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Demographics, Persistence, and Academic Performance: A Logistic Regression Analysis of who Chooses to Enter the Mathematics and Science Teaching Pipeline

Esther Joseph
efineus@fiu.edu

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

DEMOGRAPHICS, PERSISTENCE, AND ACADEMIC PERFORMANCE: A LOGISTIC REGRESSION ANALYSIS OF WHO CHOOSES TO ENTER THE MATHEMATICS AND SCIENCE TEACHING PIPELINE

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Esther Joseph

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To: Dean Delia Garcia
College of Education

This dissertation, written by Esther Joseph, and entitled Demographics, Persistence, and Academic Performance: a Logistic Regression Analysis of who Chooses to Enter the Mathematics and Science Teaching Pipeline, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

_____
Barbara King

_____
Joanne Sanders-Reio

_____
Gunhan Caglayan

_____
Maria L. Fernandez, Major Professor

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The dissertation of Esther Joseph is approved.

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Dean Delia C. Garcia
College of Education

_____
Dean Lakshmi N. Reddi
University Graduate School

Florida International University, 2014

DEDICATION

To God be the glory for all of the great things he has done

To my heart, my soul, and my better half Elmo. You believed in me when I didn't believe in me…So this is for you.

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ABSTRACT OF THE DISSERTATION

DEMOGRAPHICS, PERSISTENCE, AND ACADEMIC PERFORMANCE: A LOGISTIC REGRESSION ANALYSIS OF WHO CHOOSES TO ENTER THE MATHEMATICS AND SCIENCE TEACHING PIPELINE

by

Esther Joseph

Florida International University, 204

Miami, Florida

Professor Maria L. Fernandez, Major Professor

As of 1999, high school teachers without majors in their subject areas number 37% of biology teachers, 59% of physical science teachers, and 60% of mathematics teachers. These discouraging statistics grow more extreme in middle schools and high poverty public high schools, especially regarding mathematics and physical sciences instruction. The statistics are especially worrisome given the strong correlation between thorough teacher subject matter preparation and higher student performance. Unfortunately, the literature is limited in terms of a direct comparison between mathematics and science majors and individuals who become mathematics and science teachers. This study was undertaken to add to the body of literature in hopes of informing universities and school districts of the characteristics of individuals who enter the mathematics and science teacher pipeline.

The purpose of this study was to determine whether predictive relationships exist among the independent variables and the dependent variable, and whether certain attributes account for significant differences between mathematics and science degree earners who choose to enter the mathematics and science teacher pipeline and those who show no interest in mathematics and science teaching. This study provided a snapshot of the characteristics of both groups of individuals.

The sample for this investigation came from the Baccalaureate and Beyond Longitudinal Study (B&B: 08/09) cohort of approximately 19,000. B&B:08/09 examined information on students' educational and work experiences after they completed a bachelor's degree, with a special emphasis on the experiences of new elementary and secondary teachers. In the present study, the sample consisted of 2,400 individuals majoring in mathematics and science fields including mathematics and science education.

The research design that was used is the analytical cross sectional design. The analytical cross sectional design investigates associations and measures differences between groups. In this study, deep descriptions were used to describe the sample. A logistic regression analysis was used to assess the degree to which the dependent (outcome) variable, teacher pipeline status, is related to the independent (predictor) variables (persistence, academic performance, selected demographics).

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CHAPTER I

In 2010 the President's Council of Advisors on Science and Technology (PCAST) report revealed the current state of Science, Technology, Engineering, Mathematics (STEM) education and the vital role it plays in the United States maintaining its leadership in technology internationally. Currently the United States is behind other nations in STEM education at both the elementary and secondary grades. Scientific progress is essential in economic growth therefore students must expand both their education and their technical skills in order to become academically competitive. PCAST calls the federal government to action by setting a goal to recruit and train 100,000 great STEM teachers over the next decade who are able to prepare and inspire students (President's Council of Advisors on Science and Technology, 2010).

This report is in response to the growing shortages of mathematics and science teachers nationwide. In 1999-2000, approximately 50,000 more teachers left the profession than entered it (Stern, 2003). This shortage has caused school districts nationwide to employ more than 10,000 international teachers with H1B visas (Education week, 2003). Unfortunately, low math and science achievement has become an international epidemic (OECD, 2011). With limited interest in mathematics and science teaching internationally and a governmental decrease in granting H1B visas, recruiting foreign born teachers is doing little to remedy this shortage.

In 2000, 61% of high schools and 48% of middle schools had difficulty locating qualified science teachers to fill vacancies (National Science Teachers Association, 2000). By 2008, 260,000 to 290,000 new mathematics and science teachers were needed

for secondary schools alone (U.S. Department of Education, 2008a). With this dire need for mathematics and science teachers and a shortage of available teachers, students are being placed in classrooms with less qualified teachers. The need for elementary and secondary teachers is increasing quicker than the supply, resulting in the hiring of uncertified teachers and out of field assignments (Darling-Hammond, Kirby, & Hudson, 1989). Sixty-one percent of students are taught mathematics by teachers who do not have a major or minor in mathematics, mathematics education, or a related field. These statistics significantly increase in schools with high-poverty rates (Ingersoll, 1999).

Studies have shown a strong correlation between teacher content knowledge and student achievement, revealing that poor teacher competency in terms of content knowledge is associated with low mathematical achievement among students (Hanushek, 1986; Rice, 2003; Wayne & Youngs, 2003). Students whose math teachers received subject-specific training (a mathematics degree or certification) outperformed those without subject matter preparation (Goldhaber & Brewer, 1997; Monk & King, 1994). As previously stated, 61% of high schools and 48% of middle schools had difficulty locating qualified science teachers to fill vacancies (National Science Teachers Association, 2000). If each of these classrooms filled their vacancies with under-qualified teachers, it would be expected to result in low student mathematical achievement.

In the year 2000, mathematics scores for 12th graders indicated only 80 percent failed to reach the Proficient level in mathematics on the 2000 NAEP assessment (National Center for Education Statistics (NCES), 2001). In 2003, nearly 70 percent of fourth and eighth grade students participating in the National Assessment of Educational Progress (NAEP) failed to reach the Proficient level in mathematics (NCES, 2004).

According to the Trends in International Mathematics and Science Study (TIMSS), in 2007 fourth and eighth grade students in the United States fell behind their international counterparts in mathematics and science. The report revealed a significant disparity among U.S. students, particularly in mathematics and science. The Program for International Student Assessment (PISA) is an international assessment that measures 15-year-old students' reading, mathematics, and science literacy. In 2008, 15-year-olds in the United States ranked 25th in mathematics and 17th in science in PISA scores among OECD nations. These results suggest that problems in U.S. STEM education may begin as early as elementary school and continue through students' secondary education. Unfortunately, the lack of mathematics and science proficiency of students decreases when disaggregated by race and ethnicity.

In 2003, Hispanic and African-American student achievement scores in mathematics remained lower than those of their white peers (NCES, 2003) According to NCES in the fourth grade, 43 percent of white students were Proficient in mathematics while only 10 percent of African-American and 16 percent of Hispanic students exhibited mathematics proficiency. The findings were similar for eighth graders (NCES, 2004).

Due to the high positive correlation between content knowledge and student achievement and the undeniable poor mathematics and science performance among U.S. students, there is a distinct need for recruitment of more highly qualified mathematics and science teachers in particular those knowledgeable in both content and pedagogical content knowledge (Coble, 2012). In order for students in the United States to become academically competitive in mathematics and science, their respective teachers must be qualified (Mete, 2010). However, recruiting more highly qualified mathematics and

science teachers may not be enough to remedy this extreme shortage but increasing the diversity in the candidates interested in entering the teacher pipeline may remedy this issue.

According to the U.S Census bureau the non-Hispanic white population will fall from 74 percent to 53 percent by the year 2050 (BHEF, 2002). Given the lack of mathematics and science proficiency among minorities, bridging the achievement gap will be an imperative component in providing academically capable and highly qualified mathematics and science teachers in the future. To become truly academically competitive the United States would benefit from recruiting racially and ethnically diverse highly qualified mathematics and science teachers.

This study seeks to add to the body of literature in hopes of informing universities and school districts of the characteristics of individuals who enter the mathematics and science teacher pipeline for the purpose of recruitment.

Statement of the Problem

According to the United States Department of Education (2000b) study, "Progress through the Teacher Pipeline," though 20% of mathematics, science, and technology undergraduate students considered teaching, only 5% completed teacher preparation programs and accepted teaching jobs. Within a similar time period, there were an estimated 200,000 vacancies for secondary mathematics and science teachers in the U.S. (National Research Council, 2002). Additionally, in 2004, Staniec revealed a distinct underrepresentation of women and minorities among mathematics and science teachers, thus suggesting both sex and race/ethnicity as potential factors in recruitment.

At present, there is a lack of understanding about individuals with mathematics and science backgrounds who are considering teaching, as evidenced by joining the teaching pipeline. The lack of understanding can hinder the development and implementation of approaches to recruitment to assist in increasing the number of mathematics and science teachers, particularly those from diverse backgrounds and with strong content and pedagogical content knowledge.

Purpose of the Study

The purpose of this study was to add to the body of literature on individuals who enter the mathematics and science teacher pipeline. This study sought to determine whether predictive relationships exist among the independent variables (selected demographics, persistence, academic performance) and the dependent variable (decision to enter the mathematics and science teacher pipeline) and whether these selected variables account for a significant amount of variance between mathematics and science degree earners who entered the teacher pipeline and mathematics and science degree earners who did not enter the teacher pipeline. Since teacher pipeline status was confounded by selected demographics, this study examined whether stopout persistence and academic performance account for a significant amount of variance when holding demographics constant.

Bronfenbrenner's (1979) macrosystem describes how cultural contexts impact an individual's actions and reactions. These cultural contexts include socioeconomic status, race/ethnicity and sex; all of which were evaluated through the selected demographics

variable. This study used Bronfenbrenner's (1979) theory as a lens in evaluating the impact demographics had on teacher pipeline status.

This study examined selected demographics, persistence, and academic performance of those who entered the teacher pipeline to provide a snapshot of the attributes of individuals earning degrees in mathematics and science fields including education that entered the teacher pipeline. The study observed teacher pipeline status since this group was most susceptible to recruitment thus providing insightful results to help broaden recruitment efforts (ACT, 2013).

This study used the Baccalaureate and beyond data set. The Baccalaureate and Beyond Longitudinal Study (B&B: 08/09) examined students' educational and work experiences after they completed a bachelor's degree, with a special emphasis on the experiences of new elementary and secondary teachers. The population consists of approximately 19,000 individuals but the sample consisted of 2,400 individuals because this number represents the total number of mathematics and science degree earners, including mathematics and science education majors. A logistic regression was conducted on mathematics and science majors' teacher pipeline status based on selected variables. These variables were judged as important from the literature in individuals' decisions to pursue mathematics and science teaching and the need for a diverse teacher workforce strong in mathematics and science content and pedagogical content knowledge.

Operational Definitions of Variables

Stopout Persistence. This term is not easily measurable quantitatively; it was measured using a few factors. Persistence as defined by B&B: 08/09 measures whether

the respondent ever stopped out (took a break in enrollment of more than four months) en route to completing the 2007-08 bachelor's degree. Here are some reasons respondents might “stop out”:

- for personal reasons;
- because they needed time off from studying;
- because they needed to work;
- due to academic problems;
- due to change in family status;
- due to conflict with a job or military;
- for other financial reasons;
- to enroll in bachelor’s degree somewhere else;

Additionally, it is important to mention that while persistence is generally considered a favorable trait, this study was not making this assumption nor was it stating that one career choice shows more persistence than another. This study was investigating whether persistence was a significant variable in predicting an individual’s decision to become a mathematics or science teacher. More specifically, this study was evaluating student stop out persistence.

Course History. This term was defined as the difference of College level mathematics/science credits attempted and College level mathematics/science credits earned as measured in the Baccalaureate and Beyond Longitudinal Study: 08/09.

Academic performance. This term was measured by performance based on course history and grade point average (GPA) in mathematics or science courses.

STEM-GPA. This acronym indicates the respondent's cumulative mathematics or science undergraduate grade point average (GPA) as of 2007-08 as measured in the Baccalaureate and Beyond Longitudinal Study: 08/09.

Sex. This term was defined as Male or Female.

Race/Ethnicity. This term indicates the respondent's race/ethnicity with Hispanic or Latino origin as a separate category as measured in the Baccalaureate and Beyond Longitudinal Study: 08/09.

Age. This term was defined as of 12/31/07 as measured in the Baccalaureate and Beyond Longitudinal Study.

Marital Status. This term indicates the respondent's marital status during the 2007-08 academic year, (as measured in the Baccalaureate and Beyond Longitudinal Study: 08/09).

Dependency. This term indicates whether the respondent was financially supporting any dependents at the time of the B&B: 09 interview, (as measured in the Baccalaureate and Beyond Longitudinal Study).

SES. This term indicates whether the respondent met eligibility criteria for the federal TRIO Programs (meaning they were low income and first generation students in college), based on combinations of income and parent education levels as measured in the Baccalaureate and Beyond Longitudinal Study.

Teacher pipeline. This term refers to graduates who have participated in preparatory activities considered teaching, served as a student teacher as an undergraduate, become certified to teach, applied for teaching jobs, as well as gained teaching experiences and made plans for teaching in the future.

Research Questions

Q1. Are mathematics and science graduates in the teacher pipeline and the non-teacher pipeline similar in terms of selected demographics (sex, race/ethnicity, age, marital status, dependency, SES), stopout persistence, and academic performance (course history, STEM GPA)?

Q2. Do selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

Q3. Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) constant, does stopout persistence account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

Q4. Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence constant, does academic performance (course history, STEM GPA) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

Overall, the researcher was interested in determining whether predictive relationships exist among the independent variables (selected demographics, persistence, and academic performance) and the dependent variable (decision to enter the mathematics and science teacher pipeline).

Significance of the Study

As previously discussed, there is a distinct shortage of qualified mathematics and science teachers (Villegas, 2001; Shugart & Hounshell, 1995). Additionally, within the mathematics and science teacher 'pool' there is a lack of gender and racial/ethnic diversity (Staniec, 2004). Mathematics and science degree earners' characteristics in terms of selected demographics, persistence, and academic performance have not been widely researched in the context of predicting teacher pipeline status. This study is unique in its use of the Baccalaureate and Beyond Longitudinal Study (B&B: 08/09) data set in comparing mathematics and science degree earners who entered the teacher pipeline and those who did not enter the teacher pipeline and in drawing on Bronfenbrenner's (1979) Theory as a lens in analyzing the findings. Accurately predicting teacher pipeline status will not only help universities understand who entered the teacher pipeline but it will also give them an opportunity to use targeted recruitment and develop interventions as needed.

Hypotheses

The hypotheses for the study are listed below.

1. Demographics account for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
    a. Sex accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the

mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

b. Race/ethnicity accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

c. Age accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

d. Marital Status accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

e. Dependency accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

f. SES accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

2. Persistence accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
3. Academic performance accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
    a. Course history accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
    b. STEM GPA accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

4. Mathematics and science degree earners within the mathematics and science teacher pipeline will have higher levels of persistence and academic performance than those not in the teacher pipeline.

5. Mathematics and science degree earners within the mathematics and science teacher pipeline will have higher levels of variation of selected demographics than those not in the teacher pipeline.

Delimitations

Given the data set being used, Baccalaureate and Beyond Longitudinal Study (B&B: 08/09), the present study consisted of three main delimitations. B&B:08/09 consists of sample members who completed bachelor's degree requirements between July 1, 2007 and June 30, 2008 identified from the National Postsecondary Student Aid Study (NPSAS:08) (Wine et al., 2013). The study was confined to an investigation of mathematics and computer science majors as one group since B&B:08/09 combined these two majors. Since the coursework within these majors are similar, they were grouped together within this dataset and cannot be disaggregated. Finally, the study was confined to mathematics and science majors. Engineering students were not included in the study because the researcher wanted to investigate majors where students could get traditionally certified in the field.

Chapter Summary

The need for highly qualified, as defined by NCLB, mathematics and science teachers is not a new concept. Difficulty in recruitment has in turn resulted in the hiring of less qualified educators for these positions. Given the negative effect underqualified teachers have on students' achievement along with the number of teachers teaching out of field emphasizes the need for a clearer understanding of the characteristics of students entering the teacher pipeline in order to provide suggestions for recruitment. This study was undertaken to ameliorate this issue of underqualified mathematics and science teacher recruits by identifying the attributes of mathematics and science teachers and to see if the variables chosen are predictors for those who enter the teacher pipeline. This

chapter included the statement of the problem, purpose of the study, operational definitions, research questions, hypotheses, and delimitations. Chapter 2 includes the literature review, theoretical framework, and the conceptual framework. Chapter 3 delineates the research methods employed for this study. Chapter 4 presents the results of the study. Chapter 5 discusses the results, implications, and ends with a conclusion.

CHAPTER II

Review of Literature

The following literature review discusses theoretical and empirical work that supports the current study. The review discusses the theoretical framework of the study and reviews the literature on recruitment, selected demographics, stopout persistence and academic performance in relation to the current study. Rigorous review of the literature revealed a lack of studies comparing mathematics and science educators to mathematics and science non-educators. It is for this reason that much of the literature cited in this study discusses mathematics and science teachers in comparison to general educators. The databases used were Eric, EBSCO, Expanded Academic, Wiley, and JSTOR. The following keywords were inputted: recruitment, mathematics, science, academic AND mathematics AND education, mathematics education AND academic performance AND teacher education science education AND academic performance AND teacher education, college academic performance AND teacher recruitment, STEM recruitment, STEM persistence, and STEM academic performance.

According to Baccalaureate and Beyond (B & B: 08/09), an individual is part of the teacher pipeline if the individual is enrolled in a teacher preparation program, expresses interest in teaching or has had experience in the classroom. This experience can be short term, permanent, or a supportive role. The teacher pipeline was based on those who participated in preparatory activities that were considered teaching, served as a student-teacher as an undergraduate, became certified to teach, applied for teaching jobs, or gained teaching experiences and made plans for teaching in the future.

Currently, there is a distinct disconnect between the number of mathematics and science majors and the number of majors who choose to teach. In 1997, 31% of mathematics and science majors entered the teaching pipeline but only 8.6% ended up teaching—3% of whom were not pedagogically prepared (U.S. Department of Education, 2000b). In 1999, 59% of physical science teachers, 37% of biology teachers, and 60% of mathematics teachers were teaching outside of their fields of specialization (National Science Foundation, 2004). These staggering numbers tend to be higher in urban schools.

According to the National Research Council (2009), the effects of under-qualified mathematics or science educators have been evident in United States schools for decades. These effects include but are not limited to the following:

- Fewer than one-third of U.S. eighth grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter. Alarmingly, about one-fifth of the 4th graders and one-third of the 8th graders lacked the competence to perform even basic mathematical computations.
- In 1999, 69% of U.S. fifth to eighth grade students received instruction from a mathematics teacher who did not hold a degree or certification in mathematics.
- In 2000, 93% of students in Grades five to eight were taught physical science by a teacher lacking a major or certification in the physical sciences (chemistry, geology, general science, or physics).
- In 1995 (the most recent data available), U.S. 12th graders performed below the international average for 21 countries on a test of general knowledge in mathematics and science.

- US 15-year-olds ranked 27th out of 39 countries that participated in a 2003 administration of the Program for International Student Assessment (PISA) examination, which assessed students' ability to apply mathematical concepts to real-world problems.
- 86% of U.S. voters believe that the United States must increase the number of workers with a background in science and mathematics or America's ability to compete in the global economy will diminish (National Research Council, 2009, p. 15).

Based on the previous statistics, U.S. students are under performing when compared to their counterparts in other countries. Since student academic achievement is closely linked to teacher content knowledge, it is imperative that teachers are qualified in the content they teach which suggests a distinct need for highly qualified science and mathematics individuals to become secondary school teachers.

Recruitment

Recent initiatives such as the 100kin10 Challenge have reintroduced the national need for recruitment, preparation, retention, and support of mathematics or science teachers (Obama, 2011). This initiative calls for over the 100,000 new mathematics and science teachers over the next 10 years. Additionally, the Mathematics Teacher Education Partnership (MTE-P) was recently formed under the auspices of the Association of Public and Land-Grant Universities (APLU) to meet the challenge of increasing the number of high-quality and diverse secondary mathematics teacher candidates recruited into and graduating from our universities (MTE-P, 2012). The need for mathematics or science

teachers has been an issue nationally for over half a century. Millions have been spent on programs whose sole purpose is to recruit and prepare talented science and mathematics majors (Rothwell, 2013). Unfortunately, the need is much greater than the number of teachers produced therefore suggesting the need for new and unique approaches.

Numerous studies on teacher recruitment have been conducted; however, few were done on mathematics and science teachers. Therefore, much of the literature reviewed involves general education (Clewell & Villegas, 2001; Henke, Chen, Geis, & Knepper, 2000, Shugart & Hounshell, 1995, U.S. Department of Education, 2000a). The main area studied involved difficulties with recruitment. Factors concerning recruitment were studied, and salary, community, school, administration, teacher professionalism, and student achievement were the top concerns of prospective teachers (Amrein-Beardsley, 2012).

Ballou and Podgursky (1995) researched whether an increase in salary would significantly increase the prospects of recruiting teachers with higher academic performance. They found that higher salaries enlarged the applicant pool by encouraging applicants of all academic performance levels to enter teaching. They also found that higher wages increased retention in the field. In terms of academic performance, the researchers found the average SAT scores of the teaching workforce increased as the salary increased. The initial share of high-ranking SAT teachers (those in the 86 to 100 percentile) in the teaching workforce was 5.1 percent, and the average SAT score was 925. After a 20 percent wage increase, the share of high-ranking SAT teachers increased 7.6 percent on average (Ballou & Podgursky, 1995). While Ballou and Podgursky make a valuable point, they failed to find a causal linkage. Additionally, the overall purpose of

the present study was to determine who enters the teacher pipeline and who does not. Therefore, obtaining salary requirements does not deter us from the overall objective. For those reasons, income was not addressed in this study.

Moreover, Hanushek and Pace (1995) researched the effects of salary, teacher certification requirement, and recruitment of individuals entering the teaching field. Hanushek and Pace analyzed longitudinal data from High School and Beyond (HSB) surveys and observed employment decisions of 4,509 high school seniors after college graduation. The population of the study consisted of a single high school cohort from 1980 to 1984. Students in this study were divided into "original aspirants" and "late aspirants" groups. The original aspirants were teacher-education students who had expressed an interest in teaching while in high school. The late aspirants were students engaged in teacher-education programs who had not indicated an aspiration to teach while in high school. This study found that the majority of individuals in teacher-education programs did not aspire to teach while in high school, and only a very small proportion actually did. In addition, the study revealed that salary was not a significant deterrent to students' choices to pursue a career in teaching. Thus, revealing that salary does not necessarily have to be a recruitment tactic (Hanushek & Pace, 1995), which is in direct disagreement with previously mentioned literature.

Furthermore, Gordon (1994) addressed the issue of recruitment of minorities and researched the reasons why students of color were not pursuing careers in teaching. Gordon interviewed 114 minority teachers from three urban cities. The teachers cited the reasons they chose to teach, characteristics of an effective teacher, and obstacles for minority teachers. Gordon cited the main causes of discouragement for minority students

to pursue teaching as (a) negative experiences in school; (b) poor student discipline and lack of respect in the classroom; (c) the low status of teachers; (d) low pay; (e) professional image of a middle-class female; and (f) availability of other jobs for talented students of color (Gordon, 1994).

Farkas, Johnson, and Foleno (2000) investigated the attitudes and perceptions of new educators, college graduates, and administration, their perceptions of their new profession, and the perception of non-education graduates. Three telephone surveys were conducted with 664 K-12 public school teachers, 511 superintendents and principals, and 802 college graduates. This study examined new teachers, college graduates, and pay scale as a dominant recruitment tool. The study compared and contrasted the responses from each group providing a multifaceted view. All three groups cited the top reason to teach as being the love of the profession. Individuals who chose not to enter the teaching profession found the job to be undesirable in terms of pay and prestige.

In 2013, ACT investigated characteristics of potential mathematics and science educators for achieving the PCAST (2010) goal of 100,000 quality STEM teachers in 10 years. Researchers analyzed students on the basis of three characteristics: STEM interested, STEM qualified education majors, and STEM capable students. STEM interested students cited mathematics or science education as their desired majors in college. STEM qualified education majors are students interested in majoring in education without a science or mathematics specialty. STEM capable students are students who have met or exceeded the college readiness benchmarks in mathematics or science but have not shown interest in majoring in education. The ACT (2013) study consisted of 1.3 million high school graduates. Of that number, 76,375 expressed an

interest in education and 3,877 expressed interest in teaching mathematics or science. Of the 76,375 graduates interested in pursuing an education major, 28,372 education majors met the college readiness mathematics benchmark and 16,608 education majors met the college readiness science benchmark. High school juniors and seniors were surveyed to gauge STEM capability and 133,231 students were found to be STEM capable. Since a limited group of students are both interested and capable, suggestions were made in regards to target groups for recruitment. ACT (2013) suggested encouraging students interested in education to pursue mathematics and science teaching. While this suggestion is useful, as stated by ACT (2013), many of the education majors are not STEM qualified. The present study was unique because all degree earners considered were STEM qualified.

Theoretical Framework

Demographics, persistence, and academic performance are a set of interrelated constructs that provided perspective through which the research problem was viewed and through which the choices about the research were made. Currently, there is no theory that directly explains why selected demographics, stopout persistence, and academic performance should predict teacher pipeline status. Thus, it may be best explained by discussing how these concepts are related to an individual's actions. In *A dynamic theory of personality,* Kurt Lewin (1935) classified human behavior through the use of a formula. Lewin believed that behavior was a result of an interaction of person and environment. Urie Bronfenbrenner (1979) revised Lewin's theory and created the ecological systems theory. Bronfenbrenner's theory discussed the effects environment

and development have on one another. Each environmental influence was labeled and classified as one of the following: the microsystem, the mesosystem, the exosystem, and the macrosystem. The macrosystem encompasses the overall patterns of micro-, meso-, and exosystems characteristic of a given culture, subculture, or other broader social context; all of which are indicative of an individual's belief systems, resources, life styles, and opportunity structures (Bronfenbrenner, 1979).

Bronfenbrenner's (1979) macrosystem is most relevant to this study because it describes how cultural contexts impact an individual's actions and reactions. Cultural contexts include socioeconomic status, race/ethnicity, and sex. Berk (2000) found that the influence of the macrosystem penetrated through all of the other layers to impact development. According to Bronfenbrenner's (1979) theory, the largest impact on an individual's development, actions, and reactions are demographics. Thus, suggesting demographics may significantly affect teacher pipeline status.

Demographics

Since academic competiveness in mathematics and science is of great interest to the United States, it is imperative to understand the demographics of the students who choose to enter the mathematics and science teacher pipeline and those who study mathematics and science in order to inform on recruiting and understanding differences. Chen (2009) analyzed as the main data source the 1995-96 Beginning Postsecondary Students Longitudinal Study which consisted of 12,000 students. Chen (2009) found that White and Asian/Pacific Islander students had higher STEM-degree completion rates than Black and Hispanic students. In terms of dependency, Chen found that students who filed as dependents completed STEM degrees at a higher rate than independent students.

Additionally, male students and students of higher SES were more likely to pursue a career in STEM. This study provided useful insight on the state of STEM degree earners on a national level; unfortunately it was conducted nearly two decades ago and did not look at STEM majors who enter the teacher pipeline.

Trusty's (2002) study evaluated race/ethnicity, sex, and SES with respect to choice of college major. Like Chen (2009), Trusty revealed that African American and Hispanic male students from higher socioeconomic backgrounds were more likely to pursue science and mathematics majors in college than those from lower socioeconomic backgrounds; however, minority females from high SES backgrounds were not apt to do the same. This study utilized a large data base, the National Education Longitudinal Study of 1998. The data used is nearly 16 years old. Additionally, the analysis focused only on science, engineering, and mathematics (SEM) majors, not mathematics and science education majors.

Teacher Career Choices: Timing of Teacher Careers Among 1992–93 Bachelor's Degree Recipients by Sharon Anderson (2008), used the Baccalaureate and Beyond Longitudinal Study (B&B:93/03) to examine the characteristics of graduates who enter and leave teaching. Anderson (2008) found that within ten-years of graduating nearly three-quarters of the 1993 degree earners were either married or cohabiting/living with a partner. Interestingly, graduates who taught consistently had the lowest rates of remaining single, quantitatively speaking 34 percent of married teachers taught consistently, compared to19 percent of teachers who were never married (Anderson, 2008). These statistics suggest a correlation between marital status and retention. Since marital status

was said to have a correlation with staying in the teacher pipeline, it would be interesting to determine if marital status was a factor in entering the teacher pipeline.

Digest of Educational Statistics (1999) found the attendance of non-traditional college students (students over the age 24) was increasing 6 times faster than traditional college students. However, Tinto (1993) found that attrition among non-traditional college students was remarkably higher than traditional college students. Investigating how age factors into an individual's decision to join the mathematics or science teacher pipeline can provide valuable information on a group that may potentially be a viable source for recruitment.

Persistence

Students endure a great deal over the course of their studies. Many of these predicaments cause them to postpone or even cease their studies indefinitely, but those with high levels of persistence endure and complete their degree programs (Shaw & Barbuti, 2011). This study investigated student stopout persistence in relation to joining the mathematics and science teacher pipeline.

A 2006 study revealed the effects of interrupted enrollment on graduation and found that students who stopout initially were more likely to stopout again and were less likely to graduate (DesJardins, Ahlburg, & McCall, 2006). Consistent with this finding, Adelman (2006) reported that students who took more than a semester break from their college courses are at high risk of not graduating. Since individuals with high levels of persistence graduate and individuals who stop out are less likely to graduate, it was fair to assume a negative correlation between stopping out and graduation. As the extent of gaps in enrollment increases, the levels of persistence to complete the degree program

decreases. While all of the individuals in the present study have graduated, it is useful to understand the reasons mathematics or science majors stopout and the extent that stopout is related to teacher pipeline status. The information gained can be used by universities to supply potential teacher recruits with the needs necessary to recruit and retain them within the teacher pipeline.

Warburton, Bugarin, and Nuñez (2001) suggested patterns of enrollment are attributed to whether students' parents were college educated. First generation students were found to have more stops in enrollment when compared to their peers. Warburton, Bugarin, and Nuñez (2001) found that first generation students who took rigorous coursework in high school had stopout rates similar to their peers who were not first generation students. Rigorous coursework was defined as advanced science (biology, chemistry, and physics), 4years of mathematics (including algebra I, geometry, algebra II, and precalculus), 3 years of foreign language and one honors/Advanced Placement (AP) course or AP test score. Unfortunately, the study did not disaggregate the data by degree choice which does little to inform us about mathematics and science education majors.

Social and environmental factors affecting persistence. There are three types of factors that affect persistence: social and environmental factors, traumatic factors, and intrinsic factors (Castles, 2004). Social and environmental factors related to persistence are time allotted in terms of studying, work patterns, and support (Castles, 2004). Much of the research involving persistence cites time management as a major issue students face. Blaxter and Tight (1994) found that many of the women they interviewed had families and work commitments that had primary importance thus superseding their educational obligations. Each individual in the study found it difficult to cope with their

responsibilities while maintaining enrollment. In addition, Kember (1995) examined adult learners with existing families, jobs, and commitments internationally and found that each student was confronted with conflicts between their educational obligations and their other commitments. Kember (1995) identified negotiation, sacrifice and support as some of the many factors affecting persistence. Of these three factors, support was found to be the most crucial in encouraging persistence.

Traumatic factors affecting persistence. Traumatic factors affecting student persistence in degree programs are illness, bereavement, caring for children, and unemployment (Castles, 2004). Lazarus and Folkman (1984) pinpointed two types of stress: chronic and acute. Chronic stress refers to ongoing stressful problems such as financial issues. Acute stress refers to unexpected and abrupt stressful situations such as family conflict. Both were found to traumatize students and negatively impact their levels of persistence. The difference between those who persisted and those who did not were attributed to their coping strategies (Lazurus & Folkman, 1984). When coping with stress, individuals choose one of the following strategies: problem solving, consulting with others, or avoidance. Student's methods of coping with stress are directly correlated with their ability to overcome the stressor (Castles, 2004).

Intrinsic factors. Intrinsic factors affecting persistence are students' attitudes and motivation (Castles, 2004). Goals were defined by the participants in the study, not by their host institution. Participants in Castles study found it difficult to persist when they lacked self-confidence even if they were motivated. Castles (2004) found that the individuals that persisted were more likely able to do the following:

- take responsibility for their own lives;

- believe that they can control/influence life's events;
- have a positive attitude towards life;
- feel deeply involved in or committed to their life's activities;
- anticipate change as an exciting challenge to further development;
- believe that life's demands are meaningful and explicable;
- believe that they have the resources to face life's demands (p. 172).

While these factors were described independently, they are arguably mutually dependent because support from family, friends, tutors, and the university may affect student motivation which in turn impacts persistence.

Currently, there is a great deal known about these three factors social and environmental, traumatic, and intrinsic, affecting persistence; however, there is still a lot unknown. For instance, a majority of the studies involving persistence were qualitative, and there is a limited body of research measuring persistence quantitatively.

Academic Performance

Numerous studies have cited academic performance as a key indicator of postsecondary STEM entrance (Chen, 2009; Trusty, 2002). In a 2009 study, Chen evaluated 12,000 students using the 1995−96 Beginning Postsecondary Students Longitudinal Study (BPS:96/01). Chen's (2009) findings suggested academic performance and course history as indicators of STEM entrance. Chen found that students who entered STEM fields were most likely to have at least a 3.0 GPA and completed trigonometry, pre-calculus or calculus in high school. Also, in a prior study, Trusty (2002) found that course taking behaviors as a high school student were strongly correlated to college major choice. Trusty's study consisted of 5,703 participants from the

National Education Longitudinal Study 1988-94. Trusty studied SES, Race/ethnicity, high school behaviors, and academic performance to compare mathematics and science majors to other majors. Trusty found that students who enrolled in and completed academically intensive mathematics and science courses in high school were more likely to major in a STEM field. In particular, he found trigonometry, pre-calculus, and calculus to be significant indicators for female students and physics to be a significant indicator for male students. While Trusty's analysis was a decade old, the data he was analyzing was nearly three decades old. Additionally, it would be beneficial to know course taking behaviors, at the collegiate level, that indicate success in STEM fields and most importantly decisions to join mathematics and science teacher pipeline.

In another study, Podgursky, Monroe, and Watson (2004) compared the ACT scores of graduates from 4-year public higher education institutions in Missouri who became public school teachers following graduation to those of graduates who did not. They found that those who entered teaching had significantly lower scores than those who chose not to teach. This was primarily attributed to the ACT scores of the elementary school teachers because the STEM educator scores were comparable to the STEM non-educator scores. Moreover, high ability mathematics and science educators were found to be exiting the teacher workforce more rapidly than educators in other secondary fields (Podgursky et al., 2004).

The positive correlation between teacher content knowledge and student performance suggests the need for academically strong teachers (Darling-Hammond, 2000). As previously discussed, there was a great deal of research that suggests those who enter teaching are less qualified than their counterparts. The B&B: 93/97 data indicates

that academically stronger graduates were less likely to teach than were their academically weaker counterparts (Henke et al., 2000). As academic success increases, the proportion of 1992–93 college graduates who had entered the teacher pipeline by 1997 decreased from 41 percent to 32 percent (Henke et al., 2000). A 2000 study found that the college entrance examination (CEE) scores of graduates that fell in the top quartile were less likely than those in the bottom quartile to enter the teacher pipeline (Henke et al., 2000).

Ballou (1996) collected data on more than 50,000 new bachelor's degree recipients using the Survey of Recent College Graduates conducted from 1976 through 1991. Ballou found that college graduates from more competitive institutions were less likely to choose a teaching major and less likely to choose to teach after certification than those from less discerning institutions. Discerning refers to each institution's ranking on Barron's Profiles of American Colleges, which measures schools on the basis of selectiveness in admissions. There has been speculation that Ballou's finding may be because the higher ability students typically attend more selective universities contrary to lower ability students. Hanushek and Pace (1995) used the High School and Beyond data on high school seniors from the class of 1980 through 1986, and found that higher-ability students, as measured by performance on cognitive tests, were less likely than lower-ability students to pursue a bachelor's degree in elementary or secondary education, holding constant race and gender.

In terms of college entrance exams potential teachers or those who enter the teacher pipeline overall had lower SAT mathematics and total scores than their peers who had not entered the pipeline (Gitomer, Latham, & Ziomek, 1999). Graduates who had

prepared to teach were also found to have lower average verbal SAT scores than their non-teaching counter parts. A 1999 study found that teacher candidates who passed the Praxis II teacher licensure test had SAT scores that were lower than the average for college graduates (Gitomer, Latham, & Ziomek, 1999). Gitomer, Latham, and Ziomek (1999) also found that among ethnic groups of teacher candidates taking the Praxis test for admission to schools of education between 1994 and 1997, Black candidates passed at the lowest rate leading to the question of whether there was a correlation between race and decision to pursue a career in teaching.

It has long been reported that teachers were more likely to be female and less qualified academically. According to Darling-Hammond (2000), men were less inclined than women to enter the teacher pipeline. The B & B 1993 study revealed that within 4 years of graduation, 43 percent of female graduates had entered the teacher pipeline, compared with 29 percent of male graduates (Darling-Hammond, 2000). Additionally, females were more likely than male graduates to have prepared to teach and not taught than to have prepared and taught. Broughman and Rollefson (2000b), using the Schools and Staffing Survey also reported that 73 percent of new hires to teaching in 1993–1994 were women.

Murnane et al. (1991) surveyed over 50,000 classroom teachers to determine characteristics of individuals who prepare to teach, become teachers, leave teaching, and lastly return to teaching after leaving. Descriptive statistics and logistic regressions were used to track participants' professional lives. It was found that many academically talented college graduates were hesitant to try teaching. Similar to findings by Henke, Chen, Geis, and Knepper (2000), Murnane et al. (1991) found that women were more

likely than men to teach in elementary and secondary schools, and female college graduates were more likely than their male counterparts to enter the teacher pipeline. Since this particular 1991 study examined data from the National Longitudinal Surveys "Young Men," "Young Women," and "Youth" and the North Carolina and Michigan State Departments of Education databases, they could not determine causation (Murnane et al., 1991). Murnane et al. also found that elementary teachers were most likely to return to teaching after leaving; however, chemistry and physics teachers were found least likely to return to teaching after leaving. Murnane et al. found that an increase in salary would not suffice; instead, they suggest an improvement in recruiting strategies and licensing criteria. Unfortunately, this study does little to inform the state of mathematics and science education.

The literature has reported that women were found to be less likely than men to pursue high-status, mathematics-related fields. Although women earned 54% of U.S. doctorates in non-science/engineering fields awarded in 1997, they earned only 23% of the doctorates awarded in mathematics, 33% in the physical sciences, and 12% in engineering (National Science Foundation, 2004). Gender roles are largely associated with this phenomenon. In elementary school, females tend to surpass males in mathematical performance. In college level mathematics courses, males tend to surpass females in mathematical abilities (McGraw, Lubienski, & Strutchens, 2006). These stereotypes can cause females to question their skills and carry this feeling of inadequacy into their careers. Female student attitudes and self-concepts related to mathematics are more negative than those of male students (McGraw, Lubienski, & Strutchens, 2006).

In *Teacher Supply in the United States: Sources of Newly Hired Teachers in Public and Private Schools: 1987-88 to 1993-94,* Broughman and Rollefson (2000a, 2000b) examined teacher characteristics, career paths, and former occupations of each type of newly hired teacher. They found that new hires typically fell into four categories. There are four types of newly hired teachers: newly prepared teachers, delayed, transfers, and re-entrants. In 1988, approximately 10% of the new teacher hires in public schools and 7% in private schools were minority and it grew over 1988 through 1994 (Broughman & Rollefson, 2000a). During this period, the percent of newly prepared minority teachers hired in public schools doubled, and in private schools it quadrupled.

Interestingly enough in *Progress through the Teacher Pipeline: 1992–1993 College Graduates and Elementary/Secondary School Teaching as of 1997*, Henke et al. (2000) researched the rate at which graduates with varying demographic and academic characteristics enter the teacher pipeline. They revealed men were less inclined than women and Asians/Pacific Islanders were less inclined than members of other races to enter the pipeline. They reviewed Praxis test passing status for each individual and disaggregated the results according to race/ethnicity. This study revealed that Black candidates were passing at a 46 percent rate and Hispanic candidates at a 69 percent rate versus an 82 percent passing rate among non-minorities. This report revealed clear descriptions of individuals that are entering the teacher pipeline by percentage distribution; however, it lacked focus specifically on individuals who enter the science and mathematics teacher pipeline.

Analysis of Prior Research

Although the literature reviewed was informative, there was an apparent disparity in the number of studies conducted on STEM degree earners, particularly mathematics and science, pursuing teaching. It was clear that more research was needed on the characteristics of individuals who enter the mathematics and science teacher pipeline. In terms of recruitment to become an educator, the focus was directed at k-12 education in general. This was an issue of concern because it was believed that mathematics and science students may have different influences that other fields may not be as susceptible to.

Demographics

The largest issue within the literature was that the decision to pursue a degree in mathematics and science was a multifaceted decision affected by many variables. The variables affecting decisions are often interrelated with one another and students choose majors for a combination of reasons. In addition, a student's demographics may affect their persistence or their academic performance (Reyes & Stanic, 1988). There are a few factors plaguing minorities and persistence in mathematics and science. Alvarez and Mehan (2006) found low SES minorities most likely to be placed in low ability courses. Reyes and Stanic (1988) found that Black students were placed in lower level mathematics courses at an alarmingly higher rate than White students with similar achievement scores. These placements negatively impact student persistence levels because when given a choice in coursework these students chose the lower level course and displayed lower levels of persistence in STEM fields (Yonezawa, Wells, & Serna, 2002). Trusty (2002) suggested that students who complete calculus in high school have a

higher chance of persisting in a STEM degree; however, Loveless (1999) found a strong positive correlation between parental education and course placement. Parents without college degrees were less likely to have their children take calculus in high school. In similar vein, Cole and Barber (2003) suggested that Latinos and African Americans exhibit lower levels of persistence in STEM resulting from an underrepresentation of STEM faculty. Minority students found difficulty identifying with these fields because they had few role models within the field to look up to (Nelson, Bramer & Rhoads, 2007).

All of which subsequently results in women and minorities becoming the least likely minority group to persist towards a STEM degree (National Science Foundation, 2008). There was a great deal of literature describing disparities among mathematics and science students; however, it would be useful to find out the characteristics of students who successfully complete a mathematics or science degree. What was different about these students? The information learned will then be used to inform recruitment into mathematics and science majors and inform recruiting on a broader scale including the science and mathematics teacher pipeline.

Based on the literature, there was no question that sex and academic performance are largely associated with individuals' decisions to teach at the elementary school level. However, it was unclear if this remains the case when looking at female and male mathematics and science students in a similar ability group. Currently, there was limited research examining whether sex was associated with students who are in mathematics and science fields choosing to become an educator. This study sought to bridge this gap

and discover whether sex was a significant variable in mathematics and science students joining the teacher pipeline.

All of the studies cited involving race/ethnicity were in agreement. They all cite an apparent disparity of minorities in teaching. These disparities are attributed to many reasons. Gordon (1994) suggests that they are attributed to students of color being discouraged to enter the teacher pipeline. Gordon's (1994) results did not alleviate issues of recruitment in STEM teaching. There was no discussion on how the participants were chosen beyond race, occupation, and geographic location. The recommendations from this study are not generalizable because the sample was not representative of the population. Additionally, the research did not specifically address minorities entering the mathematics and science teacher pipeline.

Much of the data regarding race/ethnicity was neither recent nor relevant to mathematics and science teaching, therefore, the present study provided an up to date view of the current state of race/ethnicity in educational recruitment. Women were found to be less likely than men to pursue high-status, mathematics-related fields (National Science Foundation, 2004); thus, how does this play out in terms women entering the mathematics and science teacher pipeline. More information was needed regarding the lack of racial/ethnicity and gender diversity in mathematics and science education and this study evaluated factors affecting this.

The most apparent issue within the literature was that mathematics and science education degrees are not discussed. Researchers have long said students who choose mathematics or science teaching were lower academic performers than their counter parts but there was a distinct gap in the literature comparing these students to STEM majors

(Shugart & Hounshell, 1995; Tobe, 2008). This study compared and contrasted these two groups in hopes of informing those interested in recruitment about the characteristics of students majoring in mathematics and science education.

Persistence

Much of the research was focused on persistence in online education. There are very little studies that look specifically at stopout persistence in terms of teacher pipeline status. This study bridged a gap in the literature and answered these unknowns. This study will utilize a large, and representative data set to determine whether selected demographics, stopout persistence, and academic performance play a significant part in an individual's decision to pursue mathematics and science teaching.

According to the Rice, Dong and Weaver study, while students' persistence patterns were irregular they were each focused on goal attainment. Warburton, Bugarin, and Nuñez (2001) found first generation status to be positively correlated with student stopouts; however, the study provided no information on degree choice. The present study added to the body of literature by evaluating these variables for students within the mathematics and science teacher pipeline and those who chose not to enter the teacher pipeline.

Academic Performance

In 1996, the Department of Education reported that the cumulative grade point average of mathematics and science teachers were in the lowest quartile compared to teachers of all other subjects: 17.2% of mathematics/technology teachers and 15.7% of science teachers registered below 2.74 (or B average) on a 4.0 scale. This study compares

mathematics and science teachers to general education teachers. A major flaw of this study was that it does little to inform the current state of science, technology, engineering, and mathematics (STEM) teacher recruitment because the grade point average of mathematics and science educators completing mathematics or science specific coursework would likely be lower than those of general education majors. The GPA differences may be due to the difficulty level of the courses in mathematics and science. Thus, comparing the grade point averages of mathematics and science non-education majors to mathematics and science education majors would provide more meaningful information about the individuals entering the teacher pipeline and their academic performance in mathematics or science.

Hanushek and Pace (1995) investigated cognitive ability in relation to pursuing a bachelor's degree in education. They used the High School and Beyond data on high school seniors from the class of 1980 through 1986. They reported that higher-ability students, as measured by performance on cognitive tests, were less likely than lower-ability students to pursue a bachelor's degree in elementary or secondary education, holding constant race and gender. Their study had a number of strengths, two of which were a large sample size and a longitudinal design. However, they did not specifically investigate the cognitive ability of individuals seeking degrees in mathematics or science education . Additionally, a major weakness of the study was its lack of generalizability. The study was confined to a single cohort, which was severely limiting. While this study was useful, it was extremely outdated.

The ACT (2013) study suggested that recruiting STEM-capable students was an arguably challenging feat since teacher salaries are not as competitive as that of many

STEM fields. A major flaw of this study was the population it analyzed. This study only investigated students who chose to take the ACT which was an obvious bias. Some universities do not accept ACT scores; however, SAT scores are widely accepted. This limits the generalizability of the study which was an obvious strength of the present study. In addition, the study did not determine correlations or use any predictive modeling. Also, researchers such as Hanushek and Pace (1995) have suggested that salary was not a significant deterrent to students' choices to pursue a career in teaching; thus differing from the ACT (2013) report.

The present study investigated factors affecting individuals who enter the mathematics and science teacher pipeline on a larger scale. It includes mathematics and science students of all races while utilizing a large nationally representative sample. This study gives a recent look at the characteristics of individuals in the mathematics and science teacher pipeline and makes recommendations for recruitment. Lastly, the study provides a landscape of STEM-capable individuals who pursue a career in teaching in hopes of providing Insights that can be drawn on in the development of strategies to recruit a mor capable and diverse science and mathematics teacher workforce.

CHAPTER III

Methods

This chapter describes the methods and procedures that were employed in the proposed study. The first three sections of this chapter include the purpose of the study, the research questions to be addressed and the sample. The fourth section discusses the

research design. This section discusses the researcher's decision to conduct a multiple regression. Section five discusses statistical procedures and justifies their use as statistical tests for the analysis of the data.

Purpose of the Study

The purpose of this study was to understand who, of mathematics and science capable individuals, enters the teacher pipeline. To this end, the study sought to determine whether predictive relationships exist among the independent variables (selected demographics, persistence, academic performance) and the dependent variable (decision to enter the mathematics and science teacher pipeline) and whether these selected characteristics account for a significant amount of variance between mathematics and science degree earners who entered the teacher pipeline and mathematics and science degree earners who chose not to enter the teacher pipeline. This study examined the characteristics of those who entered the teacher pipeline to provide a snapshot of the attributes of mathematics and science capable individuals entering the teacher pipeline. By understanding the differences between mathematics and science degree earners entering the teacher pipeline versus those not entering the pipeline insights will be developed to aid in efforts to broaden recruitment of mathematics and science teachers.

To this end, data from the Baccalaureate and Beyond Longitudinal Study (B&B: 08/09) was used. B&B:08/09 gathered information on students' educational and work experiences after they completed a bachelor's degree, with a special emphasis on the experiences of new elementary and secondary teachers. The sample for the present study consisted of 2,400 individuals majoring in mathematics and science fields including

mathematics and science education. A logistic regression was conducted on all mathematics and science majors to seek predictive relationships of their teacher pipeline status based on selected variables.

Research Questions

Q1. Are mathematics and science graduates in the teacher pipeline and the non-teacher pipeline similar in terms of selected demographics (sex, race/ethnicity, age, marital status, dependency, SES), stopout persistence, and academic performance (course history, STEM GPA)?

Q2. Do selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

Q3. Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) constant, does stopout persistence account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

Q4. Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence constant, does academic performance (course history, STEM GPA) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

Overall, the researcher was interested in determining whether predictive relationships exist among the independent variables (selected demographics, persistence, and academic performance) and the dependent variable (decision to enter the mathematics and science teacher pipeline).

Sample

B&B: 08/09 was a nationally representative study of students who completed bachelor degree requirements between July 1, 2007 and June 30, 2008 at a postsecondary institution in the United States or Puerto Rico (Wine, Janson, Siegel, & Bennett, 2013) . The B&B: 08/09 sample was based on students originally identified as potential bachelor's degree earners between 2007 and 2008 in the 2008 National Postsecondary Student Aid Study (NPSAS:08). NPSAS: 08 included 114,000 undergraduate students selected randomly out of approximately 21 million undergraduates across 1,600 postsecondary institutions eligible to participate in Title IV federal student aid programs (Wei et al., 2009). The B&B:08 cohort included 17,160 eligible sample members: 15,050 were interview respondents; 16,070 were transcript respondents; and 14,010 were combined interview and transcript respondents (Wine et al., 2013).

The B&B:08/09 data set provides detailed information on student demographics, course history, income, undergraduate experience, types of financial aid, expectations regarding graduate study, and future employment. In addition, B&B: 08/09 observed participants' workforce participation, income after graduation, debt repayment, and entry into and persistence through graduate school programs, among other indicators. More important in reference to the present study, this data set emphasizes teaching, including

teacher preparation, entry into and persistence in the profession, and teacher career paths. Since this data was representative of the undergraduate population across 1,600 postsecondary institutions in the US and Puerto Rico, it was worthwhile to examine it to determine whether a predictive relationship exists between the independent variables (selected demographics, persistence, academic performance) and the dependent variable (decision to enter the mathematics and science teacher pipeline) and whether these selected characteristics account for a significant amount of variance between mathematics and science degree earners who entered the teacher pipeline and mathematics and science degree earners who chose not to enter the teacher pipeline. Results of this study will give valuable insight on the characteristics of those who enter the mathematics and science teacher pipeline. The teacher pipeline was defined as graduates who have taught, became certified to teach, or completed a student-teaching assignment as an undergraduate.

The sample for the present study consisted of all mathematics and science majors in the B&B:08/09 data set. For the purposes of this study and for clarity, mathematics majors are operationally defined as those with declared majors in mathematics, statistics, and computer science.. Science majors are operationally defined as those with declared majors in physics, biology, earth science and chemistry. The sample also consisted of mathematics education and science education majors. The sample was restricted to mathematics and science majors and mathematics and science majors in the teacher pipeline because there is a significant difference between them and elementary school teachers.

Research Design

This study involves quantitative research methods due to the research questions. Descriptive analysis, cross sectional analysis, and multiple logistic regression were used to analyze the data. A descriptive analysis was used to describe the data set and determine the distribution, central tendency, and the variation of the data. The overall design for this study was an analytical cross sectional design. Analytical cross sectional design investigates associations and measures differences between groups (Levin, 2006). Groups in the study were purposely chosen based upon existing differences in the B&B:08/09 sample instead of seeking random sampling. In this study, the sample that was selected were all mathematics and science majors including those in the teacher pipeline and not in the pipeline.

In this study, regression analysis was used to assess the degree to which the dependent (outcome) variable, decision to join the teacher pipeline, was predicted by the independent (predictor) variables (i.e. sex, race/ethnicity, academic performance, and persistence). This research design was appropriate because it allowed the researcher to determine which variables were better predictors of entering the mathematics or science teacher pipeline.

The most obvious con of this research design was that confounding variables may significantly affect this study because only the variables measured by B&B:08/09 can be measured. This was combatted through an in-depth literature review. It was important to the researcher that variables that may potentially serve as good predictors are not overlooked therefore making this research design most appropriate for the questions being asked.

Statistical Procedures

Data Collection

The B&B:08/09 data set was used for this study. The data collection for B&B:08/09 involved several phases, including locating sample members who completed bachelor's degree requirements between July 1, 2007 and June 30, 2008 identified from the NPSAS:08 study (Wine et al., 2013). The sample members were located using batch-locating activities. They and their parents were sent mailings to gather updated contact information; and they were mailed information regarding study participation, B&B:08 collected data through interviews, transcript collection, and administrative data records match (Wine et al., 2013). The interview data was collected in three phases: (1) the early interview response phase, (2) the production (middle) phase, and (3) the nonresponse conversion (last) phase. Nominal incentives ($30-$50) were offered for completing the interviews. Interviews lasted approximately 30 minutes and were conducted in web, telephone, or field mode during June 2008 through July 2009. Of the 17,170 sample members included in the student interview data collection, 88% responded to the interview, which was 94% of the sample members that were successfully located (Wine et al., 2013). The transcripts were collected by requesting them from the institution where the B&B:08/09 sample members completed their bachelor's degrees as determined from the NPSAS:08 data set. If the individuals had transfer credits, the transfer transcripts were also requested.

The B&B:08/09 data set was used as the sole data source in this study. The data set was used in two steps. The first step was to clean the data. The researcher disaggregated the data by choice of major. All mathematics and science majors in the

B&B:08/09 study were used. Students who did not answer all of the questions within the variables of interest were removed from the sample. As previously mentioned this data set consists of approximately 17,160 participants but the study sample consisted of 2,400 individuals. The study sample consisted of mathematics and science degree earners including mathematics and science education majors who were in the teacher pipeline and who were not in the pipeline. Individuals were dummy coded (0) for mathematics and science majors not in the teacher pipeline and (1) for mathematics and science majors within the teacher pipeline.

As previously stated individuals in the teacher pipeline were chosen because they are most likely to be recruited into teaching or targeted for recruiting. In terms of demographics, each trait investigated was evaluated individually. The academic performance variable was measured as course history and grade point average in mathematics and science courses (STEM GPA). Student course history was the difference of mathematics and science credits attempted and credits earned. Students with high levels of academic performance have higher GPAs and smaller differences of attempted to earned credits. The variable of persistence measured whether the respondent ever stopped out. In this study the persistence variable was calculated by summing up the reasons for stopping out prior to completion. Frequency and reasons for stopping out was compared across mathematics and science educators and non-educators.

Data analysis included the use of logistic regression. A multiple logistic regression is a predictive model that looks at odds. It differs from a linear regression because the dependent variable is categorical (Moore & McCabe, 1998). The use of logistic regression model for this study produced an index of odds ratio (OR) that helped

predict the probability of students entering the mathematics or science teacher pipeline or choosing not to enter the mathematics or science teacher pipeline.

A logistic regression analysis was performed to identify statistically significant predictors of a candidate's decision to join the teacher pipeline. Draper and Smith (1981) found step-wise regressions to be useful in researching outcomes of variables that are not typically tested. This study identified, using selected variables, which variables were statistically significant predictors of teacher pipeline status. Demographic predictors were placed in the model first, since they are factors that cannot be manipulated. Stopout persistence was added next and academic performance was then placed in the model.

Alpha

Since it was hypothesized that a difference exists between these groups, all of the alpha levels in this study was set at .05. This level was chosen to minimize the chances of making a Type I error.

Hypotheses

The hypotheses for the study are listed below.

1. Demographics account for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
    a. Sex accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the

mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

b. Race/ethnicity accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

c. Age accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

d. Marital Status accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

e. Dependency accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

f. SES accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

2. Persistence accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
3. Academic performance accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
    a. Course history accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
    b. STEM GPA accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

Data Analysis

As previously mentioned the data was analyzed in two steps. A descriptive analysis was used to describe the data set and determine the distribution, central tendency, the variation of the data, along with a chi-square test. A regression analyses was also carried out to examine the influence of all of the predictor variables on the criterion variable. A multiple logistic regression analyses was also performed on the dependent

variable. All of the predictor variables were entered as covariates at the same time. For correlational and regression analyses, results were considered statistically significant when the *p*-value was less than .05, alpha was set at .05. Fisher (1925) was the first to discuss using α =.05 as a value when determining statistical significance. In his book he cited his reasons for using α =.05 as a preference and method of convenience (Fisher, 1925). The same was true in this study. This level was practical for the study and the questions being raised therefore the standard practice of .05 was utilized.

The regression models for this stage of statistically analyzing the data were conducted to answer the second research question, Do selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?? To test this question the following regression models was used with Y coded as 1 or 0:

ln[y1 (TP) + y2 (non-TP)] = aou + a1(Sex) + a2(Race/ethnicity) +a3(Age) + a4(Marital status) + a5(Dependency) + a6 (SES) + E1

Another regression analysis was conducted to answer the third research question, Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) constant, does stopout persistence account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline? To test this question the following regression models was used with Y coded as 1 or 0:

ln [y1 (TP) + y2(non-TP)] = aou + a1(Persistence) + a2(Sex) + a3(Race/ethnicity) +a4(Age) + a5(Marital status) + a6(Dependency) + a7 (SES) + E1

Another regression analysis was conducted to answer the fourth research question, Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence constant, does academic performance (course history, STEM GPA) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline? To test this question the following regression models was used with Y coded as 1 or 0:

ln [y1 (TP) + y2(non-TP)] = aou + a1(Persistence) + a2(Course History) + a3(STEM GPA) + a4(Sex) + a5(Race/ethnicity) +a6(Age) + a7(Marital status) + a8(Dependency) + a9 (SES) + E1

Chapter Summary

In this chapter the purpose of the study, the research questions addressed, and the sample were discussed. The statistical approach chosen to address the research questions in the study was described and justified in this chapter. In Chapter 4, the results of the analysis are presented.

CHAPTER IV

Results

This chapter includes the results of this study. The purpose of this study was to determine whether predictive relationships existed among the independent variables and the dependent variable and whether certain attributes accounted for significant differences in mathematics and science degree earners' teacher pipeline status. This study also examined the characteristics of those degree earners who entered the teacher pipeline and those who did not.

Data Set

As previously stated, the Baccalaureate and Beyond Longitudinal Study (B&B: 08/09) data set was utilized. B&B:08/09 examined students' educational and work experiences after they completed a bachelor's degree, with a special emphasis on the experiences of new elementary and secondary teachers. The B&B:08/09 cohort consisted of approximately 19,000 individuals but the current study sample consisted of 2,400 individuals. There were many factors that led to the dramatic decrease of the sample size. The most obvious reason was the population of mathematics and science majors, including those in mathematics and science education. Since this data was nationally representative based originally on a random sample of 114,000 undergraduates from 1,600 postsecondary institutions in the NPSAS:08 study (Wine et al., 2013; Wei et al., 2009), it makes sense that the number of mathematics and science graduates would be drastically less than those in other degree programs. Missing cases also contributed greatly to the decrease in the sample. Nonetheless, this extensive sample was used to

explore the characteristics of these sample members and the differences, using conventionally used predictors, between the two groups. The conventionally used predictors include teacher pipeline status, selected demographics, persistence, and academic performance (course history) Appendix A. When the data were weighted these 2,400 individuals represented 86,033 individuals in the population.

Analysis Performed to Answer the First Research Question

Q1. Are mathematics and science graduates in the teacher pipeline and the non-teacher pipeline similar in terms of selected demographics (sex, race/ethnicity, age, marital status, dependency, SES), stopout persistence, and academic performance (course history, STEM GPA)?

Teacher pipeline was defined as graduates who have participated in preparatory activities: considered teaching, served as a student teacher as an undergraduate, certified to teach, applied for teaching jobs, as well as gained teaching experiences and made plans for teaching in the future. Individuals within the teacher pipeline have taken one of these actions therefore showing some level of interest in the field. Students who are not in the teacher pipeline have stated that they have no interest in pursuing a career in teaching. In this study graduates within the mathematics and science teacher pipeline were coded as 0 and those who have chosen not to enter the mathematics and science teacher pipeline were coded as 1.

While the literature drove much of the data analysis, the results of the initial data analysis played a vital role in the researcher's decisions. In B&B:08/09, race was disaggregated into 8 sub-groups. Four of these groups had noticeably smaller populations than the others. In order to increase the power of this study the researcher deleted

Alaskan, Native Hawaiian, Other and Tor More Races from the data set. Prior to the deletion there were 10 Alaskans, 10 Native Hawaiian/ Pacific Islanders, 10 Others, and 70 individuals of Two or More Races. Since race was a nominal variable and one race was not greater than the other, this variable was coded in this study as White 1, Black 2, Hispanic 3, and Asian 4. The variable marital status indicated the respondent's marital status during the 2007-08 academic year. Since marital status was a nominal variable, single was coded as 1, divorced or widowed were coded as 2, and married or separated were coded as 3. According to B&B: 08/09 the variable dependency indicated whether the respondent was financially supporting any dependents at the time of the B&B: 09 interview. Respondents who supported dependents at the time of the survey were coded as 1 and those who were not supporting any dependents were coded as 2 for no dependents. The variable SES was measured using respondent's eligibility for the federal TRIO Programs (meaning they were low income and first generation students in college). Respondents were coded as 1 for low income, first generation students; 2 for low income non-first generation students; 3 for first generation and non-low income students; and 4 for non-low income, non- first generation students. The variable Age was coded as 0 for traditionally aged students (24 and under) and 1 for non-traditionally aged students (25 and over).

The variable stopout persistence measured whether the respondent ever took a break in enrollment of more than four months en route to completing the requirements for their 2007-08 bachelor's degree. Stopout persistence was grouped into three categories. Respondents who stopped out for academic reasons were coded as 1, respondents who stopped out for financial reasons were coded as 2, and respondents who stopped out for

other reasons were coded as 3. Academic reasons for stopping out ranged from needing time off from studying to stopping due to academic problems. Financial reasons for stopping out ranged from respondents needing to work, conflict with employment, or other financial reasons. Other reasons for stopping out ranged from respondents having a change in family status, enrolling elsewhere, stopping for another reason, or for a personal reason. In the later analyses, persistence was grouped into two categories: 0 if the respondent did not take a break in enrollment of more than 4 months and 1 if the respondent had taken at least one break in enrollment en route to completing the requirements for their 2007-08 bachelor's degrees.

The course history variable was the difference of college level mathematics/science credits attempted and college level mathematics/science credits earned. The variable STEM GPA indicated the respondent's cumulative mathematics and science undergraduate grade point average (GPA) as of 2007-08. The variable academic performance was measured as respondent's performance in mathematics and science courses based on course history and STEM GPA.

The analysis of this study was restricted to all mathematics/computer science majors (these two degrees are combined within the data set) and biological/physical science majors (these two degrees are also combined within the data set) who graduated from a postsecondary institution. Individuals who did not have complete data sets were deleted. The multiple logistic regression models included demographics, stopout persistence, and academic performance.

To begin, it was important to understand the characteristics of the 86,033 individuals represented by the sample. Figure 1 provides findings about these

characteristics, giving a snapshot of the differences between sample members in the science and mathematics teacher pipeline and those not in the teacher pipeline.

As shown in Figure 1, when disaggregated by age, of the 23,805 degree earners who entered the teacher pipeline 13.6% were non-traditionally aged. Of the 62,228 degree earners who chose not to enter the teacher pipeline nearly 12% were non-traditionally aged. When disaggregated by disciplines of the 13,476 Mathematics degree earners nearly half (9070) joined the teacher pipeline. Additionally, this table shows that nearly a third of mathematics and science degree earners join the teacher pipeline while over three quarters of the Biological and Physical Science majors choose not to enter the teacher pipeline.

Also shown in Figure 1, of the mathematics and science majors in the sample 54.2% were women and women were found to be somewhat more likely than men to enter the teacher pipeline. The percent of men and women choosing not to enter the teacher pipeline were nearly identical to the percentages in the sample. Of the mathematics and science majors in the sample 73.9% were White and 12.7% percent were Asian. Of degree earners entering the teacher pipeline 80.5% were White; and while Asians were the next largest group in mathematics and science, they were least likely to enter the teacher pipeline. While Blacks were not as well represented in mathematics and science majors, they were the most likely of all minorities to enter the mathematics and science teacher pipeline.

Of the mathematics and science majors in the sample, 92.2% were single, divorced or widowed and only .1% of the sample was legally separated. The table revealed 92.6 % of degree earners entering the pipeline were single, divorced or widowed

and less than 1% of the degree earners entering the pipeline were legally separated. Of the degree earners who chose not to enter the pipeline, 92% were single, divorced or widowed and .2% of the degree earners not entering the pipeline were legally separated.

Of the individuals in the teacher pipeline 70.2 % were dependent and 79.1% not in the teacher pipeline were dependent. Of the mathematics and science majors in the sample 74.6% were not low income, 53.6% of mathematics and science majors were not first generation in college or low income, and 21% of mathematics and science majors were first generation but were not low income. Of the degree earners entering the pipeline, 32.9% were low income, 17.4% were both low income and first generation in college, and 17.1% of mathematics and science majors were low income but were not first generation. In terms of degree earners entering the teacher pipeline 67% were not low income and 39.3% were low income.

The Chi-Square values for the association between Bachelor's degree major, Race/Ethnicity, Dependency Status, Socioeconomic Status and Teacher pipeline status was obtained and each association was found to be significant, as shown in Figure 1. These data suggest that an association between each of these variables and teacher pipeline status indeed exists

Figure 1
Percent of graduates in the Teacher and Non-Teacher Pipeline and a Chi-Square test to determine significant differences

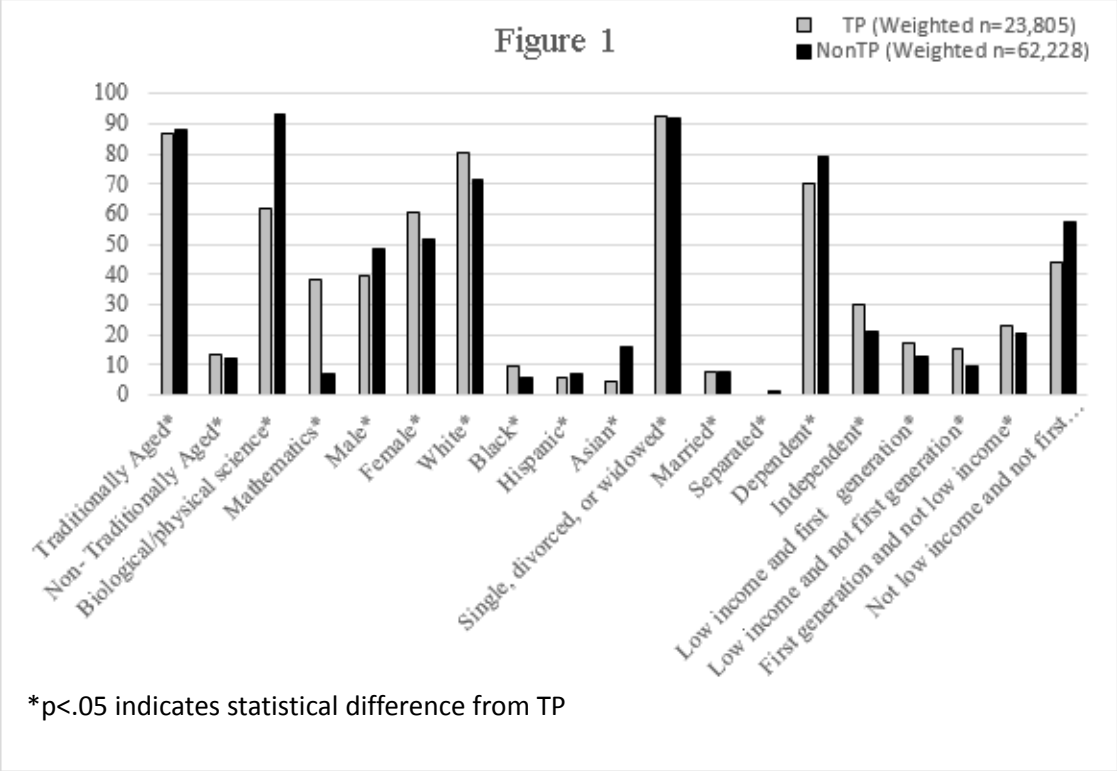

Table 1 represents individuals within the teacher pipeline. Given that the sample represents 23,705 in the teacher pipeline out of 86033, 27.7% of the sample was in the teacher pipeline. Table 1shows the teacher pipeline disaggregated by status categories. It reveals that 25.8% of mathematics and science majors in the sample have considered teaching but have not taken any action towards becoming a teacher. Only 10% of mathematics and science majors within the teacher pipeline had student taught and were certified.

Table 1

Percent of Graduates in Teacher Pipeline

Teacher pipeline status as of 2009	Percent
Considering teaching	25.8
Has prepared, not applied	21.7
Has prepared and applied to teach	4.1
Para-teaching experience (e.g., aide)	6.2
Has taught, no training	18.6
Student, no teach, no certificate	9.6
Student, taught, no certificate	1.9
Certificate, no teach	2.0
Certificate, taught	10.0

**Weighted N= 23,805*

An independent-samples *t*-test was conducted for stopout persistence in respondents within the teacher pipeline and those not in the teacher pipeline (see Table 1). There was a significant difference in respondents' stopout reasons due to financial, academic and other reasons individually and overall. These results suggest that stopping out for various reasons was statistically different between the means of those in the teacher pipeline and those not in the teacher pipeline. From the result of Levene's Test for Equality of Variances, we can reject the null hypothesis that there was no difference in the variances between those within the teacher pipeline and those who chose not to enter the teacher pipeline in terms of stopout reasons. This means that there is a significant difference between the reasons graduates within the teacher pipeline stopout versus those who are not in the teacher pipeline.

Table 2

Stopout Persistence difference of Means

Stopout Reasons	*T*	Sig. (2-tailed)
Financial	21.898	<.001

Academic	29.137	<.001
Other	17.361	<.001
Persistence	22.950	<.001

*df= 86,030

An independent-samples *t*-test was also conducted on the academic performance of respondents within the teacher pipeline and those not in the teacher pipeline (see Table 3). There was a significant difference between the means of respondents' mathematics credits, mathematics and science credits and STEM-GPA. These results suggest that the difference of attempted credits to credits earned in STEM credits, mathematics and science credits and STEM-GPA had an effect on respondents' decision to enter the teacher pipeline. From the result of Levene's Test for Equality of Variances, we can reject the null hypothesis that there was no difference in the variances between those within the teacher pipeline and those who chose not to enter the teacher pipeline in terms of mathematics and science course credits. This means that there is a significant difference between the academic performance (course history, STEM-GPA) of graduates within the teacher pipeline versus those who are not in the teacher pipeline.

Table 3

Academic Performance difference of Means

Course Credits	*T*	Sig. (2-tailed)
ADVLABCRED	12.021	<.001
BIOCRED	19.765	<.001
MATHCRED	45.366	<.001
PHYSCICRED	11.015	<.001

ALLSCICRED	16.791	<.001
STEMCRED	18.395	<.001
Transcript:STEM-GPA	-20.793	<.001

*df= 86,030

According to Table 4, 83.6% of respondents within the teacher pipeline were not certified in any content area and 16.4% were certified in mathematics or science. Therefore, of the 23,805 representing science and mathematics degree earners in the teacher pipeline, only about 3904 were certified to teach mathematics or science.

Table 4

Percent of Graduates with Content Area Certification

Content Area Certification	TP*	NonTP**
No Certification	83.6	100
Not mathematics	5.8	0
Not sciences	10.6	0
Mathematics	10.6	0
Sciences	5.8	0

TP weighted N= 23,805* * NonTP weighted N= 62,228*

Analysis Performed to Answer the Second Research Question

Q2. Do selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline? The hypothesis for Research Question two was demographics account for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

a. Sex accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
b. Race/ethnicity accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
c. Age accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
d. Marital Status accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
e. Dependency accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
f. SES accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the

mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

A logistic regression analyses was performed to evaluate the predictive relationship between teacher pipeline status and selected demographics (sex, race/ethnicity, age, marital status, dependency, SES). The logistic regression equation of teacher pipeline status and selected demographics was significant. The model was estimated using the Demographics as predictors. The full model was an improvement over the base model. The base model correctly predicted 72.3 percent of cases, while the full model correctly predicted 78.9 percent of cases which indicates an improvement over the base model.

According to the results, as depicted in Table 5, the following are true with demographics. The coefficients of four individual predictors were both positive and significant in predicting teacher pipeline status. The coefficients of eight individual predictors were both negative and significant in predicting teacher pipeline status. The odds ratio associated with the individual predictors indicate that Science majors are .107 times less likely than Mathematics majors to enter the teacher pipeline holding all other factors constant. Mathematics majors were more likely to enter the teacher pipeline than Science majors. Individuals who were claimed as dependents in 2007-2008 were .489 times less likely to enter the teacher pipeline than independents holding all other factors constant. Independents were more likely to enter the teacher pipeline. Individuals who were low income and not first generation were 2.161 times more likely to enter the teacher pipeline than students who were not low income and first generation holding all other factors constant. Overall this variable revealed that low income and/or first

generation graduates were more likely to enter the teacher pipeline than graduates who were both not low income and not first generation. Single, divorced, or widowed graduates were 22.691 times more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant. Overall, individuals who were separated from a spouse were least likely to enter the teacher pipeline. Black graduates were 6.190 times more likely to enter the teacher pipeline than individuals of Asian descent. Individuals of Asian descent were least likely of all races to enter the teacher pipeline holding all other factors constant.

Table 5

Regression Analysis of Selected Demographics

Predictor	B	S.E.	Wald	Df	Sig.	Exp(B)
Traditionally Aged	.441	.035	157.767	1	.000	1.554
Degree major-Science	-2.237	.023	9876.864	1	.000	.107
Dependent	-.716	.038	346.506	1	.000	.489
Not low income and not first generation			1146.737	3	.000	
Low income and first generation	-.076	.033	5.252	1	.022	.927
Low income and not first generation	.771	.033	534.262	1	.000	2.161
First generation and not low income	.491	.022	512.174	1	.000	1.634
Separated			313.277	2	.000	
Single, divorced, or widowed	3.122	.453	47.402	1	.000	22.691
Married	2.450	.455	29.039	1	.000	11.592
Asian			2109.840	3	.000	
White	1.579	.036	1948.733	1	.000	4.850
Black	1.823	.046	1553.038	1	.000	6.190
Hispanic	1.322	.049	734.847	1	.000	3.751
Male	-.634	.018	1244.675	1	.000	.530

Analysis Performed to Answer the Third Research Question

Q3. Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) constant, does stopout persistence account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline? The hypothesis for Research Question three was persistence accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

Based the logistic regression analysis for Question 3, the full model was an improvement over the base model. The base model correctly predicted 72.3 percent of cases, while the full model correctly predicted 78.8 percent of cases which indicates an improvement over the base model.

According to the results, as depicted in Table 6, the following are true with demographics and stopout persistence. The coefficients of five individual predictors were both positive and significant in predicting teacher pipeline status. The coefficients of eight individual predictors were both negative and significant in predicting teacher pipeline status.

The odds ratio associated with the individual predictors indicate that Science majors are .106 times less likely than Mathematics majors to enter the teacher pipeline holding all other factors constant. Mathematics majors were more likely to enter the teacher pipeline than Science majors. Individuals who were claimed as dependents in

2007-2008 were .531 times less likely to enter the teacher pipeline than independents holding all other factors constant. Independents were more likely to enter the teacher pipeline. Individuals who were low income and not first generation were 2.246 more likely to enter than the teacher pipeline than students who were not low income and not first generation holding all other factors constant. Overall this variable revealed that low income and/or first generation graduates were more likely to enter the teacher pipeline than graduates who were both not low income and not first generation.

Table 6

Regression Analysis of Demographics and Stopout Persistence

Predictor	B	S.E.	Wald	Df	Sig.	Exp(B)
Traditionally Aged	.524	.036	216.554	1	.000	1.689
Degree major-Science	-2.243	.023	9869.454	1	.000	.106
Dependent	-.633	.039	264.224	1	.000	.531
Not low income and not first generation			1227.670	3	.000	
Low income and first generation	-.079	.033	5.537	1	.019	.924
Low income and not first generation	.809	.033	583.621	1	.000	2.246
First generation and not low income	.503	.022	536.026	1	.000	1.654
Separated			340.719	2	.000	
Single, divorced, or widowed	3.332	.454	53.937	1	.000	27.981
Married	2.633	.455	33.522	1	.000	13.920
Asian			2062.710	3	.000	
White	1.567	.036	1926.869	1	.000	4.793
Black	1.793	.046	1489.288	1	.000	6.008
Hispanic	1.347	.049	764.248	1	.000	3.845
Male	-.633	.018	1235.895	1	.000	.531
Stopout Persistence	-.418	.025	287.698	1	.000	.658

Individuals who were single, divorced, or widowed were 27.981 times more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant. Married individuals were found to be 13.920 times more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant. Overall, individuals who were separated from a spouse were least likely to enter the teacher pipeline. Black graduates were 6.008 times more likely to enter the teacher pipeline than individuals of Asian descent. Individuals of Asian descent were least likely of all races to enter the teacher pipeline holding all other factors constant. Men were .531 times less likely than women to enter the teacher pipeline. Students who stopped out were .658 times less likely than those who did not stop out to enter the teacher pipeline. Individuals who did not stop en route of a bachelor's degree were more likely to enter the teacher pipeline.

The Omnibus tests of model coefficients revealed that there was a significant difference between the previous model, containing only the demographics, and the current model that included stopout persistence.

Table 7

Omnibus Tests of Model Coefficients for Research Question 3

Models	Chi-square	*df*	Sig.
Step	282.281	1	.001
Block	282.281	1	.001
Model	17269.529	13	.001

Analysis Performed to Answer the Fourth Research Question

Q4. Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence constant, does academic performance (course history, STEM GPA) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline? The hypothesis tested for this question was Academic performance accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

a. Course history accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.
b. STEM GPA accounts for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics or science teacher pipeline above and beyond the decision to not enter the mathematics or science teacher pipeline.

Based the logistic regression analysis for Question 4, the full model was an improvement over the base model. The base model correctly predicted 72.3 percent of cases, while the full model correctly predicted 79.6 percent of cases which indicates an improvement over the base model.

The model, as depicted in Table 8. According to the results, the following are true with demographics, stopout persistence, and academic performance. The coefficients of five individual predictors were both positive and significant in predicting teacher pipeline status. The coefficients of fifteen individual predictors were both negative and significant in predicting teacher pipeline status. The odds ratio associated with the individual predictors indicate that Science majors are .096 times less likely than Mathematics majors to enter the teacher pipeline holding all other factors constant. Mathematics majors were more likely to enter the teacher pipeline than Science majors. Individuals who were claimed as dependents in 2007-2008 were .612 times less likely to enter the teacher pipeline than independents holding all other factors constant.

Table 8

Regression Analysis of Demographics, Stopout Persistence, and Academic Performance

Predictors	B	S.E.	Wald	df	Sig.	Exp(B)
Traditionally Aged	.427	.037	134.612	1	.000	1.533
Degree major-Science	-2.346	.024	9587.449	1	.000	.096
Dependent	-.492	.040	151.262	1	.000	.612
Not low income and not first generation			1186.886	3	.000	
Low income and first generation	-.233	.034	46.835	1	.000	.792
Low income and not first generation	.732	.034	455.668	1	.000	2.079
First generation and not low income	.473	.022	456.688	1	.000	1.605
Separated			376.429	2	.000	
Single, divorced, or widowed	3.217	.456	49.860	1	.000	24.962
Married	2.454	.457	28.863	1	.000	11.640
Asian			2597.446	3	.000	

White	1.895	.038	2492.417	1	.000	6.654
Black	1.936	.048	1611.110	1	.000	6.931
Hispanic	1.450	.050	836.289	1	.000	4.263
Male	-.673	.018	1329.742	1	.000	.510
Stopout Persistence	-.512	.025	404.414	1	.000	.599
STEM GPA	-.430	.018	568.161	1	.000	.650
Advanced Lab Credits	.016	.004	14.941	1	.000	1.016
Biology Credits	.209	.019	120.187	1	.000	1.232
Mathematics Credits	.115	.009	175.657	1	.000	1.121
Physical Science Credits	.116	.019	36.542	1	.000	1.123
Total Science Credits	-.132	.019	50.028	1	.000	.877
STEM Credits	-.014	.003	25.347	1	.000	.986

Independents were more likely to enter the teacher pipeline. Individuals who were low income and not first generation were 2.079 more likely to enter the teacher pipeline than students who were not low income and first generation holding all other factors constant. Overall this variable revealed that low income and/or first generation graduates were more likely to enter the teacher pipeline than graduates who were both not low income and not first generation. Individuals who were single, divorced, or widowed were 24.962 times more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant.

As shown in Table 8, married individuals were found to be 11.640 times more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant. Overall, individuals who were separated from a spouse were least likely to enter the teacher pipeline. In this model Black graduates were 6.931 times more likely to enter the teacher pipeline than individuals of Asian descent. When academic performance was inputted into the model controlling for selected demographics (sex,

race/ethnicity, age, marital status, dependency, SES) and stopout persistence, White and Black graduates were almost equally as likely to enter the teacher pipeline. Individuals of Asian descent were least likely of all races to enter the teacher pipeline holding all other factors constant. Men were .510 times less likely than women to enter the teacher pipeline. Students who stopped out were .599 times less likely than those who did not stop not to enter the teacher pipeline. Individuals who did not stop en route of a bachelor's degree were more likely to enter the teacher pipeline.

Individuals with higher differences between advanced lab, biology, mathematics, and physical science credits attempted and earned were more likely to enter the teacher pipeline, all other factors being equal as seen in Table 8. Individuals with higher differences in All science credits and STEM credits were less likely to enter the teacher pipeline. Finally, individuals with higher STEM GPA's are .65 times less likely to enter the teacher pipeline holding all other factors constant. Overall, this suggests that individuals in the teacher pipeline have lower overall STEM GPA's and are less successful in their advanced lab, biology, mathematics and physical science courses.

The Omnibus tests of model coefficients revealed that there was a significant difference between the previous model, containing the demographics and stopout persistence and the current model that included academic performance.

Table 9

Omnibus Tests of Model Coefficients for Research Question 4

Models	Chi-square	df	Sig.
Step	2074.881	7	.001
Block	2074.881	7	.001
Model	19344.410	20	.001

Summary

In this chapter the researcher discussed the results of the study and addressed all of the research questions. The first research question evaluated the similarities of mathematics and science degree earners in the teacher pipeline and the non-teacher pipeline in terms of selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence and academic performance.

Results revealed that women science and mathematics degree earners were associated with entering the teacher pipeline more than men science and mathematics degree earners. Asians represented the largest minority group in mathematics and science but they were associated with not entering the teacher pipeline. Blacks were not as well represented in mathematics and science majors; however, they were associated with entering the mathematics and science teacher pipeline more than other minorities when they did earn degrees in mathematics or science fields. Single, divorced or widowed individuals were associated with not entering the teacher pipeline. Mathematics and science degree earners from low income backgrounds were associated with entering the teacher pipeline.

The Chi-Square value for the association between Bachelor's degree major, Race/Ethnicity, Dependency Status, Socioeconomic Status and Teacher pipeline status was obtained and each association was found to be significant. This data suggests that an association between each of these variables and teacher pipeline status indeed exists.

The second research question evaluated whether selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) account for a significant amount of unique variance in differentiating between an individual's decision to enter the mathematics and science teacher pipeline and mathematics and science degree earners who chose not to enter the teacher pipeline. A logistic regression analyses was performed to evaluate the predictive relationship between teacher pipeline status and selected demographics (sex, race/ethnicity, age, marital status, dependency, SES). The logistic regression equation of teacher pipeline status and selected demographics was significant.

The full model was an improvement over the base model. The base model correctly predicted 72.3 percent of cases, while the full model correctly predicted 78.9 percent of cases which indicates an improvement over the base model. Mathematics majors were more likely to enter the teacher pipeline than Science majors. Independents were more likely to enter the teacher pipeline. Overall, low income and/or first generation graduates were more likely to enter the teacher pipeline than graduates who were both not low income and not first generation. Individuals who were separated from a spouse were least likely to enter the teacher pipeline. Individuals of Asian descent were least likely of all races to enter the teacher pipeline holding all other factors constant.

The third research question evaluated whether selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence account for a

significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the teacher pipeline and mathematics and science degree earners who chose not to enter the teacher pipeline. The full model was an improvement over the base model. The base model correctly predicted 72.3 percent of cases, while the full model correctly predicted 78.8 percent of cases which indicates an improvement over the base model.

Mathematics majors were more likely to enter the teacher pipeline than Science majors. Independents were more likely to enter the teacher pipeline. Low income and/or first generation graduates were more likely to enter the teacher pipeline than graduates who were both not low income and not first generation. Individuals who were single, divorced, or widowed were more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant. Married individuals were found to be more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant. Individuals who were separated from a spouse were least likely to enter the teacher pipeline. Black graduates were more likely to enter the teacher pipeline than individuals of Asian descent. Individuals of Asian descent were least likely of all races to enter the teacher pipeline holding all other factors constant. Men were less likely than women to enter the teacher pipeline. Students who stopped out were less likely than those who did not stop not to enter the teacher pipeline. Individuals who did not stop en route of a bachelor's degree were more likely to enter the teacher pipeline.

The fourth research question evaluated whether selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence and academic performance (course history, GPA) account for a significant amount of unique

variance in differentiating between an individual's decision to enter the mathematics and science teacher pipeline and mathematics and science degree earners who chose not to enter the teacher pipeline.

The full model was an improvement over the base model. The base model correctly predicted 72.3 percent of cases, while the full model correctly predicted 79.2 percent of cases which indicates an improvement over the base model.

Mathematics majors were more likely to enter the teacher pipeline than Science majors. Independents were more likely to enter the teacher pipeline. Individuals who were low income and not first generation were more likely to enter than the teacher pipeline than students who were not low income and first generation holding all other factors constant. Low income and/or first generation graduates were more likely to enter the teacher pipeline than graduates who were both not low income and not first generation. Individuals who were single, divorced, or widowed were more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant. Married individuals were found to be more likely to enter the teacher pipeline than individuals who were separated holding all other factors constant. Individuals who were separated from a spouse were least likely to enter the teacher pipeline. In this model Black graduates were more likely to enter the teacher pipeline than individuals of Asian descent. When academic performance was inputted into the model controlling for selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence, White and Black graduates were almost equally as likely to enter the teacher pipeline. Individuals of Asian descent were least likely of all races to enter the teacher pipeline holding all other factors constant. Men were less likely than women to

enter the teacher pipeline. Individuals who did not stop en route of a bachelor's degree were more likely to enter the teacher pipeline. Overall, this model revealed that individuals in the teacher pipeline have lower overall STEM GPA's and are less successful in their advanced lab, biology, mathematics and physical science courses.

CHAPTER V

Discussion, Implications, and Conclusions

The four research questions were addressed through a quantitative research study. This chapter includes a summary of the study, discussion of the findings, implications, and limitations of the study. The final section of this chapter will be concluding remarks.

Summary of the Study

According to the United States Department of Education (2000b) study, "Progress through the Teacher Pipeline," although 20% of mathematics, science, and technology undergraduate students considered teaching, only 5% completed teacher preparation programs and accepted teaching jobs. Additionally, only 4% of new mathematics and science teachers foresee teaching as a long-term career commitment (U.S. Department of Education, 2000b). Further information is needed about science and mathematics degree earners, including science and mathematics education majors, entering the teacher pipeline in order to inform recruitment efforts.

The literature suggests gender, race/ethnicity, Socio-economic status (SES) and academic performance as potential factors that affect mathematics and science teacher

recruitment (Clewell & Villegas, 2001; Henke, Chen, Geis, & Knepper, 2000, Shugart & Hounshell, 1995). Considering Bronfenbrenner's (1979) theory, demographics have the largest impact on an individual's development, actions, and reactions; thus these are important in studying mathematics and science degree earners' decisions to enter the teacher pipeline.

In 1996 the Department of Education (1996) reported that the cumulative grade point average of mathematics and science teachers were in the lowest quartile compared to teachers of all other subjects: 17.2% of mathematics/technology teachers and 15.7% of science teachers registered below 2.74 (or B average) on a 4.0 scale. Mathematics and science fields may yield lower grade point averages than other fields pursued by teachers; thus it is important to investigate the academic performance of mathematics and science degree earners who enter the teacher pipeline and those that do not.

The purpose of this study was to understand who, of mathematics and science degree earners including mathematics and science education, enters the teacher pipeline. To this end, the study sought to determine whether predictive relationships existed among the independent variables (selected demographics, persistence, academic performance) and the dependent variable (decision to enter the mathematics and science teacher pipeline) and whether these selected characteristics account for a significant amount of variance between mathematics and science degree earners who entered the teacher pipeline and mathematics and science degree earners who chose not to enter the teacher pipeline. This study examined the characteristics of those who entered the teacher pipeline and provided a snapshot of the attributes of individuals who entered the teacher pipeline.

For this study, the Baccalaureate and Beyond Longitudinal Study (B&B: 08/09) dataset was used to respond to the research questions. The study sample included all mathematics and science degree earners including mathematics and science education majors from the B&B:08/09 cohort. The study sample was analyzed with descriptive statistics, and a multiple logistic regression.

The research questions that guided the study were as follows:

Q1. Are mathematics and science graduates in the teacher pipeline and the non-teacher pipeline similar in terms of selected demographics (sex, race/ethnicity, age, marital status, dependency, SES), stopout persistence, and academic performance (course history, STEM GPA)?

Q2. Do selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

Q3. Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) constant, does stopout persistence account for a significant amount of unique variance in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

Q4. Holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence constant, does academic performance (course history, STEM GPA) account for a significant amount of unique variance

in differentiating between mathematics and science degree earners who enter the teacher pipeline and who do not enter the teacher pipeline?

The study consisted of 2,400 individuals who earned degrees in mathematics or science, including mathematics or science education. Given the use of the B&B:08/09 dataset, when the data was weighted, these 2,400 individuals represented 86,033 mathematics and science 2007-2008 degree earners from across 1,600 postsecondary institutions eligible to participate in Title IV federal student aid programs from across the US and Puerto Rico (Wine et al., 2013; Wei et al., 2009). Prior to completing the logistic regression, the researcher felt it was important to provide a deep description of the sample. To measure the relationship between the independent variables (sex, race/ethnicity, age, marital status, dependency, SES, stopout persistence, course history, STEM GPA) and the dependent variable teacher pipeline status; the researcher performed a multiple logistic regression.

Results of statistical analyses differ by degree level. Correlational analyses indicated that the teacher pipeline status scores had moderate to strong correlations with Bachelor's degree major. Results of logistic regression analyses indicated that demographics, persistence controlling for demographics, and academic performance controlling for persistence and demographics were significant predictors in predicting teacher pipeline status.

Discussion of the Findings

This section discusses the results of each research question. The predictive relationships between demographics (sex, race/ethnicity, age, marital status, dependency,

SES), stopout persistence, academic performance (course history, STEM GPA), and teacher pipeline status were examined through the research questions.

Research Question One

The first research question explored mathematics and science graduates in the teacher pipeline and the non-teacher pipeline similarities in terms of selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence and academic performance.

Descriptive Statistics

Of the approximately 19,000 respondents in B & B: 08/09 only 2,400 were mathematics and science majors, When eighted, these 2,400 individuals represented 86,033 mathematics and science degree earners randomly selected from across 1,600 postsecondary institutions based on the NPSAS:08 study (Wei et al., 2009). When disaggregated by interest, 23,805 degree earners entered the teacher pipeline and 62,228 degree earners chose not to enter the teacher pipeline. When disaggregated by disciplines, 13,476 were Mathematics degree earners nearly half of whom joined the teacher pipeline. While nearly half of the mathematics degree earner population joined the teacher pipeline, it still provides little hope for international academic competitiveness in mathematics and science. The study also revealed that Science majors were .106 times less likely than Mathematics majors to enter the teacher pipeline with all other factors demographic variables being equal. This was an addition to the literature since there was limited information investigating degree choice and teacher pipeline status.

These statistics alone suggest a distinct need for targeted recruitment in mathematics and science education. Murnane et al. (1991) found that women were more likely than men to teach in elementary and secondary schools, and female college graduates were more likely than their male counterparts to enter the teacher pipeline. Chen (2009) found that Men were more likely to pursue a career in STEM. Murnane's sample included all education majors and Chen's sample focused on all STEM majors neither looked at mathematics and science education individually. This study enhanced both of these studies because it investigated a combination of the two. Since much of the research suggests a difference between mathematics and science teachers when compared to general education majors, it was useful to evaluate these graduates independently. The results revealed that even within STEM, where females were equally represented (54.2% of the sample), females were still more likely than males to enter the teacher pipeline when compared to their male counterparts.

Chen (2009) analyzed the 1995-96 Beginning Postsecondary Students Longitudinal Study which consisted of 12,000 students. Chen (2009) found that White and Asian/Pacific Islander students had higher STEM-degree completion rates than Black and Hispanic students. In 1997, 18 percent of Asian/Pacific Islander graduates had entered the pipeline. Moreover, Asian/Pacific Islander graduates were less likely than other racial/ethnic groups to have prepared and taught (Chen, 2009). Over a decade later, the results of this study were nearly identical to Chen's study in that it found that individuals of Asian descent were most likely of the evaluated minority groups to pursue STEM but additionally were least likely to enter the teacher pipeline holding all other factors constant.

In terms of dependency, Chen (2009) found that students who filed as dependents, completed STEM degrees at a higher rate. This study took Chen's finding a step further in that graduates who were claimed as dependents in 2007-2008 were more likely than independents to enter the teacher pipeline.

Trusty (2002) found that African American and Hispanic male students from higher socioeconomic backgrounds were more likely to pursue science and mathematics majors in college than those from lower socioeconomic backgrounds; however, minority females from high SES backgrounds were not apt to do the same. Trusty found that low-income Asian/Pacific Islanders were most likely to have chosen a science or mathematics degree. All in all, Trusty (2002) found that increases in SES resulted in large increases in choice of science and mathematics for Hispanic men and moderate increases for African American men.

This study expanded Trusty's findings in that it looked at how SES affects teacher pipeline status within mathematics and science degree earners. Individuals who were low income and not first generation were more likely to enter the teacher pipeline than students who were not low income and first generation holding all other factors constant. Low income and/or first generation graduates were more likely to enter the teacher pipeline than graduates who were both not low income and not first generation. A statistically significant association was found between income/first generation in college and teacher pipeline status. Low income/first generation degree earners were more likely to teach and Non-low income/non-first generation in college were least likely to teach. While consistent with much of the research, it suggests that despite continued efforts to increase recruitment of minorities there was still a distinct under representation

of racial minorities of low socio-economic statuses within the mathematics and science teacher pipeline (Clewell & Villegas, 2001; Henke, Chen, Geis, & Knepper, 2000, Shugart & Hounshell, 1995; Staniec, 2004).

Correlational data were analyzed for all the independent variables and teacher pipeline status. The results indicated that the teacher pipeline status had strong correlations with all of the variables. Strong and significant correlations among these variables were not surprising since the literature suggested an interaction between demographics, stopout persistence, and academic performance within STEM (Chen, 2009; Trusty, 2002).

Research Question Two

The second research question evaluated whether selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) accounted for a significant amount of unique variance in differentiating between a mathematics and science degree earner's decision to enter the teacher pipeline and not to enter the teacher pipeline.

Demographics to Predict teacher Pipeline Status

Results of the multiple logistic regression analysis indicated that the relationships between the selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) and teacher pipeline status were significant. This result makes sense because a great deal of literature has cited disparities in mathematics and science degree earners in regards to demographics (Chen, 2009; Cole & Barber, 2003; Loveless, 1999; Nelson, Bramer & Rhoads, 2007).

Since Chen's (2009) study only evaluated STEM students, it was important to evaluate STEM students considering teaching. This study's results add to that of Chen's

study. Chen found that the rate of men pursuing mathematics and science degrees was significantly higher than that of women. In this study, Sex was found to be statistically significant in teacher pipeline status, meaning women in mathematics and science majors were more likely than men to enter the mathematics and science teacher pipeline. Given this scenario, it is important to broaden the mathematics and science teacher pipeline by seeking recruitment approaches to recruit more male mathematics and science degree earners into teaching and strengthening the backgrounds and interests of women in mathematics and science in order that more pursue these fields and thus proportionally more will be recruited into teaching.

Mathematics and science degree earners who were not low income were approximately half as likely as low income individuals to enter the teacher pipeline, holding all other factors constant. This finding is disconcerting because as previously mentioned Trusty (2002) found that increases in SES resulted in large increases in choice of science and mathematics for Hispanic men and moderate increases for African American men. Trusty also found that low-income Asian/Pacific Islanders were most likely to have chosen a science or mathematics degree, but the present study found that individuals of Asian descent were least likely to enter the teacher pipeline holding all other factors constant.

If minorities classified as not low income were more likely to enter STEM and these same minorities who are not low income were least likely to enter the teacher pipeline the hope for increasing racial/ethnic diversity within mathematics and statistics teaching is bleak. When this finding is coupled with tracking, where minorities were placed in lower ability courses at a higher rate than White students with similar

achievement scores, it reveals the reasons why minorities are underrepresented in mathematics and science teaching therefore suggesting where interventions and efforts for reforms should be placed (Alvarez & Mehan, 2006; Reyes & Stanic, 1988).

In addition to sex, race/ethnicity and SES, marital status was also considered in this study. Individuals who were single, divorced, or widowed were most likely to enter the teacher pipeline holding all other factors constant.

These findings were consistent to Bronfenbrenner's (1979) macrosystem which suggests that cultural contexts distinctly impact an individual's actions. It was clear that demographics was significantly associated with the decision to enter the teacher pipeline and since these variables cannot be manipulated it was useful to see how other variables in addition to demographics predict teacher pipeline status. Cultural contexts include socioeconomic status, ethnicity, schools and parental work place.

Research Question Three

The third research question evaluated whether stopout persistence accounted for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the mathematics and science teacher pipeline and not to enter the teacher pipeline, when holding selected demographics (sex, race/ethnicity, age, marital status, dependency, SES) constant. The odds ratio associated with the individual predictors indicated that Science majors were less likely than Mathematics majors to enter the teacher pipeline holding all other factors constant. Students who stopped out were less likely than those who did not stop out to enter the teacher pipeline. Individuals who were low income and not first generation were more likely to enter the teacher

pipeline than students who were not low income and first generation, holding all other factors constant.

Tracking was found to be a key factor plaguing minorities and persistence in mathematics and science. Alvarez and Mehan (2006) found low SES minorities most likely to be placed in low ability courses and Yonezawa et al. (2002) found that these placements negatively impact student persistence in STEM fields. Thus, the findings from this study that low income individuals were more likely to enter the teacher pipeline, holding all other factors constant, and individuals entering the teacher pipeline were less likely to have stopped out are important to consider in recruitment for teaching. Science and mathematics majors from low income backgrounds and lower ability courses that are interested in teaching should be supported academically, as needed, in order to increase their level of persistence in completing the science and mathematics coursework needed to teach mathematics or science.

In terms of persistence, Trusty (2002) found that students who completed calculus in high school had a higher chance of persisting in a STEM degree. Similarly, Cole and Barber (2003) found that Latinos and African Americans exhibited lower levels of persistence in STEM resulting from an underrepresentation of STEM faculty. Tinto (1993) found that attrition among non-traditional college students was remarkably higher than traditional college students. However, in 1999, Digest of Educational Statistics found the attendance of non-traditional college students (students over the age 24) was increasing 6 times faster than traditional college students. The findings from this study

are aligned with Tinto's (1993) findings in that that traditionally aged students were more likely to enter the teacher pipeline and least likely to stopout. To broaden the teacher pipeline, recruitment strategies might consider ways of recruiting non-traditional college students into mathematics and science teaching.

Results of the multiple logistic regression analysis indicated that stopout in enrollment was a significant predictor to teacher pipeline status holding all other factors constant. These findings are consistent with the literature reviewed which indicated significant differences in stopout persistence based on race, gender and SES (Rice, Dong, & Weaver, 2006; Shaw & Barbuti, 2010). Currently, there was no information discussing mathematics and science degrees and stopout persistence but there are quite a few articles discussing stopout persistence in other degrees. This finding adds to the body of literature and informs those interested in recruitment that this was found to be a statistically significant predictor in teacher pipeline status.

Research Question Four

The fourth research question evaluated whether academic performance (course history, STEM GPA) accounted for a significant amount of unique variance in differentiating between a mathematics or science degree earner's decision to enter the teacher pipeline and not to enter the teacher pipeline, when holding demographics (sex, race/ethnicity, age, marital status, dependency, SES) and stopout persistence constant.

The odds ratio associated with the individual predictors indicated that Science majors were less likely than Mathematics majors to enter the teacher pipeline holding all

other factors constant. Individuals with higher differences between advanced lab, biology, mathematics, and physical science credits attempted versus earned were more likely to enter the teacher pipeline other factors being equal. Additionally, individuals with higher STEM GPA's are less likely to enter the teacher pipeline holding all other factors constant.

Prior research has indicated that the college entrance exams of graduates within the teacher pipeline were lower overall in comparison to their peers who had not entered the pipeline with respect to scores in SAT mathematics (Gitomer, Latham, & Ziomek, 1999). Podgursky, Monroe, and Watson (2004) found that those who entered teaching had significantly lower ACT scores than those who chose not to teach. This was primarily attributed to the ACT scores of the elementary school teachers because the STEM educator scores were comparable to the STEM non-educator scores. Moreover, high ability mathematics and science educators were found to be exiting the teacher workforce more rapidly than educators in other secondary fields (Podgursky et al., 2004).

Researchers have long said students who choose mathematics or science teaching were lower academic performers than their counter parts but there was a distinct gap in the literature comparing these students to STEM majors (Shugart & Hounshell, 1995; Tobe, 2008). This study revealed that with respect to mathematics and science degree earners individuals in the teacher pipeline have lower overall STEM GPA's and are less successful in their advanced lab, biology, mathematics and physical science courses than those not in the teacher pipeline. Given this finding, to broaden the mathematics and science teacher pipeline, it is important to seek approaches to recruit a broader range of academically capable STEM majors, including higher performing students, into teaching.

Results of the multiple logistic regression analysis indicated that the predictive relationships between the selected demographics (sex, race/ethnicity), stopout performance, academic performance and teacher pipeline status were significant. Individuals with higher differences between advanced lab, biology, mathematics, and physical science credits attempted versus earned were more likely to enter the teacher pipeline. Individuals with lower differences between STEM courses and Science credits attempted were less likely to enter the teacher pipeline. These results revealed that students entering the teacher pipeline retake these courses more often than those who choose not to enter pipeline. This was consistent with the literature suggesting that that educators are typically lower performing when compared to their counterparts (Darling-Hammond, 2000; Tobe, 2008).

Implications for Theory, Research and Practice

Factors affecting mathematics and science teacher pipeline status have been a topic of interest for universities, researchers, and government officials alike. Evaluating selected demographics (sex, race/ethnicity, age, marital status, dependency, SES), stopout persistence, and academic performance as potential predictors of teacher pipeline status seeks to answer these questions and start a more meaningful discussion about the factors impeding mathematics and science teacher recruitment. This section addresses implications for theory and research.

Implications for Theory

Results of the present study provide empirical evidence to support Bronfenbrenner's ecological systems theory. Bronfenbrenner's theory discussed the effects environment and development have on one another. Each environmental influence was labeled and classified as one of the following: the microsystem, the mesosystem, the exosystem, and the macrosystem. The macrosystem encompasses the overall patterns of micro-, meso-, and exosystems characteristic of a given culture, subculture, or other broader social context; all of which are indicative of an individual's belief systems, resources, life styles, and opportunity structures (Bronfenbrenner, 1979).

Bronfenbrenner's (1979) macrosystem is most relevant to this study because it describes how cultural contexts impact an individual's actions and reactions. Cultural contexts include socioeconomic status, race/ethnicity and sex. Berk (2000) found that the influence of the macrosystem penetrated through all of the other layers to impact development. According to Bronfenbrenner's (1979) theory the largest impact to an individual's development, actions, and reactions are demographics.

Bronfenbrenner's theory indicates that cultural contexts, such as socioeconomic status, ethnicity, schools and parental work place, impact an individual's actions and reactions. Additionally the theory posits that the largest impact to an individual's development, actions, and reactions are an individual's material resources, opportunity structures culture and life course options. All of which supports the variable selected demographics as the greatest predictor of teacher pipeline status within the study.

Results of the present study also provided empirical evidence to support theories positing that social and environmental factors have an effect on teacher pipeline status. The study revealed selected demographics as being significant in determining teacher pipeline status.

Implications for Research

The findings of this study indicated a need for future research in several areas. First, it was recommended that future researchers analyze the relationship between course history and teacher pipeline status more deeply. There was a lot of literature discussing high school course selection and its relationship to mathematics and science, it would be useful to investigate course taking trends at the collegiate level to determine a student's success and retention in mathematics and science fields. Second, it would also be of interest to investigate the high school course history of students who entered the teacher pipeline to determine if any courses were found to be statistically significant in predicting teacher pipeline status. Third, it would be useful to investigate this study by discipline. This study was conducted with both mathematics and science respondents; however, it would be interesting to see if these two groups are equal. Furthermore, the study revealed significant differences among minorities. Asians were found to be most likely, when compared to other minority groups, to enter STEM fields but were least likely to enter the teacher pipeline. This finding suggests that cultural factors may be affecting their decisions. This should be investigated further qualitatively.

Lastly, while the issue of increasing diversity within the teacher pipeline was imperative, it was important to evaluate what was happening within the teacher pipeline,

For example, 16.3% of individuals within the pipeline are either certified or took courses towards an education degree yet are not teaching. This was a cause for concern because these degree earners are both qualified and capable to teach mathematics or science but are not doing so. In addition, one year post-baccalaureate, 25.8% are considering teaching but have not taken any action towards it. Therefore, while these degree earners are considered to be part of the teacher pipeline, they are doing little to improve the current state of mathematics and science education.

Implications for Practice

The implications of the results on practice will improve recruitment into the mathematics and science teaching pipeline. For instance, the study revealed that mathematics majors were more likely to enter the teacher pipeline than science majors thus we should target science majors more. Women were more likely to enter the teacher pipeline; thus, we should focus additinal recruitment efforts on men and so on. In essence, the results in this study should aid universities by clearly stating who is entering the teacher pipeline and prompting conversations about developing methods to recruit these groups into the teacher pipeline more effectively.

Individuals within the teacher pipeline have lower overall STEM GPA's and were less successful in their advanced lab, biology, mathematics and physical science courses. Given the positive correlation between teacher content knowledge and student performance, it would be useful to develop interventions to improve the academic performance of graduates within the pipeline. These interventions can range from providing additional assistance, to scheduled meetings, to ameliorating financial, academic and other obstacles.

Limitations of the Study

One limitation needs to be addressed for interpretation of the findings of this study. The sample consisted of a large number of biological/physical science degree earners, however the dataset did not allow for the information to be disaggregated by discipline. The coursework required for a biology major is drastically different from that required of a Physics major or a mathematics major. Therefore, the results may not accurately represent these majors.

Conclusions

The purpose of this study was to determine whether predictive relationships exist among the independent variables (selected demographics, persistence, academic performance) and the dependent variable (decision to enter the mathematics and science teacher pipeline) and whether these selected characteristics account for significant amount of variance between mathematics and science degree earners who entered the teacher pipeline and mathematics and science degree earners who chose not to enter the teacher pipeline. This study examined the characteristics of those who entered the teacher pipeline to provide a snapshot of the attributes of individuals entering the teacher pipeline.

Correlational data analyzed for all the independent variables and teacher pipeline status indicated that the teacher pipeline status scores had a moderate correlation with Bachelor's degree major.

The results of the multiple logistic regression analysis indicated that the relationships between the selected demographics (sex, race/ethnicity) and teacher pipeline status were significant.

The results of the second multiple logistic regression analysis indicated that stopout in enrollment was a significant predictor to teacher pipeline status. This finding was consistent with the literature reviewed which indicated significant differences in stopout persistence based on race, gender and SES (Rice, Dong, & Weaver, 2006; Shaw & Barbuti, 2010).

The results of the third multiple logistic regression analysis indicated that the predictive relationships between the selected demographics (sex, race/ethnicity), stopout persistence, academic performance and teacher pipeline status were significant. Individuals with higher differences between advanced lab, biology, mathematics, and physical science credits attempted versus earned were more likely to enter the teacher pipeline. Individuals with lower differences between STEM courses and Science credits attempted were less likely to enter the teacher pipeline. These results revealed that students entering the teacher pipeline retake these courses more often than those who choose not to enter pipeline. This was consistent with the literature suggesting that that educators are typically lower performing when compared to their counterparts (Darling-Hammond, 2000; Tobe, 2008).

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VITA

ESTHER FINEUS JOSEPH

2005-2009	B.S., Mathematics Education Indian River State College Fort Pierce, FL
2008-2009	Mathematics Teacher, Intern Port Saint Lucie, FL
2009-2011	Mathematics Teacher, Miami, FL
2011	M.S., Curriculum and Instruction: Mathematics Education Florida International University Miami, FL
2011-2013	Graduate Research Assistant Florida International University Miami, FL
2013-	Director of Secondary Education Programs Florida International University Miami, FL
2014	Ed.S, Curriculum and Instruction: Mathematics Education Florida International University Miami, FL
2014	Ph..D, Curriculum and Instruction: Mathematics Education Florida International University Miami, FL

PUBLICATIONS AND PRESENTATIONS

Fineus, E. (2012, January). Pathways to Excellence in Teaching Project: Math as a Language. Presenter (MDC) Conference, Miami, Florida.

Fineus, E. (2012, February). STEM Summit: Careers in Mathematics. Presenter. (AAWU) Conference, Vero Beach, Florida.

Fineus, E. & Fernandez, M. (2012, April). Investigation of Learning Assistant Program. Presenter. (COERC) Conference. North Miami Beach, Florida.

Fineus, E. & Fernandez, M. (2012, June**).** A STEM Learning Assistant (LA) Program and LAs Decisions to Become a Teacher, Presenter. (SMTI), Conference, Alexandria, Virginia.

Joseph, E. (2012, October). The interaction of highstakes testing and math anxiety on student math achievement, Florida council for Teachers of Mathematics, Orlando, Fl.

Joseph, E., Fernandez, M., & Anhalt, C. (2013, January) Recruitment Strategies and STEM Undergraduates' Decisions to Become a Mathematics Teacher, American Math Teacher Educators, Orlando, Fl.

Joseph, E. (2013, May). Keeping Math Fun!!! Implementing the use of manipulatives in Elementary and ESE classrooms. Indian River State College Annual Conference, Fort Pierce, Fl.

Joseph, E. & Fernandez, M. (2013, June). Becoming a STEM Teacher: Investigations of the Learning Assistant Program. Presenter. (SFLERC) Conference. North Miami Beach, Florida.

Joseph, E. (2013, October). Preparing Tomorrow's Student Today: Using the iPad to teach Geometry. Presenter. Florida Council of Teachers of Mathematics Conference. Orlando, Florida.

Joseph, E. (2013, October). An investigation of Mathematics Learning Assistants and their decisions to become teachers. Presenter. University of Colorado Learning Assistant Conference. Boulder, Colorado.

Fernandez, M. & Joseph, E. (2014, November). Recruitment of Hispanic Undergraduates to Become Mathematics Teachers through a Learning Assistant Program. Florida Educational Research Association (FERA) Conference. Cocoa Beach, Florida.

Fernandez, M. L., Molina, R., Joseph, E. F., Nisbet, L. (2013). Microteaching lesson study for fostering the development of preservice teachers' Habits of mind in methods of teaching mathematics courses. In E. dottin, G. O'Brien & L. Miller (Eds.), Structuring Learning Environments in Teacher Education to Elicit Democratic Habits of Mind: Strategies and Approaches Used and Lessons Learned. (p. 155-170). University Press of America: Lanham, MD.

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