Title
The STEM and CTE Pipeline for Community College Students with Learning Disabilities

Author
Morgan, Micaela Victoria Cesario

Publication Date
2016

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Santa Barbara

The STEM and CTE Pipeline for Community College Students with Learning Disabilities

A dissertation submitted in partial satisfaction of the requirements for the degree

Doctor of Philosophy in Education

By

Micaela Victoria Cesario Morgan

Committee in charge:

Professor Michael M. Gerber, Chair

Professor Karen Nylund-Gibson

Professor Michael Gottfried

December 2016

The dissertation of Micaela V. C. Morgan is approved.

Michael A. Gottfried

Karen Nylund-Gibson

Michael M. Gerber, Committee Chair

November 2016

The STEM and CTE Pipeline for Community College Students with Learning Disabilities

ACKNOWLEDGEMENTS

The journey to pursue my PhD and produce this dissertation has been full of unexpected twists and turns along with many challenges and joys. I began my academic journey in the field of chemistry and through some very difficult experiences I almost turned away from my love of learning. After leaving my chemistry doctoral program with a masters, for reasons I will not address here, I found my way to the UCSB McNair Scholars Program, which was my work home for over six years. Being surrounded by bright minds seeking doctoral degrees in many different fields helped me heal and realize I wanted to continue my academic journey and that I still have much to contribute to the world. My time with the McNair Scholars was very special and I am thankful for each and every one of them. In a desire to help transfer students, which I once was myself, I volunteered to be a discussion leader for Dr. Don Lubach's ED 118 transfer success course. Don has been an esteemed friend, colleague, and mentor over the years and he started the process of building my confidence up to the point of going back into a graduate program to pursue my doctorate in education. There was a doctoral student doing research on Don's class who I asked Don to connect me with because I wanted to understand more about possibly changing fields and understand what education research looked like. That graduate researcher is now my colleague and friend, Veronica Fematt, who I cannot thank enough for taking me in and encouraging me to pursue my passion. Veronica then introduced me to her advisor, Dr. Michael (Mike) Gerber, and the rest is history. Mike, who I consider a dear mentor and friend, restored my faith in advisors, which was a feat after what I had been through in my previous program. He has always nurtured my academic interested and pushed me to do more and be better.

I want to thank my esteemed colleagues, Veronica Fematt, Dr. Ann Kim, Dr. Jenna Joo, Mayra Ramos, Dr. Cameron Sublett, and Dr. Ken Sterling, who were founding members of the Gevirtz Graduate School of Education Higher Education Research Group, which helped to form the academic I have become. One of my dearest friends and colleagues, Jacob Kirksey, I met halfway through my program, but his drive and support have helped me through some of the challenging milestones of the last couple years. There have been many other special graduate students who have also helped form the researcher I have grown into and I am sorry for not naming them all. I cannot wait to see where my colleagues end up and I look forward to working with them in the future.

I wanted to give a special thank you to my doctoral committee members, Dr. Michael Gerber (chair), Dr. Karen Nylund-Gibson, and Dr. Michael Gottfried. I cannot thank each of these very special and impressive academics enough for caring about my future and the type of academic I would become. I have taken several classes from each of these faculty and I hope this work does justice to all they have taught me over the years, both formally and informally. Karen has provided me with the methodological knowledge to maneuver the many analysis challenges I faced in this study and I will take what she has taught me and utilize it in my work moving forward. Michael has provided me with amazing opportunities to meet colleagues with various specializations across the country and provided great policy insights. Finally, Mike has always been able to see the

big picture and has helped me narrow and expand my focus as needed. Each of them provided a crucial component of my development. I cannot thank each of them enough for their support and mentorship.

I would not be who I am, or able to tackle the challenges life has thrown at me, if not for my family. My parents, Lisa and Mark, always valued education and ensured that I obtained a solid academic foundation throughout my life. My mother made substantial sacrifices to ensure I was well educated, which fueled my love of learning and desire to pursue my doctorate. I am very thankful to have them in my life and love them very much. Last, but certainly not least, I want to thank my best friend and husband, Andrew. Without him I would not be on the precipice of completing this journey. He has supported me throughout this entire process, through failures and successes, and has been my strength when I had none left. I could not have done his without him and can never thank him enough for all he has done.

Finally, I want to thank those I have mentored, as I have learned much from them, and those that have mentored me, as they helped to illuminate paths and opportunities I did not know existed. For all those who have supported or helped me grow I thank you and look forward to providing that support to others.

VITA OF MICAELA VICTORIA CESARIO MORGAN

November 2016

EDUCATION

University of California, Santa Barbara
Santa Barbara, CA
Gevirtz Graduate School of Education
Doctoral Degree in Education, Expected Fall 2016

Dissertation title: "The STEM and CTE Pipeline for Community College Students with Learning Disabilities"

University of California, Santa Barbara
Santa Barbara, CA
Master's Degree in Policy, Leadership, and Research Methods
2015

University of California, Santa Barbara
Santa Barbara, CA
Master's Degree in Organic Chemistry
2009

University of California, Santa Cruz
Santa Cruz, CA
Bachelor's Degree in Chemistry and ACS (American Chemical Society) Certified
2007

Cabrillo College
Aptos, CA
Associate's Degrees in General Science and Liberal Arts
2005

PUBLICATIONS

Morgan, M.V.C. & Gerber, M.M. (2015). Utilizing Factor Analysis to Inform the Development of Institutionally Contrived Experiences to Increase STEM Engagement. *Community College Journal of Research and Practice*, *40*(3), 204-218. doi: 10.1080/10668926.2015.1112322

Johnson, T.A., Morgan, M.V.C., Aratow, N.A., Estee, S.A., Sashidhara, K.V., Loveridge, S.T., Segraves, N.L., & Crews, P. (2009). Assessing Pressurized Liquid Extraction for the High-Throughput Extraction of Marine-Sponge-Derived Natural Products. *Journal of Natural Products*, *73*, 359-364. doi: 10.1021/np900565a

Manuscripts in Preparation

Morgan, M.V.C. *A Literature Review of STEM Learning Interventions for Secondary and Postsecondary Students with Individual Differences.*

Morgan, M.V.C. *Individualized Mentorship for Community College STEM Majors.*

RESEARCH TEAMS

Community College STEM Engagement and Transfer Success (CCSETSS) Study
Santa Barbara, CA
Project Lead
2013-Present

The CCSETSS team is a subgroup of the Higher Education Research Group (HERG) and is comprised of two first-year graduate students and six undergraduates. This research group developed and administered the STEM Engagement and Transfer Success (SETS) Survey. We collected survey responses from local community colleges, inputted the survey data, and are conducting analyses.

UCSB Higher Education Research Group (HERG)
Santa Barbara, CA
Graduate Student Member
2012-Present

The goal of this research group is to study the community college transfer student pipeline to four-year universities. My focus is on Science, Technology, Engineering, and Mathematics (STEM) transfer students and what can be done to increase their persistence in STEM majors and admission to graduate school.

ORGANIZATIONS

HEARC – Higher Education Action and Research Consortium
Santa Barbara, CA
Co-Founder and Steering Committee Member
2013-Present

The UCSB Higher Education Action and Research Consortium (HEARC) is a graduate student run organization, which provides a forum to discuss research, policies, and trends in higher education. HEARC events are open to all UCSB faculty, administrators, staff, and students who research and/or have an interest in higher education.

SKILLS

- Statistical software - SPSS, M*plus*, STATA
- Various Statistical Methods – Experimental and Confirmatory Factor Analysis, Latent Class and Profile Analysis, Structural Equation Modeling (SEM) and various Causal Inference methods (e.g., Instrumental Variables, Fixed Effects Modeling, Difference-in-Differences, and Propensity Score Matching)
- Learning Management Systems (LMS) - Moodle and Blackboard
- Program Development and Evaluation
- Survey Design and Implementation

TEACHING EXPERIENCE SUMMARY

University of California, Santa Barbara
Santa Barbara, CA
ED 20 Discussion Leader – Introduction to the Research University for International Students
2016

University of California, Santa Barbara
Santa Barbara, CA
ED 118 Discussion Leader – The Research University and the Transfer Student Experience
2012-2013

Morgan Private Tutoring Services
Lompoc, Santa Barbara & Santa Maria, CA
Private Tutor
2009-2011

University of California, Santa Barbara
Santa Barbara, CA
Graduate Teaching Assistant – Head Teaching Assistant for CHEM 6AL (1st yr. Organic Chemistry Lab)
2007-2009

University of California, Santa Cruz
Santa Cruz, CA
Course Assistant
2006-2007

Cabrillo College
Aptos, CA
ACCESS Supplemental Instruction Leader
2002-2005

WORK EXPERIENCE SUMMARY

K-12 Programs Director, Office of Education Partnerships
Santa Barbara, CA
University of California, Santa Barbara
2016 – Present

Program Coordinator, McNair Scholars Program
Santa Barbara, CA
University of California, Santa Barbara
2010 – 2016

Program Coordinator, AERA-UCSB 2016 Invited Conference
Santa Barbara, CA
Gevirtz Graduate School of Education
University of California, Santa Barbara
2016

ACCESS Coordinator
Santa Cruz, CA
University of California, Santa Cruz
2005

Administrative Research Coordinator
Santa Cruz, CA
University of California, Santa Cruz
2005

COMMITTEES

2015 **California Forum for Diversity in Graduate Education**
UCSB Local Arrangements Planning Committee Member

The Forum rotates campuses every year and UC Santa Barbara is hosted the event November 7, 2015. I organized the parking and student bus accommodations, created and distributed signage for the event, created and developed various maps with another UCSB department, organized volunteers to create all packets given to participants, and did a variety of tasks the day before and during the event.

CONFRENENCES & PRESENTATIONS

PAPERS

4/2016 American Educational Research Association (AERA) Conference – Washington, DC
Paper Session: "Determining a Student's Mentorship Latent Profile as a way to Effectively Mentor Community College STEM Majors."

4/2013 55th Annual Council for the Study of Community Colleges Conference – San Francisco, CA
Presented in a symposium titled "Conceptualizing Individual Transition Probabilities in Community College to Four-Year Degree Completion Pathways."

POSTERS

5/2016 Modern Modeling Methods (M3) Conference – Storrs, CT
"Utilizing Latent Profile Analysis to Determine the Appropriate Mentorship for Community College STEM Majors."

4/2015 American Educational Research Association (AERA) Conference – Chicago, IL
In-Progress Research Gala: "Increasing STEM Engagement and Transfer Success of Community College Students."

4/2015 57th Annual Council for the Study of Community Colleges Conference – Fort Worth, TX
"Improving STEM Engagement of Students in the 2-Year to 4-Year Higher Education Pipeline."

10/2005 SACNAS National Conference – Denver, CO
"Isolation of Bastadin Library, from Marine Sponge *Ianthella basta*, in Pursuit of Biological inhibitors."

10/2004 SACNAS National Conference – Austin, TX
"Creating and Isolating Carbozole Derivatives in Pursuit of Lipoxygenas Inhibitors."

PRESENTATIONS

4/2016 8th Annual Conference for Social Justice in Education at California State University, Channel Islands – Camarillo, CA
Presentation titled: "High School Science Courses: Do they Contribute to the Gender and Ethnicity Gap in College?"

11/2015 Presentation to ED 118 section titled: "Graduate School, Is it for me?" – Santa Barbara, CA

4/2015 University of California, Santa Barbara Grad Slam Presentation – Santa Barbara, CA
Presentation titled: "STEM Engagement Activities for Community College Students."

7/2015 Presentation to Kern STEM Academy titled: "Planning and Preparing for College and Beyond." – Santa Barbara, CA

1/2013 Presentation to ED 118 class titled: "Improving the STEM engagement of students in the 2-year to 4-year higher education pipeline" – Santa Barbara, CA

MODERATED PRESENTATIONS

Moderated the Physical Science Panel at the following California Forums for Diversity in Graduate Education.

11/2015 25th Annual California Forum for Diversity in Graduate Education – Santa Barbara, CA

11/2014 24th Annual California Forum for Diversity in Graduate Education – San Diego, CA

4/2013 23rd Annual California Forum for Diversity in Graduate Education - Irvine, CA

4/2012 22nd Annual California Forum for Diversity in Graduate Education - San Diego, CA

AWARDS RECEIVED

2016 – University of California, Santa Barbara Academic Senate Doctoral Student Travel Grant

2014 – University of California, Santa Barbara Graduate Student Association Travel Grant

2013 – Institute for Social, Behavioral and Economic Research's Graduate Research Award for Social Science Surveys (GRASSS), University of California, Santa Barbara

2013 – Gevirtz Graduate School of Education Recruitment Block Grant Fellowship, University of California, Santa Barbara

2012 – Dilling Yang Endowed Scholarship Recipient, University of California, Santa Barbara

2008 – Outstanding Teaching Assistant Award, University of California, Santa Barbara

2008 – Phi Lambda Upsilon National Honorary Chemical Society, University of California, Santa Barbara

2007 – Joseph F. Bunnett Undergraduate Research Prize, University of California, Santa Cruz

2005 – Carolyn and Ira Guthrie Chemistry Endowed Scholarship, Cabrillo College

PROFESSIONAL DEVELOPMENT

6/2016 Association for Institutional Research (AIR) NCES Data Institute (NDI) on Integrated Postsecondary Education Data System (IPEDS) Workshop, Arlington, VA

4/2016 AERA Division J Emerging Scholars Workshop, Washington, D.C.

12/2012 Grant Writing USA Course, Paso Robles, CA

6/2012 **S**ponsored **P**rojects **T**raining for **A**dministrators in **R**esearch (**STAR**), Santa Barbara, CA

VOLUNTEER EXPERIENCE

Mock Interviewer for MESA Undergraduate Students
Santa Clara, CA
MESA Student Leadership Conference
2016

Mentorship and Graduate Application Assistance
Santa Barbara, CA
University of California, Santa Barbara
2010-Present

MESA Tutor
Aptos, CA
Cabrillo College
2002-2005

PROFESSIONAL MEMBERSHIPS

2013 – Present AERA – American Educational Research Association

- Division D – Measurement and Research Methodology
- Division J – Postsecondary Education
- SIG – Adult Literacy and Adult Education
- SIG – Mixed Methods Research
- SIG – Mentorship and Mentoring Practices
- SIG – Multilevel Modeling
- SIG – Special Education Research
- SIG – Structural Equation Modeling

2013 – Present CSCC – The Council for the Study of Community Colleges

2011 – Present PWA – UCSB Professional Women's Association

2010 – 2012 COE – Council for Opportunity in Education

004 – Present SACNAS – Society for the Advancement of Chicanos & Native Americans in Science

ABSTRACT

The STEM and CTE Pipeline for Community College Students with Learning Disabilities

by

Micaela Victoria Cesario Morgan

The technological nature of the world we live in has produced a need for a workforce that is technologically savvy and possesses 21st century skills and abilities. Given that students with a learning disability (LD) may be an untapped source of science, technology, engineering, and mathematics (STEM) or career and technical education (CTE) potential, it is important to understand 1) whether LD students are capable of pursuing STEM and CTE fields and 2) what will aid them in successfully pursuing those fields. The two studies presented aim to answer those questions through a latent profile and latent class analysis. The results from the first study indicated that there are two STEM capable profiles of LD students: *High-STEM and CTE Capability* or *Low-STEM Capability*. It was found that female LD students were significantly more likely to be in the *High-STEM and CTE Capability* profile (.75, $p < .05$) by 2.11 times and that African-American LD students were significantly more likely to be found in the *Low-STEM Capability* profile (-1.31, $p < .10$). It was also more prevalent for LD students to pursue either STEM or CTE at the 2-year college regardless of what profile they resided in. Understanding a students' STEM or CTE capability can play a role in how they prepare and plan for their future. For the second study it was found that LD students could be categorized into three engagement classes: *Highly Engaged LD Students*, *Moderately Engaged LD Students*, and *Poorly Engaged LD Students.* Again, gender played a role in students' classification and it was found that female students were significantly more likely to be in the *Moderately Engaged* class (.22, $p < .05$). Results from this study also indicate that the 2-year pathway is the most traversed by LD students. LD students who were engaged in their IEP process, possess self-determination, and are able to utilize accommodations were more successful in pursuing a STEM and CTE field. Implications for postsecondary institutions will be discussed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

Introduction

In the progressively technical world we live in, now, more than ever, it is essential to prepare U.S. students for success in STEM learning. According to the United States Department of Labor (2016), current "hot jobs" that are growing at the fastest rates in the past decade are those in health, computer, personal care, and service related fields. To populate the "hot jobs" of the 21st century employers will be seeking employees who are trained in science, technology, engineering, and mathematics (STEM). However, there is a STEM workforce shortage across the country (Alper, 2016; Iammartino, Bischoff, Willy, & Shapiro, 2016; Stine & Matthews, 2009; Xue, 2015). One reason for this scarcity is that states such as California, the third largest state in the U.S., are not producing an adequate number of students majoring in STEM, career and technical education (CTE), or, in particular, health related fields (Leal, 2016). These occupational fields require a general technological knowledge base of 21st century skills, including digital literacy, technical skills, advanced problem solving, and critical thinking. To prepare students for success in an increasingly technical society, we must ensure that they are engaged in STEM learning from an early age. In turn, they will be prepared to pursue a STEM major as they move through the educational pipeline to postsecondary education and finally, enter a technologically driven workforce upon graduation.

The U.S. Government understands that providing our youth with STEM education is imperative for the growth of our nation. On April 13, 2016 the

Department of Education released a “Dear Colleague” letter for educational institutions nationwide to announce that providing equal access to a “high-quality STEM education” is a priority for the Obama Administration and that Federal funds would be available to support advances in STEM education at the pre-K-12 level in the 2016-17 school year (Dabby, Uvin, Whalen, & Yudin, 2016). Importantly, “equal access” means that students with disabilities must also be included when designing STEM curricula and programs. This stipulation is important, given the high number of students with disabilities in the public education system today. The National Center for Education Statistics (NCES) states that 6.4 million (approximately 13%) students in public schools receive special education services and 35% of those students have a specific learning disability (NCES, 2016). Students with learning disabilities (LDs) are steadily growing in the U.S. (Cortiella & Horowitz, 2014); therefore, we must ensure that this population of students is also obtaining the 21^{st} century STEM skills necessary to succeed in the future workforce. This work is timely, as ensuring students with disabilities have access to a STEM education and future job opportunities is also a policy priority for 2016 presidential candidate Hillary Clinton. The goal of this study is to understand how resources and services already in place (e.g., transition planning, accommodations, and developing self-determination) aid STEM capable LD students in obtaining the STEM skills they need for life and entering the STEM workforce. The term “STEM capable” was devised for this study to represent someone who shows an aptitude for STEM learning. An aptitude for STEM learning can be quantified in various ways and will be discussed in more detail in Chapter 2. Findings will highlight ways to improve these resources and services so that they can then be applied at a national level.

Importance of Current Study

Recent studies and reports indicate that we will need a STEM trained workforce in the coming years (Carnevale, Smith, & Melton, 2011; McComas, 2014; PCAST, 2012; Salzman, 2013; Xue & Larson, 2015), and people with disabilities are an untapped population with STEM potential that can help to fill this need. With appropriate planning in K-12 and accommodation use in college, students with disabilities can help fill the STEM jobs of the future. The 2010 U.S. Census states that children 6 to 15 years of age who need assistance comprise 4.4% of the population and people with disabilities aged 15-21 make up 21.3% of the population; therefore, nearly a quarter of our youth have some disability, but they also have the potential to be successful in STEM with the proper training and support. What resources and training do students with a LD need to be successful in STEM? Research suggests that there are several known factors that contribute to students' pursuit of a STEM field in postsecondary education that range from engagement in STEM (Christensen, Knezek, & Tyler-Wood, 2015; Degenhart, 2007; Heggen, Omokaro, & Payton, 2012; Hu and Wolniak, 2010; Slemrod, 2014), taking appropriate STEM courses (Gottfried & Sublett, in press, Gottfried, Bozick, Rose, & Moore, 2016; Lee, Rojewski, & Gregg, 2016; Plasman & Gottfried, 2016; Shifrer, Callahan, & Muller, 2013; Shifrer & Callahan, 2010), and obtaining encouragement from teachers, counselors, and/or parents (Bean, Gnadt, Maupin, White, & Andersen, 2016; Chachashvili-Bolotin, Milner-Bolotin, & Lissitsa, 2016; Rosenzweig & Wigfield, 2016). However, less is known about what factors contribute to a LD student's successful journey from high school through postsecondary education to a STEM or CTE career. The current study aims to answer this question by focusing on three specific factors that students with a LD have some control over: 1) engagement in developing an individualized education plan (IEP), 2) utilization of accommodations, and 3) the self-determination required to obtain needed services and resources. Although these three factors have been researched for students with disabilities, they have not yet been examined as set of factors used in conjunction to increase LD students' successful completion of a STEM major and entry into a STEM career (Barnard-Brak, Lectenberger, & Lan, 2010; Chou, Wehmeyer, Palmer, & Lee, 2016; Cobb & Alwell, 2009; Eckes & Ochoa, 2005; Field, Sarver, & Shaw, 2003; Hadley, 2007; Herbert, et al., 2014; Hill, 1996; Marshak, Wieren, Ferrell, Swiss, & Dugan, 2010; Newman & Madaus, 2015; Newman, Madaus, & Javitz, 2016).

To determine whether a LD student is capable of pursing a STEM or CTE field, a latent profile analysis (LPA) will be used to classify LD students into STEM capable profiles based on their grades in 12th grade mathematics, science, and CTE courses. It is hypothesized that LD students' grades in mathematics, science, and CTE will be heterogeneous given the individual differences of LD students, which makes LPA a reasonable statistical choice (Geary, 2004; Gerber, 2000; Kim, Vermunt, Bakk, Jaki, & Van Horn, 2016; Masyn, 2013; Siegel, 1989; Stanovich, 1986). Similarly, a latent class analysis will be performed to discover

LD students' enterprising nature in terms of developing their individualized education plan (IEP), seeking accommodations, and possessing self-determination. Finally, understanding what type of postsecondary education a student pursues and, ultimately, their major and career choice can have serious implications for future policy and practice surrounding students with disabilities in STEM. The current study will utilize the National Longitudinal Transition Study-2 (NLTS-2), which is comprised entirely of people with disabilities, to explore how the career trajectory of students in various STEM capable profiles changes and how their postsecondary major choice and career is effected by their engagement in developing an ITP, utilization of accommodations, and possession of self-determination.

Science and Disabilities in Education

The value of STEM education has ebbed and flowed in our country for nearly 100 years; however, within the last decade STEM education has entered the spotlight again. In 2006, President Bush put forward the American Competitiveness initiative in his State of the Union address, which came to fruition with the America COMPETES Act of 2007. Following the announcement of this initiative, and the act that followed, published studies on STEM education increased at a rate not seen for several years. More recently, the research on STEM education was reinvigorated when President Obama launched the Educate to Innovate initiative in 2009. In 2012, the President's Council of Advisors of Science and Technology (PCAST) put forth a report addressing a dire need for the U.S. to produce more STEM professionals in order for the country to stay competitive. Perhaps in response to this 2012 report, research on STEM learning, teaching, and engagement has increased in recent years.

Much like the value of STEM education, policies for students and people with disabilities have gone through several iterations throughout the history of the United States. One of the major changes for educating students with disabilities came with the Individuals with Disabilities Education Act (IDEA) of 1990. In 1997, amendments were added to IDEA that affected the individualized education program, which included changes in accommodation guidelines and transition planning. Additionally, amendment 1415 to IDEA in 2004 is of particular importance to the current study because it introduced response to intervention (RTI), which is used to identify students with specific learning disabilities (SLDs) early in their education and then provide timely interventions (Department of Education, 2010). Prior to RTI, students were diagnosed with a SLD based on the discrepancy between what they were assumed capable of and their academic achievement based on grades and test scores (Bradley, Danielson, & Doolittle, 2005; Steinberg, 2012). It should be noted that §1415 does not mandate RTI be used to identify students with SLDs; however, it is a widely used tool that is allowed in all fifty states (Steinberg, 2012). Prior to RTI, students who may have had a SLD were not being accurately identified and others may have been identified for an SLD that should not have been (Bradley, Danielson, & Doolittle, 2005). Currently, students are being identified with SLD more accurately and at a greater rate; therefore, the time is ripe to put considerable effort towards helping them be successful academically and specifically in STEM fields. As of the 1997 amendments to IDEA, students identified with a SLD who are receiving appropriate accommodations in K-12 must have individualized transition planning (ITP) for postsecondary education in their IEP once they reach 14 years of age (Yell & Shriner, 1997). However, IDEA does not allow the accommodations that students define in their ITP to follow them through postsecondary education. Rather, a student's accommodations that they receive in high school as they were laid out in their ITP will cease to exist once they either graduate from high school or turn twenty-two. Not surprisingly, this lack of consistent accommodations can negatively affect a students' future and hurt their chances of successfully entering a career path, such as a STEM career (Lam, 2015).

National STEM Workforce Needs

The American workforce will need one million workers in STEM fields through 2022, according to a 2012 PCAST report (PCAST, 2012). By 2020 STEM employment is projected to grow by 17% versus 14% for non-STEM professions. The largest area of growth is thought to take place in computer and technology related fields with a projected employment growth of 20%; an increase that is said to be despite the recession (U.S. Congress Joint Economic Committee, 2012). Additionally, the STEM workforce needs more STEM professionals due to the fact that in the next decade Baby Boomers (those people born between 1946 and 1964), who represent approximately 10% of the STEM workforce, will begin to shift into retirement, accounting for approximately 10% of the STEM workforce (Carnevale, Smith, & Melton, 2011; Iammartino, Bischoff, Willy, & Shapiro, 2016). Large companies have also expressed a need for more STEM professionals; at the National Academies of Sciences, Engineering, and Medicine's (NASEM) 2016 workshop on "Developing a National STEM Workforce Strategy," one of the topics discussed was that 80% of manufacturing executives said they could "not find workers who have the critical thinking and technical skills modern manufacturers need to succeed in today's global economy" (NASEM, 2016, p. 41). Similarly, Lockheed Martin shared with the workshop participants that they look for students who "show academic curiosity, critical thinking skills, business acumen, and an entrepreneurial mindset (NASEM, 2016, p. 45). With the current workforce needs and a large amount of potential STEM jobs opening in the future, preparing students with LDs to become the next generation of STEM professionals should be a top education policy concern (McComas, 2014; Salzman, 2013; Xue & Larson, 2015).

Students with Disabilities and STEM

As a national push for more students in STEM fields has surfaced in the last few years, attention has been brought to students with disabilities as a possible source of untapped STEM potential (PCAST, 2012; U.S. Congress Joint Economic Committee, 2012). As of the 2010 census, 10% of the U.S. workforce consists of people with disabilities, yet they only make up 2% of the STEM workforce (Moon, Utschig, Todd, & Bozzorg, 2011). Does this mean that only 2% of our disabled population is capable of pursuing a STEM profession? Alternatively, are disabled students lacking the training, resources, and/or opportunities in their education to pursue STEM fields? Historically our education system has not sufficiently supported students with disabilities in STEM fields at the secondary level, as both STEM teachers and classrooms were not equipped to accommodate their needs (Moon, Todd, Morton, & Ivey, 2012). However, teacher training, curriculum, and tools have since improved we now have the ability to increase the number of students with disabilities in STEM fields (Alber-Morgan, Sawyer, & Miller, 2015; Brigham, Scruggs, & Mastropieri, 2011; Isaacson, 2011; Lenhard, 2015). Students with disabilities are an underutilized source of STEM professionals, and statistics show that they are being lost through the STEM pipeline: 9-10% of LD students major in STEM at the undergraduate level, 5% at the graduate level, and only 1% obtain doctorates in STEM (Moon, Todd, Morton, & Ivey, 2012). As a nation we are beginning to realize we should nurture and cultivate this population that could become the future STEM professionals. Since only 2% of our STEM workforce consisting of people with disabilities, there very well may be STEM capable students with disabilities who have the capacity to persist in STEM fields but need extra, or different, support to succeed (Moon, Utschig, Todd, & Bozzorg, 2011; U.S. Census, 2010).

Focusing on Learning Disabled Students

There are fourteen disabilities categories laid out in IDEA and they can be grouped into three general types of disabilities: physical (e.g., visual, speech, hearing, or dexterity issues), cognitive and behavioral (e.g., general learning disabilities, traumatic brain injuries, attention deficit hyperactive disorder (ADHD), behavioral, and emotional), and developmental (e.g., specific learning disorders, such as dyslexia or dyscalculia, and Autism Spectrum Disorders (ASD), including Asperger's Syndrome). Each of these disability types poses their own challenges for students in STEM education. While researchers have classified disabilities in various ways, just like the three categories proposed above, two students with the same disability classification may process and learn information differently. The purpose of thinking of students as having an "individual difference" as opposed to a "disability" when discussing students with a LD in this study is to realize that students belong on a learning continuum regardless of their specific disabilities category. While the students used in this study do have a LD, each student will have slightly different needs than any other with the same disabilities classification, causing heterogeneity in their academic achievement (Gerber, 2000). The same accommodations are available for all students; however, the extent to which students need and utilize the accommodations available to them will depend greatly on their individual needs. Similarly, a student's level of self-determination varies by individual and can affect their academic performance.

In 2011, 41.5% of United States students ages 6-21 were identified as having a SLD, comprising the largest percentage of students with disabilities (Cortiella & Horowitz, 2014). In this study, students with a SLD will be referred to as having a LD. Of the students identified with a LD, 66% are male and 51% are female (Cortiella & Horowitz, 2014); however, females tend to be identified when their LD is more severe than for males (Vogel, 1990). Therefore, it is possible that females with a LD are often under identified, which can have effects on their academic performance as they progress in their education. Students with a LD are also a group of students that can possess high intellectual abilities, however there is something in the way they learn and process information that slows their academic progress if the correct strategies are not employed to assist them. The intelligence quotient (IQ) test has been used to try to quantify a person's intellectual ability; however, for someone with a learning disability a low IQ score does not necessarily mean they are unintelligent. Rather, it only demonstrates that they learn differently than the average person. Over 100 years after the IQ test was developed, Stuebing, Barth, Molfese, Weiss, and Fletcher (2009) demonstrated that even with a low IQ score students who receive the appropriate remediation can increase their math and reading ability. However, the type of remediation needed can be unique for each student. In a study looking at non-LD 8th grade students, it was discovered that students' self-discipline traits (i.e., absent from school less often, spent significant time on homework and started their homework early in the day, and watched less television) were better predictors of GPA and test scores than students' IQs (Duckworth & Seligman, 2005). It was also found by Duckworth and Seligman (2005) that when a multiple regression was conducted utilizing self-discipline and IQ that self-discipline accounted for more than twice as much of the variance in GPA as IQ. Although the Duckworth and Seligman (2005) study did not look at students with a LD, their findings still highlight the fact that a student's IQ is not as strong a predictive factor of their academic success as other variables. This study will explore how students with a LD can be STEM capable, meaning that even with initially low achievement in math and science at an early age, they can successfully pursue a STEM major in college or STEM career later in life if the proper supports are in place for them.

Statement of the Problem

The current study aims to determine how the latent constructs of engaging in developing an ITP, utilizing accommodations, and possessing self-determination affects a student's trajectory from high school to a STEM career. The survey data from waves two through five and transcript data from wave two of the National Longitudinal Transition Study-2 (NLTS-2) will be used to understand how the three latent constructs mentioned affect LD students through the STEM pipeline, but specifically through the 2-year to 4-year college pathway. Students may work their way to a STEM career from a postsecondary education in one of three ways; by going the route of vocational school, going from a 2-year to 4-year college, or going directly to a 4-year college. This study will look at all pathways, but its primary focus will be on the 2-year to 4-year college pathway. When looking at the college path of students with a LD, specifically, it was found, utilizing the NLTS-2 dataset, that 21.5% of LD students pursue 2-year college following high school compared to 5.0% attending a vocational school and 9.7% attending a 4-year college (Wagner, Newman, Cameto, Garza, & Levine, 2005). Therefore, there will be a larger sample available to analyze the 2-year college pathway in this study allowing for the statistical technique of structural equation modeling (SEM).

In understanding how LD students traverse the STEM pipeline and what skills and services aid them, it is beneficial to first determine their STEM capability (i.e., aptitude for STEM learning), which will be done by determining the STEM learning profiles of LD students in mathematics, science, and CTE courses based on their grades in those courses via LPA. Only one study was found that used latent class analysis (LCA) to classify pre-medical school students into performance categories based on their academic potential to aid medical school admissions committees in selecting candidates (Lambe & Bristow, 2011). The Lambe and Bristow (2011) study utilized categorical variables of the quartiles a student scored on a standardized admissions test, interview score, and grade levels in physical science courses. The current study, however, utilizes the continuous variables of GPA in various STEM and CTE courses to classify students into STEM capable profiles instead of categorical variables as Lambe and Bristow (2011) used. The second component of this study is to discover how developing a transition plan, utilizing accommodations, and possessing self-determination can affect STEM capable students in pursuing STEM and CTE in their postsecondary education and career. Students are required to have an IEP in K-12, which includes a transition plan and can be important for students with a LD to ensure they have a well thought out academic plan following high school; however, once the student leaves high school their IEP will not be in place at the secondary institution. A student's level of engagement in the IEP process can vary widely, which is why it cannot be assumed that each student has the same quality and comprehensive plan in place following high school (Cobb & Alwell, 2009). Additionally, given that students' IEP accommodations (which are mandated in K-12) do not follow them to postsecondary education (Gil, 2007; Johnson, Stodden, Emanuel, Luecking, & Mack, 2002; Madaus & Shaw, 2006), accommodation use is especially important to examine in the current study. Finally, in postsecondary education, students with a LD are protected under ADA and Section 504 of the Rehabilitation Act, however, ensuring that they receive the services and accommodations they need to be academically successfully requires a high amount of proactive work and self-advocacy. (DaDeppo, 2009). Therefore, it is necessary to look at how self-determination plays a role in a students' path through the pipeline, as it has been found that students with a higher self-determination will work harder to ensure they receive the accommodations they need (Getzel, 2008). The covariates that will be used in this study as control variables are gender, age, race, ethnicity, parents' education, and household income. Finally, the distal outcome variables used will be pursuing a STEM or CTE field in vocational and 2-year college, majoring in a STEM or CTE field in 4-year college, and possessing a STEM or CTE career for LD students.

Studies Examining the STEM and CTE Pipeline for Students with Learning Disabilities

The current dissertation is presented in two studies that, when combined, will aid in understanding a LD student's path to a career in a STEM or CTE field via a vocational and/or 2-year college pathway. Each study utilized the NLTS-2, which is a national dataset comprised entirely of students with disabilities who were tracked over a ten-year period. The current study will only focus on LD students. These studies utilize SEM statistical techniques to illuminate how policies can be developed to best support LD students in pursing STEM and CTE fields.

Study One. In order to understand the STEM pipeline, it is important to understand who is traversing and who is capable of traversing this path. The first study, titled: “Examining the STEM Capability of Learning Disabled Students,” will examine the STEM capability of LD students by categorizing students into STEM capable profiles via their grade point average (GPA) in mathematics, science, and CTE courses in 12^{th} grade. For this study, the LD sample of students from the second wave of the NLTS-2 dataset will be used (n = 2,002). The covariates of student’s gender, age, ethnicity, parent’s education, and household income will be utilized in the LPA to determine if any of these factors are significant in predicting students’ STEM capable profiles. Additionally, several outcome variables will be explored, including whether a student pursed a STEM or CTE field at the 2-year college, had a STEM or CTE major at the 4-year college, and/or is in a STEM or CTE related career.

Study Two. The second study, titled: “Factors Effecting Learning Disabled Students’ Path to a STEM or CTE Career,” will utilize an SEM by combining an LCA of LD student’s level of self-determination, IEP development, and accommodation utilization in a regression mixture model. There will also be a descriptive component of this study that will lay out the three pathways (i.e., vocational, 2-year college, and 4-year college) that LD students in the NLTS-2 dataset take in pursuing a STEM or CTE career to gain a descriptive understanding of the LD student STEM pipeline. Again, only students with an LD from the NLTS-2 dataset will used; however, this study will include students from waves two through five (*n* = 2,002). The regression mixture model will analyze how the relationship between pursuing a STEM or CTE major and obtaining a STEM or CTE career is altered by a student's latent class categorization in terms of their possession of self-determination, IEP development, and accommodation utilization.

Summary. The two studies of this dissertation will not only contribute new knowledge about students with LDs pursuing STEM and CTE fields but also aid in developing policies to support LD students in K-12 and postsecondary education who have an aptitude for STEM learning. Once each study is presented an analysis of the findings from each study will be utilized to make recommendations for future research and educational policies.

References

Alber-Morgan, S. R., Sawyer, M. R., & Miller, H. L. (2015). Teaching Science to Young Children with Special Needs. *Research in Early Childhood Science Education* (pp. 299-324). Columbus, OH: Springer Science. doi: 10.1007/978-94-017-9505-0_14

Alper, J. (Ed.). (2016). *Developing a National STEM Workforce Strategy: A Workshop Summary*. National Academies Press. doi: 10.17226/21900

Barnard-Brak, L., Lechtenberger, D., & Lan, W. Y. (2010). Accommodation strategies of college students with disabilities. *The Qualitative Report, 15*(2), 411. Retrieved from http://nsuworks.nova.edu/tqr/vol15/iss2/10

Bean, N., Gnadt, A., Maupin, N., White, S. A., & Andersen, L. (2016). Mind the Gap: Student Researchers Use Secondary Data to Explore Disparities in STEM Education. *Prairie Journal of Educational Research*, *1*(1), 7. Retrieved from http://newprairiepress.org/pjer/vol1/iss1/7/

Bradley, R., Danielson, L., & Doolittle, J. (2005). Response to intervention. *Journal of Learning Disabilities*, *38*(6), 485-486. doi: 0.1177/00222194050380060201

Brigham, F. J., Scruggs, T. E., & Mastropieri, M. A. (2011). Science education and students with learning disabilities. *Learning Disabilities Research & Practice*, *26*(4), 223-232. doi: 10.1111/j.1540-5826.2011.00343.x

Carnevale, A. P., Smith, N., & Melton, M. (2011). STEM: Science, Technology, Engineering, Mathematics. Georgetown University, Center on Education and the Workforce. Retrieved from http://files.eric.ed.gov/fulltext/ED525297.pdf

Chachashvili-Bolotin, S., Milner-Bolotin, M., & Lissitsa, S. (2016). Examination of factors predicting secondary students' interest in tertiary STEM education. *International Journal of Science Education*, *38*(3), 366-390. doi: 10.1080/09500693.2016.1143137

Chou, Y. C., Wehmeyer, M. L., Palmer, S. B., & Lee, J. (2016). Comparisons of Self-Determination Among Students With Autism, Intellectual Disability, and Learning Disabilities A Multivariate Analysis. *Focus on Autism and Other Developmental Disabilities*, 1-9. doi: 10.1177/1088357615625059

Christensen, R., Knezek, G., & Tyler-Wood, T. (2015). Alignment of Hands-on STEM Engagement Activities with Positive STEM Dispositions in Secondary School Students. *Journal of Science Education and Technology*, 1-12. doi: 10.1007/s10956-015-9572-6

Cobb, B., & Alwell, M. (2009). Transition planning/coordinating interventions for youth with disabilities: A systematic review. *Career Development for Exceptional Individuals*. doi: 10.1177/0885728809336655

Cortiella, C., & Horowitz, S. H. (2014). *The state of learning disabilities: Facts, trends, and emerging issues.* New York: National Center for Learning Disabilities. Retrieved from https://www.ncld.org/wp-content/uploads/2014/11/2014-State-of-LD.pdf

DaDeppo, L. M. (2009). Integration factors related to the academic success and intent to persist of college students with learning disabilities. *Learning Disabilities Research & Practice*, *24*(3), 122-131. doi: 10.1111/j.1540-5826.2009.00286.x

Dabby, N. C., Uvin, J. E., Whalen, A., & Yudin, M. K. (2016, April). U.S. Department of Education Issues Guidance for Schools on Leveraging Federal Funding to Support STEM Education [Dear Colleague Letter]. *U.S. Department of Education, Washington, D.C*. Retrieved from http://www2.ed.gov/programs/promiseneighborhoods/stemdearcollegeeagueltr.pdf

Degenhart, H. S. (2007). *Relationship of Inquiry-Based Learning Elements on Changes in Middle School Students' Science, Technology, Engineering, and Mathematics (STEM) Beliefs and Interests* (Doctoral dissertation). Retrieved from ProQuest. (UCSB ILL#: 7222937)

Department of Education. (2010, November). Thirty-Five Years of Progress in Educating Children with Disabilities through IDEA. Retrieved from https://www2.ed.gov/about/offices/list/osers/idea35/history/idea-35-history.pdf

Duckworth, A. L., & Seligman, M. E. (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychological science*, *16*(12), 939-944. doi: 10.1111/j.1467-9280.2005.01641.x

Eckes, S. E., & Ochoa, T. A. (2005). Students with disabilities: Transitioning from high school to higher education. *American Secondary Education*, 6-20. Retrieved from http://www.jstor.org/stable/41064551

Field, S., Sarver, M. D., & Shaw, S. F. (2003). Self-determination a key to success in postsecondary education for students with learning disabilities. *Remedial and Special Education*, *24*(6), 339-349. doi: 10.1177/07419325030240060501

Geary, D. C. (2004). Mathematics and learning disabilities. *Journal of learning disabilities*, *37*(1), 4-15. doi: 10.1177/00222194040370010201

Gerber, M. M. (2000). An appreciation of learning disabilities: The value of blue-green algae. *Exceptionality*, *8*(1), 29-42. doi: 10.1207/S15327035EX0801_4

Getzel, E. E. (2008). Addressing the persistence and retention of students with disabilities in higher education: Incorporating key strategies and supports on campus. *Exceptionality*, *16*(4), 207-219. doi**:** 10.1080/09362830802412216

Gil, L. A. (2007). Bridging the transition gap from high school to college: Preparing students with disabilities for a successful postsecondary experience. *Teaching Exceptional Children*, *40*(2), 12. Retrieved from http://search.proquest.com/openview/56b81171c9e8e7add6a0ae3512d8a0d3/1?pq-origsite=gscholar

Gottfried, M. A., & Sublett, C. (in press). Is there a role of applied STEM coursetaking for students with learning disabilities? *Journal of Learning Disabilities.*

Gottfried, M. A., Bozick, R., Rose, E., & Moore, R. (2016). Does Career and Technical Education Strengthen the STEM Pipeline? Comparing Students With and Without Disabilities. *Journal of Disability Policy Studies,26,* 232-244. doi: 0.1177/1044207314544369

Hadley, W. M. (2007). The Necessity of Academic Accommodations for First-Year College Students with Learning Disabilities. *Journal of College Admission, 195*, 9-13. Retrieved from http://files.eric.ed.gov/fulltext/EJ783943.pdf

Heggen, S., Omokaro, O., & Payton, J. (2012, October). Mad Science: Increasing engagement in STEM education through participatory sensing. Proceedings from *The Sixth International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies*. Barcelona, Spain. Retrieved from http://www.sheggen.com/sites/default/files/publications/ubicomm_2012_4_10_10115.pdf

Herbert, J. T., Hong, B. S., Byun, S. Y., Welsh, W., Kurz, C. A., & Atkinson, H. A. (2014). Persistence and graduation of college students seeking disability support services. *journal of Rehabilitation, 80*(1), 22. Retrieved from http://crawl.prod.proquest.com.s3.amazonaws.com/fpcache/d10b69f0f6e1

4a5d4ae8a6dcdcca5c67.pdf?AWSAccessKeyId=AKIAJF7V7KNV2KKY2NUQ&Expires=1475558477&Signature=iSeHdraaTQoV6iCkH9qdnPmcQ14%3D

Hill, J. L. (1996). Speaking Out: Perceptions of Students with Disabilities Regarding Adequacy of Services and Willingness of Faculty To Make Accommodations. *Journal of Postsecondary Education and Disability*, *12*(1), 22-43. Retrieved from http://files.eric.ed.gov/fulltext/EJ555749.pdf

Hu, S., & Wolniak, G. C. (2010). Initial evidence on the influence of college student engagement on early career earnings. *Research in Higher Education*, *51*(8), 750-766. doi: 10.1007/s11162-010-9176-1

Iammartino, R., Bischoff, J., Willy, C., & Shapiro, P. (2016). Emergence in the US Science, Technology, Engineering, and Mathematics (STEM) workforce: an agent-based model of worker attrition and group size in high-density STEM organizations. *Complex & Intelligent Systems*, *2*(1), 23-34. doi: 10.1007/s40747-016-0015-7

Isaacson, M. D. (2011). Increasing STEM accessibility in students with print disabilities through MathSpeak. *Journal of Science Education for Students with Disabilities*, *14*(1), 3. doi: 10.14448/jsesd.03.0002

Johnson, D. R., Stodden, R. A., Emanuel, E. J., Luecking, R., & Mack, M. (2002). Current challenges facing secondary education and transition services: What research tells us. *Exceptional children*, *68*(4), 519-531. doi: 10.1177/001440290206800407

Kim, M., Vermunt, J., Bakk, Z., Jaki, T., & Van Horn, M. L. (2016). Modeling predictors of latent classes in regression mixture models. *Structural Equation Modeling: A Multidisciplinary Journal*, *23*(4), 601-614. doi: 10.1080/10705511.2016.1158655

Lam, Y. W. (2015). *The Effects of Identity and Psychological Empowerment on Accommodation Usage and Achievement for College Students with Disabilities* (Doctoral dissertation). Retrieved from http://search.proquest.com/docview/1765692917

Lambe, P., & Bristow, D. (2011). Predicting medical student performance from attributes at entry: a latent class analysis. *Medical education*, *45*(3), 308-316. doi: 10.1111/j.1365-2923.2010.03897.x

Leal, F. (2016, June 13) Report: California public colleges not producing enough STEM degrees. [Web blog]. Retrieved from https://edsource.org/2016/report-california-public-colleges-not-producing-enough-stem-degrees/565713?utm_source=June+14+digest+-+Fermin&utm_campaign=Daily+email&utm_medium=email

Lee, H., Rojewski, J. W., & Gregg, N. (2016). Causal Effects of Career-Technical Education on Postsecondary Work Outcomes of Individuals with High-Incidence Disabilities. *Exceptionality*, *24*(2), 79-92. doi: 10.1080/09362835.2014.986608

Lenhard, S. E. (2015). Utilizing Problem-Based Learning Activities in Science with Students with Disabilities. (Master's thesis, The College at Brockport, State University of New York). Retrieved from http://digitalcommons.brockport.edu/ehd_theses/533/

Madaus, J. W., & Shaw, S. F. (2006). The impact of the IDEA 2004 on transition to college for students with learning disabilities. *Learning Disabilities Research & Practice*, *21*(4), 273-281. doi: 10.1111/j.1540-5826.2006.00223.x

Marshak, L., Van Wieren, T., Ferrell, D. R., Swiss, L., & Dugan, C. (2010). Exploring Barriers to College Student Use of Disability Services and Accommodations. *Journal of Postsecondary Education and Disability*, *22*(3), 151-165. Retrieved from http://files.eric.ed.gov/fulltext/EJ906688.pdf

Masyn, K. (2013). Latent class analysis and finite mixture modeling. In T. Little (Ed.), *The Oxford handbook of quantitative methods in psychology* (Vol. 2, pp. 375–393). Oxford, UK: Oxford University Press.

McComas, W. F. (2014). 21st-Century Skills. In *The Language of Science Education*. Rotterdam, The Netherlands: Sense Publishers. doi: 10.1007/978-94-6209-497-0_1

Moon, N. W., Todd, R. L., Morton, D. L., & Ivey, E. (2012). *Accommodating students with disabilities in science, technology, engineering, and mathematics (STEM).* Retrieved from Center for Assistive Technology and Environmental Access, Georgia Institute of Technology: http://advance.cc.lehigh.edu/sites/advance.cc.lehigh.edu/files/accommodating.pdf

Moon, N. W., Utschig, T. T., Todd, R. L., & Bozzorg, A. (2011). Evaluation of Programmatic Interventions to Improve Postsecondary STEM Education for Students with Disabilities: Findings from SciTrain University. *Journal of Postsecondary Education and Disability*, *24*(4), 331-349. Retrieved from http://files.eric.ed.gov/fulltext/EJ966141.pdf

National Academies of Sciences, Engineering, and Medicine. 2016. *Developing a National STEM Workforce Strategy: A Workshop Summary*. Washington, DC: The National Academies Press. doi: 10.17226/21900

Newman, L. A., & Madaus, J. W. (2015). An Analysis of Factors Related to Receipt of Accommodations and Services by Postsecondary Students With Disabilities. *Remedial and Special Education*, *36*(4), 208-219. doi: 10.1177/0741932515572912

Newman, L. A., Madaus, J. W., & Javitz, H. S. (2016). Effect of transition planning on postsecondary support receipt by students with disabilities. *Exceptional Children*, 1-18. doi: 10.1177/0014402915615884

Plasman, J., & Gottfried, M. A. (2016). Applied STEM Coursework, High School Dropout Rates, and Students with Learning Disabilities. *Educational Policy*, 1-33. doi: 10.1177/0895904816673738

President's Council of Advisors on Science and Technology (U.S.), & United States. Executive Office of the President. (2012). *Report to the President, Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*. Washington, D.C.: Executive Office of the President, President's Council of Advisors on Science and Technology. Retrieved from https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-executive-report-final_2-13-12.pdf

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescents: A promising start, but further to go. *Educational Psychologist*, 1-18. doi: 10.1080/00461520.2016.1154792

Salzman, H. (2013). What shortages? The real evidence about the STEM workforce. *Issues in Science and Technology*, *29*(4), 58-67. Retrieved from http://www.researchgate.net/profile/Hal_Salzman2/publication/259466494_58_ISSUES_IN_SCIENCE_AND_TECHNOLOGY/links/00b7d52bdd78d4064c000000.pdf

Siegel, L. S. (1989). IQ is irrelevant to the definition of learning disabilities. *Journal of learning disabilities*, *22*(8), 469-478. doi: 10.1177/002221948902200803

Slemrod, T. (2014). *Using Assistive Technology to Increase Vocabulary Acquisition and Engagement for Students with Learning Disabilities in the High School Science Classroom* (Doctoral dissertation). Retrieved from ProQuest. (UCSB ILL#: 7222940)

Shifrer, D., Callahan, R. M., & Muller, C. (2013). Equity or marginalization? The high school course-taking of students labeled with a learning disability. *American educational research journal,50*(4), 656-682. doi: 10.3102/0002831213479439

Shifrer, D., & Callahan, R. (2010). Technology and communications coursework: Facilitating the progression of students with learning disabilities through high school science and math coursework. *Journal of Special Education Technology*, *25*(3), 65-77. doi: 10.1177/016264341002500307

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading research quarterly*, 360-407. Retrieved from http://www.jstor.org/stable/747612?seq=1#page_scan_tab_contents

Steinberg, G. (2012). Amending Sec. 1415 of the IDEA: Extending Procedural Safeguards to Response-to-Intervention Students. *Colum. JL & Soc. Probs.*, *46*, 393. Retrieved from http://www.columbia.edu/cu/jlsp/pdf/Spring2013/Steinberg.pdf

Stine, D. D., & Matthews, C. M. (2009). The US science and technology workforce. *Federal Publications*, 644. Retrieved from http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1649&context=key_workplace

Stuebing, K.K., Barth, A.E., Molfese, P.J. Weiss, B. and Fletcher, J.M. (2009). IQ is not strongly related to response to reading instruction: A meta-analytic interpretation. *Exceptional Children*, *76*, 31-53. Retrieved from http://p8888-ucelinks.cdlib.org.proxy.library.ucsb.edu:2048/sfx_local?sid=google&auinit=KK&aulast=Stuebing&atitle=IQ+is+not+strongly+related+to+response+to+reading+instruction:+A+meta-

analytic+interpretation&id=doi:10.1177/001440290907600102&title=Exceptional+Children&volume=76&issue=1&date=2009&spage=31&issn=0014-4029

U.S. Census Bureau. (2010). *Prevalence of Disability for Selected Age Groups: 2005 and 2010, Table 1*. Retrieved from https://www.census.gov/people/disability/publications/disab10/table_1.pdf

U.S. Congress Joint Economic Committee. (2012, April). STEM Education: Preparing for the jobs of the future. US Congress Joint Economic Committee, Washington, DC. Retrieved from http://www.jec.senate.gov/public/index.cfm/democrats/2012/4/stem-education-preparing-jobs-of-the-future

U.S. Department of Education, National Center for Education Statistics. (2016). *Digest of Education Statistics, 2014* (NCES 2016-006). Retrieved from https://nces.ed.gov/programs/coe/pdf/Indicator_CGG/COE_CGG_2013_01.pdf

Vogel, S. A. (1990). Gender Differences in Intelligence, Language, Visual-Motor Abilities, and Academic Achievement in Students with Learning Disabilities A Review of the Literature. *Journal of Learning Disabilities*, *23*(1), 44-52. doi: 10.1177/002221949002300111

Wagner, M., Newman, L., Cameto, R., Garza, N., and Levine, P. (2005). *After High School: A First Look at the Postschool Experiences of Youth with Disabilities. A Report from the National Longitudinal Transition Study-2*

(NLTS2) Menlo Park, CA: SRI International. Retrieved from www.nlts2.org/reports/2005_04/nlts2_report_2005_04_complete.pdf

Xue, Y., & Larson, R. C. (2015). STEM Crisis or STEM Surplus: Yes and Yes. *Monthly Lab. Rev.*, *138*, 1. Retrieved from http://www.bls.gov/opub/mlr/2015/article/stem-crisis-or-stem-surplus-yes-and-yes.htm

Yell, M. L., & Shriner, J. G. (1997). The IDEA amendments of 1997: Implications for special and general education teachers, administrators, and teacher trainers. *Focus on Exceptional Children*, *30*(1), 1. Retrieved from http://search.proquest.com/openview/55872ff92f0cfa0b471571bb2acae398/1?pq-origsite=gscholar

CHAPTER TWO

Examining the STEM Capability of Learning Disabled Students

Abstract

The number of students identified with a learning disability (LD) is growing yearly and there is evidence that future jobs will be increasingly more technical in nature, therefore requiring a science, technology, engineering, and mathematics (STEM) background or training in a career and technical education (CTE) field. Using latent profile analysis, the current study first categorized LD students into various STEM capable (i.e., aptitude to perform well in STEM related fields) profiles based on their 12th grade GPA in STEM and CTE courses. Next, analyses examined whether students' STEM capable profiles predicted their pursuing of a STEM or CTE field at a 2-year college, majoring in a STEM or CTE discipline at a 4-year college, and/or obtaining a career in a STEM or CTE area. Models with one through three profiles were examined and the two-profile model was selected based on various fit statistics. It was discovered that students could be categorized into two profiles: *High-STEM and CTE Capability* or *Low-STEM Capability*. It was discovered that female students were significantly more likely to be in the *High-STEM and CTE Capability* profile (.75, $p < .05$) by 2.11 times. A statistical difference was only discovered between STEM Capable profiles for LD students pursuing a STEM or CTE career (χ^2 (2) 2.49, $p = .01$) but not a STEM or CTE major and students in the *High-STEM and CTE Capability* profile were more likely to pursued a STEM or CTE career.

Introduction

Only two percent of the 41.1 percent of the U.S. employed disabled population are employed in some sector of the science technology, engineering, and mathematics (STEM) workforce (Moon, Utschig, Todd, & Bozzorg, 2011; U.S. Census, 2010); however, there may be a larger percentage who are STEM capable, meaning they have the capacity to persist in STEM fields but need extra, or different, support to succeed. The purpose of this study is to utilize data from the National Longitudinal Transition Study-2 (NLTS-2) to understand typical profiles of STEM learning disabled (LD) students, with the goal of being able to project their postsecondary pathway, major, and career outcomes. Once these profiles are determined, attention can be turned towards developing mechanisms and policies to improve resources and services for STEM training of LD students nationwide.

As a national push for more students in STEM fields has surfaced in the last several years, attention has been drawn towards students with disabilities as a possible source of untapped STEM potential (PCAST, 2012; U.S. Congress Joint Economic Committee, 2012). For example, as of the 2010 U.S. Census, 10% of the U.S. workforce consisted of people with disabilities, yet they only made up 2% of the STEM workforce (Moon, Utschig, Todd, & Bozzorg, 2011). Students with disabilities are an underutilized source of STEM professionals and we are losing them through the STEM pipeline; 9-10% major in STEM at the undergraduate level, 5% at the graduate level, and finally, only 1% obtain doctorates in STEM (Moon, Todd, Morton, & Ivey, 2012).

Learning disabilities is the largest category among students with disabilities, yet the amount of research devoted to LD students and STEM is not representative of this size (Cortiella & Horowitz, 2014). For example, a Google Scholar search for articles published in the past 12 years (2004-2016) revealed an interesting trend (see Table 2.1). The time span from 2004-2016 was chosen because in 2004 Congress amended IDEA to include the use of response to intervention (RTI) to identify students with specific learning disabilities (SLDs). There are nearly a million articles published on "science AND disabilities," but when the search is changed to "science AND learning disabilities" the articles drop to 17,700. Additionally, the number of articles published on "reading AND disabilities" is approximately ten times the number of articles on "math AND disabilities." A main take away from this exercise is that consistently fewer articles are published on learning disabilities versus general disabilities, even though 41.5% of students with disabilities have a learning disability (Cortiella & Horowitz, 2014).

Table 2.1

Google Scholar Search Results for Articles Published from 2004-2016 in Various Subjects for Students with General Disabilities and Learning Disabilities

Search Request	**Search Result Quantities**
Science AND Disabilities	925,000
Science AND Learning Disabilities	17,700
Math AND Disabilities	44,600

Math AND Learning Disabilities	27,900
STEM AND Disabilities	32,700
STEM AND Learning Disabilities	18,200
Reading AND Disabilities	403,000
Reading AND Learning Disabilities	55,300

Note. The grey text is utilized in this table to visually distinguish between the sample of people with a LD only and the combined sample of people with all disabilities.

The current study aims to add to the limited existing body of research on students with a LD by determining their STEM capability in 12th grade. This will be achieved by empirically classifying students into STEM capable profiles based on their GPA in science, mathematics, and CTE courses (i.e., agriculture, health, technology, and trade). Determining the capability of learning disabled students can contribute to the development of targeted policies to engage the LD population in STEM learning and ultimately STEM or CTE careers; therefore, the current study aims to answer two main research questions.

1. Which characteristics (i.e., gender, age, ethnicity, parents' education, and household income) of LD students are associated with various levels of STEM (e.g., mathematics and science) and/or career and technical education (CTE; e.g., agriculture, health, technology, and trade and industry) ability?
2. What are the outcomes (i.e., pursuing a STEM or CTE field at a 2-year college, majoring in STEM or CTE at a 4-year college, and/or obtaining a STEM or CTE career) of LD students based on their STEM capable classification?

To answer these questions, data from each individual will be utilized to create group classifications through latent profile analysis (LPA). In turn, results will contribute to current understanding of how this group of individuals behaves and potentially inform the development educational policies to support students with individual needs.

Conceptual Framework

The current study utilizes previous literature on student achievement to inform the development of a conceptual framework to understand what a STEM capable LD student is and what they can achieve. To characterize what a STEM capable LD student is, student characteristics along with STEM and CTE related academic and career outcomes are obtained from a national sample of LD students. Utilizing a national sample enables this framework to be applied to smaller, local samples of students. Additionally, the framework can be applied to students with other disabilities or pursuing various areas of academic interest.

STEM Capable Students

In this study, a STEM capable student is defined as someone who shows an aptitude for STEM learning. There are various measures that can be used to quantify a student's ability to learn and succeed in STEM (e.g., standardized test scores or grades in math and/or science). Given the variables available in the NLTS-2 data set, a STEM capable student is determined through a latent profile analysis (LPA) of LD students' grades in science, mathematics, and CTE courses in 12th grade. 12th grade was selected in order to contribute to understanding of the STEM pipeline for LD students, beginning with the transition between exiting high school and entering postsecondary education. Past studies in this area have used math or reading performance in a latent class analysis (LCA) to predict a learning disability or utilized other academic constructs (i.e., perfectionism, academic failure, and deviant behaviors) to predict STEM ability (Darney, Reinke, Herman, Stormont, & Ialongo, 2013; Reinke, Herman, Petras, & Ialongo, 2008; Rice, Lopez, & Richardson, 2013), however, no previous work has utilized the continuous variables of grades to categorize students' STEM capability. The most similar study to point to as an example is work done by Geary and colleagues (2009), which predicted mathematics achievement from intelligence quotient (IQ), memory, and mathematics tests. (Geary et. al, 2009). Another study used LCA to predict which students would be successful in medical school based on a combination of grades and test scores, which were categorical based on letter grades and quartiles of test scores (Lambe & Bristow, 2011). However, to the author's knowledge, no study has used a combination of GPA in science, mathematics, and CTE courses to predict students' abilities to do well in a STEM or CTE major and career.

Previous studies exploring STEM achievement and outcomes for students with disabilities have found that students with disabilities are less likely to take advanced math and science courses than their non-disabled peers, which has an effect on their ability to pursue STEM in postsecondary education, given they were less academically prepared to take the necessary physical science courses (Gottfried & Sublett, in press; Gottfried, Bozick, Rose, & Moore, 2014). Similarly, students with disabilities were found to have taken fewer applied

STEM courses in high school. Additionally, it appeared that non-disabled students benefited from taking applied STEM courses, but students with disabilities did not (Gottfried, Bozick, Rose, & Moore, 2014). When specifically looking at students with a LD, one study discovered that a mere 45% obtain at least three science credits compared to 71% of their non-disabled peers (Shifrer, Callahan, & Muller, 2013). In a recent Gottfried and Sublett (in press) study it was discovered that LD students were less likely to enroll in applied STEM courses, and for those that did take applied STEM courses early in high school they did not increase their odds of taking advanced STEM courses later in high school, as was seen with the non-LD students. In terms of employment, it has been discovered that when LD students complete three or more CTE courses within a concentration (e.g., health care or technology) their workforce outcomes increase and they have a 1.85 times greater chance of securing full-time employment (Lee, Rojewski, & Gregg, 2016). Taking applied STEM courses in high school has been shown to increase college-going behavior in LD students and reduce dropout (Plasman & Gottfried, 2016). As demonstrated by the literature discussed, LD students consistently tend to be less academically prepared than non-LD students and take fewer applied STEM courses. However, current literature is limited in that it analyzes students with a LD as a homogeneous sample, which can show trends but not individual differences. The current study will focus on the heterogeneous nature of LD students and showcase their individual differences. An LPA analysis was chosen to analyze student's individual differences because it is a person-centered statistical approach, also referred to as a direct application, that utilizes the heterogeneity of the data, such as students' grades in courses, which are unique for every student, to determine latent homogeneous groups based on individual responses to continues variables, which is GPA in this study (Laursen & Hoff, 2006; Masyn, 2013). The proposed conceptual model (Figure 2.1) for this study displays STEM capable profiles created from various STEM and CTE course GPAs predicting the distal outcomes of STEM or CTE field pursued at the 2-year college, STEM or CTE major at the 4-year college, and STEM or CTE career. Additionally, a series of covariates are controlled for, including gender, age, race, ethnicity, household income, and parent's education level.

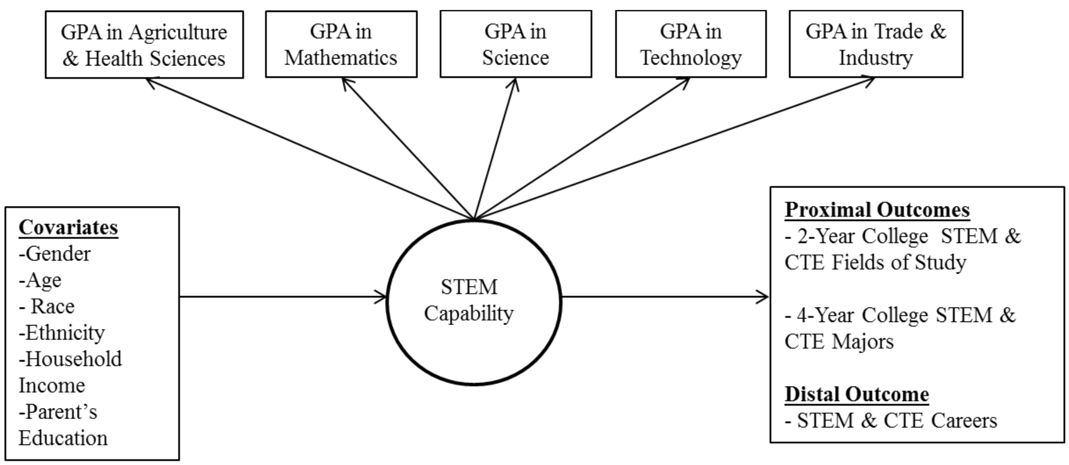

Figure 2.1. Latent profile analysis model with covariates and proximal and distal outcomes.

The Current Study

In the current study a latent profile analysis (LPA) will be used to determine the STEM capable profiles of LD students by categorizing LD students based on their grades in mathematics, science, and CTE courses in 12th grade.

Other statistical analyses utilize a variable-centered approach, also referred to as an indirect application, which looks at the population of interest as a homogenous group and seeks to understand how variables relate to each other among a homogeneous population (Masyn, 2013). Every human being is unique and every LD presents itself differently in different people; therefore, a standard variable-centered approach will not suffice when the goal is to understand individual differences. By utilizing a LPA technique, it is possible to study the heterogeneous population of LD students and how their individual GPAs in STEM and CTE courses allow them to be classified into homogeneous STEM capable profiles. To the author’s knowledge, an LPA of students’ GPA in courses utilizing the NLTS-2 dataset has not been done before; therefore, this study will contribute new knowledge of the ability of students with a LD to pursue STEM or CTE fields and careers. As previously discussed, LD students possess individual differences and have unique learning styles and abilities. In Table 2.2 below the research questions guiding this study, general variables used, covariates used, and the statistical model employed are laid out. The results from this study have policy implications for how LD high school students should prepare to enter postsecondary education and how postsecondary institutions should support incoming STEM capable LD students.

Table 2.2

Research Questions, Measures Used, and Statistical Methods Employed to Examine the STEM Capability of Students with Learning Disabilities in High School

Research Question	Variables Used	Covariates Used	Model Employed
1. What is the heterogeneity of science, mathematics and CTE course grades for students with a LD in 12th grade?	GPA earned in: agricultural, health, mathematics, science, technology, and trade and industry courses in classrooms of any setting (variable codes listed in Table A-1 of the Appendix).	None	Correlational Analysis
2. What latent profiles exist for LD students in 12th grade based on their grades in science, mathematics, and CTE courses?	GPA earned in: agricultural, health, mathematics, science, technology, and trade and industry courses in classrooms of any setting (variable codes listed in Table A-1 of the Appendix).	- Gender - Age - Race - Ethnicity - Household Income - Parents Education	Latent Profile Analysis

3. Which characteristics (i.e., gender, age, ethnicity, parents' education, and household income) of LD students are associated with various levels of STEM and/or CTE capability?	GPA earned in: agricultural, health, mathematics, science, technology, and trade and industry courses in classrooms of any setting (variable codes listed in Table A-1 of the Appendix).	- Gender - Age - Race - Ethnicity - Household Income Parents Education	Latent Profile Analysis
4. What are the outcomes (i.e., pursuing a STEM or CTE field at a 2-year college, majoring in STEM or CTE at a 4-year college, and/or obtaining a STEM or CTE career) of LD students based on their STEM capability?	GPA earned in: agricultural, health, mathematics, science, technology, and trade and industry courses in classrooms of any setting and whether students pursued STEM or CTE at the 2-year college, majored in STEM or CTE at the 4-year college, and/or if they ended up in a STEM or CTE career (variable codes listed in Table A-1 of the Appendix).	- Gender - Age - Race - Ethnicity - Household Income	Latent Profile Analysis

Methods

Dataset

The current study utilized data from the National Longitudinal Transition Study-2 (NLTS-2; SRI, 2000), which was conducted on behalf of the Department of Education's (DOE) Office of Special Education Programs (OSEP) and the Institute of Education Sciences (IES) by the Scientific Research Institute (SRI) International, Research Triangle Institute (RTI) International, and Westat. The majority of the study was conducted by SRI International; however, RTI International assisted with parent interviews, and the research firm Westat aided with the student assessments. The NLTS-2 study began in 2000 and tracked a set of students with disabilities from across the country for 10 years. Prior to the NLTS-2 there was the NLTS, which was also run by SRI International and was conducted from 1985 through 1993 on a sample of students with disabilities. The NLTS-2 utilized the same variables from the NLTS study but collected data for a ten-year period versus 8 years and is a more recent dataset.

The NLTS-2 study began with 11,270 students with disabilities in an age range of 13 to 16; therefore, at the conclusion of the study, the participants were 23 to 26 years old and had typically graduated from a vocational school or 4-year college and were either in graduate school or a job (see Table 2.3 below). The NLTS-2 dataset was designed to track the transition of students from high school through young adulthood. The dataset is robust in that it provides information on the households of students with disabilities, their schools, the services and accommodations they received, extracurricular activities, social activities and programs available in their adult lives, education, and employment.

Table 2.3

The Grade and Age Range of Participants in Each Wave of the NLTS-2 Dataset

Wave	Student Grade Range	Student Age Range
1	7th – 9th	13-16
2	10th – 12th	15-18
3	1st – 3rd Year in College	17-20
4	4th – 6th Year in College or Beginning of Career	19-22
5	End of College through Beginning of Career	21-26

The data for the study was collected via several methods, including telephone interviews. The student's parents were interviewed via telephone starting in 2001 and every other year until 2009 to collect data on the students' family life and general experiences. The students who were capable of talking on the telephone were interviewed beginning in 2003 and every other year until 2009. The interviews of both parents and students took place in either English or Spanish depending on the families' preference.

Participants

Because no national database currently exists for students who are receiving special education services, the NLTS-2 dataset obtained participants who were receiving special education from Local Educational Agencies (LEAs). The participants chosen for this study were all students who were identified as receiving special education at 13 to 16 years old in 2000. Given the duration of this study (10 years), a large sample size of students was initially obtained so that statistical power could be maintained through the last data collection even when accounting for anticipated attrition. A sample of 11,500 students was initially selected to participate in wave 1 of the study and that amount was determined to provide approximately 1,250 students in each of the disabilities categories (SRI International, 2000). It was initially estimated that 92% of students would be retained from each previous wave of data collection (SRI International, 2000). Ultimately, 11,226 parents or students participated in the second wave of the study. It should be noted that the first wave only involved responses from parents and schools (Javitz & Wagner, 2005). Table 2.4 below shows the number of LD students utilized in this study by their ethnicity and gender for wave two and Table 2A-1 in the Appendix shows the descriptive statistics of the course GPAs obtained from the wave two transcripts.

Table 2.4

Ethnicity and Type of Disability by Gender for Participants in Wave Two of the NLTS-2 Dataset

	Wave 2 (*N* = 2,002)			
	Female		**Male**	
	N	**%**	***N***	**%**
Type of Disability				
LD	714	35.66	1288	64.34
Ethnicity for LD Students				
American Indian/Alaska Native	31	1.55	52	2.60
Asian	16	0.80	20	1.00
Black	155	7.74	265	13.24
Latina/o	128	6.39	227	11.34
Native Hawaiian/ Other Pacific Islander	5	0.25	7	0.35
White	492	24.58	906	42.25
Multiple Ethnicities	61	3.05	103	5.14

Participants in the study were selected from five hundred LEAs from across the county in from the following regions the Northeast, Southeast, Central, and West/Southwest United States plus an additional 40 special education schools from across the country as well. Each LEA or special education school was responsible for designating the disability category of the participants. Table 2.5 shows the national numbers of students with a LD between 14-21 years of age and is a snapshot of the total number as they exit high school, which provides a national reference point for the data in the current study.

Table 2.5

Type of Disability, Gender, and Ethnicity for Students between the Ages of 14-21 Exiting High School in 2014-15

Type of Disability	**Number of Students (*N*)**
All Disabilities Combined	1,229,166
LD	592,813 (48.23%)
Gender – All Disabilities	
Female	418,364 (34.04%)
Male	795,514 (64.72%)
Ethnicity	
American Indian/Alaska Native	18,436 (1.50%)
Asian	18,985 (1.54%)
Black	272,100 (22.14%)
Latina/o	258,410 (21.02%)
Native Hawaiian/ Other Pacific Islander	4,454 (0.36%)
White	628,451 (51.13%)
Multiple Ethnicities	28,095 (2.29%)

SOURCE: U.S. Department of Education, Office of Special Education Programs, Individuals with Disabilities Education Act (IDEA) Section 618 Data Products: State Level Data Files. Retrieved June 18, 2016, from http://www2.ed.gov/programs/osepidea/618-data/state-level-data-files/index.html#bcc

Measures

The complete list of variables to be used in this study can be found in the Appendix, Table 2A-1. The LD variable is that of specific learning disabilities and includes students with dyslexia. The variables for GPA in 12th grade, which is an individual grade for each student, were obtained from the wave two transcript data, are for courses in science, mathematics, agriculture, health, technology, and trade and industry for all school settings. To determine what courses fit into each of the CTE categories above the "Vocational-Technical Course Taxonomy," developed by Silverberg, Warner, Fong, and Goodwin (2004, p. 22), was used and their table can be viewed to see the breakdown of courses. The covariates used in the study are gender, age, ethnicity, household income, and parents' education level. All covariates were dichotomous except for age. Since students with LDs may have to retake courses or are held back at some point in their education, age was included as a covariate to explore whether a student's age affected their STEM capable profile assignment. The distal dichotomous outcome variables used included whether students pursued a STEM or CTE field of study in 2-year college, STEM or CTE major in 4-year college, and/or a STEM or CTE job as an adult. All distal variables were dichotomous and created from variables in waves two through five in the dataset. The variables for STEM and CTE fields at the 2-year college and STEM and CTE majors at the 4-year college were coded as 0 for students who did not pursue STEM or CTE and 1 if they did. Due to low sample sizes, students who pursued STEM or CTE were combined into the three following variables: pursuing STEM or CTE at the 2-year college, majoring in STEM or CTE at the 4-year college, and being in a STEM or CTE career. NLTS-2 used the Standard Occupational Classification (SOC) System to code the occupations of the participants.

Data Analysis Plan

The analytical procedure used for this study is outlined below following the conceptual model in Figure 1. The data files were merged and composite and dummy variables were created using SPSS 24 (IBM Corp., 2016). All analyses were conducted using M*plus* version 7.4 software (Muthén & Muthén, 1998-2015). The NLTS-2 dataset does contain non-missing responses and missing data. Missing data were handled by employing the full information maximum likelihood (FIML) estimator, which does not insert missing values but rather "estimates model parameters and standard errors using all available raw data" (Enders, 2001, p. 715). The FIML estimator can handle item-level missingness and it assumes that missing data is missing at random (MAR), therefore, participants with at least one observed variable will still be included in the model using FIML.

Correlational Analysis. The first step of the current analyses was to determine if students with a LD could be classified into profiles based on their grades in science, mathematics, and CTE courses in 12th grade. Therefore, a correlational analysis was conducted to determine the level of heterogeneity of participants' GPA in science, mathematics, and CTE courses. One hypothesis was that if a student performs well in mathematics then they will probably perform well in science and CTE courses as well, therefore, the GPAs will be highly correlated ($r > .70$). However, an alternative hypothesis, which was the working hypothesis for this study, was that LD students are each unique and it cannot be assumed that if a LD student perform well in mathematics, science, or CTE courses that they will also perform well in all the other STEM and CTE courses. If the latter hypothesis were true, there would be heterogeneity among the GPAs ($r < .60$). To test this hypothesis, a correlational analysis of the LD student GPAs in 12th grade mathematics, science, and CTE courses was conducted to determine if the grades were highly correlated with each other ($r > .70$). The GPA data was obtained from transcript data in wave two of the NLTS-2 study.

Latent Profile Analysis. If there is heterogeneity of student GPA's across subjects, LPA can be performed to classify students into STEM capable profiles. LPA is an exploratory (Ing & Nylund-Gibson, 2013; Nylund-Gibson, Ing, & Park, 2013) that empirically creates distinct classes based on continuous variables, rather than latent class analysis (LCA) which assigns individuals to latent classes based on categorical variables. Both LCA and LPA utilize a person-centered approach instead of the item centered approach of factor analysis and are exploratory analyses (Ing & Nylund-Gibson, 2013; Nylund-Gibson, Ing, & Park, 2013). To avoid change in latent profiles due to auxiliary variables, a three-step approach was utilized (Nylund-Gibson, Grimm, Quirk, Furlong, 2014). In this method, the first step is to run an unconditional model that does not contain covariates or outcome variables, beginning with a single profile and increasing one profile at a time until the appropriate level of fit is obtained (Nylund, Asparouhov, & Muthén, 2007). Like structural equation modeling, LPA does not rely on only one model fit criteria, there are six that are often used in combination with substantive theory (Nylund, Asparouhov, & Muthén, 2007). These criteria include the Bayesian information criterion (BIC) and adjusted BIC (ABIC), where lower BIC values mean a better fitting model. Two more criteria, which are based on the Likelihood, are the Lo-Mendell-Rubin Test (LMRT) and bootstrap likelihood ratio test (BLRT), where a non-significant *p*-value signifies that the model with one less class is the best fit. The Bayes Factor (BF) is another fit criteria and is a value of the ratio of the probability that one model compared to another is the correct model, where a BF between a value of three and ten is considered moderate evidence of the correct model (Masyn, 2013). The final fit criteria to mention is the correct model probability (cmP), where the summed cmP value from all models should equal one (Ing & Nylund-Gibson, 2013; Masyn, 2013; Nylund-Gibson, Ing, & Park, 2013). Additionally, entropy, which is a measure of classification and not used to compare models to each other but as a descriptor of a chosen model, indicates a clearer separation between classes when the values are closer to one. Finally, two conditional LPA models were run, first with covariates and then with distal outcomes, utilizing the BCH method, which allows for covariates and outcome variables to be run in one step. In these analyses, the latent profile variable is regressed on the covariates of gender, ethnicity, parents' education level, and household income to produce logits for interpretation rather than regression coefficients. Finally, means for the proximal outcomes of pursuing CTE or STEM in a 2-year college and majoring in CTE or STEM in a 4-year college are estimated, as well as the distal outcome of pursuing a CTE or STEM job.

Results

Correlational Analysis

Correlation analyses revealed that all intercorrelations were below .60 (see Table 2.6), with the exception of the GPA for the Trade and Industry courses with the GPA of Agriculture at $r < .62$; however, this value is within reason and not considered a very high correlation according to Kline (2011). Therefore, an LPA was conducted utilizing all GPA's from all courses.

Table 2.6

Correlations among the GPA Variables from the Wave 2 Transcripts

	1	2	3	4	5
1. GPA in Agriculture & Health	-				
2.GPA in Mathematics	.37*	-			
3.GPA in Science	.58	.61**	-		
4.GPA in Technology	.49	.43**	.43**	-	
5. GPA in Trade & Industry	.63**	.19*	.15	.45**	-

Note. * $p < .05$ and ** $p < .01$.

Unconditional Models

Initially, unconditional LPA models were run in M*plus*, version 7.4, (Muthén & Muthén, 1998-2015) with 1- to 3-profile models (Table 8). Fit statistics were examined in order to choose the best-fitting model. The BIC and ABIC values began to level off between the second and third profiles, indicating that the correct number of profiles was reached. The non-significant *p*-value of .20 for the LMRT of the third profile also indicated the second profile was the best fitting model. Additionally, the BF reached its highest value (5.34), which is considered a moderate level of evidence that the 2-profile model is the correct model, and the cmP values of profiles 1-3 summed to a value of 1.0 (Masyn, 2013). Therefore, the 2-profile model (bolded in Table 2.7) was selected as the best-fitting model. The entropy of the 2-profile model reached a height of 0.55, which is not an ideal entropy value (Clark & Muthén, 2009), however, combined with other fit statistics it was clear that the 2-profile model was the best choice. The final model presented two STEM capable profiles (Figure 2.2) which were categorized as: *High-STEM and CTE Capability* (representing 59.7% of the sample) and *Low-STEM Capability* (representing 40.7% of the sample.

Table 2.7

Summary of Latent Profile Analysis Fit Indices with 1-3 Latent Classes (N = 2002)

Classes	LL	BIC	ABIC	BLRT p-value	LMRT p-value	Entropy	BF	cmP
1	-2015.45	4099.15	4067.39	0	0.00	-	0.00	<0.001
2	**-1923.36**	**3955.94**	**3905.12**	**0**	**0.01**	**0.55**	**5.34**	**0.71**
3	-1904.56	3959.28	3889.41	0	0.20	0.52	0.86	0.13

Note. The bolded row indicates the best fitting model. LL = Log Likelihood; BIC = Bayesian Information Criterion; ABIC = Adjusted BIC; BLRT = Bootstrap Likelihood Ratio Test; LMRT = Lo-Mendel-Rubin Test

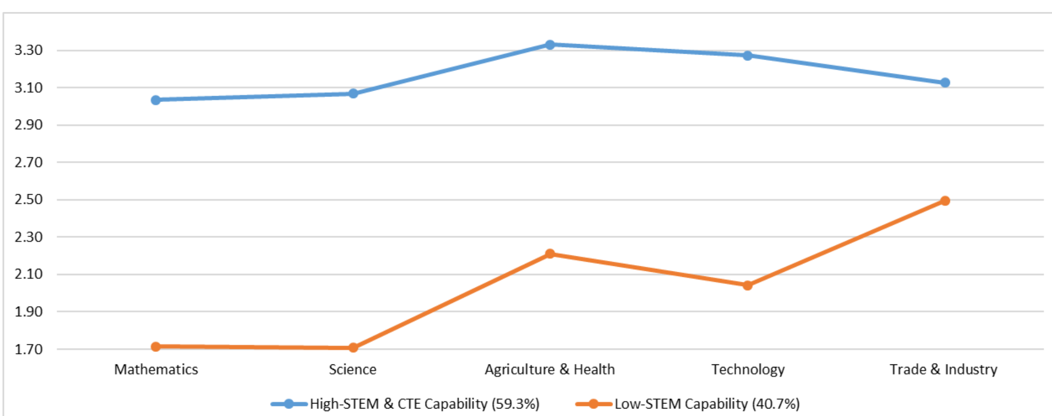

Figure 2.2. Conditional probability profile plot for the three-class model.

Conditional Model with Covariates

After selecting the two-profile model as the final LPA model, a conditional model was run and the logistic regression coefficients (i.e., logit values), standard error, and odds ratios were obtained (Table 2.8). The *Low-STEM Capability* profile was chosen as the reference profile, meaning that the *High-STEM and CTE Capability* profile was compared to this reference profile. Analyses suggested that there were no significant differences at the .05 level across age, ethnicity, parent's education level, or household income between the *High-STEM and CTE Capability* and *Low-STEM Capability* profiles. However, female students were significantly more likely to be in the *High-STEM and CTE Capability* profile (logit = 0.75, $OR = 2.11$, $p < .05$). When looking at significance at the .10 level it was discovered that LD students of a Hispanic, Latino, or other Spanish origin were significantly more likely to be in the *Low-STEM Capability* reference profile (logit = -1.31, $OR = 0.27$, $p < .10$) by .27 times, but those who identified in the "other ethnicity" category were significantly more like to be in the *High-STEM and CTE Capability* profile (logit = 1.51, $OR = 4.50$, $p < .10$) by 4.50 times.

Table 2.8

Log Odds Coefficients and Odds Ratio for the 2-Profile Model with Gender, Ethnicity, Parent's Education, and Household Income Covariates (N = 2,002)

Profile	Effect	Logit	SE	*p*-Value	Odds Ratio
P2:	***High-STEM and CTE Capability***				
	Female	0.75*	0.36	.04	2.11
	Age	-0.16	0.16	.31	0.85
	Hispanic, Latino, or Other Spanish Origin	-1.31†	0.98	.18	0.27
	African American	-0.74	0.65	.25	0.48
	Other Ethnicity	1.51†	0.97	.12	4.50
	Parents completed a high school education	-0.34	1.44	.81	0.71
	Parents completed a vocational or 2-year college education	-0.96	1.57	.54	0.38
	Parents completed a 4-year college education	0.45	1.55	.77	1.57
	Parents completed a graduate education	0.17	1.55	.91	1.18
	Household Income Between $50,000 and $75,000	0.41	0.45	.36	1.51
	Household Income More than $75,000	0.43	0.00	.98	1.54

Note. Comparison group (reference class) is the *Low-STEM Capability* profile. The gender reference group is males and the ethnicity reference group is White. †p<.10. *p<.05.

Conditional Model with Proximal and Distal Outcome Variables

After examining the covariates, the conditional LPA was then assessed with respect to the proximal and distal outcome variables of pursuing a STEM or CTE field in a 2-year college and 4-year college and the distal outcome of going into a STEM or CTE career (Table 2.9 and Figure 2.3). Overall, there was a non-significant mean difference between the profiles for the proximal outcomes of pursuing a STEM or CTE field at the 2-year college (X^2 (2) 0.80, p = .37) and majoring in a STEM or CTE field at the 4-year college (X^2 (2) 0.06, p = .81). A significant difference was found for the distal outcome of pursuing a STEM or CTE career (X^2 (2) 2.49, p = .01).

The mean was higher for students in the *Low-STEM Capability* profile (M = 0.11, SE = 0.02) when looking at the proximal outcome of pursuing a STEM or CTE field at the 2-year college, indicating that at the 2-year college it is the LD students with a low-STEM capability that pursue STEM or CTE. When looking at the proximal outcome of pursuing a STEM or CTE major at the 4-year college or the distal outcome of going into a STEM or CTE career, the mean was higher for students in the *High-STEM and CTE Capability* profile (M = 0.08, SE = 0.02 and M = 0.30, SE = 0.04, respectively). This indicates that LD students who obtain a college degree in a STEM or CTE field or end up in a STEM or CTE career are students who possess a high-STEM and CTE capability in 12th grade.

Table 2.9

Proximal and Distal Outcomes for the 3-Class Model

CTE and STEM Capability Profiles	**2-Year STEM or CTE Field *M* (*SE*)**	**4-Year STEM or CTE Major *M* (*SE*)**	**STEM or CTE Career *M* (*SE*)**
High-STEM and CTE Capability (59.3% of the sample)	0.09 (0.02)	0.08 (0.01)	0.30 (0.04)
Low-STEM Capability (40.7% of the sample)	0.11 (0.01)	0.07 (0.02)	0.19 (0.05)

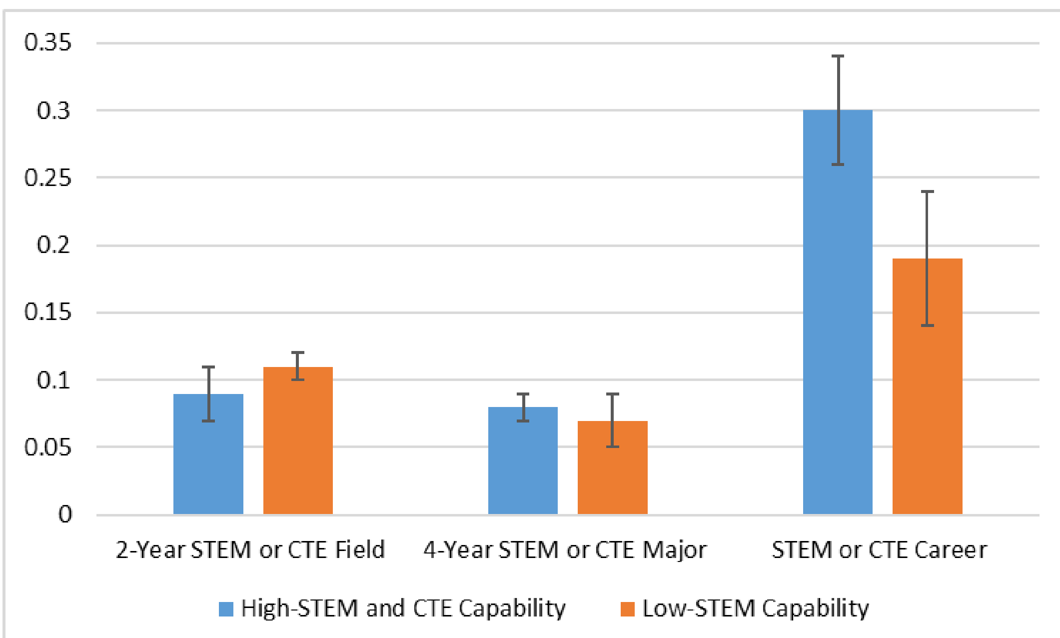

Figure 2.3. Mean value of LD students pursuing a STEM or CTE field in the 2-year college, 4-year college, or career with standard errors for each class.

Discussion and Conclusion

Study Significance. This is the first known study of its kind that utilized GPA to classify students into STEM capable profiles. Previous studies have used test scores to try to quantify a student's academic ability, but not grades (Bradley, Danielson, & Doolittle, 2005; Steinberg, 2012). The findings from this study could be a valuable tool as they will allow students, parents, and teachers to work together to develop an academic and career plan early on. The purpose of determining the STEM or CTE capable profile that a student classifies into is not to track them into a specific pathway, but rather to help them adjust the courses they are taking in high school and the postsecondary pathway they enter so they can achieve their goals. All students possess individual differences in how they learn and process information and students with learning disabilities are no different, and, in fact, it could be argued that they have even more nuanced differences compared to the general population given that a LD can present in different ways in different people (Gerber, 2000). Latent Profile Analysis was chosen for this study because it utilizes the differences (i.e., heterogeneity among LD students' learning) among LD students, which allows students to be classified into various STEM capable profiles based on their individual abilities in STEM and CTE courses in the 12th grade. Analyses suggested that LD students in the NLTS-2 sample could be categorized into two profiles: *High-STEM and CTE Capability* and *Low-STEM Capability*.

Discussion of Results. One of the initial study hypotheses was that students who perform well in mathematics and science would also perform well in

CTE courses, but this hypothesis was found to be incorrect. The students in the *Low-STEM Capability* profile, which was comprised of students who had GPAs of 2.50 and below, performed better in technology and trade and industry courses, which tend to be similar to applied engineering courses, but poorly in the STEM courses. One reason for this could be that a group of LD students tend to think and learn in a mechanical, hands-on way that allows them to perform better in those courses, which made up 40.7% of the sample. The *High-STEM and CTE Capability* profile, which comprised 59.3% of the students, showed LD students performing well in the STEM and CTE courses with an average GPA of 3.17. A main goal of this study was to uncover untapped STEM and CTE potential in LD students and the findings from this study can help to do just that.

The students in the *Low-STEM Capability* profile appeared more engaged in the CTE courses based on the grades they received, especially in the Trade and Industry courses; however, LD students in this profile tended to not end up in a STEM career. It is important to be clear that students in this profile will not only end up in a non-STEM career, but these findings can help students decide what postsecondary pathway they should take if they do want to pursue a STEM or CTE field after high school. The LD students in the *Low-STEM Capability* profile are also at the greatest risk of not pursuing any form of postsecondary education given their average GPA is 2.03. A high school GPA near 2.0 limits the postsecondary pathway any student can pursue; therefore, either a vocational school or 2-year college would be the best option for students in the *Low-STEM Capability* profile. The mean for students pursing STEM or CTE at the 2-year or

4-year college level was found to be very low, which indicates LD students are not pursing postsecondary education, which, in turn, means their job opportunities are also reduced.

The results from this study are highlighting the important issue that LD students may either not be well represented in the 4-year college and/or they may not be going into STEM fields, which is a suggested issue with this population (Moon, Todd, Morton, & Ivey, 2012; Moon, Utschig, Todd, & Bozzorg, 2011). Students performed the best (i.e., above a 3.0 GPA) in the CTE courses, especially technology (e.g., GPA at 3.27 for the *High-STEM and CTE Capability* profile), which could indicate that preparing LD high school students to enter either a vocational or 2-year college pathway may be the best use of resources. The LD students in this study did not do well in the STEM courses, but they did much better in the applied CTE courses; however, recent studies found that LD students, and students with disabilities in general, tend to take fewer applied STEM courses in high school (Gottfried & Sublett, in press; Gottfried, Bozick, Rose, & Moore, 2014l Shifrer, Callahan, & Muller, 2013). The higher STEM capable LD students in this study demonstrate that taking both CTE and STEM courses serve these students better— perhaps this is due to their being more engaged in their studies. A LD student learns differently than a non-LD student and the hands on nature of CTE courses may suit their learning style better than the way traditional STEM courses are taught (Alber-Morgan, Sawyer, & Miller, 2015; Brigham, Scruggs, & Mastropieri, 2011; Isaacson, 2011; Lenhard, 2015). Another interesting finding of the current study is that for LD students the mean for pursing a STEM or CTE field is higher at the 2-year college as opposed to the 4-year college. This finding is consistent with the literature in that only 2% of the STEM workforce consists of people with a disability, and more students pursue the 2-year or vocational postsecondary pathway (Moon, Todd, Morton, & Ivey, 2012; Moon, Utschig, Todd, & Bozzorg, 2011). These findings suggest that including LD students in both STEM and CTE courses in high school is the best preparation for a career in either a STEM or CTE field.

Limitations and Future Research. There are several limitations to the current study that are important to acknowledge. A limitation of this study was that the sample sizes of LD students pursuing a STEM major at the 4-year college and STEM careers were smaller than ideal. Only 16 LD students were in a STEM career at the conclusion of the NLTS-2 study, which made the distal STEM career outcome not reliable and, therefore, the STEM career variable had to be combined with the CTE career variable. There were also too many missing values for students taking health courses, therefore, variables for students taking agriculture and/or health courses were combined. This was unfortunate as it did not allow for an exploration between the two CTE courses. Analyzing additional disabled populations to determine how the STEM outcomes vary by disability type in future research could increase current knowledge in this field. Another limitation to the current work was that students in other postsecondary pathways (i.e., vocational school) were not examined. In addition to analyzing other types of disabilities, future work can examine other pathways to STEM and CTE careers that disabled students may take, as some may be more successful than others in general and/or for specific types of disabilities. Additionally, given that other courses were not included in this study, future work should include the GPAs for students in humanities and social science courses. These analyses will help to determine if LD students show an aptitude for STEM and CTE courses versus humanities and social science courses or if the majority of LD students tend to perform at a “B” or better grade level in non-STEM or CTE courses. Finally, exploring CTE and STEM capable profiles for students from 9th through 12th grades could help to determine when students tend to be more inclined to take STEM or CTE courses and when they perform better in these courses. Analyzing the STEM and CTE courses in grades 9-12 could help to elucidate what CTE and STEM courses LD students excel in and where to focus resources.

Policy Implications. There are several potential policy implications from this study. The results from this study, and previous work conducted, highlight the need to include LD students in both STEM and CTE courses. Study findings show that LD students are disproportionally represented in CTE careers versus STEM careers; however, it is unclear if that means resources should be funneled towards increasing LD students’ representation in STEM careers. Care should be taken to engage high school students in STEM courses, along with CTE courses, to ensure they are not being “tracked” into a specific field, but, rather, are being given the tools to excel in any field. One way to engage students in STEM learning could be through providing summer research and/or internship opportunities to students, as this method has been successful in the past (Burgstahler, 2014; Burgstahler & Bellman, 2009). Devoting resources to engaging students in STEM learning at a young age and providing them with 21st century skills will better position them to pursue a variety of careers. However, as Dougherty (2016) cautions, there is a risk that LD students might be unequally directed into CTE courses, which may not prepare them to succeed in postsecondary education; therefore, policies regarding taking a certain amount of CTE courses must also be balanced with taking the appropriate foundational STEM courses (e.g., mathematics and physical sciences). It was interesting to find in this study that the mean for students pursing a STEM or CTE career was higher than for students pursing a STEM or CTE field in a 2-year or 4-year college; this could suggest that students are finding their way to a STEM or CTE career without traditional postsecondary education. If our goal, as a nation, is to increase the STEM and CTE workforce, which means including people with an LD, we will either need to funnel more resources towards vocational school or better prepare our LD students in secondary education to pursue a STEM or CTE field in postsecondary education.

References

Alber-Morgan, S. R., Sawyer, M. R., & Miller, H. L. (2015). Teaching Science to Young Children with Special Needs. *Research in Early Childhood Science Education* (pp. 299-324). Columbus, OH: Springer Science. doi: 10.1007/978-94-017-9505-0_14

Brigham, F. J., Scruggs, T. E., & Mastropieri, M. A. (2011). Science education and students with learning disabilities. *Learning Disabilities Research & Practice*, *26*(4), 223-232. doi: 10.1111/j.1540-5826.2011.00343.x

Burgstahler, S., & Bellman, S. (2009). Differences in perceived benefits of internships for subgroups of students with disabilities. *Journal of Vocational Rehabilitation*, *31*(3), 155-165. doi: 10.3233/JVR-2009-0485

Burgstahler, S. (2014). Gender differences in perceived value of a program to promote academic and career success for students with disabilities. *Journal of Science Education for Students with Disabilities*, *12*(1), 2. doi: 10.14448/jsesd.01.0001

Clark, S. L., & Muthén, B. (2009). Relating latent class analysis results to variables not included in the analysis. Retrieved from http://statmodel2.com/download/relatinglca.pdf

Darney, D., Reinke, W. M., Herman, K. C., Stormont, M., & Ialongo, N. S. (2013). Children with co-occurring academic and behavior problems in first grade: Distal outcomes in twelfth grade. *Journal of school psychology*, *51*(1), 117-128. doi: 10.1016/j.jsp.2012.09.005

Dougherty, S. M. (2016). Career and technical education in high school: does it improve student outcomes? Thomas B. Fordham Institute. Retrieved from https://edexcellence.net/publications/career-and-technical-education-in-high-school-does-it-improve-student-outcomes

Enders, C. K. (2001). The performance of the full information maximum likelihood estimator in multiple regression models with missing data. *Educational and Psychological Measurement*, *61*(5), 713-740. Retrieved from http://epm.sagepub.com.proxy.library.ucsb.edu:2048/content/61/5/713.full.pdf

Geary, D. C., Bailey, D. H., Littlefield, A., Wood, P., Hoard, M. K., & Nugent, L. (2009). First-grade predictors of mathematical learning disability: A latent class trajectory analysis. *Cognitive development*, *24*(4), 411-429. doi:10.1016/j.cogdev.2009.10.001

Gerber, M. M. (2000). An appreciation of learning disabilities: The value of blue-green algae. *Exceptionality*, *8*(1), 29-42. doi: 10.1207/S15327035EX0801_4

Gottfried, M. A., & Sublett, C. (in press). Is there a role of applied STEM coursetaking for students with learning disabilities? *Journal of Learning Disabilities.*

IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.

Ing, M., & Nylund-Gibson, K. (2013). Linking early science and mathematics attitudes to long-term science, technology, engineering, and mathematics career attainment: latent class analysis with proximal and distal outcomes. *Educational Research and Evaluation, 19*(6), 510-524.

Isaacson, M. D. (2011). Increasing STEM accessibility in students with print disabilities through MathSpeak. *Journal of Science Education for Students with Disabilities*, *14*(1), 3. doi: 10.14448/jsesd.03.0002

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York, NY: The Guilford Press.

Laursen, B. & Hoff, E. (2006). Person-centered and variable-centered approaches to longitudinal data. *Merrill-Palmer Quarterly, 52,* 377-389.

Lenhard, S. E. (2015). Utilizing Problem-Based Learning Activities in Science with Students with Disabilities. (Master's thesis, The College at Brockport, State University of New York). Retrieved from http://digitalcommons.brockport.edu/ehd_theses/533/

Masyn, K. (2013). Latent class analysis and finite mixture modeling. In T. Little (Ed.), *The Oxford handbook of quantitative methods in psychology* (Vol. 2, pp. 375–393). Oxford, UK: Oxford University Press.

Moon, N. W., Todd, R. L., Morton, D. L., & Ivey, E. (2012). *Accommodating students with disabilities in science, technology, engineering, and mathematics (STEM).* Retrieved from Center for Assistive Technology and Environmental Access, Georgia Institute of Technology:

http://advance.cc.lehigh.edu/sites/advance.cc.lehigh.edu/files/accommodating.pdf

Moon, N. W., Utschig, T. T., Todd, R. L., & Bozzorg, A. (2011). Evaluation of Programmatic Interventions to Improve Postsecondary STEM Education for Students with Disabilities: Findings from SciTrain University. *Journal of Postsecondary Education and Disability*, *24*(4), 331-349. Retrieved from http://files.eric.ed.gov/fulltext/EJ966141.pdf

Muthén, B. O., & Muthén, L. K. (1998-2015). Mplus (Version 7.4) [software]. Los Angeles, CA: Muthén & Muthén.

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural equation modeling*, *14*(4), 535-569. doi: 10.1080/10705510701575396

Nylund-Gibson, K., Ing, M., & Park, K. (2013). A Latent Class Analysis of Student Science Attitudes, Perceived Teacher Support, and STEM Career Attainment. *The International Journal of Engineering and Sciences*, *2*(12), 2319-1805. Retrieved from http://files.figshare.com/1349733/

Nylund-Gibson, K., Grimm, R., Quirk, M., & Furlong, M. (2014). A latent transition mixture model using the three-step specification. *Structural Equation Modeling: A Multidisciplinary Journal*, *21*(3), 439-454. doi: 10.1080/10705511.2014.915375

President's Council of Advisors on Science and Technology (U.S.), & United States. Executive Office of the President. (2012). *Report to the President,* *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*. Washington, D.C.: Executive Office of the President, President's Council of Advisors on Science and Technology. Retrieved from https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-executive-report-final_2-13-12.pdf

Reinke, W. M., Herman, K. C., Petras, H., & Ialongo, N. S. (2008). Empirically derived subtypes of child academic and behavior problems: Co-occurrence and distal outcomes. *Journal of Abnormal Child Psychology*, *36*(5), 759-770. doi: 10.1007/s10802-007-9208-2

Rice, K. G., Lopez, F. G., & Richardson, C. M. (2013). Perfectionism and performance among STEM students. *Journal of Vocational Behavior*, *82*(2), 124-134. doi:10.1016/j.jvb.2012.12.002

Silverberg, M., Warner, E., Fong, M., & Goodwin, D. (2004). National Assessment of Vocational Education. Final Report to Congress, U.S. Department of Education, Washington, DC. Retrieved from http://files.eric.ed.gov/fulltext/ED483149.pdf

SRI International. (2000). *National Longitudinal Transition Study-2 (NLTS-2) Sampling Plan.* Menlo Park, CA: Author. Retrieved from http://www.nlts2.org/studymeth/nlts2_sampling_plan2.pdf

U.S. Census Bureau. (2010). *Prevalence of Disability for Selected Age Groups: 2005 and 2010, Table 1*. Retrieved from https://www.census.gov/people/disability/publications/disab10/table_1.pdf

U.S. Congress Joint Economic Committee. (2012, April). STEM Education: Preparing for the jobs of the future. US Congress Joint Economic Committee, Washington, DC. Retrieved from http://www.jec.senate.gov/public/index.cfm/democrats/2012/4/stem-education-preparing-jobs-of-the-future

Appendix

Table 2A-1

Descriptive Statistics for the Variables Used in this Study

	N		*M*	*SD*
	Valid	Missing		
Female	2002	0	0.36	0.48
Age	2002	0	17.15	1.20
Hispanic, Latino, or other Spanish origin	1992	10	0.18	0.38
Caucasian	1983	19	0.70	0.46
African-American or Black	1983	19	0.21	0.41
Other Ethnicity	1983	19	0.11	0.31
Parents have less than a high school education	1955	47	0.21	0.41
Parents have a high school education	1955	47	0.48	0.50
Parents have a vocational or 2-year college education	1955	47	0.14	0.34
Parents have a 4-year college education	1955	47	0.12	0.32
Parents have a graduate level education	1955	47	0.06	0.24
Household Income $25,000 or less	1777	225	0.35	0.48
More than $25,000	1777	225	0.65	0.48
Household Income Between $25,001-$50,000	494	1508	1.00	0.00
Household Income Between $50,001-$75,000	605	1397	0.78	0.42
Household Income $75,000 or Greater	605	1397	0.22	0.42
STEM or CTE at the 2-Year College	2001	1	0.09	0.29
STEM or CTE at the 4-Year College	2002	0	0.07	0.25
STEM or CTE Career	634	1368	0.26	0.44
GPA in Mathematics	541	1461	2.52	0.91
GPA in Science	384	1618	2.49	0.96
GPA in Agriculture	83	1919	2.81	0.85
GPA in Health Sciences	20	1982	3.19	0.74
GPA in Agriculture & Health Sciences	101	1901	2.89	0.84
GPA in Technology	216	1786	2.78	0.92
GPA in Trade and Industry	290	1712	2.85	0.83

CHAPTER THREE

Factors Effecting Learning Disabled Students' Path to a STEM or CTE Career

Abstract

Students with a learning disability (LD) is the largest disability category. Each student with a LD is unique and learns slightly differently, which means they can be capable of pursing a science, technology, engineering, and mathematics (STEM) or a career and technical education (CTE) career. Current, and future, jobs are technical in nature, but to pursue a STEM or CTE field takes persistent and engagement in scientific learning. The current study focused on analyzing three ways to ensure LD students who are interested in STEM or CTE pursued their interests after high school. The first is to engage LD students in their individualized education planning (IEP) before they graduate, the second is to ensure they actively seek the accommodations they need, and the third is to maintain a high level of self-determination. The current study is a secondary analysis of the National Longitudinal Transitions Study-2 (NLTS-2) and utilized latent class analysis (LCA) to examine how LD high school students are categorized into various classes of IEP engagement, accommodation utilization, and possession of self-determination. Additionally, it was determined how the three factors mentioned predicted students pursuing a STEM or CTE field at a 2-year college, majoring in a STEM or CTE discipline at a 4-year college, and obtaining a career in a STEM or CTE area. A three-class model was discovered to be the best fitting model where students were categorized into three engagement classes: *Highly Engaged LD*

Students (15.8% of the LD students), *Moderately Engaged LD Students* (39.5% of the LD students), and *Poorly Engaged LD Students* (44.7% of the LD students). The mean for students pursing a STEM or CTE field (major or career) was higher for students who were classified as being *Highly Engaged* but not by a wide margin. The results suggest that LD students who are engaged in their IEP, possess self-determination, and are able to utilize accommodations are more successful in STEM and CTE fields.

Introduction

The value of science, technology, engineering, and mathematics (STEM) education has ebbed and flowed in our country for nearly 100 years. Since 1924, when the American Association for the Advancement of Science released a report that science should be a critical component of educating students the nation became enamored with science (Kohlstedt, Sokal, & Lewenstein, 1999). Science was fueled further, and better funded, by the “Great Space Race” that began with the launch of Sputnik I in 1957 by the Union of Soviet Socialist Republics (USSR) and ended with the United States successfully landing Apollo 11 on the moon in 1969. In the twenty years that followed our moon landing, science education gradually lost more and more funding until Gardner’s (1983) report titled: “A Nation at Risk” attempted to show where the country was still deficient in science education compared to the rest of the world. Since that infamous 1983 report was published various reports were commissioned, programs were started, and initiatives enacted to make our country competitive in the STEM fields. We are still in an era of STEM education vigor, and as recently as four years ago the President’s Council of Advisors of Science and Technology (PCAST) put forth a report stating we need to produce one million more STEM professionals then are currently being projected (PCAST, 2012).

In the year prior to the PCAST report, the book “STEM the Tide: Reforming Science, Technology, Engineering, and Math Education in America” was published and outlined the need for students to pursue STEM fields and how they could best be supported so they would excel in mathematics at an early age and then pursue STEM majors in postsecondary education (Drew, 2011). There was a plethora of research in this book on gender, ethnicity, and socioeconomic status and the struggles students with those demographics face in STEM; however, there was no mention of students with disabilities pursuing STEM and the different struggles they face. In reforming STEM education students with disabilities must be included in the conversation; furthermore, students with learning disabilities (LD), the largest disabilities category, need to be considered (Cortiella & Horowitz, 2014). A recent report by the National Academies Press does acknowledge that we must start including students with disabilities in the STEM conversation and develop ways to support them through the STEM pipeline (NASEM, 2016). This study will focus on three constructs that have the potential to increase postsecondary and career outcomes in STEM for students with LDs. The three constructs are: 1) engagement in developing an individualized education plan (IEP), 2) accommodation utilization, and 3) possession of self-determination. These specific factors were chosen because each student has the ability to affect these factors directly and policies can be put in place to support students in bolstering these three factors. By affecting these three factors LD students will be better prepared to transition from high school to postsecondary education and also transition into adulthood.

The literature reviewed in this study will look at recent peer reviewed journal articles, within the past 12 years, on the three factors of interest and how they can support students with LDs in STEM through the STEM pipeline from high school to a STEM career. Only non-international studies that involved U.S.

students were included. Utilizing the criteria discussed a literature search was conducted through multiple databases (e.g., Google Scholar, ERIC, Web of Science, and ProQuest Social Sciences electronic database). Phrases such as "STEM AND learning disabilities," "science AND learning disabilities," "transition plan AND learning disabilities," "utilization of services and accommodations AND learning disabilities", "self-determination AND learning disabilities," and "science achievement in LD students" are an example of some queries that were used. A search for relevant dissertations was conducted using the ProQuest Dissertations and Theses database as well as scouring reference lists for appropriate literature.

Conceptual Framework

A student's desire to learn the mechanisms of how the world works and be tenacious when the material is not easily understood along with having the resources, services, and support systems in place is important for students with disabilities to succeed in STEM (Gregg, 2007). For students with disabilities, a STEM interest can be documented in their individualized education plan (IEP), which involves teachers and parents working with the student to create an overall postsecondary education plan (Eckes & Ochoa, 2005; Foley, 2006; Madaus & Shaw, 2006; Milsom & Hartley, 2005; Morningstar et al., 2010; Newman, Madaus, & Javitz, 2016). The IEP is the key to ensuring LD students have opportunities after high school by providing a structured way for them to think about and plan for the future. For students with disabilities having access to the appropriate accommodations to carry out STEM work will also have an impact on them pursuing STEM in postsecondary education (Chan, 2016; Hadley, 2007; Hamblet, 2016; Newman & Madaus, 2015). When students with a LD do not have the appropriate supports and services in place they may fail out of STEM courses, which can be quite intensive (Chan, 2016). Another critical component for an LD student's success in STEM is self-determination. A LD student will face additional hurdles on their education path than a non-LD student would face and they will need self-determination if they want to pursue and be successful in STEM education. Students who possess self-determination and are able to advocate for themselves when needing to seek out appropriate accommodations, resources, and support to get through the academic STEM pipeline will likely be more successful than those that do not have those intrinsic qualities. To the author's knowledge, there is no known conceptual framework that incorporates the latent constructs of being engaged in the IEP process, accommodation utilization, and self-determination to predict whether students will pursue STEM learning at the postsecondary level or go into a STEM career. Therefore, the framework to be explored in this study is how the three latent constructs of being engaged in developing an IEP, utilizing accommodations, and possessing self-determination affect a LD student's ability to traverse the STEM pipeline.

Engagement in the Individualized Education Planning

One purpose of the individualized education plan (IEP) is to aid students with disabilities in preparing for their next life steps after high school. Students utilize the IEP to plan coursework in secondary education that, ideally, will prepare them to enter the appropriate postsecondary path (i.e., vocational school, 2-year college, or 4-year college). Unfortunately, the IEP is often not used correctly and parents and/or students are not as involved in the process as would be beneficial for both them and the student. It has been found that the exit goals listed on students' IEPs were not well aligned in the areas of employment goals with employment experience and the goal of attending college while being restricted from taking necessary state exams (Trainor, 2005). Having students directly involved in their life planning via the IEP process was the intention of the IDEA amendment; however, it was discovered that students were not actively involved in the development of the IEP process and did not understand the services and resources the plan was meant to put in place for them following high school (Department of Education, 2007; 2010). In fact, when students who were in an IEP meeting were asked immediately following the meeting if they could recall anything about the meeting and planning that took place they were unable to do so as they were completely disengaged in the process (Trainor, 2005). One should not overlook self-determination either as it can be a large factor in students taking control of their lives by planning their future, which for LD students' means being actively involved in the IEP process. Unfortunately, Trainor (2005) found that students did not exercise self-determination unless a teacher or parent set up parameters and encouraged them to make choices.

Developing an ITP is important and it has previously been discovered that the students who tend to self-disclose their disability at the beginning of entering college are those that received transition planning in high school (Newman, Madaus, & Javitz, 2016). Another study reported that 98% of their sample received some services or accommodations in high school, but only 24% of those students received services in their postsecondary institution, which could be a reflection of the level of transition planning they received or their lack of self-determination to pursue the services they need on their own (Newman, Madaus, & Javitz, 2016). The common practice of developing a transition plan in the IEP meetings has been found to be ineffective because there ends up being inadequate time for the transition planning during the IEP meeting, which greatly effects the transition process from high school to college (Baker & Scanlon, 2016; Cobb & Alwell, 2009). It was also discovered in a meta-analysis conducted by Cobb and Alwell (2009) that vocational training and mentorship was an important component for successful student transition and later career outcomes.

In analyzing the NLTS-2 data, Newman, Madaus, and Javitz (2016) found that the largest percentage of students who received transition planning (62%) attended a vocational postsecondary institution; whereas, 58% of those attending a 2-year college and nearly half attending a 4-year college received transition planning. While not the focus of this study, these findings do call into question whether teachers, counselors, and parents are guiding their disabled student towards vocational or 2-year college at a higher rate than 4-year college or is it that the students are more interested in the vocational careers? It was also discovered that transition planning in high school significantly increased the chance that students would seek out and receive services and support at vocational and 2-year postsecondary institutions, yet that was not the case for 4-year colleges as the transition planning was found to not contribute to the student seeking or receiving services or accommodations there (Newman, Madaus, & Javitz, 2016).

Over the years, since IDEA was mandated, several transition planning practices have been developed with the main ones being: community agency/collaboration, daily living training, employment preparation program participation, general education/inclusion, paid or unpaid work experience, parent/family involvement, self-determination training, and social skills training (Landmark, Ju, & Zhang, 2010). It would be ideal for colleges to collaborate with K-12 institutions to ensure smooth transitions for students with disabilities; however, it has been found that collaboration and communication between institutions is not taking place, which is effecting students' successful transition from high school to college and/or a career (Chan, 2016; Cobb & Alwell, 2009; Eckes & Ochoa, 2005; Landmark, Ju, & Zhang, 2010; Test, Mazzotti, Mustian, Fowler, Kortering, & Kohler, 2009). When obtaining services and accommodations a key difference between K-12 and postsecondary education is that in K-12 the institution is responsible for finding the students that may have a disability and getting them the help they need, yet, in postsecondary education the student is responsible for self-disclosing that they have a disability and seeking out the services and accommodations that they need (Eckes & Ochoa, 2005). Given the issues previously discussed in terms of communication between K-12 and post-secondary institutions, Eckes and Ochoa (2005) recommend that students with a LD need to understand the special education laws, increase or cultivate their self-advocacy skills, and become comfortable with disclosing their disability to faculty and administrators so they can obtain the services and accommodations they need.

An effective transition plan is a key component of students successfully transitioning from high school to college/career. Four components have been found effective in developing an IEP: knowledge of one's disability, knowledge of postsecondary support services, knowledge of disabilities legislation, and the ability to self-advocate (Chiang, Cheung, Hickson, Xiang, & Tsai, 2012; Milsom & Hartley, 2005). In a study conducted by Daviso, Denney, Baer, and Flexer (2011) they found that from their sample of LD students 65.4% were satisfied with the postsecondary education planning their high school provided and 98% felt their high school adequately prepared them to meet their post-high school goals. The main aspects of the framework developed by Garrison-Wade and Lehmann (2009) to improve the transition of LD students to the community college is frequent and increased communication between K-12 and postsecondary institutions, clear goals set for high school students, and having defined goals for their experience at the community college and in a career.

While in high school LD students have services and accommodations available to them as they progress through grades and even when they move to different schools; however, that structure that was in place for K-12 students disappears when entering postsecondary education. In college students must first go to a Disabled Students Program (DSP) or equivalent office (some have online portals) and disclose they have a disability. For the next step students will either be asked to provide documentation of their disability depending on the type of disability they have or, in the case of a LD, they will have to undergo an assessment before being able to access services and accommodations. This can be a lengthy process. The IEP is designed to help students think about the transition to college and what they will need to do when they move on to be successful; however, students lack of engagement in the IEP process often leaves them unprepared to take the steps necessary to obtain the services and accommodations they need. Assessments of LD students at the K-12 level are not always up-to-date; therefore, even if students have a well-designed IEP and the initiative to visit a DSP office when they enter college the documentation they provide may not be accurate and it can take the student time and effort to obtain services (Madaus & Shaw, 2006). With the amendments to IDEA in 2004, a student may not be reevaluated in high school if a qualified professional deems it unnecessary; however, a school's IEP team and/or parents can request an evaluation. Up-to-date evaluation assessments for LD students would be beneficial for students, as it would make obtaining services and accommodations in college easier (Madaus & Shaw, 2006). Another issue is that many colleges have limited services for students with disabilities and the services they do have are often more general academic support (Foley, 2006). Colleges must abide by ADA and Section 504 but students in college are no longer covered by IDEA; this is an issue because students then lose their individualized education services when beginning college, which can affect their success (Cortiella, 2011). In addition, it has previously been found by Klassen (2007) and Marshak et al. (2010) that students with a LD, in particular, overestimate their abilities, so when they transition to postsecondary education they try to ‘make it’ without the services and accommodations they had in high school and had planned to have in postsecondary education in their IEP transition plan.

Accommodation Use by Students with Learning Disabilities

While the IEP can be very successful for students with a LD there is a shift that takes place as a student traverses the academic pipeline that can be convoluted for them. As previously discussed, the IEP that students create with administrators, teachers, and their parents does not transfer to college with that student. Colleges are required by ADA to provide ‘reasonable accommodations’ for students with disabilities but this can be problematic because it does not ensure that people who need accommodations are actually seeking them out because the burden is placed on the student alone. Not all disabilities are easily seen or detected and there can be a stigma around seeking services or accommodations; therefore, once students go on to postsecondary education they may not be obtaining the services or accommodations that they need to be successful (Newman & Madaus, 2015; Salzer, Wick, & Rogers, 2008). An issue found in accommodation use at the postsecondary level is that some students, if they had taken the first step and sought out accommodations, were apprehensive to utilize accommodations because they were not familiar with the ones provided and they tended to not use the accommodation at all unless a Disabilities Services staff member encouraged them to experiment and try out the new accommodation (Marshak et al., 2010). The process a student has to go through to obtain services and accommodations at a postsecondary institution is also a deterrent in their making utilization of the supports available (Marshak et al., 2010).

A study conducted by Hill (1996) found that 78.7% of their sample, which contained students with all disabilities, learned how to obtain services and accommodations through referral; however, it may be more difficult to tell that LD students have a disability, which means they may not get the referrals they need to seek services. When students enter postsecondary education, if they seek services and accommodations, they have a tendency to think that utilization of those services will guarantee them success in their coursework and when that is not the case they might drop the accommodations which can cause their achievement to drop further (Hamblet, 2016; Herbert et al., 2014). If students do not address the underlying cause of why they are not being successful (e.g., living on their own for the first time, having to work while take classes, or mastering time management) then utilization of services and accommodations alone will not be enough for them to succeed academically. In Hadley's research (2007) she discovered that LD students in her sample sought out services when they entered college; however, they found many of these services lacking because the services were often provided by more advanced undergraduates (i.e., seniors) and not LD professionals who know how to properly assist them. Therefore, a students' utilization of accommodations may not be because they do not believe that they need accommodations but that they have tried the accommodations provided and found them to be ineffective. Even academically successful students that self-disclose their disability early on and seek services and accommodations still have difficulties in postsecondary education in terms of accommodation utilization. Accommodation utilization can also be a factor of how well students can communicate their needs with faculty by negotiating what they need to be successful as well as being able to signal when they need accommodations (Baker & Scanlon, 2016; Barnar-Brak, Lectenberger, & Lan, 2010).

In a study conducted in 2007, which was three years after the IDEA mandate of 2004, at a 4-year university with a sample size of 110 LD students an interesting change in accommodations was discovered from high school to college as well as a disappointing lack in sufficient ITPs being created (Cawthon & Cole, 2010). While the Cawthon and Cole (2010) sample size was small what they discovered could be a larger issue and they found a significant difference between nine out of sixteen accommodations that were offered in both high school and college. In high school students were significantly more likely to have an assistive technology accommodation, alternate test formats, had use of a tutor, and participated in therapy than in college (Cawthon & Cole, 2010). In college students were significantly more likely to receive a classroom assistant, extended time on exams, alternate testing setting/location, attend individual counseling, and administrative accommodations (i.e., priority registration and reduced course load) than in high school (Cawthon & Cole, 2010). While it was good to see that the students in the Cawthon & Cole (2010) study were utilizing many of the accommodations at their college it would have been good to see some of the accommodations that were available in high school replicated in college. Seeking accommodations for students with disabilities can be due to a lack of self-determination to take control and pursue the services they need or a concern that faculty and/or peers will stigmatize them if they self-disclose they have a disability (Newman & Madaus, 2015; Salzer, Wick, & Rogers, 2008). For the purposes of this study only the former issue of self-determination will be analyzed and discussed next.

Self-Determination and Students with Learning Disabilities

Self-determination theory (SDT) has been around since the 1970s but it has been in the last twenty years that SDT has been viewed as an important key in aiding students with disabilities to take advantage of services and accommodations offered to them. There is an integrated perspective of SDT that is an organismic dialectical framework in which an individual plays a conscious and active role in wanting to pursue challenges, reach their potential, and reach out for anything accessible that will help them succeed; however, one’s social environment can effect one’s ability, in a positive or negative way, to push ahead and reach for what they need to be successful (Ryan & Deci, 2004). Intentional motivation is a large component of SDT and can be viewed as being autonomous, meaning personal choice is exercised in pursuing needs and goals or controlled, meaning one is pushed towards pursuing a need or goal (Gagné & Deci, 2005). Both autonomous and controlled motivation can be effective for students with a LD. According to Anctil and Scott (2008) self-determination is comprised of four constructs: persistence, career decision making, competence, and self-realization. It was found that LD students whose decisions were motivated by a desire to succeed have a clear goal, understand their ability in setting goals, were successful in college, and they were able to self-advocate by requesting accommodations when they entered college (Anctil & Scott, 2008). Self-determination among a sample of LD students was found to be significant and highly correlated with how involved a student was in the IEP process and the strength of the high school transition program (Morningstar et al., 2010).

In postsecondary education it was found, utilizing data from the NLTS-2 study, that students with a visible disability (i.e., physical disability) were more likely to receive services and accommodations than LD students in all postsecondary institutions (Newman & Madaus, 2015). Therefore, LD students must have a higher self-determination to advocate for services and accommodations for themselves when they enter a postsecondary institution. Students with a LD, compared to students with an autism spectrum disorder (ASD) or intellectual disability (ID), possess constructs of self-determination (i.e., empowerment, self-realization, self-regulation, and autonomy) at significantly higher levels, which suggests LD students are better equipped to self-advocate than students in other disabilities categories (Chou, Wehmeyer, Palmer, & Lee, 2016). Students' ability to self-advocate for themselves can ensure they receive accommodations, which has the potential to lead to academic success. In a study by Thoma and Getzel (2005) students with disabilities identified self-determination as a key to their being successful in college and it was by trying and failing that they realized they should have sought or advocated for services when they first started college and these students said they believe self-determination training should begin in ninth or tenth grade.

Self-determination involves a person’s own will and Wehmeyer (2005) said that to understand self-determination one must understand volition, which is “making conscious choices or the actual power to make conscious choices, or will” (p. 117). Students with a LD need to training, preferably in K-12, to make their own choices, advocate for themselves, and develop self-determination. It is important to keep in mind that self-determination is not a process, outcome, or set of skills that can automatically make one successful, or simply making choices (Wehmeyer, 2005). Through the Garrison-Wade and Lehmann (2009) study and others it was determined that self-determination skills, such as self-awareness and self-advocacy, are a critical factor in ensuring students get the services and accommodations they need to be successful (Hadley, 2006; Katsiyannis, Zhang, Woodruff, & Dixon, 2005).

The Current Study

The literature review demonstrated that when LD students are engaged in developing the IEP they tend to seek accommodations in postsecondary education, which can make them more successful. Equally important as developing an IEP is LD students having the self-determination to advocate for the accommodations they need in postsecondary education. The three factors discussed in this literature review can be utilized together to increase a LD students’ successful journey through the STEM pipeline. In the current study a latent class analysis (LCA) will be used to categorize LD students into empirically derived groups based on their engagement in developing an IEP, utilization of accommodations, and possessing self-determination. Covariates of gender, age, ethnicity, and parents' education are used to better understand the external factors that affect each class. The proximal outcomes of whether a student pursued STEM or CTE at the 2-year college and/or majored in STEM or CTE at the 4-year college and the distal outcome of whether a student ended up in a STEM or CTE career are explored for each class. Classifying students based on the three constructs discussed, to the author's knowledge, has not been explored utilizing the NLTS-2 dataset. As previously discussed, LD students possess individual differences and have unique learning styles and abilities, which makes an LCA analysis that explores the variation in individual responses an appropriate choice.

The LCA performed utilized five variables that pertained to a student's involvement in the IEP process, three variables focusing on accommodation utilization, and nine variables that measured a students' possession of self-determination. Below is a general conceptual model for the latent construct of being an *Engaged LD Student* that also includes the covariates and proximal and distal outcomes to be used (Figure 3.1). One LCA was conducted with all variables at once, but it can be helpful to think of each construct individually; therefore, a conceptual model focusing on each construct can be found in the Appendix (Figures A1-A3).

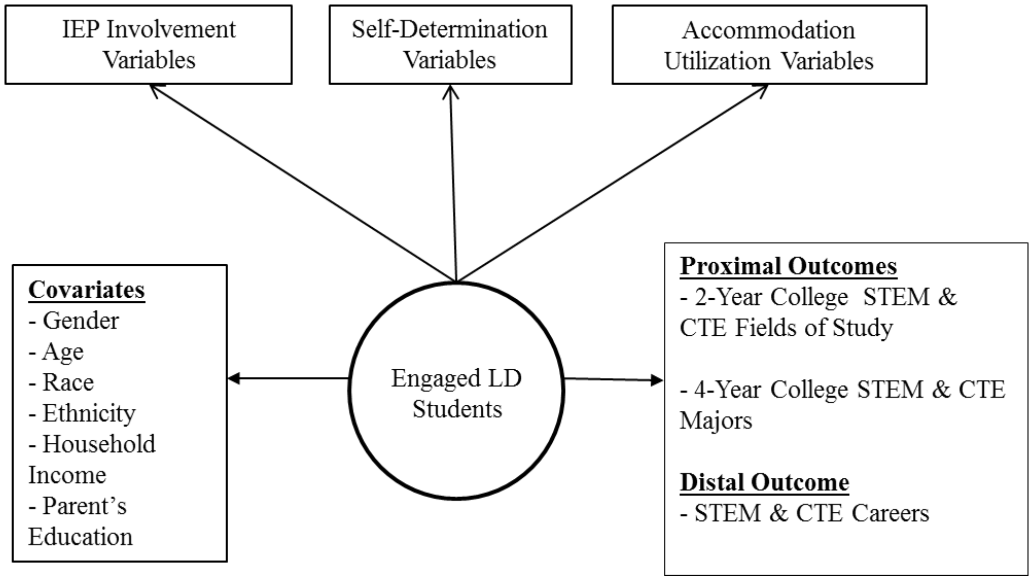

Figure 3.1. Latent class analysis model for LD student engagement with covariates and proximal and distal outcomes.

Another component of this study is to descriptively assess the STEM pipeline for LD students in the NLTS-2 dataset to gain a broad understanding of what postsecondary pathway LD students tend to traverse. By combining the results from the LCA with the knowledge of the route LD students take to their career, interventions can be proposed to support them in postsecondary education and pursuit of STEM or CTE careers. In Table 3.1 below the research questions guiding this study, general variables used, covariates used, and statistical model employed are laid out. The results from this study will have policy implications for how LD high school students should prepare to enter postsecondary education and how postsecondary institutions should support incoming LD students.

Table 3.1

Research Questions, Measures Used, and Models Employed to Examine the STEM Pipeline of Students with Learning Disabilities in High School and the Latent Constructs that Affect Their Trajectory

Research Question	Variables Used	Covariates Used	Model Employed
1. What does the STEM and CTE pipeline look like for LD students?	Variables for postsecondary institution attended, major chosen, and career obtained (variable codes listed in Table A-2 of the Appendix).	None	Descriptive Analysis
2. What latent classes exist for LD students based on their IEP engagement, accommodation use, and self-determination?	Variables for IEP involvement, accommodation utilization, and self-determination (variable codes listed in Table A-2 of the Appendix).	- Gender - Age - Race - Ethnicity - Household Income - Parents Education	Latent Class Analysis
3. How does a LD students' engagement level (i.e., level of IEP engagement, accommodation use, and self-determination) predict their STEM or CTE major and career?	Variables for IEP involvement, accommodation utilization, self-determination, major chosen and career (variable codes listed in Table A-2 of the Appendix).	None	Latent Class Analysis

Methods

Dataset

Data from the National Longitudinal Transition Study-2 was used to perform this study (NLTS-2; SRI International, 2000). The NLTS-2 study began in 2000 and tracked a set of students with disabilities from across the country for 10 years. The NLTS-2 study began with 11,270 students with disabilities and was designed to track the transition of students from high school (i.e., ages 13-16) through young adulthood (i.e., ages 23-26). The data used in this study was from the second wave of data collection, which utilized student interviews and surveys and the fifth wave, which contained postsecondary major outcomes. The dataset is robust in that it provides information on the households of students with disabilities, their schools, the services and accommodations they receive, extracurricular activities, social activities and programs available in their adult lives, education, and employment.

Participants

The NLTS-2 dataset contains participants who were receiving special education from Local Educational Agencies (LEAs) because no national database currently exists for students who are receiving special education services. The participants chosen for this study were all students who were identified as receiving special education at 13 to 16 years old in 2000. Given the duration of this study was 10 years a large enough sample size of students was initially obtained so that statistical power could be maintained through the last data collection given the anticipated attrition during the span of the study. A sample of

11,500 students was initially selected to participate in wave 1 of the study and that amount was determined to provide approximately 1,250 students in each of the disabilities categories (SRI International, 2000). It was initially estimated that 92% of students would be retained from each previous wave of data collection (SRI International, 2000). Ultimately, 11,226 parents or students participated in the second wave of the study. The first wave only involved responses from parents and schools (Javitz & Wagner, 2005). Table 3.2 below shows the number of LD students and their race/ethnicity by gender for waves 2-5 that will be utilized in this study. As is expected in longitudinal studies, there was participant attrition with each additional wave of data collection.

Table 3.2

Race/Ethnicity and Type of Disability by Gender for Participants in Waves 2-5 of the NLTS-2 Dataset

	Female (*N*)				**Male (*N*)**			
	W2	**W3**	**W4**	**W5**	**W2**	**W3**	**W4**	**W5**
Type of Disability								
LD	714	163	170	87	1288	293	303	9
Race/Ethnicity for LD Students								
American Indian/Alaska Native	31	19	20	9	52	29	31	0
Asian	16	14	16	25*	20	21	33	9*
Black	155	101	107	199	265	194	187	24
Latina/o	128	92	91	136	227	145	159	15
Native Hawaiian/ Other Pacific Islander	5	3	3	-	7	7	7	-
White	492	411	417	760	906	733	778	128
Multiple Ethnicities	61	33	32	-	103	58	59	-

*Categories of Asian and Native Hawaiian/Other Pacific Islander were combined in Wave 5.

The LEAs where participants were selected from were obtained from four regions of the United States: Northeast, Southeast, Central, and West/Southwest. From the four regions 500 LEAs were chosen to participate and an additional 40 special education schools. The LEA or special education school was responsible for designating the disability category of the participants. Table 3.3 shows the national numbers of students with a LD between 14-21 years of age and is a snapshot of the total number as they exit high school, which provides a national reference point for the data in the current study.

Table 3.3

Type of Disability, Gender, and Race/Ethnicity for Students between the Ages of 14-21 Exiting High School in 2014-15

Type of Disability	**Number of Students (*N*)**
All Disabilities Combined	1,229,166
LD	592,813 (48.23%)
Gender – All Disabilities	
Female	418,364 (34.04%)
Male	795,514 (64.72%)
Ethnicity	
American Indian/Alaska Native	18,436 (1.50%)
Asian	18,985 (1.54%)
Black	272,100 (22.14%)
Latina/o	258,410 (21.02%)
Native Hawaiian/ Other Pacific Islander	4,454 (0.36%)
White	628,451 (51.13%)
Multiple Ethnicities	28,095 (2.29%)

SOURCE: U.S. Department of Education, Office of Special Education Programs, Individuals with Disabilities Education Act (IDEA) Section 618 Data Products: State Level Data Files. Retrieved June 18, 2016, from http://www2.ed.gov/programs/osepidea/618-data/state-level-data-files/index.html#bcc

Measures

The complete list of variables to be used in this study can be found in the Appendix, Table A-2. The LD variable is that of specific learning disabilities (np2B1a_13). The development of an IEP latent construct utilized five variables that ask about the students IEP attendance, involvement in planning for the future, and setting goals. The utilization of accommodations latent construct was comprised of three composite variables created from observed variables that focused on whether students asked for accommodations, received accommodations, were accommodations used to retain them, and their general use of accommodations. The self-determination latent construct looked at nine variables. The covariates used in the study were gender, race, ethnicity, household income, and parents' education level. The proximal outcome variables were whether students pursued a STEM or CTE major at the 2-year or 4-year college and the distal outcome variable was whether students obtained a STEM career or not. NLTS-2 used the Standard Occupational Classification (SOC) System to code the occupations of the participants in wave 5 of the study.

Data Analysis Plan

The conceptual models proposed in Figure 1 required a 3-step LCA approach be taken. The composite and dummy variable used in this study were created using SPSS 24 (IBM Corp., 2016; see Table A-1). All analyses were conducted using M*plus* version 7.4 software (Muthén & Muthén, 1998-2015). The full information maximum likelihood (FIML) estimator was utilized because the NLTS-2 dataset contains both non-missing and missing data and FIML can handle item level missingness by assuming the data are missing at random (MAR; Enders, 2001).

Descriptive Analysis. A descriptive analysis was conducted to determine how many students are traversing the STEM and CTE pipeline via a vocational, 2-year college, and 4-year college pathway. Given there is not a standardized number of years it takes a student to traverse the STEM pipeline and there is no set length of time a student will spend at each transition point (i.e., from vocational to career, 2-year to 4-year to career, or 4-year to career) data from waves 2-5 were utilized.

Latent Class Analysis. LCA is a person-centered, exploratory statistical technique that empirically creates distinct classes based on categorical observable variables (Ing & Nylund-Gibson, 2013; Nylund-Gibson, Ing, & Park, 2013). To avoid latent class switching due to auxiliary variables, a three-step LCA approach was utilized (Nylund-Gibson, Grimm, Quirk, Furlong, 2014). The first step in the three-step approach is to run an unconditional model, which means that covariates and outcome variables are not included, to determine the ideal number of classes. The first step begins with a single class and increasing one class at a time until the appropriate level of fit is obtained and the ideal number of classes is discovered (Nylund, Asparouhov, & Muthén, 2007). There is not one ideal model fit criteria to determine the appropriate number of classes for the LCA. However, there are six model fit criteria that can be used in combination with substantive theory. The first two criteria are the Bayesian information criterion (BIC) and adjusted BIC (ABIC), where lower BIC and ABIC values mean a better fitting model. The next two criteria are the Lo-Mendell-Rubin Test (LMRT) and bootstrap likelihood ratio test (BLRT), where a non-significant *p*-value indicates that the model with one less class is the best fit. The final two criteria are the Bayes Factor (BF), where a higher value indicates better fit, and correct model probability (cmP), where the summed cmP value from all models should equal one and each model is being compared to the others (Ing & Nylund-Gibson, 2013; Masyn, 2012; Nylund-Gibson, Ing, & Park, 2013). The entropy associated with the model is technically not a fit statistic, but values closer to one indicate that there is clearer separation between classes; therefore, a high entropy value indicates students are correctly categorized into the proposed classes.

Once the appropriate number of classes is determined, the next step is to include auxiliary variables (i.e., covariates and proximal and distal outcomes) to determine which class students should be categorized into utilizing measurement error to determine the most probably class each LD student should be assigned to. In the final, step, the measurement error is fixed at the values found in the second step. The three-step approach was found to be the ideal procedure by Nylund-Gibson, Grimm, Quirk, and Furlong (2014) given it allows the latent class variable to not be affected by the auxiliary variables. As long as the entropy is .60 or greater there should be an acceptable separation between classes and the three-step approach will be the ideal technique to use (Asparouhov & Muthén, 2013). In these analyses, the latent class variable is regressed on the covariates of gender, age, ethnicity, and parents' education level to produce logits for interpretation rather than regression coefficients using the "C on X" ("C" being the class and

“X” being the covariates) approach. Finally, means and standard errors for the proximal outcomes of pursuing CTE or STEM in a 2-year college and majoring in CTE or STEM in a 4-year college are estimated and the distal outcome of pursuing a CTE or STEM career were explored using a BCH approach.

Results

Descriptive Analysis of the STEM and CTE Pipeline for LD Students

The NLTS-2 dataset was explored via a descriptive method to determine what path LD students are taking to be in a STEM or CTE field. Table 3.4 shows the number of LD students who attend various types of institutions immediately following high school, within two years following high school, and at some point during the ten-year span of the NLTS-2 study. The most prolific path appears to be the 2-year college route regardless of when they chose to pursue postsecondary education. In Table 3.5 below it can be seen what postsecondary path LD students take in various STEM and CTE fields as well as the careers they go into. It is interesting to point out that LD students who pursue a trade end up in a trade career without pursing a trade in a secondary institution. Another interesting point is that Table 3.5 also highlights that the 2-year path is most prolific for LD students who pursue a STEM or CTE field. Finally, Table 3.5 shows how few LD students pursue STEM fields or end up in STEM careers.

Table 3.4

Sample Sizes for LD Students Who Attend a Vocational School, 2-Year College, or 4-Year College at Different Time Points during the NLTS-2 Study

	Vocational School (*N*)	2-Year College (*N*)	4-Year College (*N*)
Attended immediately following high school	31	53	17
Attended within two years of high school	154	338	210
Attended at some point during the NLTS-2 study following high school	285	479	269

Table 3.5

Sample Sizes for LD Students Who Pursue STEM or CTE Fields in a Vocational School, 2-Year College, 4-Year College, or Career (N = 2,002)

	Vocational School		2-Year College		4-Year College		Career	
	N	%	*N*	%	*N*	%	*N*	%
Agriculture	5	0.25	5	0.25	2	0.10	16	0.80
Health Science	30	1.50	85	4.25	29	1.45	33	1.65
Computer Science	45	2.25	35	1.75	32	1.60	40	2.00
Trades	21	1.05	21	1.05	0	0	187	9.34
Mathematics	0	0	3	0.15	3	0.15	1	0.05
Science	0	0	0	0	6	0.30	4	0.20
Engineering	13	0.65	3	0.15	11	0.55	3	0.15

Latent Class Analyses

Correlational Analysis. To conduct a LCA there must be an appropriate amount of heterogeneity among the variables. Correlation analyses revealed that all intercorrelations were within reason and considered appropriate for a LCA (see Table 3A-3; Kline, 2011). The variables with the highest correlations were the self-determination variables, but given they were below a value of .75 the LCA was conducted.

Unconditional Models. The unconditional LCA models, LCA models without covariates or distal outcomes, were conducted in M*plus*, version 7.4, (Muthén & Muthén, 1998-2015) with 1- to 4-profile models (Table 3.6). The fit statistics obtained were inspected to determine the best-fitting model. The BIC and ABIC values plateaued between the third and fourth classes, which indicated that the correct number of classes was reached at three classes (Nylund et al., 2007). The non-significant *p*-value of .76 for the LMRT of the third profile was further indication that the second profile was the best fitting model. The BF and BLRT statistics did not provide any useful information in choosing the appropriate model. However, the cmP value of profiles 3 was 1.0, which means this is the preferred model (Masyn, 2013). Therefore, the 3-class model (bolded in Table 3.6) was selected as the best-fitting model. The entropy of the 3-profile model was 0.89, which is a strong entropy value (Clark & Muthén, 2009) and further confirms the 3-class model was the best choice. The final model presented three *Engaged LD Students* classes (Figure 3.2) which were categorized as: *Highly Engaged LD Students* (representing 15.8% of the sample), *Moderately Engaged LD Students* (representing 39.5% of the sample) and

Poorly Engaged LD Students (representing 44.7% of the sample). Figures 3.3-35 are enlarged views of each of the segments of the 3-class *Engaged LD Students* model, which helps to showcase the nuances between the three constructs portrayed in the *Engaged LD Students* model.

Table 3.6

Summary of Latent Class Analysis Fit Indices for the IEP, Self-Determination, and Accommodation Utilization Variables with 1-4 Latent Classes (N = 2,002)

Classes	LL	BIC	ABIC	BLRT p-value	LMRT p-value	Entropy	BF	cmP
1	-37995.33	76247.88	76139.86	0.00	0.00	-	0	0
2	-30359.16	61111.72	60946.52	0.00	0.00	0.88	0.00	0.00
3	**-24581.82**	**49693.20**	**49470.81**	**0.00**	**0.00**	**0.89**	**0.00**	**1.00**
4	-23686.10	48037.94	47758.36	0.00	0.76	0.91	0.00	0.00

Note. The bolded row indicates the best fitting model. LL = Log Likelihood; BIC = Bayesian Information Criterion; ABIC = Adjusted BIC; BLRT = Bootstrap Likelihood Ratio Test; LMRT = Lo-Mendel-Rubin Test

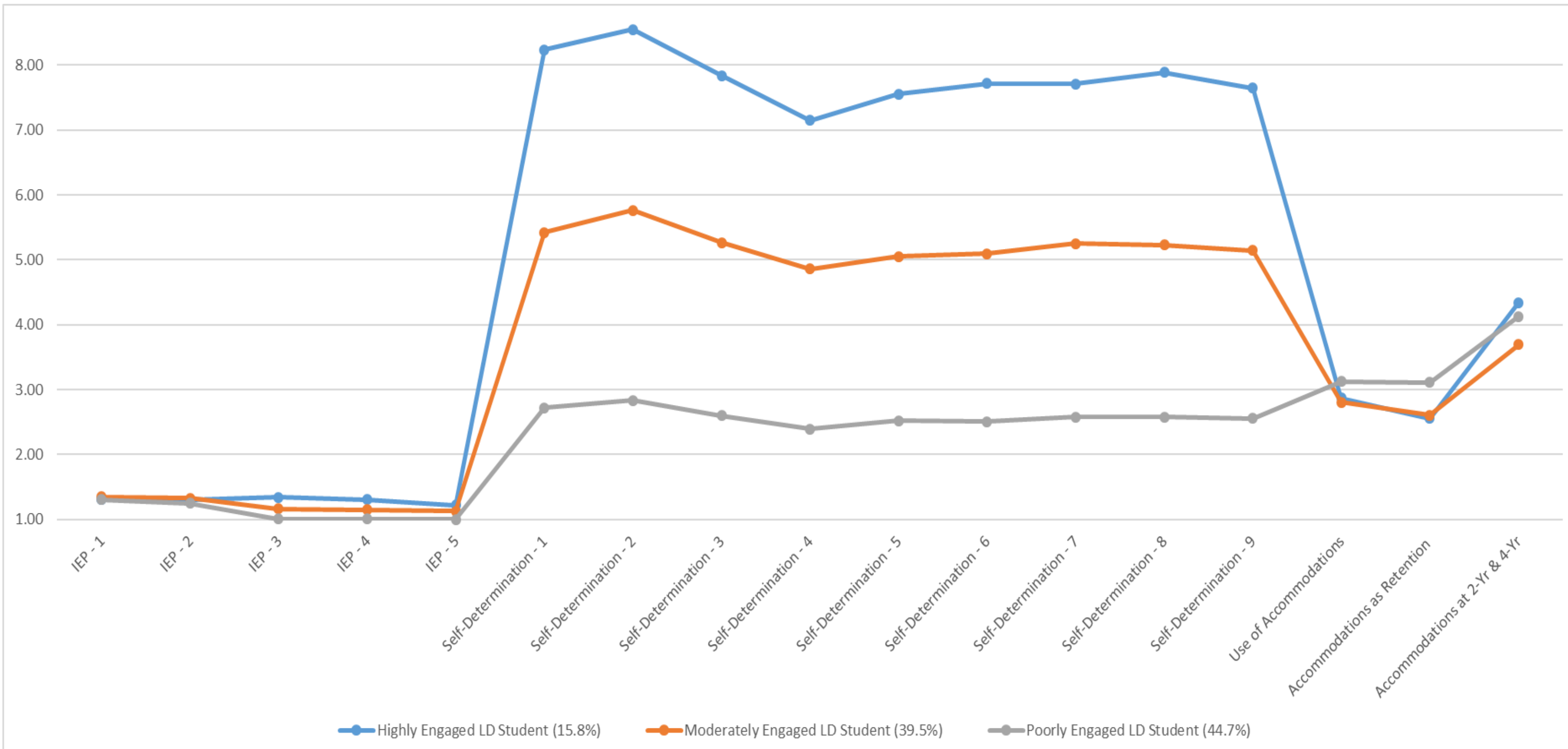

Figure 3.2. Conditional probability class plot of the IEP, self-determination, and accommodation utilization variables for the three-class model.

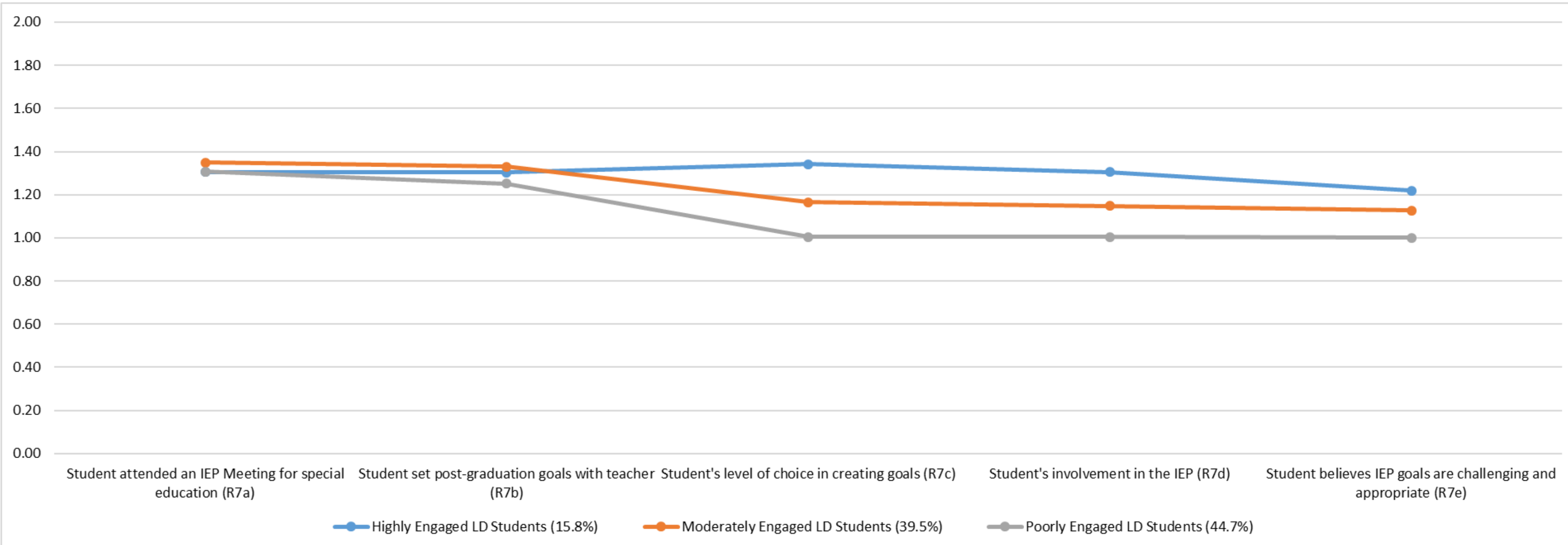

Figure 3.3. Individualized education planning (IEP) variables section of the conditional probability profile plot for the 3-class model.

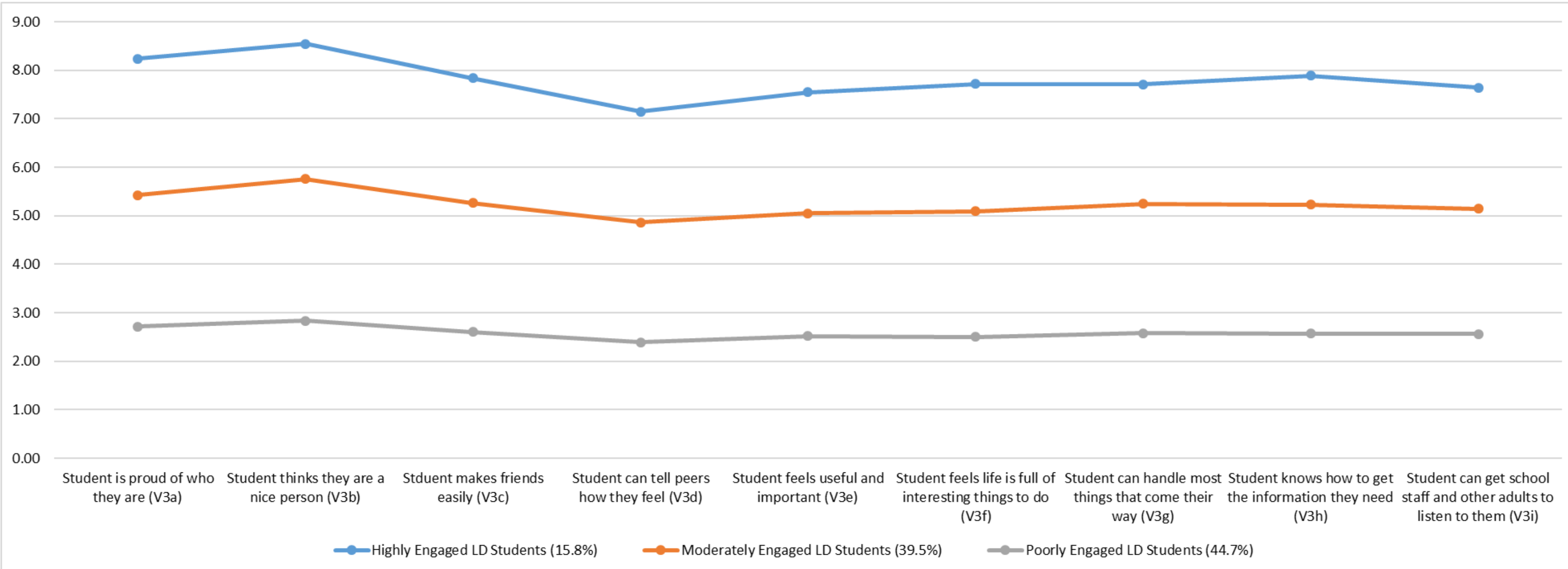

Figure 3.4. Self-Determination variables section of the conditional probability profile plot for the 3-class model.

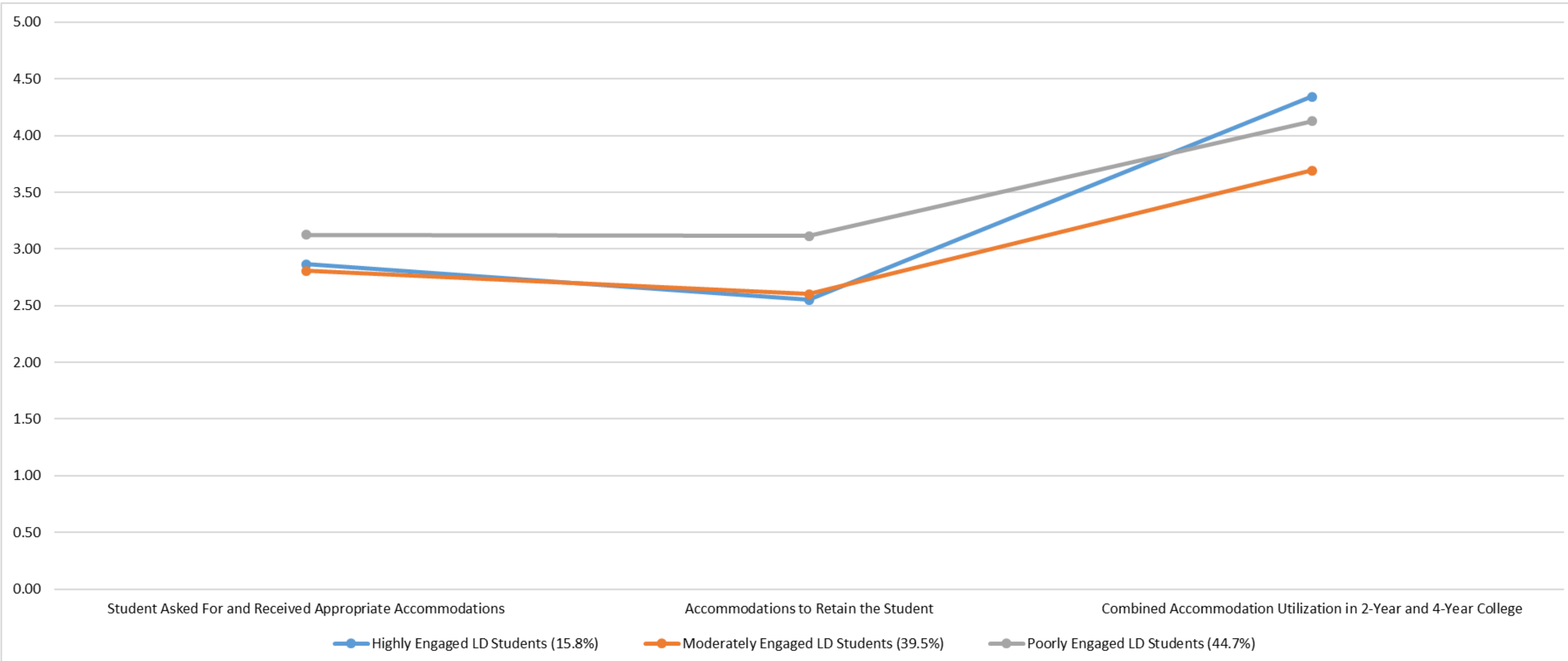

Figure 3.5. Accommodation utilization variables section of the conditional probability profile plot for the 3-class model.

Conditional Model with Covariates. After selecting the three-profile model as the final LCA model, a conditional model was run and the logistic regression coefficients (i.e., logit values), standard error, and odds ratios were obtained (Table 3.7). The *Poorly Engaged LD Students* class was chosen as the reference profile, meaning that the *Highly Engaged LD Students and Moderately Engaged LD Students* classes were compared to the reference profile. It was discovered that female students were significantly more likely to be in either the *Highly Engaged LD Students* (logit = 0.26, *OR* = 1.30, $p < .05$) or *Moderately Engaged LD Students* (logit = 0.22, *OR* = 1.25, $p < .05$) classes by 1.30 and 1.25 times, respectively. Students in the other ethnicity category, which included Asian, Pacific Islander, Native American, and mixed ethnicities, were significantly more likely to be located in the *Moderately Engaged LD Students* (logit = 0.48, *OR* = 1.62, $p < .05$) class by 1.62 times. It was also found that the age of the LD student and their parents having obtained a 4-year college degree made them significantly more likely at the .10 level to be found in the *Highly Engaged LD Students* class by 1.61 times. None of the other covariates significantly affected which class LD students were in based on their engagement.

Table 3.7

Log Odds Coefficients and Odds Ratio for the 3-Class Model with Gender, Ethnicity, and Parent's Education Covariates

Profile	Effect	Logit	SE	*p*-value	Odds Ratio
C2: Moderately Engaged LD Students					
	Female	0.22*	0.11	.05	1.25
	Age	-0.02	0.05	.68	0.98
	Hispanic, Latino, or Other Spanish Origin	-0.20	0.18	.26	0.82
	African American	0.10	0.15	.50	1.11
	Other Ethnicity	0.48*	0.21	.02	1.62
	Parents completed a high school education	0.18	0.17	.30	1.20
	Parents completed a vocational or 2-year college education	0.09	0.21	.67	1.09
	Parents completed a 4-year college education	0.26	0.23	.24	1.30
	Parents completed a graduate education	-0.01	0.28	.97	0.99
C3: Highly Engaged LD Students					
	Female	0.26*	0.15	.08	1.30
	Age	-0.09†	0.06	.13	0.91
	Hispanic, Latino, or Other Spanish Origin	-0.31	0.25	.21	0.73
	African American	-0.08	0.20	.71	0.93
	Other Ethnicity	0.00	0.32	.99	1.00
	Parents completed a high school education	0.09	0.24	.69	1.10
	Parents completed a vocational or 2-year college education	-0.03	0.29	.91	0.97
	Parents completed a 4-year college education	0.48†	0.29	.10	1.61
	Parents completed a graduate education	0.03	0.38	.95	1.03

Note. Comparison group (reference class) is the Poorly Engaged LD Students class. The gender reference group is males and the ethnicity reference group is White. *†p<.10. *p<.05.*

Conditional Model with Proximal and Distal Outcome Variables. The samples sizes for those that pursued STEM or CTE fields were small, with those pursuing STEM being the smallest; therefore, the STEM and CTE variables were combined to create the following three dichotomous variables: pursuing STEM or CTE at the 2-year college, majoring in STEM or CTE at the 4-year college, and being in a STEM or CTE career. Following the addition of the covariates to the 3-class LCA model, a conditional LCA model was run via the BCH method utilizing the proximal and distal outcome variables of pursuing a STEM or CTE field in a 2-year college and 4-year college and the distal outcome of going into a STEM or CTE career (Table 3.8). For the variable of pursuing a STEM or CTE field in a 2-year college it was discovered that there was a significant difference between the *Poorly Engaged* and *Moderately Engaged* classes (X^2 (2) 20.75, $p <$ .001) and the *Poorly Engaged* and *Highly Engaged* classes (X^2 (2) 23.09, $p <$ .001). It was also determined that there was an overall significant difference between the classes (X^2 (2) 35.20, $p < .001$). The mean values for each class, when looking at pursuing a STEM or CTE field in a 2-year college, can be found in Table 6 below and show that the *Highly Engaged* class displays the highest mean value at .17, which is not close to 1.0 indicating that not many students are pursuing a STEM or CTE field. When looking at majoring in a STEM or CTE field in a 4-year college it was found that there was an overall statistical significant difference between the means of each class (X^2 (2) 19.56, $p < .001$). However, the means for each class were lower than that of those pursing a STEM or CTE field at the 2-year college. There was a statistically significant difference between the *Moderately Engaged* and *Poorly Engaged* classes (X^2 (2) 8.23, $p <$ .001), *Moderately Engaged* and *Highly Engaged* classes (X^2 (2) 4.74, $p < .001$), and the *Poorly Engaged* and *Highly Engaged* classes (X^2 (2) 15.87, $p < .001$). For the distal outcome of pursuing a STEM or CTE career there was no statistically significant difference found between the classes overall or individually. The mean values for each class were higher for pursuing a STEM or CTE career than for going into STEM or CTE in either the 2-year or 4-year college but still low. Figure 3.6 below graphically displays the data shown in Table 3.8. It is interesting to note that the *Highly Engaged* class does not always have the highest mean.

Table 3.8

Proximal and Distal Outcomes for the 3-Class Model for the IEP, Accommodation Utilization, and Self-Determination Variables

LD Student Engagement Profiles	**2-Year STEM or CTE Field *M* (*SE*)**	**4-Year STEM or CTE Major *M* (*SE*)**	**STEM or CTE Career *M* (*SE*)**
Highly Engaged LD Students (15.8% of sample)	0.17 (0.02)	0.13 (0.02)	0.21 (0.04)
Moderately Engaged LD Students (39.5% of sample)	0.12 (0.01)	0.08 (0.01)	0.27 (0.03)
Poorly Engaged LD Students (44.7% of sample)	0.05 (0.01)	0.04 (0.01)	0.29 (0.04)

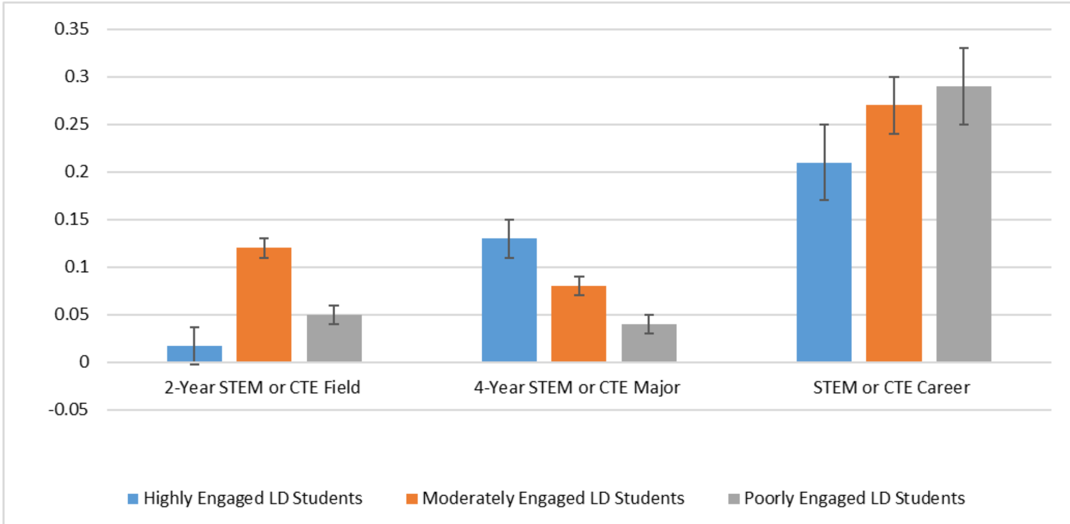

Figure 3.6. Mean value of LD students pursuing a STEM or CTE field in the 2-year college, 4-year college, or career with standard errors for each of the three classes.

Discussion and Conclusion

Study Significance. This study adds to the literature on LD students by exploring their engagement in a holistic way. The goal was to incorporate the involvement of students planning for their future, students being proactive and seeking the accommodations they need to be successful, and the possession of self-determination to ensure the first two elements take place. The hypothesis was that these three components work synergistically to improve an LD students' academic success, and specifically success in STEM or CTE fields. Previous research has looked at one or two of these components together but none, to the author's knowledge, have looked at all three simultaneously and how they work together (Baker & Scanlon, 2016; Chan, 2016; Chou, Wehmeyer, Palmer, & Lee, 2016; Cobb & Alwell, 2009; Eckes & Ochoa, 2005; Hadley, 2006; Hamblet, 2016; Katsiyannis, Zhang, Woodruff, & Dixon, 2005; Newman & Madaus, 2015; Newman, Madaus, & Javitz, 2016; Ryan & Deci, 2004; Salzer, Wick, & Rogers, 2008; Thoma and Getzel, 2005). It was determined that latent class analysis would be the best statistical analysis to use as it would allow LD students, who are all unique and, therefore, display a level of heterogeneity as a sample, to be categorized into specific classes based on their overall level of engagement as well as showing their relationship to postsecondary and career trajectories based on their classification. It was discovered that LD students could be categorized into three classes: *Highly Engaged LD Students*, *Moderately Engaged LD Students*, and *Poorly Engaged LD Students*.

Discussion of Results. The descriptive analysis portion of this study highlighted that LD students who pursue a STEM or CTE field tend to take the 2-year college pathway, which is consistent with previous findings (Newman, Madaus, & Javitz, 2016); however, the number of students who pursue STEM or CTE at the 2-year college are not found at the 4-year college. The numbers of LD people in STEM or CTE, particularly CTE, increase again at the career stage. This could mean that LD students who are pursuing STEM or CTE at the 2-year college end up leaving with a certificate or enter an apprenticeship before entering the workforce, which means they do not enter, or need for their career, a 4-year college. While this is not necessarily an undesirable outcome, given CTE careers are needed and can provide a good living wage, the concern is if LD students, in particular, are being tracked at the IEP stage to enter the CTE and/or non-college degree track, which is a concern that has been brought up by Dougherty (2016) as well. It is important that LD students are provided with an array of postsecondary options and prepared academically to enter STEM majors and careers if they have the aptitude and desire to pursue STEM.

The LCA conducted in this study provided a useful way of classifying the LD students in this sample into engagement profiles based on their IEP involvement, level of self-determination, and accommodation utilization. The unconditional model, without covariates and outcome variables (proximal or distal), yielded a three-profile model, which revealed that the majority of LD students were categorized into either the *Moderately Engaged* (39.5%) or *Poorly Engaged* (44.7%) classes; however, 15.8% were categorized into the *Highly Engaged class.* As expected, the *Highly Engaged* LD students were the most involved in the IEP process and had the highest level of self-determination. An unexpected finding is that the *Highly Engaged* LD students displayed the lowest level of accommodation utilization and the *Poorly Engaged* students demonstrated the highest level of accommodation utilization. One explanation for this finding could be that successful LD students do not need accommodations to reach their goals and that having a postsecondary plan in place in high school and possessing enough self-determination will allow them to conquer their goals. This finding could also indicate that accommodation utilization is not as crucial for a LD student's success in STEM or CTE fields, or at least not in the form it is currently provided.

When adding the covariates of gender, age, and parent's education level the two statistically significant findings were for female and other ethnicity (i.e., all ethnicities except Caucasian, African-American, and Hispanic/Latina/o) LD students. Female LD students were significantly more likely to be in the *Highly Engaged* or *Moderately Engaged* classes than male students. This finding could be highlighting emotional gender differences among males and females or touching on an individual difference in LD severity between the genders. Unfortunately, that distinction cannot be teased out in this analysis, but it should be an area of further investigation as female students seem poised to do well in STEM and CTE fields yet they are not as well represented. Student from primarily Asian, Pacific Islander, Native American, and mixed ethnicities were significantly more likely to be found in the *Moderately Engaged LD Students* class. The *Moderately Engaged* class displayed the highest mean for pursuing STEM or CTE at a 2-year college. Students with an LD in this ethnicity category are either not being prepared to enter a 4-year college directly following high school or there are other family or personal concerns that are placing those students into the *Moderately Engaged* class. While not in the *Highly Engaged* class, these students could do well in STEM and CTE courses if the proper supports were in place for them, which could mean more exposure to STEM and CTE careers and being encouraged to pursue those fields. Both age and parent's having a 4-year college degree was statistically significant at the .10 level and were found to be in the *Highly Engaged* class. In a certain sense this is an expected finding given that parents with a 4-year degree have the cultural capital to ensure their child is engaged in learning and obtaining necessary resources. Students who might have been held back a grade may have a greater drive to finish their education and enter the workforce, which could contribute to their level of engagement.

The mean values found for students pursuing a STEM or CTE field at the 2-year college, 4-year college, or career were very low with most values below 0.20, with values of 0 being students did not enter STEM or CTE fields and 1 being that they did. This indicates that LD students are not pursuing STEM or CTE, which can be a serious issue for our future workforce as the LD student population is growing. An interesting finding was that the LD students in the *Poorly Engaged* class had the highest mean for pursing a STEM or CTE career and from the descriptive analysis it was discovered that trade fields are top fields LD students are entering. Chan (2016) discussed how LD students who do not have the appropriate supports and services in place can fail out of STEM courses, which can lead to leaving STEM entirely and that may be what is being seen here. There was also a statistically significant difference between the *Poorly Engaged* class and the more engaged classes, further indicating the differences in engagement level and nearly half of the students were categorized into this class. While statistical differences between classes were found for those pursuing STEM or CTE at the 2-year and 4-year college there were no statistical differences found between classes for those in a STEM or CTE career. The *Highly Engaged* class only has the highest mean for 4-year college and not for 2-year college or career. Students do have to be motivated and invested in their education to make the effort to apply to 4-year colleges in high school, so that is not an unexpected result; however, it is interesting that engagement, in terms of the components of this study, does not play a role in terms of having a STEM or CTE career. Part of the reason for this finding could be that an IEP does not play a strong role in what career a student pursues, and the same may be true for accommodation usage. Additionally, self-determination may not be as important at the career stage as persistence is. Self-determination may be important in terms of "climbing the ladder" in one's career, but not as important for entering a specific career.

Limitations and Future Research. There are a few items in this study that it would be good to disentangle in future research in this area. While we know that females tend to not be properly identified with a LD at a higher rate than males (Vogel, 1990), each student is different and has different learning challenges; therefore, it was difficult to determine why females tended to be in the *Highly Engaged* and *Moderately Engaged* classes. Additionally, as the NLTS-2 study continued the percentage of female students still participating increased versus the percentage of male students, which shifted the demographics between waves two through five. This could be contributed to the fact that females tend to participate in surveys more than males (Curtin et al 2000; Moore & Tarnai, 2002; Singer et al 2000). Similarly, due to sample sizes, STEM majors and careers had to be combined with CTE majors and careers for the outcome variables, which means the distinction between the two is lost. If more data could be obtained it would be valuable to analyze the differences between STEM and CTE for the various engaged categories based on the IEP involvement, accommodation utilization, and self-determination do see which factor plays a larger role in STEM and/or CTE careers. This study only looked at LD students, but our schools have students with various disabilities and it is important to see how the engagement classes change with different disabilities. While policy recommendations can be proposed based on the findings from this study caution should be taken during implementation as recommendations for LD students may not work well for students with an emotional disturbance (ED) or Autism Spectrum Disorder (ASD), for example.

A good future step for this study would be to combine LCA with causal inference techniques. Given students are not randomly assigned in the NLTS-2 study causation cannot be determined and all that can be said with certainty is that there is an association between classes and the outcome variables, which is a good first step. A technique to try in the future would be to utilize propensity score matching to estimate the causal effects of covariates on the latent classes found so that the causal effects of the latent classes on the proximal and distal outcomes can be determined. Some work has previously been done in this area (Butera, Lanza, & Coffman, 2013; Lanza, Coffman, & Xu, 2013; Schuler, Leoutsakos, & Stuart, 2014) and it would be a good next step in this study to determine if the engaged classes of student cause them to pursue a STEM or CTE field or career later in life.

Policy Implications. When thinking of the policy implications of this study it is important to keep in mind the desired outcome. What are the benefits or consequences of students attending a vocational school versus attending a 2-year college and then transferring to a 4-year college versus going to a 4-year college directly after high school? Is the goal to produce more STEM majors or students with 21^{st} Century skills that they can apply to a wide variety of careers. The literature discussed in this study would suggest that producing a technologically advanced workforce is a goal. Finding from this study suggest that ensuring students are engaged via the three constructs discussed will help them succeed in either STEM or CTE postsecondary education. Because a students' IEP does not follow them into postsecondary education there is a drop off in support once students leave high school unless they possess the necessary self-determination to advocate for themselves and make sure they receive the accommodations they need. Therefore, a key policy implication is to develop a way to transfer a student's IEP from high school to the postsecondary institution they choose to attend. In addition to transferring an IEP, students must be actively involved in the IEP process. There was not much separation between the classes for students attending an IEP meeting or setting goals; however, the classes separated more with variables that looked at student involvement and choice, so those are areas that need attention.

References

Aiken, L. S., West, S. G., & Reno, R. R. (1991). *Multiple regression: Testing and interpreting interactions*. Sage.

Anctil, T. M. & Ishikawa, M. E., & Scott, A. T. (2008). Academic identity development through self-determination: Successful college students with learning disabilities. *Career Development for Exceptional Individuals*, *31*(3), 164-174. doi: 10.1177/0885728808315331

Asparouhov, T., & Muthén, B. (2014). Auxiliary variables in mixture modeling: Using the BCH method in Mplus to estimate a distal outcome model and an arbitrary secondary model. *Mplus Web Notes*, *21*(2). Retrieved from https://www.statmodel.com/examples/webnotes/webnote21.pdf

Asparouhov, T., Muthén, B. O. (2013). *Auxiliary variables in mixture modeling: A 3-step*

approach using Mplus, Mplus Web Notes: No:15.

Baker, D., & Scanlon, D. (2016). Student Perspectives on Academic Accommodations. *Exceptionality*, *24*(2), 93-108. doi: 10.1080/09362835.2015.1064411

Barnar-Brak, L., Lectenberger, D., & Lan, W. Y. (2010). Accommodation Strategies of College Students with Disabilities. *The Qualitative Report*, *15*(2), 411-429. Retrieved from http://nsuworks.nova.edu/tqr/vol15/iss2/10

Brown, T. A. (2006). Confirmatory factor analysis for applied research. New York, NY: Guilford Press.

Butera, N. M., Lanza, S. T., & Coffman, D. L. (2013). A framework for estimating causal effects in latent class analysis: Is there a causal link between early sex and subsequent profiles of delinquency? *Prevention Science, 15*(3), 397-407. doi: 10.1007/s11121-013-0417-3

Cawthon, S. W., & Cole, E. V. (2010). Postsecondary Students Who Have a Learning Disability: Student Perspectives on Accommodations Access and Obstacles. *Journal of Postsecondary Education and Disability*, *23*(2), 112-128. Retrieved from http://files.eric.ed.gov/fulltext/EJ906696.pdf

Chan, V. (2016). Special Needs: Scholastic Disability Accommodations from K-12 and Transitions to Higher Education. *Current psychiatry reports*, *18*(2), 1-7. doi: 10.1007/s11920-015-0645-2

Chiang, H. M., Cheung, Y. K., Hickson, L., Xiang, R., & Tsai, L. Y. (2012). Predictive factors of participation in postsecondary education for high school leavers with autism. *Journal of Autism and Developmental Disorders*, *42*(5), 685-696. Retrieved from http://link.springer.com/article/10.1007/s10803-011-1297-7

Chou, Y. C., Wehmeyer, M. L., Palmer, S. B., & Lee, J. (2016). Comparisons of Self-Determination Among Students With Autism, Intellectual Disability, and Learning Disabilities A Multivariate Analysis. *Focus on Autism and Other Developmental Disabilities*,1-9. doi: 10.1177/1088357615625059

Cobb, B., & Alwell, M. (2009). Transition planning/coordinating interventions for youth with disabilities: A systematic review. *Career Development for Exceptional Individuals*. doi: 10.1177/0885728809336655

Cortiella, C. (2011). The state of learning disabilities. *New York, NY: National Center for Learning Disabilities*. Retrieved from http://illinoiscte.org/PDF/research_and_reports/state_of_learning_disabilities.pdf?lbisphpreq=1

Cortiella, C., & Horowitz, S. H. (2014). *The state of learning disabilities: Facts, trends, and emerging issues.* New York: National Center for Learning Disabilities. Retrieved from https://www.ncld.org/wp-content/uploads/2014/11/2014-State-of-LD.pdf

Curtin, R., Presser, S., & Singer, E. (2000). The effects of response rate changes on the index of consumer sentiment. *Public Opinion Quarterly*, *64*(4), 413–428. Retrieved from http://ucla-dev-web01.reliam.com/chis/tac2015/Documents/SDSM%20TAC/Curtin%20etal_2000.pdf

Daviso, A. W., Denney, S. C., Baer, R. M., & Flexer, R. (2011). Postschool goals and transition services for students with learning disabilities. *American Secondary Education*, *39*(2), 77. Retrieved from http://search.proquest.com.proxy.library.ucsb.edu:2048/openview/0aa41be114c7b2a4f837d26ff0c1a54c/1?pq-origsite=gscholar

Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology/Psychologie canadienne*, *49*(3), 182. doi: 10.1037/a0012801

Department of Education. (2007, July 19). Twenty-Five Years of Progress in Educating Children with Disabilities through IDEA. Retrieved from http://www2.ed.gov/policy/speced/leg/idea/history.html

Department of Education. (2010, November). Thirty-Five Years of Progress in Educating Children with Disabilities through IDEA. Retrieved from https://www2.ed.gov/about/offices/list/osers/idea35/history/idea-35-history.pdf

Drew, D. E. (2011). STEM the Tide: Reforming Science, Technology, Engineering, and Math Education in America. Baltimore: The Johns Hopkins University Press. Retrieved April 14, 2016, from Project MUSE database.

Eckes, S. E., & Ochoa, T. A. (2005). Students with disabilities: Transitioning from high school to higher education. *American Secondary Education*, 6-20. Retrieved from http://www.jstor.org.proxy.library.ucsb.edu:2048/stable/pdf/41064551.pdf

Enders, C. K. (2001). The performance of the full information maximum likelihood estimator in multiple regression models with missing data. *Educational and Psychological Measurement*, *61*(5), 713-740. Retrieved from http://epm.sagepub.com.proxy.library.ucsb.edu:2048/content/61/5/713.full.pdf

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. Psychological Methods, 4(3), 272–299. doi:10.1037/1082-989X.4.3.272

Field, S., Sarver, M. D., & Shaw, S. F. (2003). Self-Determination a key to success in postsecondary education for students with learning disabilities.

Remedial and Special Education, *24*(6), 339-349. doi: 10.1177/07419325030240060501

Foley, N. E. (2006). Preparing for college: Improving the odds for students with learning disabilities. *College Student Journal*, *40*(3), 641. Retrieved from http://search.proquest.com.proxy.library.ucsb.edu:2048/openview/1d856eb3c28f3b7ef57ab175a84abf0e/1?pq-origsite=gscholar

Gagné, M., & Deci, E. L. (2005). Self-determination theory and work motivation. *Journal of Organizational behavior*, *26*(4), 331-362. doi: 10.1002/job.322

Gardner, D. P. (1983). A nation at risk. *Washington, DC: The National Commission on Excellence in Education, US Department of Education*. Retrieved from http://202.120.223.158/download/b42c4210-e82c-4244-aa4f-89d2b313f44a.doc

Garrison-Wade, D. F., & Lehmann, J. P. (2009). A conceptual framework for understanding students' with disabilities transition to community college. *Community College Journal of Research and Practice*, *33*(5), 415-443. doi: 10.1080/10668920802640079

Gregg, N. (2007). Underserved and unprepared: Postsecondary learning disabilities. *Learning Disabilities Research & Practice*, *22*(4), 219-228. doi: 10.1111/j.1540-5826.2007.00250.x

Hadley, W. M. (2007). The Necessity of Academic Accommodations for First-Year College Students with Learning Disabilities. *Journal of College Admission*, *195*, 9-13. Retrieved from http://files.eric.ed.gov/fulltext/EJ783943.pdf

Hadley, W. M. (2006). LD students' access to higher education: Self-advocacy and support. *Journal of Developmental Education*, *30*(2), 10. Retrieved from http://crawl.prod.proquest.com.s3.amazonaws.com/fpcache/684a5cf7a804789d8da43284d2c8ce9d.pdf?AWSAccessKeyId=AKIAJF7V7KNV2KKY2NUQ&Expires=1463540927&Signature=RNghezmz%2FmsrCl6oEeEOI7yw%2Fjc%3D

Hamblet, E. (2016). Are academic accommodations all students need?. *Disability Compliance for Higher Education*, *21*(9), 1-6. Retrieved from http://onlinelibrary.wiley.com.proxy.library.ucsb.edu:2048/doi/10.1002/dhe.30164/epdf

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Press.

Henseler, J., & Fassott, G. (2010). Testing moderating affects in PLS path models: An illustration of available procedures. In *Handbook of partial least squares* (pp. 713-735). Springer Berlin Heidelberg. Retrieved from http://download.springer.com.proxy.library.ucsb.edu:2048/static/pdf/156/chp%253A10.1007%252F978-3-540-32827-8_31.pdf?originUrl=http%3A%2F%2Flink.springer.com%2Fchapter%2F10.1007%2F978-3-540-32827-8_31&token2=exp=1464214483~acl=%2Fstatic%2Fpdf%2F156%2Fchp%25253A10.1007%25252F978-3-540-32827-8_31.pdf%3ForiginUrl%3Dhttp%253A%252F%252Flink.springer.com%

252Fchapter%252F10.1007%252F978-3-540-32827-8_31*~hmac=b978aae8b3bcf4d32f0e035b3c5f4172878bfb336794d4eb090b1da381acb0f7

Herbert, J. T., Hong, B. S., Byun, S. Y., Welsh, W., Kurz, C. A., & Atkinson, H. A. (2014). Persistence and graduation of college students seeking disability support services. *journal of Rehabilitation*, *80*(1), 22. Retrieved from http://p8888-ucelinks.cdlib.org.proxy.library.ucsb.edu:2048/sfx_local?sid=google&aufirst=JT&aulast=Herbert&atitle=Persistence+and+graduation+of+college+students+seeking+disability+support+services&title=Journal+of+Rehabilitation&volume=80&issue=1&date=2014&spage=22&issn=0022-4154

Hill, J. L. (1996). Speaking Out: Perceptions of Students with Disabilities Regarding Adequacy of Services and Willingness of Faculty To Make Accommodations. *Journal of Postsecondary Education and Disability*, *12*(1), 22-43. Retrieved from http://files.eric.ed.gov/fulltext/EJ555749.pdf

IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.

Jameson, D. R. (2007). Self-determination and success outcomes of two-year college students with disabilities. *Journal of College Reading and Learning*, *37*(2), 26-46. doi:10.1080/10790195.2007.10850196

Javitz, H., & Wagner, M. (2005). Analysis of potential bias in the Wave 1 and Wave 2 respondents to the National Longitudinal Transition Study-2

(NLTS2). *Menlo Park, CA: SRI International*. Retrieved from http://nlts2.org/studymeth/nlts2_analysis_bias_respondents.pdf

Joshi, G. S., Bouck, E. C., & Maeda, Y. (2012). Exploring employment preparation and postschool outcomes for students with mild intellectual disability. *Career Development and Transition for Exceptional Individuals*, *35*(2), 97-107. doi: 10.1177/0885728811433822

Katsiyannis, A., Zhang, D., Woodruff, N., & Dixon, A. (2005). Transition supports to students with mental retardation: An examination of data from the National Longitudinal Transition Study 2. *Education and Training in Developmental Disabilities*, 109-116. Retrieved from http://www.jstor.org.proxy.library.ucsb.edu:2048/stable/pdf/23880084.pdf?_=1463537148899

Klassen, R. M. (2007). Using predictions to learn about the self-efficacy of early adolescents with and without learning disabilities. *Contemporary Educational Psychology*, *32*(2), 173-187. doi:10.1016/j.cedpsych.2006.10.001

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York, NY: The Guilford Press.

Kohlstedt, S. G., Sokal, M. M., & Lewenstein, B. V. (1999). *The establishment of science in America: 150 years of the American Association for the Advancement of Science*. Rutgers University Press.

Lamont, A. E., Vermunt, J. K., & Van Horn, M. L. (2016). Regression Mixture Models: Does Modeling the Covariance Between Independent Variables and Latent Classes Improve the Results?. *Multivariate behavioral research*, *51*(1), 35-52. doi:10.1080/00273171.2015.1095063

Landmark, L. J., Ju, S., & Zhang, D. (2010). Substantiated best practices in transition: Fifteen plus years later. *Career Development for Exceptional Individuals*. doi: 10.1177/0885728810376410

Lanza, S. T., Coffman, D. L., & Xu, S. (2013). Causal inference in latent class analysis. *Structural Equation Modeling*, *20*(3), 361-383. doi: 10.1080/10705511.2013.797816

Madaus, J. W., & Shaw, S. F. (2006). The impact of the IDEA 2004 on transition to college for students with learning disabilities. *Learning Disabilities Research & Practice*, *21*(4), 273-281. doi: 10.1111/j.1540-5826.2006.00223.x

Marshak, L., Van Wieren, T., Ferrell, D. R., Swiss, L., & Dugan, C. (2010). Exploring Barriers to College Student Use of Disability Services and Accommodations. *Journal of Postsecondary Education and Disability*, *22*(3), 151-165. Retrieved from http://files.eric.ed.gov/fulltext/EJ906688.pdf

Masyn, K. (2013). Latent class analysis and finite mixture modeling. In T. Little (Ed.), *The Oxford handbook of quantitative methods in psychology* (Vol. 2, pp. 375–393). Oxford, UK: Oxford University Press.

Milsom, A., & Hartley, M. T. (2005). Assisting students with learning disabilities transitioning to college: What school counselors should know. *Professional School Counseling*, 436-441.

Retrieved from http://www.jstor.org.proxy.library.ucsb.edu:2048/stable/pdf/42732486.pdf

Moore, D. L., & Tarnai, J. (2002). Evaluating nonresponse error in mail surveys. In: Groves, R. M., Dillman, D. A., Eltinge, J. L., and Little, R. J. A. (Eds.), *Survey Nonresponse* (pp. 197–211), New York: Wiley.

Moosbrugger, H., Schermelleh-Engel, K., & Klein, A. (1997). Methodological problems of estimating latent interaction effects. *Methods of Psychological Research Online*, *2*(2), 95-111. Retrieved from https://www.researchgate.net/profile/Karin_Schermelleh-Engel/publication/256089187_Methodological_problems_of_estimating_latent_interaction_effects/links/02e7e521b361f0c693000000.pdf

Morningstar, M. E., Frey, B. B., Noonan, P. M., Ng, J., Clavenna-Deane, B., Graves, P., ... & Williams-Diehm, K. (2010). A preliminary investigation of the relationship of transition preparation and self-determination for students with disabilities in postsecondary educational settings. *Career Development for Exceptional Individuals*. doi: 10.1177/0885728809356568

Muthén, B. O., & Muthén, L. K. (1998-2015). Mplus (Version 7.4) [software]. Los Angeles, CA: Muthén & Muthén.

National Academies of Sciences, Engineering, and Medicine. 2016. *Developing a National STEM Workforce Strategy: A Workshop Summary*. Washington, DC: The National Academies Press. doi: 10.17226/21900.

Neale, M. C. (2000). Individual fit, heterogeneity, and missing data in multi-group SEM. *Modeling longitudinal and multiple-group data: Practical issues, applied approaches, and specific examples*. *Hillsdale, NJ: Lawrence Erlbaum Associates*. Retrieved from http://www.vipbg.vcu.edu/OpenMxFall09/berlin.pdf

Newman, L. A., Madaus, J. W., & Javitz, H. S. (2016). Effect of Transition Planning on Postsecondary Support Receipt by Students With Disabilities. *Exceptional Children*, doi: 10.1177/0014402915615884

Newman, L. A., & Madaus, J. W. (2015). An Analysis of Factors Related to Receipt of Accommodations and Services by Postsecondary Students With Disabilities. *Remedial and Special Education*, *36*(4), 208-219. doi:10.1177/0741932515572912

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural equation modeling*, *14*(4), 535-569. doi: 10.1080/10705510701575396

President's Council of Advisors on Science and Technology (U.S.), & United States. Executive Office of the President. (2012). *Report to the President, Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*. Washington, D.C.: Executive Office of the President, President's Council of Advisors on Science and Technology. Retrieved from https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-executive-report-final_2-13-12.pdf

Ryan, R. M. & Deci, E. L. (2002). Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 3-36). Woodbridge, Suffolk, UK: University of Rochester Press.

Salzer, M. S., Wick, L. C., & Rogers, J. A. (2008). Familiarity with and use of accommodations and supports among postsecondary students with mental illnesses. *Psychiatric Services*. Retrieved from http://ps.psychiatryonline.org/doi/pdf/10.1176/ps.2008.59.4.370

Sanford, C. B. (2011). *Analysis of Self-Determination and Transition Planning in Relation to Postsecondary Outcomes for Students with Emotional Disturbances* (Doctoral dissertation). Retrieved from http://digitalassets.lib.berkeley.edu/etd/ucb/text/Sanford_berkeley_0028E_11955.pdf

Sardeshmukh, S. R., & Vandenberg, R. J. (2016). Integrating Moderation and Mediation A Structural Equation Modeling Approach. *Organizational Research Methods*, 1094428115621609. doi: 10.1177/1094428115621609

Schuler, M. S., Leoutsakos, J. S., & Stuart, E. A. (2014). Addressing confounding when estimating the effects of latent classes on a distal outcome. *Health Services Outcomes and Research Methodology*, *14*(4), 232-254. doi: 10.1007/s10742-014-0122-0

Shogren, K. A., & Shaw, L. A. (2015). The role of autonomy, self-realization, and psychological empowerment in predicting outcomes for youth with disabilities. *Remedial and Special Education*, 0741932515585003. doi: 10.1177/0741932515585003

Singer, E., van Hoewyk, J., & Maher, M. P. (2000). Experiments with incentives in telephone surveys. *Public Opinion Quarterly*, *64* (2), 171–188. doi: 10.1086/317761

SRI International. (2000). *National Longitudinal Transition Study-2 (NLTS-2) Sampling Plan.* Menlo Park, CA: Author. Retrieved from http://www.nlts2.org/studymeth/nlts2_sampling_plan2.pdf

Test, D. W., Mazzotti, V. L., Mustian, A. L., Fowler, C. H., Kortering, L., & Kohler, P. (2009). Evidence-based secondary transition predictors for improving postschool outcomes for students with disabilities. *Career Development for Exceptional Individuals*. doi: 10.1177/0885728809346960

Thoma, C. A., & Getzel, E. E. (2005). " Self-determination is what it's all about": What Post-secondary Students with Disabilities Tell us are Important Considerations for Success. *Education and Training in Developmental Disabilities*, 234-242. Retrieved from http://www.jstor.org.proxy.library.ucsb.edu:2048/stable/pdf/23879718.pdf

Trainor, A. A. (2005). Self-determination perceptions and behaviors of diverse students with LD during the transition planning process. *Journal of*

Learning Disabilities, *38*(3), 233-249. doi: 10.1177/00222194050380030501

Van Horn, M.L., Jaki, T., Masyn, K., Howe, G., Feaster, D.J., Lamont, A.E., Kim, M. (2015).

Evaluating differential effects using regression interactions and regression mixture

models. *Educational and Psychological Measurement.* 75(4), 677-714. doi: 10.1177/0013164414554931

Van Horn, M. L., Jaki, T., Masyn, K., Ramey, S. L., Smith, J. A., & Antaramian, S. (2009). Assessing differential effects: Applying regression mixture models to identify variations in the influence of family resources on academic achievement. *Developmental Psychology*, *45*(5), 1298. doi: 10.1037/a0016427

Wehmeyer, M. L. (2005). Self-determination and individuals with severe disabilities: Reexamining meanings and misinterpretations. *Research and Practice for Persons with Severe Disabilities*, *30*(3), 113-120. doi: http://dx.doi.org/10.2511/rpsd.30.3.113

Appendix

Table 3A-1

Descriptive Statistics for the Variables Used in this Study

	N		*M*	*SD*
	Valid	Missing		
Female	2002	0	0.36	0.48
Age	2002	0	17.15	1.20
Hispanic, Latino, or other Spanish origin	1992	10	0.18	0.38
Caucasian	1983	19	0.70	0.46
African-American or Black	1983	19	0.21	0.41
Other Ethnicity	1983	19	0.11	0.31
Parents have less than a high school education	1955	47	0.21	0.41
Parents have a high school education	1955	47	0.48	0.50
Parents have a vocational or 2-year college education	1955	47	0.14	0.34
Parents have a 4-year college education	1955	47	0.12	0.32
Parents have a graduate level education	1955	47	0.06	0.24
STEM or CTE at the 2-Year College	2001	1	0.09	0.29
STEM or CTE at the 4-Year College	2002	0	0.07	0.25
STEM or CTE Career	634	1368	0.26	0.44
Student attended an IEP Meeting for special education (R7a)	1403	599	1.32	0.51
Student set post-graduation goals with teacher (R7b)	1312	690	1.29	0.49
Student's level of choice in creating goals (R7c)	882	1120	1.15	0.37
Student's involvement in the IEP (R7d)	808	1194	1.13	0.35
Student believes IEP goals are challenging and appropriate (R7e)	704	1298	1.11	0.32
Student is proud of who they are (V3a)	1707	295	4.67	2.11
Student thinks they are a nice person (V3b)	1710	292	4.90	2.14
Student makes friends easily (V3c)	1707	295	4.49	2.06
Student can tell peers how they feel (V3d)	1706	296	4.13	1.97
Student feels useful and important (V3e)	1702	300	4.33	2.01
Student feels life is full of interesting things to do (V3f)	1711	291	4.35	2.05
Student can handle most things that come their way (V3g)	1708	294	4.45	2.02
Student knows how to get the information they need (V3h)	1709	293	4.47	2.07
Student can get school staff and other adults to listen to them (V3i)	1707	295	4.39	2.02

Student Asked for and Received Appropriate Accommodations	127	1875	2.94	1.11
Accommodations to Retain the Student	572	1430	2.75	2.21
Accommodation Utilization in 2-Year and 4-Year College	354	1648	3.99	3.14

Table 3A-2

Correlations among the IEP, Self-Determination, and Accommodation Use Variables Used in the LCA

Table A-3

Correlations among the IEP, Self-Determination, and Accommodation Use Variables Used in the LCA

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. IEP-1	-																
2. IEP-2	.63**	-															
3. IEP-3	.36**	.45**	-														
4. IEP-4	.28**	.41**	.70**	-													
5. IEP-5	.30**	.40**	.71**	.63**	-												
6. Self-Determination-1	.01	.06*	.34**	.33**	.27**	-											
7. Self-Determination-2	.01	.05	.33**	.31**	.25**	.72**	-										
8. Self-Determination-3	-.01	.05	.33**	.30**	.26**	.70**	.70**	-									
9. Self-Determination-4	.01	.06	.31**	.29**	.23**	.75**	.74**	.75**	-								
10. Self-Determination-5	.03	.07*	.32**	.30**	.26**	.70**	.70**	.67**	.74**	-							
11. Self-Determination-6	.02	.07*	.34**	.33**	.28**	.70**	.70**	.68**	.74**	.69**	-						
12. Self-Determination-7	-.00	.03	.30**	.29**	.23**	.72**	.70**	.68**	.74**	.67**	.69**	-					
13. Self-Determination-8	-.01	.03	.30**	.28**	.22**	.70**	.71**	.69**	.75**	.68**	.69**	.71**	-				
14. Self-Determination-9	.01	.05	.31**	.29**	.25**	.72**	.70**	.68**	.75**	.68**	.68**	.68**	.69**	-			
15. Use of Accommodations	-.09	.13	.15	.35*	.20	-.08	-.07	-.07	-.09	-.09	-.07	-.06	-.10	-.03	-		
16. Accommodations as Retention	.07	.06	.08	.07	.04	-.10*	-.07	-.09*	-.10*	-.11**	-.11**	-.06	-.11*	-.09*	.36**	-	
17. Accommodation at 2-Year & 4-Year College	.13*	.05	-.12	-.15	-.05	.01	.02	.01	-.01	.04	.03	.04	.01	.02	.18	.28**	-

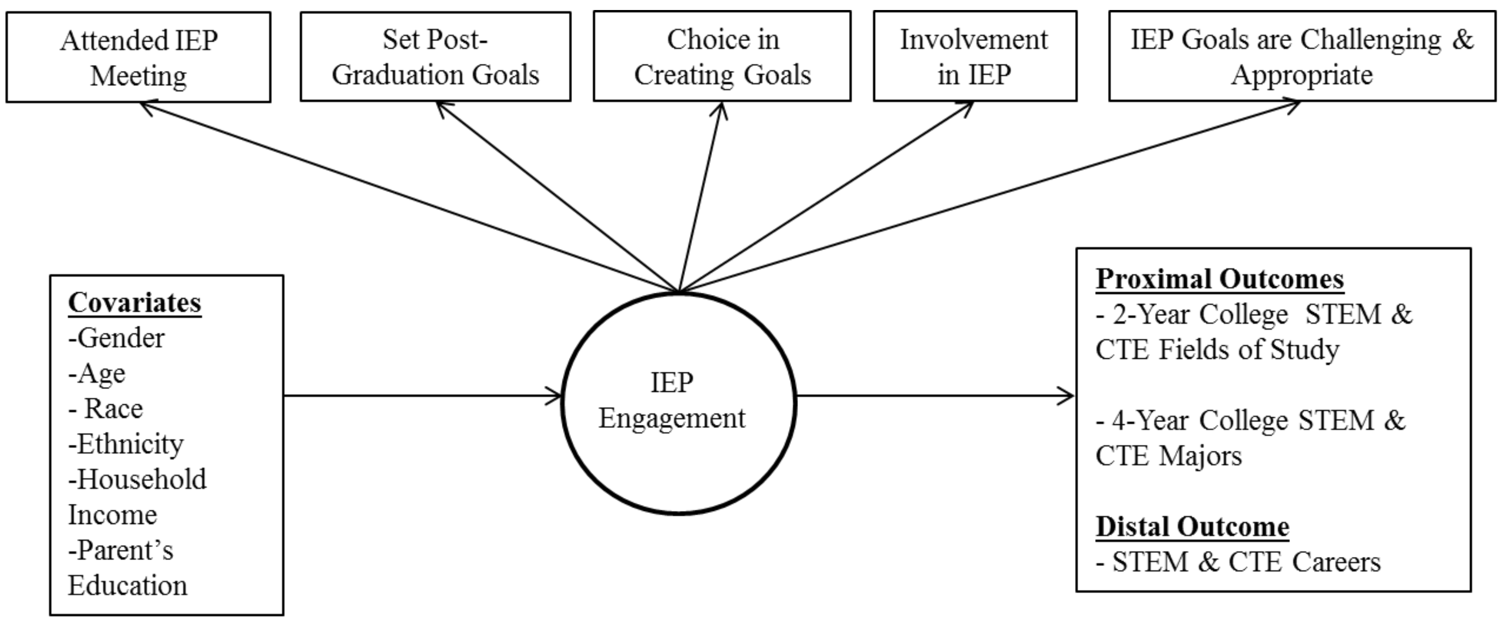

Figure 3A-1. Latent class analysis model for IEP engagement with covariates and proximal and distal outcomes.

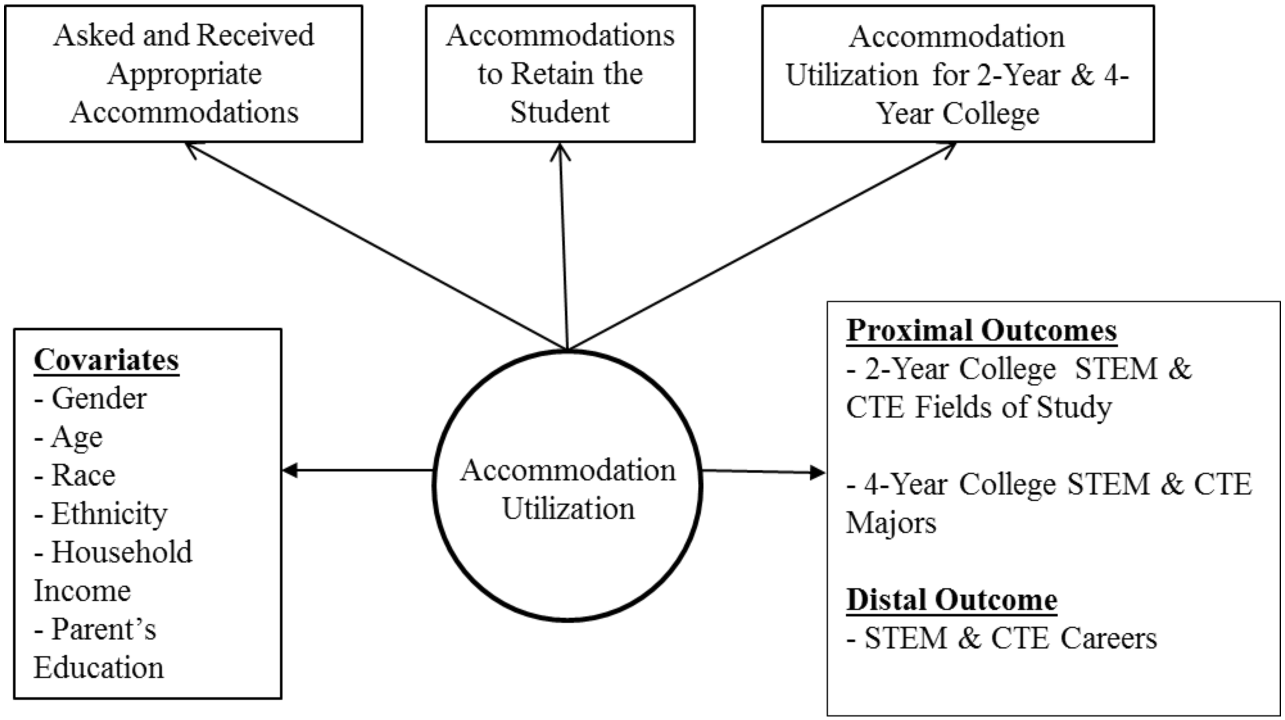

Figure 3A-2. Latent class analysis model for accommodation utilization with covariates and proximal and distal outcomes.

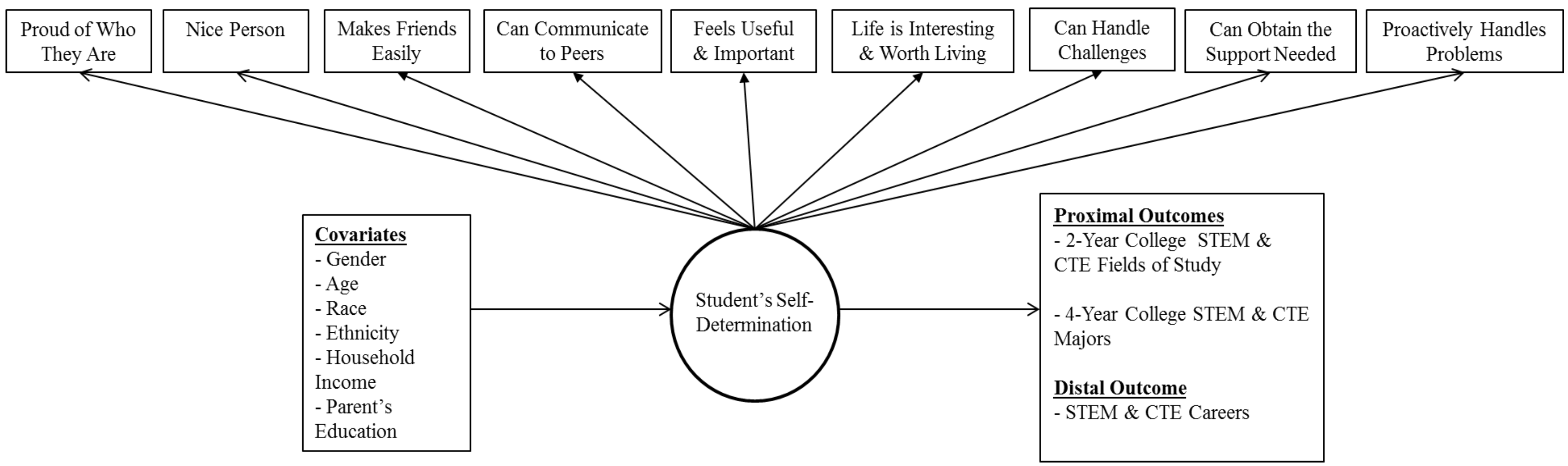

Figure 3A-3. Latent class analysis model for student's self-determination with covariates and proximal and distal outcomes.

CHAPTER FOUR

Conclusion

This study was separated into two chapters that inform each other and shed light on what learning disabled (LD) students are capable of in terms of pursuing a STEM or CTE field and what components are needed to make them successful in that pursuit. Each study also looked at common covariates, such as age, gender, ethnicity, parents' education, and household income. Each study utilized the same sample of LD students (n = 2002) from the National Longitudinal Transition Study-2 (NLTS-2). The studies utilized either latent profile analysis (LPA) for study one or latent class analysis (LCA) for study two to empirically categorize students. By understanding what makes a STEM capable LD student, what postsecondary path they take in pursuit of a STEM or CTE field, and what components aid them in that pursuit we can strategically develop ways to support them and help them reach their full potential. In the following sections each study will be summarized and the significance of the findings and future policy implication will be discussed.

Study One.

The first study explored the STEM capability of LD students and how that affects their outcomes of pursuing STEM or CTE fields in postsecondary education and careers. This study contributed to the literature given that previous studies have not used GPA to classify students into any type of academic capability profiles. Other studies have used test scores to determine a student's academic ability, but not GPA (Bradley, Danielson, & Doolittle, 2005; Steinberg, 2012). Utilizing data for LD students in the NLTS-2 dataset it was found that students could be categorized into two profiles: *High-STEM and CTE Capability* and *Low-STEM Capability,* with over half of the students residing in the *High-STEM and CTE Capability* profile. It was found that students in the *Low-STEM Capability* profile performed well in the technology and trade and industry courses that tend to be more applied and hands-on, while students in the *High-STEM and CTE Capability* profile performed well in both STEM and CTE courses. This finding could be a function of the individual learning styles of LD students and the profile students resided in had implications for whether they pursued postsecondary education in a STEM or CTE field or not. It was found that LD students had a higher mean for pursuing STEM or CTE at the 2-year college as opposed to the 4-year college, which has also been found in other studies (Moon, Todd, Morton, & Ivey, 2012; Moon, Utschig, Todd, & Bozzorg, 2011). Knowing if an LD student is STEM capable can affect the courses they choose to take in high school and the postsecondary and career pathways they may want to pursue.

Study Two

The second study examined how LD students being involved in the IEP process (Baker & Scanlon, 2016; Cobb & Alwell, 2009), possessing self-determination (Chou, Wehmeyer, Palmer, & Lee, 2016; Ryan & Deci, 2004; Thoma & Getzel, 2005), and utilizing accommodations (Eckes & Ochoa, 2005; Madaus & Shaw, 2006; Newman & Madaus, 2015; Salzer, Wick, & Rogers, 2008) can be classified into various engagement classes and how those classes can predict a student pursuing a STEM or CTE field in postsecondary education or for a career. It was found that the LD students in the NLTS-2 sample could be classified into three engagement classes: *Highly Engaged LD Students, Moderately Engaged LD Students,* and *Poorly Engaged LD Students.* Interestingly, students in the *Poorly Engaged* class portrayed the best use of accommodations and they had the highest mean for being in a STEM or CTE career. Female students were significantly more likely to be categorized in the *Highly Engaged* or *Moderately Engaged* classes, which were the classes that pursed postsecondary education in STEM and CTE fields. Students who identified as an ethnicity of Asian, Pacific Islander, Native American, and mixed were significantly more likely to be categorized in the *Moderately Engaged* class, which is the class that had a higher mean for pursing STEM or CTE at the 2-year college. A LD student's engagement level does seem to play a role in them pursing a STEM or CTE field; therefore, finding ways to support and engage students in planning for the future in high school can be one solution to producing a LD STEM and CTE workforce in the future.

Overall Implications

The two studies presented here fill a gap in our understanding of LD students pursuing STEM and CTE fields and they can be used in combination to better prepare LD students to enter, and succeed, in STEM or CTE fields. Utilizing a LPA approach, it was possible to first determine which students are STEM capable in 12th grade prior to transition to postsecondary education or a career. The next step was to use a LCA method to categorize students into engagement classes. Future work could look at taking the STEM capable group of students only and then determining the engagement classes for that group alone. That analysis would be difficult to conduct with the sample size of LD students found in the NLTS-2 study; however, that dataset is now almost a decade old, which could warrant conducting another national study utilizing the NLTS-2 protocol. Students being classified with a LD is on the rise (Cortiella & Horowitz, 2014) and a stronger pool of potential STEM and CTE professionals are needed (Alper, 2016; Iammartino, Bischoff, Willy, & Shapiro, 2016; Stine & Matthews, 2009; Xue, 2015), which makes continuing this work a valuable contribution.

In this study, LD students were overrepresented in the CTE careers in comparison to the STEM careers, which indicates care should be taken in developing policies to increase LD students' representation in science so that "science" does not become synonymous with CTE courses only. It has previously been found that disabled students are less academically prepared to take STEM courses (Gottfried & Sublett, in press; Gottfried, Bozick, Rose, & Moore, 2014), but while it was not a large portion of the sample, a group of LD students were found to perform well in STEM courses at the 12th grade level. Tapping into the *STEM Capable* LD students and ensuring they are encouraged to pursue STEM learning and remain engaged could affect our future as a nation and ensure we are able to fill the STEM and CTE jobs we will need in the future. Another component to consider is what pathway students are taking and should be taking to succeed in STEM and CTE careers. Three postsecondary pathways emerged in this study: vocational school, 2-year college, and 4-year college. There are pros and cons that could be made for each option; however, we need to develop a successful and equitable way of providing LD students with their postsecondary options in high school. It is also important to provide the necessary support to help them make the right postsecondary decisions for the careers they want without pushing them into specific tracks. This is a delicate balance that must be reached, but one way to ensure students have the ability to pursue any pathway is to ensure they are given a strong STEM foundation in high school. By providing student with the necessary STEM skills and abilities they will be able to succeed in either STEM or CTE postsecondary pathways, which can unlock a bright future for them whatever their career desires.

References

Alper, J. (Ed.). (2016). *Developing a National STEM Workforce Strategy: A Workshop Summary*. National Academies Press. doi: 10.17226/21900

Baker, D., & Scanlon, D. (2016). Student Perspectives on Academic Accommodations. *Exceptionality*, *24*(2), 93-108. doi: 10.1080/09362835.2015.1064411

Bradley, R., Danielson, L., & Doolittle, J. (2005). Response to intervention. *Journal of Learning Disabilities*, *38*(6), 485-486. doi: 0.1177/00222194050380060201

Chou, Y. C., Wehmeyer, M. L., Palmer, S. B., & Lee, J. (2016). Comparisons of Self-Determination Among Students With Autism, Intellectual Disability, and Learning Disabilities A Multivariate Analysis. *Focus on Autism and Other Developmental Disabilities,*1-9. doi: 10.1177/1088357615625059

Cobb, B., & Alwell, M. (2009). Transition planning/coordinating interventions for youth with disabilities: A systematic review. *Career Development for Exceptional Individuals*. doi: 10.1177/0885728809336655

Cortiella, C., & Horowitz, S. H. (2014). *The state of learning disabilities: Facts, trends, and emerging issues.* New York: National Center for Learning Disabilities. Retrieved from https://www.ncld.org/wp-content/uploads/2014/11/2014-State-of-LD.pdf

Eckes, S. E., & Ochoa, T. A. (2005). Students with disabilities: Transitioning from high school to higher education. *American Secondary Education*, 6-20. Retrieved from http://www.jstor.org.proxy.library.ucsb.edu:2048/stable/pdf/41064551.pdf

Gottfried, M. A., & Sublett, C. (in press). Is there a role of applied STEM coursetaking for students with learning disabilities? *Journal of Learning Disabilities.*

Gottfried, M. A., Bozick, R., Rose, E., & Moore, R. (2016). Does Career and Technical Education Strengthen the STEM Pipeline? Comparing Students With and Without Disabilities. *Journal of Disability Policy Studies*,*26,* 232-244. doi: 0.1177/1044207314544369

Iammartino, R., Bischoff, J., Willy, C., & Shapiro, P. (2016). Emergence in the US Science, Technology, Engineering, and Mathematics (STEM) workforce: an agent-based model of worker attrition and group size in high-density STEM organizations. *Complex & Intelligent Systems*, *2*(1), 23-34. doi: 10.1007/s40747-016-0015-7

Madaus, J. W., & Shaw, S. F. (2006). The impact of the IDEA 2004 on transition to college for students with learning disabilities. *Learning Disabilities Research & Practice*, *21*(4), 273-281. doi: 10.1111/j.1540-5826.2006.00223.x

Moon, N. W., Todd, R. L., Morton, D. L., & Ivey, E. (2012). *Accommodating students with disabilities in science, technology, engineering, and mathematics (STEM).* Retrieved from Center for Assistive Technology and Environmental Access, Georgia Institute of Technology: http://advance.cc.lehigh.edu/sites/advance.cc.lehigh.edu/files/accommodating.pdf

Moon, N. W., Utschig, T. T., Todd, R. L., & Bozzorg, A. (2011). Evaluation of Programmatic Interventions to Improve Postsecondary STEM Education for

Students with Disabilities: Findings from SciTrain University. *Journal of Postsecondary Education and Disability*, *24*(4), 331-349. Retrieved from http://files.eric.ed.gov/fulltext/EJ966141.pdf

Newman, L. A., & Madaus, J. W. (2015). An Analysis of Factors Related to Receipt of Accommodations and Services by Postsecondary Students With Disabilities. *Remedial and Special Education*, *36*(4), 208-219. doi:10.1177/0741932515572912

Ryan, R. M. & Deci, E. L. (2002). Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 3-36). Woodbridge, Suffolk, UK: University of Rochester Press.

Salzer, M. S., Wick, L. C., & Rogers, J. A. (2008). Familiarity with and use of accommodations and supports among postsecondary students with mental illnesses. *Psychiatric Services*. Retrieved from http://ps.psychiatryonline.org/doi/pdf/10.1176/ps.2008.59.4.370

Stine, D. D., & Matthews, C. M. (2009). The US science and technology workforce. *Federal Publications*, 644. Retrieved from http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1649&context=key_workplace

Steinberg, G. (2012). Amending Sec. 1415 of the IDEA: Extending Procedural Safeguards to Response-to-Intervention Students. *Colum. JL & Soc. Probs.*, *46*, 393. Retrieved from http://www.columbia.edu/cu/jlsp/pdf/Spring2013/Steinberg.pdf

Thoma, C. A., & Getzel, E. E. (2005). " Self-determination is what it's all about": What Postsecondary Students with Disabilities Tell us are Important Considerations for Success. *Education and Training in Developmental Disabilities*, 234-242. Retrieved from http://www.jstor.org.proxy.library.ucsb.edu:2048/stable/pdf/23879718.pdf

Xue, Y., & Larson, R. C. (2015). STEM Crisis or STEM Surplus: Yes and Yes. *Monthly Lab. Rev.*, *138*, 1. Retrieved from http://www.bls.gov/opub/mlr/2015/article/stem-crisis-or-stem-surplus-yes-and-yes.htm