0.22%	advisor, advisors
teachers	128	0.22%	teacher, teachers
teach	118	0.21%	teach, teaches, teaching
science	103	0.18%	science, sciences
math	99	0.17%	math
understand	99	0.17%	understand, understandable, understandably
successful	75	0.13%	success, successful, successfully
disabilities	65	0.11%	disabilities, disability
**laughs	152	0.27%	laugh, laughing, laughed, laughs

**The interviews were full of laughter. *Laugh* is not only the literal word count, but also the actual laugh count from notations the transcription service rendered.



Figure 1: Word cloud representing word frequency from 1000 most common words.

Finding 1: Academic counseling is the core support. Technology facilitates, not supplements, this relationship.

Virtually every interviewee commented at great length about the influence the academic counseling support provides in the persistence and learning. Testimony emphasized a relational component to the support, providing a platform by which other supports could be rendered. Frequent attention was paid to ancillary supports such as technology and psycho-educational models (i.e., metacognition, goals, time management, and self-efficacy). Students and staff

seemed to intuit how an ancillary support such as technology was a partial support, with academic counseling being the comprehensive support throughout.

The majority of interview testimony consisted of the academic advisors' unequivocal role as the primary resource for support and growth of the students. This conclusion was unanimous across all participants' data from both students and staff alike. This theme within LC's support model tended toward the relational aspects of coaching and counseling. Even when interview questions prompted lines of inquiry regarding technological supports, the students noted the role the advisors played, not the technology.

Generally, the technology was a simple means to an end. It provided functionality and ease for more possibility within the complex relational interplay between advisor and student. Yet it never supplanted the role of the advisor. And it didn't supplement it. Technology for its own sake was disregarded by the students. Advisors studiously persisted in adopting various technologies as a method for connection with the students. In reality, both sides were just seeking more functional connection and ease of communication.

The academic counseling at Landmark College focuses on weekly meetings, accountability, prioritization of goals, and practice of self-advocacy and metacognition skill sets. The successful blending of psychology and education provide a rich platform for growth in academic, social, and emotional domains. This cognitive-behavioral therapy (CBT) approach emphasizes self-growth, determination, grit, persistence, resilience, to name only a few research constructs that empower the persistence and learning of the student. The advisors, whether realizing it or not, were implementing many of these concepts into practice, in attempt to increase the persistence and learning of their students.

Students overwhelmingly raved about their academic advisors. One participant noted that his proudest accomplishment at college was to “create, *like*, a lasting relationship” with his advisor. Students testified in their belief that the faculty and advisors “take heart, care about my success.” There was an undeniable element of apprenticeship and mentorship with ... “side-by-side” work together... leading to realizations that, “Wow, this professor believes in me.”

Students also emphasized their belief that advisors were there to build relationships over the long run. They stated how the academic advisor-advisee relationship “takes time to build.” Once built, staff can prod students into greater challenges asking a simple, “do you believe me?” as an encouragement and trust element to pushing for greater challenges and growth. Staff believe wholeheartedly in the “connection” as the most important, most effective component. This relational awareness bodes well for the promise of future practice, as the staff came by it naturally and whole-heartedly, without much need for explicit professional development in relationship building. They also emphasized teaching a willingness to connect and work hard (e.g., “Are you willing?”)

Being a “real” person also helps tremendously. To put students at ease, many counselors bring their own sense of humor to their desks. Jokes were easily brought about, anecdotes, and personal examples of fun and connection. One counselor hosted “millions” of Pez candy dispensers in her office. This lightened the load for her student, ameliorating anxiety and creating an easier trust-building environment. Students also explained their need for time to take a challenging piece of academic content and “break it down and explain it...as many times as you need.” Undeniably, the time allocated for mutual discussion amongst student and staff was much higher than other institutions.

Finding 2: Persistence comes through self-efficacy

Cultivating a belief in one's own self to persist and achieve a STEM degree was an enormously popular theme. It was uttered to such extent that it was felt to be deserving to be considered its own finding. Students remarked, "I tend to underestimate my own abilities," in one form or the other on several occasions. Academic coaches help them feel valued, feel worthwhile, and worth investing in. Students noted how they "have seen a lot of potential in me" in helping develop skills toward motivation and attainment of their degrees.

Despite the impressive intelligence of many students, there was a common sentiment of self-invalidation. Students tended toward lower self-valuations and lower self-esteem regarding their aptitude. It was the work of the advisors who challenged these concepts of self. "I ought to be able to...." was uttered more times than expected. There is a paradoxical contrast between knowing when something required attention (e.g., needed tutelage for an assignment) and ability to "activate" (e.g., approach the tutor, coach, or counselor). Perhaps students are typically unable to approach a faculty member for fear of rejection and/or reminders of previous unpleasant experiences in specialized academic instruction (e.g., resource rooms). They are "resourced out," as an interviewee noted, and typically choose to receive lower scores instead of pursue help.

Regardless of past issues that may have contributed to intractable "activating" skills, both counselors and students unanimously addressed multiple instances of self-efficacy and executive functioning skill building throughout their interview process. For example, staff were skillful with accountability measures. As one counselor shared, there's a "balance between a really soft touch and a really firm touch" in terms of accountability. Although staff conceded they had no real power of recourse (e.g., an advisor can't "dock" points for lack of attendance to a weekly

meeting), the health and strength of the relationship between student and staff often contributed to an organic motivational force.

Staff exercised the motivational psychology of the dialectic, paradoxical posturing of two opposing, yet complimentary forces. For example, in the cases of staff needing to coach toward greater activation behaviors (e.g., a student beginning their math homework), the staff member would walk through the challenges with compassion and understanding, yet insist upon gradual improvement. As one counselor stated, “here's where the difficulties are, and here's what you're going to do to improve.” With increased “elaborative rehearsal” and accountability, the students reportedly blossom and mature in their self-efficacy, lending themselves to greater perseverance with each step.

Finding 3: Learning comes through metacognition

A student’s awareness of her own learning process, her learning strengths and weakness, and an understanding of her disability were all factors contributing to the construct of metacognition used in this study. As students shared about “learning about my own learning process,” they would admit beautiful statements of victory in their academic careers (e.g., “When I came here I just blossomed”). There were countless examples of students boasting of their impressive grades and test scores in traditionally troubling coursework (even statistics!).

The students were very frank about their journey on the path to STEM learning and the persistence he needed to succeed. They could readily discuss the deficits they used to have, how they were confronted with the reality (metacognition) that needed to change; how they battled the "learning curve;" and how this persistence led to a point of maturity in their STEM academic career. As one advisor stated, “the big thing that we provide at Landmark is the ability to

demystify cognition and learning.” Terrific strides were made by the supporting staff to learn about these processes in professional development efforts for the benefit of their students.

A common refrain heard from the coaches and counselors was toward a structured program of accountability in order to teach metacognition to their students. Weekly meetings were highly recommended venues for beginning this metacognition and EF training. Standard meetings occurred at least once a week for a half hour. Depending on the ability and need of the student, sometimes the student could receive up to a meeting per day. A list, loosely agreed upon (although implicitly understood as a contract), detailing all classes and timelines, was included as the agenda and arrangement for learning about metacognition.

Weekly goals and big picture goals were included in the “curriculum” since advisors want to “have that student remember why they’re here, what’s important to them.” Goal setting complimenting time management well, given that goals are achieved on the back of a finely managed schedule. Time as a resource is a wise investment within the LC model. The ability of students to access their advisors or professors with greater ease than traditional universities is a strong advantage of the Landmark College model. One student raved about the “open office hours” at LC, comparing the availability to her previous community college which had office hours “that were, like, very limited. It was like 10 minutes. But here I can spend about a half an hour with a professor, one-on-one. And that's like the really nice thing about Landmark.”

A refreshing element to the LC model included an openness toward failure, limitations of disability, and flat out owning yourself despite it all. Learning from failure was a common refrain. Failure is undeniably helpful for learning. There seemed to be an acceptance of having “gone off the rails” as long as one works to “come back on.” As a counter to the typical deficit

model that pathologizes and limits one with a label of disability, the staff informally discussed their philosophy of a “strength based approach.”

None of these tenets are easy to uphold, however. Beating learned helplessness is a difficult feat as one ages, especially behind years of reinforced behaviors. Staff noted how students can “game the system” and making the pathology of their disability their “default mode,” not the openness toward change. The most advanced students in metacognitive skills flat out owned their disability. They were very knowledgeable of their “learning differences,” as they often called their disability. They were fluent in discussion of their medication, behavioral traits, and need for consistency in learning routines. “I’ve really learned how to feel comfortable in my own skin about my learning difference,” one student mused. The student attributed the “united community” of Landmark as “a population where we all have a learning difference.”

Not only do students speak magnanimously about their corporate mission to remain united and effective. They are also well-versed in the specific elements of their learning. That is, they can readily quote neuroscientific speaking points on memory and learning processes that impact their specific disabilities and abilities. One student nicely summed up her experience with dyslexia.

“What happens with people with dyslexia is they end up, you know, accepting failure as who they are, like, ‘I’m never going to learn how to read and write, it’s just not how my brain works.’ And reading and writing is a natural process for humans, you know, it was invented like 3,000 years ago. We just didn’t take into account the way my brain works. I learn differently.”

These findings and their sub-thematic nodes are difficult to conceptualize quantitatively without a visual representation. The relative proportion of each of these nodes can be visualized in a tree map (Figure 2). The quantified values for proportional representation are somewhat problematic in qualitative methods, however. For instance, the parameters by which a node were coded (e.g., *metacognition*) could entail an entire paragraph of lengthy sentences from a long-winded interview participant. In similar respects, another participant could contribute toward the same node yet do so with much less verbiage. Therefore, we see that the amount (i.e., proportion) represented in the tree map is somewhat subjective to the relative loquaciousness of each participant. For this reason, holistic measures of comprehensive node tracking are also included (Figures 3 & 4) as an overlay to visualize nodes without subjective quantity. Figure 3 demonstrates the most salient nodes that emerged from the transcript of an individual advisor interview. Figure 4 offers similar representation of the prominent nodes from a student's interview data.

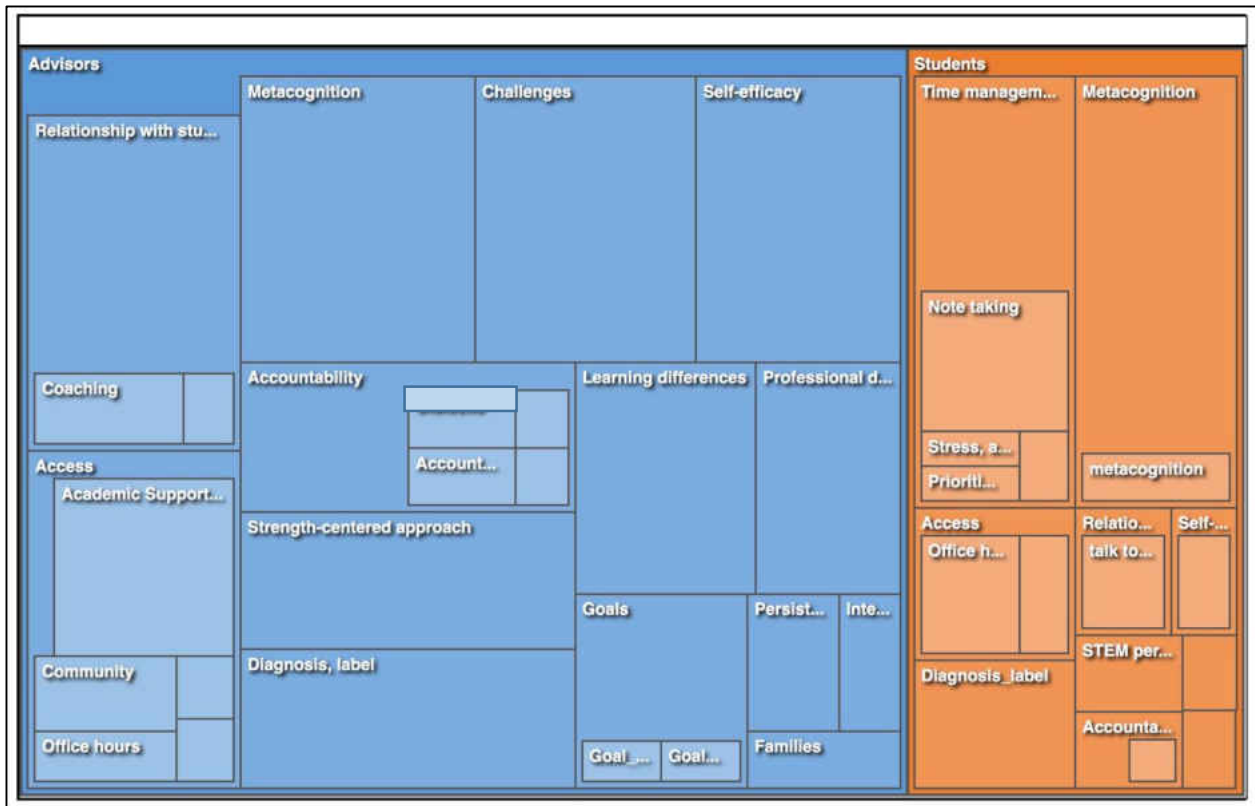


Figure 2: Tree map of advisors' and students' most common themes, by volume. Blue denotes advisors' percentage of talk time on a given node. Orange denotes students' percentage of talk time on a given node.

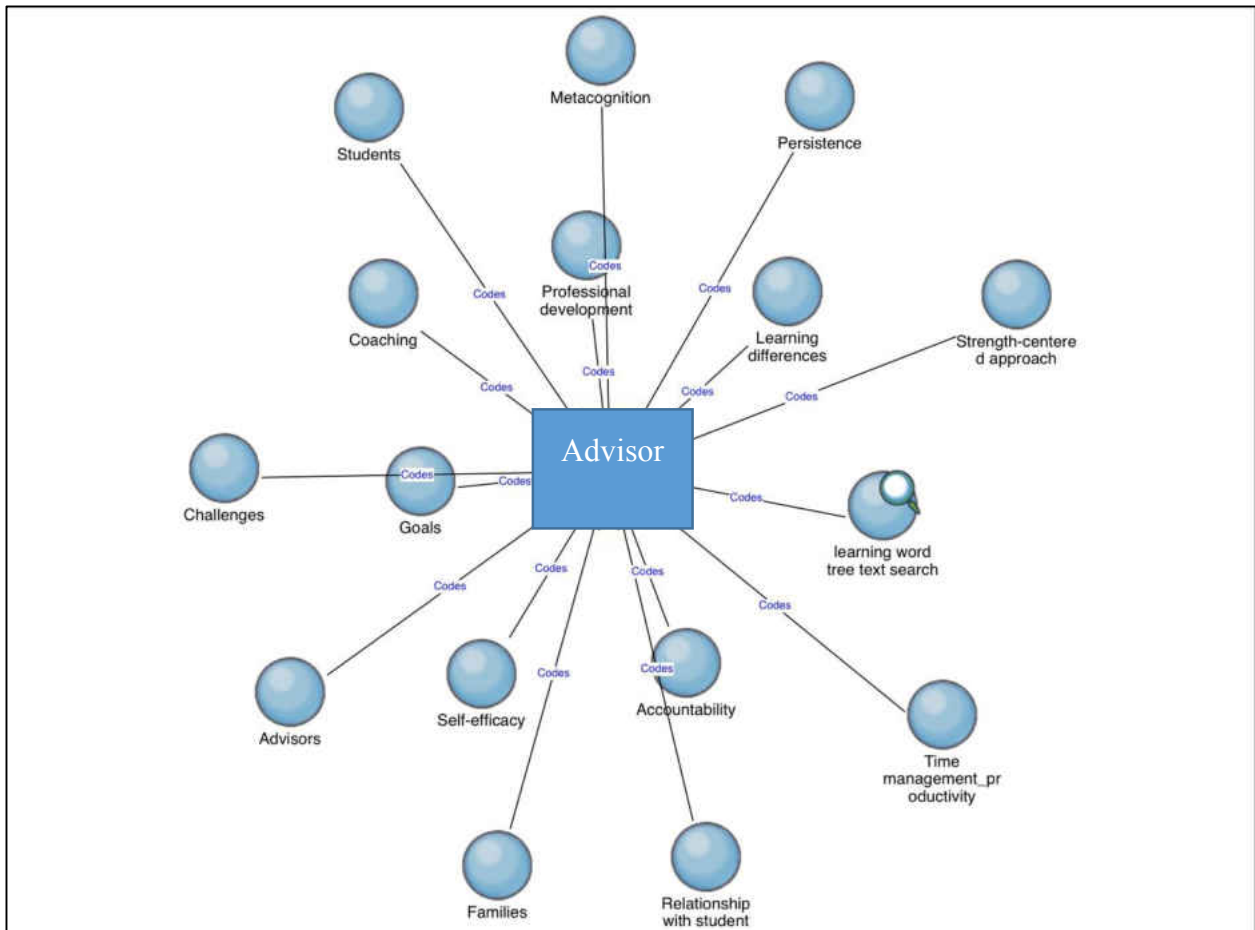


Figure 3: Example word tree of a Landmark College advisor’s key nodes. Nodes are the most prevalent themes that emerged from interview data.

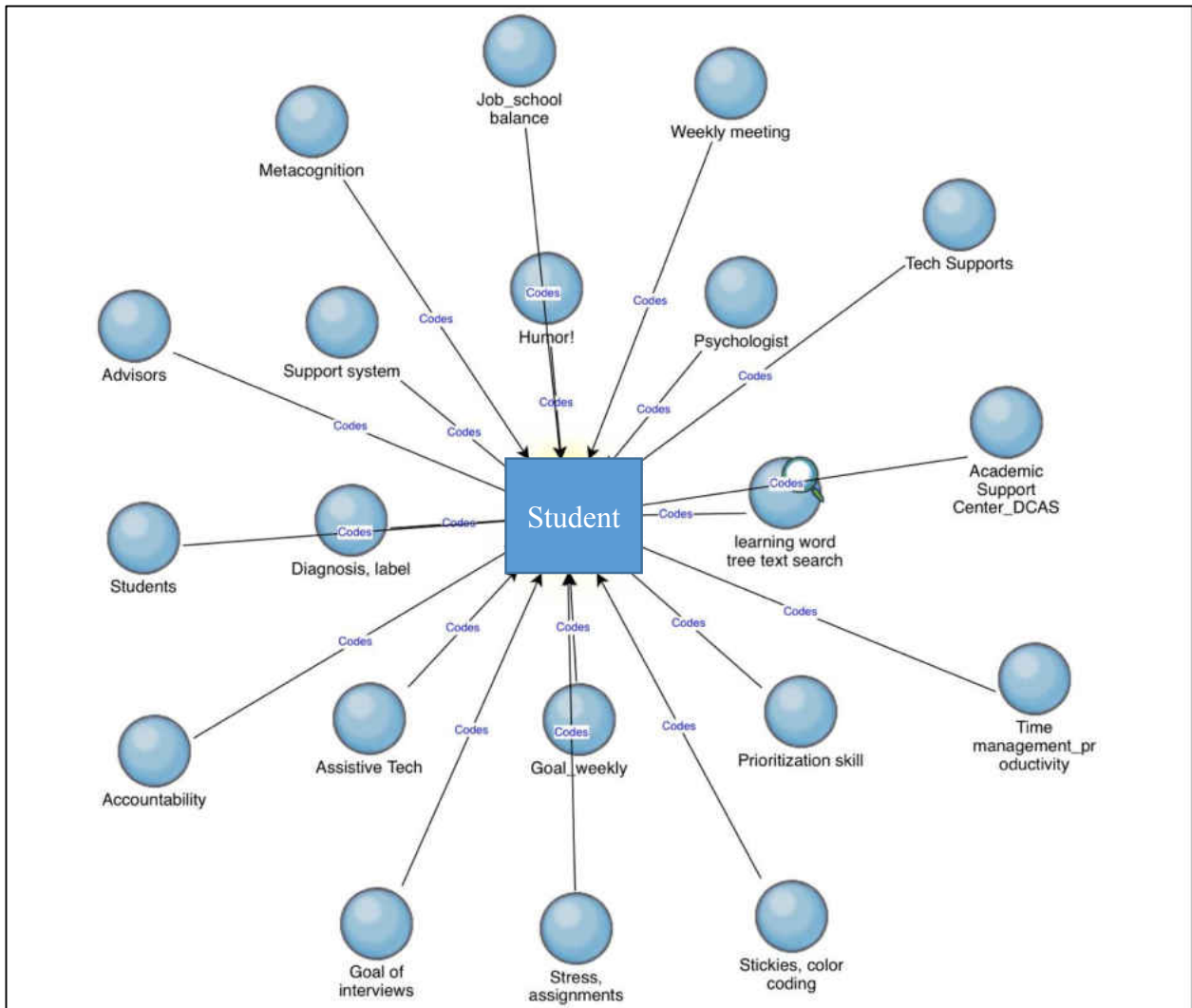


Figure 4: Example word tree of a Landmark College student’s key nodes. Nodes are the most prevalent themes that emerged from interview data.

CHAPTER FIVE: DISCUSSION

Limitations

Interobserver agreement (IOA). NVivo offers transparency and oversight of large amounts of qualitative data. Teams of individuals can follow the line of inquiry, the analytic trends, or the interpretations of the data by noting the elements their colleagues coded. The advantage to this software is in its ability to generate multiple users who can find common understanding and agreement in the data. This IOA is represented with a kappa coefficient from software with another rating figure from other members. However, there is a strong contradiction to qualitative analysis inherent in this figure.

Figures (e.g., statistical frequencies) are typically not assigned to data in an analysis of interview data (Pope, Ziebland, & Mays, 2000). That said, although kappa coefficients are an option for qualitative analysis in NVivo, there is still great debate as to how to systematize this process. For the purposes of this study, no IOA was derived given that only one doctoral researcher coded this data at a post hoc level. Should future iterations of these analyses transpire, it is recommended that the team establish clear parameters and operational definitions for coding. It is equally important that comprehensive protocol training and performance feedback be administered to ensure IOA is established.

For the lack of apparent IOA, there was an inherent strength embedded within this research design: iterative analysis. This process of developmental, constant checking and re-checking yielded a built-in reliability check. The direction of the themes was established, then questioned, then re-established, and then refined some more in multiple versions of reading and

interpretation. Member checking was the final phase of analysis (Mertens & McLaughlin, 1995) for this research study. The PIs of Project iCAN co-presented preliminary findings to the interviewees and asked for clarification in interpretation of the findings. Overwhelming consensus from the interviewees and the larger Landmark College population confirmed much of the conclusions that were established in the analysis.

Researcher bias. Researcher bias is a common concern when dealing with qualitative interview data. Developing a robust measurement device and ensuring that researcher bias doesn't contribute untoward results is an essential obligation (Chenail, 2011). In order to diffuse likelihood of bias, many researchers will co-develop instrumentation that is tailored to the specific content of the setting and participants, in attempt to ameliorate researcher bias (Gubrium & Holstein, 2003). In subjectively coding large quantities of transcription data, there can be similar bias influencing the trueness of a body of data. This study employed a single researcher coding based upon multiple iterations and familiarizations with the data. Certain protocols may be implemented in further studies to ensure fidelity of coding, especially if a secondary (inter-rater) coder were to participate.

Limitations in analysis. NVivo's quantifiable signature to the data can be problematic. When coding a larger passage for a latter verbatim example, the entire volume of that passage will apply to later analysis. I may come across a single word in another paragraph that perfectly encapsulates that previous paragraph. So I will code them the same, say as "metacognition." From a quantitative perspective, the former passage had much more weight. But semantically and qualitatively, they were of equal value. So if I only allow the percentages component of the

software to inform my truth, it could be wildly off. The value of the product is in its ability to process large volumes of data (in this case interview transcript data).

Implications & Recommendations for Future Support Models

In summation, there were three predominant findings in the data. These findings inform the bearing of future direction for STEM learning and persistence models. They include: (1) Academic counseling is the core support. Technology facilitates, not supplements, this relationship; (2) Persistence comes through self-efficacy; (3) Learning comes through metacognition. There was so much emphasis on healthy relational discourse and interplay amongst student and staff, that this element to academic coaching should always be seriously appraised. As technology continues to pervade every aspect of our work and personal lives, these models will ideally harness the ability to communicate with one another and facilitate, not hinder, this process. In many instances, the students seemed nonplussed with the plethora of technologies imposed on their academic lives. Savvy advisors appeared to understand this dilemma, and didn't belabor the use of a specific technology over another.

In similar fashion to the structured interview approach of the iCAN pilot, the *AccessSTEM* academic coaching pilot gathered data from student surveys and open-ended questioning (Bellman et al., 2015) to reveal parallel findings. EF skill sets and their accompanying constructs such as self-efficacy, self-advocacy, and metacognition should be stressed at every turn in a professional development context and daily digest for student access.

Based upon the tried and true traditions of older theoreticians, plus the added vantage of newer studies, STEM learning and persistence models are more robust than ever before. Bandura (1977) contributed much forethought to our current practices, which include activities that

exercise coping behaviors to help persistence through adverse situations, “experience of mastery,” and “further enhancement of self-efficacy.” Modern theorists such as Meyerhoff (2013) echo Bandura, and also specify further direction including (a) early exposure to STEM content and experiences, (b) active learning, and (c) participation in learning communities. As evidenced in the data from this study, technology is a necessary component, but not the entire means to successful persistence and learning model. The NSF insists on utilizing technological supports that connect and grow students (NETP, 2016), but students’ nowadays are so inclined toward familiarization with technology that it surely won’t be an issue to merge technology within an effective model.

Daley et al. (2014) found students’ metacognition was strongest when technology (e.g., performance data) was readily supplied to the learner and Weiss and Rohland (2015) found it was most meaningful when oriented toward student strengths. The offers from technology can be so rich with customization and student preference now that increased participation and completion rates are more common. For example, the students in Project iCAN study reported use of various technologies to improve productivity, scheduling, stress management, and ease of communication. Other studies have corroborated similar findings before, attributing such technology to increases in in academic performance and degree completion (Troiano, Liefeld, & Trachtenberg, 2010).

Parker and Boutelle (2009) found that not only did coaching help students increase positive work behaviors, but it also decreased overall stress in their lives. The self-reporting from many of the interviewed students commented in a similar vein. The preference for a strong relationship with their academic counselor was the basis by which they could not only pro-

actively learn these EF skills but also blossom in the process and experience less stress, greater confidence, and self-validation. A strong sentiment of the advisors in Project iCAN was toward a strength-based philosophy of student EF training. With the examples in literature for customizable supports and nascent of virtual learning technologies (e.g., *BreakThru* theory of change, the increased digitization of these services is imminent. Effective future support models will include these findings in the design and implementation of their product and service.

Future research proposals may continue in this track of customization and personalized training methods. As we see personal data tracking become increasingly prominent for mass consumption in society, so too will the ability for institutions of higher education to provide personalized data and training for their students. For example, the “quantified self movement” aims to provide calculable baseline performance data and training suggestions for end-users (e.g., Fitbit with exercise and diet). Although academic counseling is arguably much more complex of an endeavor to quantify as compared to exercise foot-steps, there are many potential avenues that research could exploit for greater discovery and gains. For instance, researchers could borrow from the best technologies at hand (i.e., virtual learning environments with intelligent training agents) to construct research on social elements of the academic counseling experience.

As vertical integration in these technologies fades to allow mass consumption (i.e., cheaper access), cost effectiveness will make the investment in the STEM workforce a meaningful return on investment. The inevitability of digitization of these services, as evidenced already in contemporary literature, will surely provide terrific gains in access, communication, clarity, scope, and sequence for our practitioners and students. It is the role of the savvy advisor,

researcher, teacher, and/or parent to be watchful of these technologies as they emerge and implement them as interesting and beneficial means for student learning and persistence.

Project iCAN is a story of success. “What makes you successful?” was an initial question posed to interviewees. Time and again the data revealed students expressing an openness and transparency to their past learning deficits. The students demonstrated ownership of their issues. They also boasted, deservedly, of stories of success. There is a story to be told here, based upon the data. The themes we saw time and again focused on learners learning to learn. There were multiple tales of students with varying degrees of struggle in their past, working hard to push past these challenges and take responsibility for their own disability and find solutions to their needs.

Further merit of this research focus is in the broader utility of the intended services model. Traditionally underrepresented groups will surely benefit from the manifold findings and nuances of product and service that are identified and implemented with Project iCAN. It is the hope of this research that the extant testimonials from these interviews would inform future model that cater to benefitting all persons and populations.

APPENDIX A LANDMARK COLLEGE INTERVIEW PROMPTS

LANDMARK COLLEGE INTERVIEW PROMPTS

For Staff

What types of supports does Landmark college offer undergraduate STEM majors?

Describe your role at Landmark College.

How much time do you spend each week working with students with disabilities?

What cognitive supports do you offer related to STEM?

Which STEM supports do students use the most?

Which STEM supports do students benefit from the most?

Please draw the Landmark college model of STEM reports?

Please prioritize the STEM supports you would digitize

What STEM supports do you think are most easily digitized? Why?

For Students

Please describe why you chose to participate in a STEM major?

What challenges do you foresee as you move to complete your major?

What supports does Landmark offer that you find to be most beneficial given your STEM major?

(i.e., advising, tutoring, coaches, study space, etc.)

At what level do you feel having an expert in your field (i.e., software engineer) as a personal connection provides encouragement for you to stay in a STEM major?

At what level do you feel having an expert in your field (i.e., software engineer) as a will help you get a job?

What types of job skills do you feel are important for you to gain employment?

What types of software are most beneficial for students in your major?

If you could change the services you currently access what would they be? Why?

APPENDIX B LANDMARK COLLEGE VIGNETTES FROM STUDENT INTERVIEWS

Selected Vignettes from LC Student Interviews

Vignette 1

*from Student Group 1 Transcript

*On the benefits of corporate-wide use of Outlook for planning, keeping track of your time (down to the minute, for each appointment), and being reminded to attend your next appointment.

Adam, 18: “On my phone, we use Outlook here...it reminds us automatically 15 minutes before we have a class and stuff. And that alone has been such a big thing for me.”

Drew, 18: “That’s agreed, that it’s a really big thing. Some of us aren't capable of creating our own schedules... it's still a really good thing for those of us that just often forget.

Adam: “It literally just let's me go...I actually have to leave soon. Sadly, I have class in a half an hour. It lets me just open my phone and I just go to calendar and it's like, this is what the time is now and it says, oh, in 29 minutes I have class.”

Vignette 2

*from Student Group 2 Transcript

*On regular advising appointments at LC and potential digital supports for advising appointments, such as Skype, email, or texts.

Rob, 20: “Every week you meet with them (advisors). If it is your first year, it is a mandatory thing. After a few semesters, you can choose. This is my 4th, and I go every Monday. That is a huge aspect. Every time we go, we make goals. What am I going to do this week? How am I going to accomplish it? We have a website that reminds us if we have a counseling appointment. It pops on my phone and I see I have to be there in 20 minutes, so that helps get me there.”

Speaker 1: “Do you guys think it is important that you sit down face to face with the person, or is it something we could do at distance? Because we have students who are all over the country. I have a student in Hawaii and another one in Virginia. Is it something we could use Skype you think for?”

Ashley, 22: “Well I think also, a lot of the times, I don't always have a ton of time to sit down with my advisor...I text my advisor a lot about things, so she will let me go if I don't have time to make goals, and she will say that you have until the end of the day to text me your goals or email me your goals for the week, and I have to set them. They are goals you set yourself. It is not them setting it, it is me setting goals around courses I am taking or extracurricular things. It is definitely something I don't think you always have to be face to face with advising.”

Vignette 3

*from Student Group 5 Transcript

*On the importance of the library support staff, DCAS, and their therapy dogs

Steven, 26: "There was one more thing I did want to mention that I think is really good here... The library in this college has the research librarians, some of the nicest people you will ever meet. One who stands out to me most is named Cathy. She actually has a therapy dog that does work on campus as well, named Snickers... And if it wasn't for the fact I have someone in the library, I don't think I would be able to get half the research that I need."

Reya, 28: "In terms of the library, I definitely agree. I work with Cathy all the time, I have since day one. I just write her an e-mail. She gets back to me right away. We meet about my paper topic and then I form an outline. Then she helps me, like, "well, this is getting there." So I get a lot of one-on-one... It starts to build up as people you know get all these assignments. I have about 4 research papers I have to do at the end of the semester... I know I have her that can help relieve my anxiety and it won't be so bad."

Vignette 4

*from Student Michael_Sam Transcript

*on UDL accessing content in textbooks via voice; Dragon; learning how to learn with UDL.

Sam, 21: "And they put all of your textbooks on there, and that way you have electronic copies... you can listen to it verbally... If I were to walk to class, I might not be able to kill, 50 pages of reading for each class in a night, but if I'm listening to it, and I'm just doing it as I do my every day thing, that's fantastic, and I urge, the availability of the portability of at least an iPad versus a computer. I know the technology is on computers, but how often are you going to carry around a computer, open, listening to stuff as you're like going through your day?

...online textbooks, e-readers, stuff like that... I know Dragon dictation is very good, speech to text...

...I think it's also not just advertising this to students as they're coming in, but really working down with them and explaining, this is how this works, this is how you can utilize this, because, if I'm just coming in, and they're like, "oh, yeah, here's Dragon..." You know, like, go learn, you know? That's not going to be good. How am I supposed to then go back to my room and write the paper, and be like, "Oh, wait, maybe I can do something that I still have to learn?" My immediate motivation isn't going to be there.

...So, I think also learning it in different ways that you can kind of make it so it's more individual, where you know they can get to... a better type of learning than when they're in the classroom. Because the 125 people (in class), the TAs, all that, it's not very individual, but if you can find a way to reiterate what they learned there, and make it feel more personal, that is what I've definitely realized has been successful here."

**APPENDIX C INSTITUTIONAL REVIEW BOARD HUMAN SUBJECTS PERMISSION
LETTER**



University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: UCF Institutional Review Board #1
FWA00000351, IRB00001138

To: Matthew Todd Marino and Co-PIs: Brian Moore, Eleazar Vasquez III

Date: April 06, 2015

Dear Researcher:

On 4/6/2015, the IRB approved the following human participant research until 04/05/2016 inclusive:

Type of Review: IRB Continuing Review Application Form
Project Title: Interdisciplinary Coaching as a nexus for transforming how institutions support undergraduates in STEM (iCAN)
Investigator: Matthew Todd Marino
IRB Number: SBE-14-09971
Funding Agency: National Science Foundation (NSF #: 1505202)
Grant Title:
Research ID: 1056710

The scientific merit of the research was considered during the IRB review. **At the time of Continuing Review, the following changes were made: Study title was changed from “Enhancing Student’s with Disabilities Persistence And Learning in STEM using mixed-reality learning communities (E-PALS)” TO “Interdisciplinary Coaching as a nexus for transforming how institutions support undergraduates in STEM (iCAN).” In addition, Dr. Brian Moore has been added as a Co-PI and Charles Hughes and Bonnie Swan have been removed from the study.**

The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at <https://iris.research.ucf.edu>.

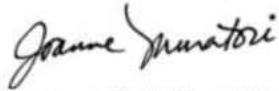
If continuing review approval is not granted before the expiration date of 04/05/2016, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the [Investigator Manual](#).

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

A handwritten signature in black ink that reads "Joanne Muratori". The signature is written in a cursive style with a large initial "J" and a distinct "M".

Signature applied by Joanne Muratori on 04/06/2015 03:07:16 PM EDT

IRB manager

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