FACTORS RELATED TO GRADUATE STUDENTS' COMPLETION OF MATHEMATICS AND MATHEMATICS EDUCATION DOCTORAL DEGREES

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ABSTRACT

FACTORS RELATED TO GRADUATE STUDENTS' COMPLETION OF MATHEMATICS AND MATHEMATICS EDUCATION DOCTORAL DEGREES

Maria Fernanda Cuadrado

The production of doctorates in the United States has increased over the years. Many of these successful graduates have had to face difficult situations to continue through graduation completion. Previous research studies have paid attention to factors related to doctoral degree completion based on broad field of studies. For this reason, the purpose of this research is to (1) examine characteristics of successful doctoral students by field (mathematics and mathematics education) from 2002 to 2013; (2) determine by field which factors were associated with degree completion in successful graduates for fiscal year 2013; and (3) identify which factors were significant in predicting time to degree completion in the two fields for fiscal year 2013.

The data utilized for this study were obtained from the Survey of Earned Doctorates for fiscal years 2002 to 2013. The participants of this study were all graduates who completed this survey and obtained a doctoral degree in mathematics and mathematics education in the United States. The 11 variables in the study were: Sex, Marital Status, Primary Source of Support, Ethnic Background or Race, Doctoral Institution Public/Private Carnegie, Domestic and International students, Master's

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Degree at Entry, Advanced Parents' Education, Age at Entry the Program, Time to Degree Completion and Dependents.

The two regression models for each field of study were statistically significant at the $p \leq .05$ level. Furthermore, for the Mathematics program, 7% of the variance in the dependent variable (time to degree completion) was explained by this set of variables. Same set of variables explained 47% of the variance in the time to degree completion for Mathematics Education program. The significant variables related to time to degree completion for mathematics were: Doctoral institution Carnegie, domestic students, master's degree at entry, and primary source of support. For mathematics education, the only significant variable was master's degree at entry. This research provides important information not only for individuals that are considering enrolling in a doctoral program but also for faculty members and programs. The results of this study highlight continued challenges for educators and institutions at the doctoral level. The results found can be used to create new strategies for improving time to degree completion for mathematics and mathematics education doctoral programs.

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Chapter I

INTRODUCTION

Need for the Study

According to U.S. Doctorates in the 20th century, the number of students pursuing doctoral degrees has not only increased, but the population of students has become more heterogeneous in terms of social origins, such as the enrollment of more women, members of minority ethnic groups, and international students (Thurgood, Golladay, & Hill, 2006). This information is in agreement with Allum's report (2014) that showed an annual average increase of 1.5% in total percentage of graduate enrollments between fall 2003 to fall 2013. In addition, this report showed a change in graduate enrollments of 2.2% at private not-for-profit institutions, which was higher than enrollment growth at public institution (1.2%).

Even though the number of students pursuing a doctoral degree has increased, the completion of doctoral degrees in mathematics education is small compared to those who received a doctoral degree in mathematics. For the 2013 fiscal year, there were only 131 students who received a doctorate in mathematics education (including

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Ph.D. and Ed.D. degrees) and 1,699 students who obtained a doctorate in a mathematical science[1] (National Center for Science and Engineering Statistics, 2015).

The 2007 status report by Reys and Dossey (2008) showed that the number of programs in mathematics education has increased (from 70 in 1960s to 115 in 2000s) in the last 40 years. Although the number of recipients of doctorates in mathematics education has risen (495 in 1960s to 863 in 2000s), this increase remains insufficient for meeting the market demand for this degree. That is, the growth in job opportunities for mathematics educators is greater than the current number of individuals with this doctoral degree (Reys & Dossey, 2008).

The study of mathematics, as a field, began in ancient times. In contrast, the field of mathematics education, as a research field, is relatively new. David Eugene Smith, considered the founder of research in mathematics education, established the first mathematics education research program at Teachers College Columbia University in 1901 (Kilpatrick, 2013). The disciplines of mathematics and mathematics education are related in their common interest in mathematics (Sriraman et al., 2008). Mathematicians use mathematics to explain problems. Mathematics educators use knowledge of mathematics for teaching. "Mathematics and mathematics education have a synergistic relation, and neither can exist without the other" (Kilpatrick, 2008, p. 26).

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[1]The Survey of Earned Doctorates 2013 from July 1, 2012 to June 30, 2013, includes the following fields in mathematics Science: Applied Mathematics, Algebra, Analysis and Functional Analysis, Geometry/Geometric Analysis, Logic, Number Theory, Statistics, Topology/Foundations, Computing Theory and Practice, Operations Research, Mathematics General, Mathematics Other.

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However, knowing mathematics does not guarantee being a good educator. Teaching mathematics is challenging in that it not only requires knowing the subject, but also requires skill and preparation. A major difference between mathematicians and mathematics educators lies in the way they look at mathematics (Kilpatrick, 2008).

These reasons highlight questions about the nature of doctoral programs in mathematics and mathematics education and their students. Undoubtedly, researchers have spent a lot of time studying the reasons for persistence, beliefs, and attrition of doctoral students (Ivankova, 2004). However, there is not enough research focused on the major influencing factors for those who already obtained their doctoral degree and the time needed for successful candidates to accomplish their goal.

In 1993, Tinto proposed a complex model of graduate persistence that consisted in different stages for degree completion. These stages were: Transition to the academic community; acquisition of knowledge and demonstration of competency through examinations; and completion of a doctoral dissertation. His study explained that doctoral completion seemed to be influenced by many factors, such as student background, student attributes, financial resources, financial assistance, and external commitments. In addition, these factors could vary based on the field of study and appear relevant at one stage of persistence, but not in another (Tinto, 1993).

The challenges experienced by successful graduates could impact the time spent until the doctoral degree is awarded. Previous research has shown that one factor that affects time to degree completion might be the economy. The student population is composed of full-time and part-time students. Usually, part-time adult students have

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obligations beyond studying. They need to work to support themselves and sometimes their families. Even though some mathematics and mathematics education programs offer scholarships for their students, this help may be insufficient. Each year, higher education institutions increase tuition in order to meet expense requirements (Rusk & Leslie, 1978).

Another factor that influences degree completion could be the age of students. Older students express diverse incentives, such as passion for research, support received from others, and increase in salaries (Spaulding & Rockinson-Szapkiw, 2012). However, studies have reported that older students take more time to complete their doctorates. “Age is the most consistent statistically significant variable, has a large impact on time and explains the largest amount of variation in the data” (Tuckman, Coyle, & Bae, 1990, p. 77).

Gender is another factor related to degree completion. The experiences of women in mathematics beyond the undergraduate degree are still fraught with challenges to their graduate study (Herzig, 2002). Berg and Ferber (1983) reported that, particularly in male-dominated field, women graduate students are at a disadvantage in finding mentors. This is the result of the greater proportion of male faculty to male students compared to the proportion of female faculty to female students. Berg and Ferber concluded that “the disadvantage is an inevitable result of rising proportions of women students without concomitant changes in the makeup of faculties” (p. 639).

Unfortunately, there is missing information focused on the major influencing factors for those who already obtained their doctoral degree in mathematics and

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mathematics education. Indeed, there is no previous analysis related to both disciplines in terms of time to degree completion using national data. Exploring these factors may contribute important information useful to increase access to and success in doctoral programs, and decrease attrition from these programs.

It is clear that these factors vary from student to student. Each member of a graduate program must overcome his or her individual challenges in order to earn a doctoral degree. Receiving a doctoral degree is one of the most rewarding accomplishments a person can obtain. Therefore, it is relevant to understand the factors related to degree completion and how these factors influence the time to degree completion for successful doctoral recipients in mathematics and mathematics education.

Purpose of the Study

The purpose of this study was to: (1) examine characteristics of successful doctoral students by field (mathematics and mathematics education) from 2002 to 2013; (2) determine by field which factors were associated with degree completion in successful graduates for fiscal year 2013; and (3) identify which factors were significant in predicting time to degree completion in the two fields for fiscal year 2013.

For that purpose, these questions were evaluated:

1. What are the changes in mathematics and mathematics education doctoral degrees awarded in terms of four factor variables (time to degree

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completion, sex, ethnic background/race, and production of doctorates) over a span of 11 years?

2. What are the major factors related to doctorate recipients in mathematics and mathematics education for the fiscal year 2013?

3. What is the relationship between time to degree completion and predictor factors (age at entry, sex, ethnic background/race, master's degree at entry, primary source of support, doctoral institution public/private Carnegie, marital status, parents' advanced education, domestic and international students, and dependents) for successful graduates that earned doctoral degrees in mathematics and mathematics education fields during fiscal year 2013?

Data analysis was performed using the Statistical Package for Social Sciences software (SPSS).

Procedure of the Study

In order to answer the research questions, the procedures used are summarized below:

First, literature was reviewed to determine important factors related to graduate students' completion of doctoral degrees.

Second, the data used for this study were obtained from the National Science Foundation, one of the six federal agencies that sponsor the Survey of Earned Doctorates (SED). The SED is an annual census that was first administered in 1957. The

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participants of this study were all graduates who completed this survey and obtained a doctoral degree in mathematics and mathematics education in the United States during fiscal year 2013. The sponsor of this dissertation, along with the researcher of this investigation, applied and obtained a license agreement from the National Science Foundation to work with the Survey of Earned Doctorates (SED) restricted data from 2002 to 2013.

Third, the researcher cleaned the data requested from the survey. To accomplish this, some significant factors (variables) were recoded into new variables. Indeed, some variables needed to be computed and recoded into different variables, such as Age at Entry. This variable was calculated by subtracting the date of birth from the date of entering in the doctoral program. The intention was to modify the values of existing variables for better analysis.

Fourth, the researcher conducted statistical analysis using data from the SED. The first research question, “What are the changes in mathematics and mathematics education doctoral degrees awarded in terms of four factor variables (time to degree completion, sex, race, and production of doctorates) over a span of 11 years?” was answered using descriptive analysis. Summaries of the population in terms of four measured factors related to degree completion and graphic displays are provided for both fields.

Fifth, cross-sectional data analysis was used to answer research questions 2 and 3. Cross-sectional surveys are useful in measuring experience, knowledge, and viewpoints of a population in relation to an event in a single point in time (Vogt, Gardner, &

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Haeffele, 2014). Therefore, research question 2, “What are the major associated factors related to doctorate recipients in mathematics and mathematics education for the fiscal year 2013?” was answered by exploring the association of each group of graduates between the variables of interest using chi-square analysis. This test is statistically significant when finding the relationship between two categorical variables (Powers, Knapp, & Powers, 2010). A chi-square test of association or independence was performed for the dichotomous dependent variable Type of Degree Earned (mathematics and mathematics education) and the independent variables Sex, Marital Status, Doctoral Institution Public/Private Carnegie, Ethnic Background/Race, Primary Source of Support, Advanced Parents’ Education, Master’s Degree at Entry, Domestic and International Students, and Dependents for fiscal year 2013.

Sixth, the third research question, “What is the relationship between time to degree completion and predictor factors (age at entry, sex, ethnic background/race, master’s degree at entry, primary source of support, doctoral institution public/private Carnegie, marital status, advanced parents’ education, domestic and international students, and dependents) for successful graduates that earned doctoral degrees in mathematics and mathematics education fields during fiscal year 2013?” was addressed by performing multiple regression analysis. Multiple regression models for mathematics and mathematics education doctoral recipients were built to obtain a significant model that predicted time to degree completion by each field of study.

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Chapter II

LITERATURE REVIEW

Overview of Doctoral Duration

It has always been a concern for the U.S. graduate education system to investigate the reasons that impact students' attrition, completion, and time to degree completion. The statistics show that graduate students who abandon the program before receiving a degree represent more than 40% in many disciplines, and those students who did complete the program could take between 8 to 10 years or even longer (Commission on the Future of Graduate Education in the United States, 2010).

Previous research has explored time to degree completion relating to motivations, experience, and financial and personal characteristics that stimulate the achievement of a doctoral degree (Tinto, 1975). Some studies have focused on the analysis of time to degree completion by broad major fields such as English, History, Political Science, Economics, Mathematics, and Physics (Bowen & Rudenstine, 1992) or Education, Engineering, Humanities, Sciences and Mathematics, and Social Sciences (Nettles & Millett, 2006). The diversity of the doctoral student population and program fields has urged the study of the causes of lengthened time of duration in a doctoral program by

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focusing on broad fields of study without focusing on specific majors of study. Exploring specific majors could reveal more significant results.

This study expects to highlight the factors that impact degree completion and time to degree completion by concentrating on two fields only: mathematics and mathematics education. The data used for this research were collected from the National Science Foundation's “Survey of Earned Doctorates,” which collects characteristics of all individuals who obtained a doctoral degree from an accredited U.S. institution.

Pursuing the Doctorate

The maximum academic qualification a student can earn is a doctoral degree. For some of them, this is the greatest investment in life. More time spent in the doctoral program results in an increased number of failures not only for the participants but also for the program. Some talented candidates do not accomplish their goals, and the time, money, and resources invested are vanished. In addition, the program also suffers loss in graduate students, funding resources, and credibility (Lightfoot, 2007).

Previous studies have recognized the importance of knowing the challenges graduate students confront while pursuing their degree. Obtaining a doctoral degree not only improves significantly on financial return, but also has personal knowledge benefits. Consequently, it is important to analyze the possible challenges that limit degree attainment in a graduate school (Nevill & Chen, 2007). One of these challenges is related to a deficiency in time management (West, Gokalp, Pena, Fischer, & Gupton,

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2011). Golde and Dore's (2001) study found that some graduate students struggle in keeping balance with already established responsibilities, such as work and personal life. It is easy to assume that the responsibility for doctoral completion lies completely with the doctoral students. But researchers have found that institutions, along with their programs, influence degree completion. Cooke and Sims (1995) suggested that students with an emotional sense of belonging to the institution and engagement with faculty members were more likely to remain with their degree program. Social and academic integration are significant for doctoral students' persistence (Tinto, 1987; Vaquera, 2007). Understanding the time a student takes to complete a doctoral degree is relevant not only for students themselves but also for graduate institutions. Excessive time during the doctoral program creates frustration, wastes money, and contributes to attrition (Berelson, 1960; Tucker, Gottlieb, Pease, & Michigan State University, 1964).

Doctoral education in the United States is recognized as part of the best higher education system in the world (Wendler et al., 2010). Yearly reports from U.S. doctorate recipients have shown not only an increasing number of domestic students, but also international students who pursue a doctorate degree in this country. The characteristics of graduate students in U.S. institutions over the years have been changing in many aspects, including more representation in racial, gender, and age groups (National Center for Science and Engineering Statistics, 2015). According to the National Center for Science and Engineering Statistics' report, the number of doctorates in science and engineering fields has been growing since 2003. Now, these fields

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represent 74% of all 52,760 doctorates granted in 2013. However, only 9% of all doctorates awarded in 2013 were in education.

Measures of Degree Completion Times

The time that a student takes to obtain a doctoral degree can be measured in different forms. Berelson (1960) states that there are three measures of “duration” of doctoral study: total time to degree, elapsed time to degree, and registered time to degree. Total time to degree is the elapsed time between receiving a bachelor’s degree and receiving the doctorate. The elapsed time to degree is the amount of time between entering a doctoral program and receiving the doctorate. The registered time to degree is the actual time from being registered in the doctoral program to completing the doctorate. Each of the measurements is helpful and suitable depending on what question is addressed. According to a study by Stricker (cited in Bowen & Rudenstine, 1992), the time from first enrollment in a doctorate program until completion is associated with source of financial support (see also Thurgood, 1989). Also, time registered in a graduate program is associated with ethnicity and citizenship (Coyle & Thurgood, 1989). Since Berelson’s (1960) study covers graduate education, including both doctoral degrees and masters’ degrees, his results are noteworthy in relation to this investigation. Berelson’s procedures and findings have contributed to the chronicle of graduate education in the United States. For this reason, many studies have adopted his time to completion metric, including Nettles and Millett (2005), in their book, *Three*

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Magic Letters: Getting to Ph.D., and Lightfoot (2007), in his book, *Finding the Real Odds: Attrition and Time-To-Degree in The FSU School of Criminology and Criminal Justice*.

Studies of the Relationship Between Discipline and Time to Completion

Discipline of study has been identified as a factor that contributes to the duration of doctoral study. Previous studies have demonstrated that students in science disciplines have a longer duration than engineering students in completing the doctoral program (Tuckman et al., 1990). Tuckman et al. explained this result, based on the model used in their study, by stating that each doctoral program requires knowledge already established to earn the degree. As a result, some students take more time to maintain the program standards. Another cause for discrepancies in time to degree completion between fields is the university departmental environment. The researchers found that the interaction between faculty and students can affect the time to degree completion.

Seagram, Gould, and Pyke (1998) also found that natural science graduates had the shortest time to completion when compared to social science graduates, emphasizing that the first group had the least number of part-time students. Bowen and Rudenstine's (1992) study, based on their calculations to time to degree, found that education students took 10.3 years to complete their program when compared to 7.4 years in social science. Their report indicates that higher completion rates with shorter completion times are connected with smaller programs.

Baird (1990) was concerned with the association between time to degree and field study. For his study, he used national data collected by the National Research

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Council. He found that biological, mathematical, and physical sciences and engineering had a comparatively low average of years to obtain the doctorate when compared to humanities, which had the highest average of years. Baird claims that one reason for the difference between disciplines and time to degree is related to the participation of women in the program. Women tend to have more responsibilities, and for this reason they might enroll part-time or interrupt their doctoral program. In addition, some programs attract older students. Older students generally have families and full-time jobs, and, as a consequence, duration is longer. Also, Baird reported, “The factors most strongly associated with the variation in the duration of doctoral study suggest the importance of an emphasis on scholarship and the resources to implement that emphasis” (p. 383).

Doctorate Recipients from U.S. Universities 2013 reports that the time to degree from entering graduate school and attaining the degree has decreased in all fields for the last 20 years. Even though there has been a positive change in time to degree completion, the broad field of education has the longest time span as compared to other fields. In 2013, the median time to degree in education was approximately 12 years. This output could be related to the fact that many students in education are full-time workers, including teachers, curriculum developers, and educational administrators (National Center for Science and Engineering Statistics, 2014).

A recent study on timely completion focuses on reasons observed to be important contributors to timely Ph.D. completion. The study has specified perceived likelihoods of completion through Bayesian network analysis. The Pitchforth et al. (2012) study is

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based on a single research group of doctoral students in mathematical science. The research uses Statistics as a single discipline area in the Mathematical Sciences discipline at Queensland University of Technology, Australia. The group of study had 10 volunteers who they claimed amply represent the population with respect to age, gender, and background, and cover 25% of all students registered in that discipline. Using the Bayesian Network approach, the factors perceived to affect the probability of timely completion were: personal aspects, research environment, research project, and incoming skills. Research project was the most affecting factor on timely completion when compared to the others. The overall probability of timely PhD completion was around 0.7 to 0.8, meaning that on average just less than one student in four would not graduate within the established period. Current domestic students obtained the highest probability of timely completion. Overall, Pitchforth et al. concluded that the outputs of a Bayesian Network helped understand decision-making related to Ph.D. concerns by students, supervisors, and university management.

Another study based on secondary data from 1990 to 2006 with 1,028 graduate students accepted to either a Ph.D. or Ed.D. program in 24 disciplines at a southeastern American public university catalogued as a research university (Wao, 2010) showed that the median time to degree was 5.8 years. Wao employed multilevel discrete time hazard analysis to understand time to completion in education and the factors associated with it. Mathematics education, adult education, and instructional technology were some of the 24 programs in the study. Although personal characteristics of the participants, such as gender, race/ethnicity, age at entry, and GRE

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scores, were not associated with time to degree, Wao's study revealed that as more female students register in a doctoral program, the odds of doctoral completion increased.

Even though studies have concentrated on time to completion, there is no current information comparing U.S doctoral programs in mathematics and mathematics education. On the contrary, those studies that have focused on any of the two fields were interested in students' perceptions, opinions, success, retention, and attrition in doctoral programs.

Mathematics and Mathematics Education Doctoral Programs

Mathematics is an exact science, while mathematics education is related to how a person learns and does mathematics (Kilpatrick, 2008). For both disciplines, the knowledge of mathematics is important. These two fields are interrelated and are part of an unbroken system where they both depend on each other (Dörfler, 2003). According to Kilpatrick (2008), the demand for formalized scholarship through a mathematics education lens took root in the early 1900s. The foundation of mathematics education research as an area of study separate from the field of mathematics began in 1906 at Teachers College Columbia University. David Eugene Smith and Jacob William Albert Young are considered the two main initiators of mathematics education as an academic field in the United States (Kilpatrick, 2008). Smith and Young took this action as a response to the need for better-qualified mathematics teachers. From that moment, mathematics and mathematics education

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were considered to be two separate fields. The first Ph.D. degrees in mathematics education were awarded from Teachers College (Reys & Dossey, 2008). Lambert Lincoln Jackson and Alva Walker Stamper were the first recipients of this Ph.D. in 1906. Since then, Teachers College has contributed significantly with the production of doctorates in mathematics education and has produced numerous leaders in the education system (Reys & Dossey, 2008).

Kilpatrick (2008) affirms that “mathematics is a well-established discipline. It is a branch of knowledge with clearly defined objects of study and accepted methods for studying them. Whether education is a discipline is a more open question” (p. 12). It is important to differentiate the nature and emphasis of these two doctoral programs. They differ significantly, and each of them has distinctive goals, necessities, commitments, and institutional factors.

The doctoral degree in mathematics is granted by several institutions across the country. These programs vary according to their particular program requirements, but they share a common goal. According to National Research Council Staff (NRCS, 1991), the goal of doctoral programs in mathematics is to prepare talented graduate students for research in academic and non-academic career positions. Usually doctoral programs in mathematics consist of already recognized stages. The first stage requires coursework and specialized study. Some courses are mandatory to be taken by all students. Other courses are elective and may be offered by other departments in order to promote wider experience. Graduate students should ensure the course work helps them with the preparation for qualifying exams (NRCS, 1991). For example, in mathematics

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doctoral programs, an institution may require more applied courses and fewer pure mathematics courses or vice versa (Marshall, 2008). At the second stage, students must pass certification exams to continue in the program. This is an eliminating process. Only qualified students remain. Finally, the last stage is the research and thesis. The time a student spends working on his or her research varies from student to student. However, they are required to report to their sponsor frequently about their progress (NRCS, 1991).

Doctoral degree programs in mathematics education have different goals and purposes than doctoral degrees in mathematics. In general, the ideal intention for the doctoral degree in education is to ensure a well-prepared next generation of professionals in terms of researchers, Scholars, and leaders (Nerad & Heggelund, 2011). As a result, graduates in education will be ready to become not only prolific researchers, but also visionaries and accessible instructors for future generations (Nerad & Heggelund, 2011). According to Nerad and Heggelund, doctoral education programs in the United States appear to be almost self-ruling; they explained that while doctoral education programs differ by institution, many typical programs require fixed courses with a great number of elective classes. Also, students have to demonstrate expertise in their major and pass the certification exams. Furthermore, doctoral students are required to create articles for publication during this period. Subsequently, the final stage comes with the development and completion of the dissertation. For example, in the mathematics doctoral program in education, a student may have the opportunity to

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choose if she or he would concentrate on more education classes than mathematics content classes (Nerad & Heggelund, 2011).

The diversity of programs in mathematics and mathematics education, as well as in faculty, is also related in part to the unpredictable changes in our economy, such as business closures, layoffs, and job loss. According to Bass (1997), these pressures provide demands for educational improvement and knowledgeable accumulation that mathematical ideas and thinking can provide. Unfortunately, due to economic pressures, a great number of students either fail or leave the study of mathematics (Bass, 1997).

Gender, Mathematics, and Degree Completion

A gender gap is still present at the doctoral level. According a study by Vélez, Maxwell, and Rose (2014), only 31% of new doctoral recipients in the United States are female. The difference in proportion of degrees conferred by gender is alarming. According to Cheryan (2012), women are still underrepresented in those careers that are stereotyped as masculine. The stereotype that men have more intellectual ability than women is a clear message that leads one to think that women are less capable in mathematics. Cheryan reported, “These stereotypes negatively influence women’s sense of belonging and expectations for success and pressure them to choose careers that do not violate social expectations” (p. 186). Even though she emphasizes that this statement does not suggest that all women feel this way, still the enrollment of women in math-related careers is overshadowed by men. Unfortunately, this stereotype may have influenced the absence of female recipients of prestigious mathematical

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excellence awards, such as the Abel Prize and the Wolf Prize, over the years (Stoet & Geary, 2013). Nevertheless, Maryam Mirzakhani made history in 2014 as being the first woman to win the Fields Medal, the highest honor in mathematics.

Meyer, Cimpian, and Leslie (2015) examined fields of study that are perceived as requiring “brilliance and inherent ability as a key to success” and found an association with the stereotype that women’s innate intelligence is inferior to men’s. Female representation in certain science, technology, engineering and mathematics (STEM) fields continues to show low numbers. Meyers et al. affirm that, “If these beliefs pervade our society, then—in combination with the stereotypes against women’s intellectual abilities—they could lead a variety of individuals (parents, teachers, peers, etc.) to see women as somewhat unsuited for ‘brilliance-required’ domains” (p. 3).

In a recent nationwide study (Leslie, Cimpian, Meyer, & Freeland, 2015), 30 different academic disciplines were used to investigate the field-specific ability beliefs hypothesis. The 1,820 participants included instructors, postdoctoral members, and graduate educatees. Furthermore, this population was rich in diversity from reputable public and private research institutions all over the United States. The participants were asked to evaluate four determiners concerning success in their own discipline. The study used hierarchical regression models to predict female representation. Their finding concluded that women are underrepresented in those disciplines where it is believed that innate talent is required. Low percentages of women in those fields seem to be influenced by the stereotype of lack of such talent.

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Gender is a factor related to mathematics performance, and it is also related to time to degree completion. According to the National Science Foundation (2009), in general women take more time to obtain a doctoral degree compared to men. However, the increase in women enrolled in doctoral programs has been progressive, and the academic year 2012–2013 has reflected this outcome. The Council of Graduate Schools (2014) reported that women represented 52.2% of the doctorate recipients for that academic year, and that it was the sixth straight year that women achieved the majority of overall doctoral degrees earned.

Even though this movement is positive, it is still low for those diplomas granted in the mathematics field. The difference across fields, especially in mathematics, is significant. Hill, Corbett, and St. Rose (2010) reported, "Although women have clearly made great progress in earning doctorates in STEM fields, at the doctoral level women remain underrepresented in every STEM field except biology" (p. 13). Their research showed that from 1966 to 2006, the percentage of earned doctorates by women in mathematics increased from 6.1% to 29.6%. Again, this increment is impressive, but it is still small as compared to men.

More women earned doctoral degrees in education than men. From academic year 2007-2008 to 2012-2013, the average annual percentage of change in doctoral degrees awarded in education for men was 1.9% and women 5.6% (Allum, 2014). Similarly Robert and Barbara Reys (2016) reported that since 1970, there has been a stable increase in women earning mathematics education degrees at the doctoral level. The result of growth could be given to "a surge in recruitment efforts due to an

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announced shortage of doctorates in mathematics education in institutions of higher education" (p. 8).

In general, the population of doctoral students in education tends to be engaged in many more responsibilities when compared to other doctoral students. This is especially true of female students, with multiple responsibilities in their roles as mothers, daughters, wives, and professionals (Rockinson-Szapkiw & Spaulding, 2015). Haynes et al. (2012) concluded that "it becomes more important to understand the demands and pressures of female doctoral students as women" (p. 14). Some women have experienced having to choose between their personal or academic priorities while attending their doctoral program. As a result, women's graduate school experiences are impacted. Overall, women enrolled in doctoral studies seem to have lower academic perseverance in male-dominated programs than all other student groups (Ülkü-Steiner, Kurtz-Costes, & Kinlaw, 2000).

Ethnic Background/Race and Time to Completion

While racial segregation in the United States has lessened over time, minorities still face discrimination in many forms—especially in education. In their study of Minority Students in Science and Math, Tapia and Johnson (2008) stated, "One of the most pernicious forms of bias and prejudice in the academic environment is low expectation of success—a serious obstacle to academic achievement" (p. 187). Minority students such as Hispanics, African Americans, Native Americans, and Asians are often seen as a representation of their race rather than recognized as individuals (Ehrenberg

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& Kuh, 2008). Indeed, Hispanics and African Americans are perceived as the minority groups with highest risk of failing when talking about performance in education. According to a publication from the Tomas Rivera Policy Institute, when the participation of minorities in high schools tends to be high, the science and mathematics programs are weak (Taningco, Mathew, & Pachon, 2008). This contributes to minority students taking less rigorous classes, which affects them negatively when entering a college to pursue a STEM field. Additionally, Latinos are the minority group with the biggest gender gap in STEM professions.

Former President Obama and his administration, Dr. Riegle-Crumb, and others have worked and continue to work incessantly to improve "STEM for all" in education. Obama believed that high-quality education in a STEM major must be accessible to every American student for the betterment of our nation and our students. In fact, Obama wanted to engage diversity by addressing the barriers that discourage underrepresented students to pursue a STEM career. Even though addressing this problem has become a nationwide purpose, minority students still carry this disadvantage from their early years of life. Crisp and Nora (2012) suggested that improvement in gap achievement should start as early as kindergarten enrollment. Their journal clearly found that early intervention in school curricula positively impacted students' educational participation and success in mathematics and science during high school among Hispanics and African Americans. However, the investigation of Riegle-Crumb, King, Grodsky, and Muller (2012) concluded that those recurring arguments, where gender gap differences into STEM programs are explained by prior achievement,

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do not really reduce the gender breach. In fact, their results explained that Blacks and students with lower socioeconomic status are not underrepresented in physical science and engineering. Based on their sample of college enrollees, Riegle-Crumb et al. indicated that STEM fields are not related to social background characteristics for entry.

Participation in higher education is challenging, especially for minorities. Data for Latinas in higher education often report lack of educational support. Ruiz (2013) reported, "[Latinas] oftentimes function within an education system that does not support them. Just as they did in prior schooling, they again encounter language barriers, poor curricula, low expectations, a lack of role models, and other such hurdles" (p. 39). It is very important for minority students to encounter professors that share the same ethnicity, color, and cultural similarities in their education. This gives students hope and encouragement to succeed. Although minority populations are increasing, graduation rates among different ethnic groups are still inconsistent. Unfortunately, representation of minority students decreases as the education degree level rises (Frehill & Ivie, 2013).

According to a journal article by Ross et al. (2012), the percentage of young adults who have at least a bachelor's degree was higher for Asians (62%) and Whites (37%) when compared to Blacks (19%), Hispanics (13%), Native Hawaiians/Pacific Islanders (14%), and American Indians (12%). Higher participation in graduate education does not imply an increase in degree completion. The inclusion of more minorities as African American and Hispanic students in doctoral programs has generated interest by researchers. For this reason, many investigators have been interested in studying

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whether the race of the students is related to degree completion. Nettles and Millett's (2006) study found that Black doctoral students seemed to require the highest need for intervention in terms of preparation, teaching, research, and financial assistantship when compared to the other groups. Black and Hispanic students have felt racial differences among White-predominant institutions, creating discontent with their programs. This predicament becomes more distressing when considering time to degree completion. Nettles and Millett's research has shown that Black students took longer to complete a degree in the doctoral population. Contradictory with this, Bair's (1999) research study found that race or ethnic background and completion rates were unrelated. The change in racial/ethnic groups in doctoral programs points out the need for more information on how to increase the number of doctoral degrees among minorities.

Age at Entry and Time to Completion

There is no consistent association between students' age at entry to a doctoral program and time to degree. Sheridan and Pyke's (1994) study used multiple regression analysis with a sample of participants from a Canadian university to find possible relationships. The population of the study consisted of 395 master's and 79 doctoral students where demographic, academic, and financial support were used as predictors of time to completion. Their results found that neither the gender nor the age variable was an important predictor on the length of time to degree completion. Abedi and Benkin (1987) also found that age at entry does not have an important effect on time to

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doctorate. Their stepwise regression study of 4,225 doctorates from the University of California during the years 1976 to 1985 found that source of support had the greatest impact on doctoral completion.

This result disagreed with Tuckman et al.'s (1990) study of a model that affects total time to the doctorate. This time series study used a model with five variables: family background, student characteristics, financial aid, institutional type, and market forces applied to eleven engineering and scientific fields. Their finding confirms that the students' age at the time of entrance into the graduate program is the most noteworthy factor in raising the number of years until degree achievement. Allen (1996) also noticed that age and citizenship had a significant impact on time to degree. Allen examined a cross-sectional survey of all Ph.D. and Ed.D. recipients during the 1988 to 1994 period. Seven hundred three questionnaires were mailed, but the number of responses received was 353. His research suggested that older students took shorter length of time than younger students to complete their doctoral degrees.

Marital Status and Number of Dependents

According to Tuckman et al. (1989) and Abedi and Benkin (1987), doctoral students who are married with dependents have been shown to spend more years achieving a doctoral degree. Their findings are contradictory to the study of Siegfried and Stock (2001), which found that married students are more likely to finish their degrees sooner. This result can be given in part to the economic support provided by the spouse. Siegfried and Stock did find that women took substantially more time when

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they had dependents. Wilson and the Southern Regional Education Board (1965) also found that individuals with fewer numbers of dependents at all stages of the doctoral program achieved the doctoral degree in better than normal time. Home obligations have been identified to be a relevant factor that may influence the delay in earning a doctorate. Trying to educate children, managing marriage, and other related family issues seem to be related to length matters (Maher, Ford, & Thompson, 2004).

Master's Degree at Entrance

Some doctoral programs require students to have a master's degree when entering the program. Prior research has shown that the characteristics of the program affect the rate completion and the time students spend to achieve their degree. According to Nerad and Cerny (as cited in de Valero, 2001), a master's degree was not required where quicker times to degree completion were reported. For Lightfoot (2007), the source of a master's degree seemed to influence time to degree completion. Based on the results from this study, he found that students who completed the M.A. at Florida State University obtained a doctoral degree in less time than those who had not. He also explains that this can be the result of a deficiency in the M.A. and Ph.D. programs. In other words, a student may be working on his or her master's degree while meeting the requirements for the doctoral program.

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Parental Higher Education Achievement and Degree Completion

One of the demographic factors of students is their parents' education. Parents' education has been recognized to be associated with such educational outcomes of students as competence, accomplishment, and academic success. Parental education levels seem to influence their children's aspirations. On average, highly prepared parents will produce children who achieve high levels of education, albeit not as high as theirs (Haveman & Wolfe, 1995). A study by Berelson in 1960 found that, even though doctoral students' backgrounds are heterogeneous, students' enrollments in doctoral education were partly influenced by better-educated homes. In addition, Kirkpatrick and DeFleur (1960) reported that university professors function as producers of Ph.D. receivers. Their study revealed that one-third of the offspring of male professors had achieved a Ph.D. This implies that university professors inspire their children to follow their paths. Choy's (2002) research about students at graduate levels found that not having a parent with a bachelor's degree negatively affected enrollment in a graduate degree program. This research supports the conclusion that parents with a university degree can lead their children to accomplish higher education levels, such as a doctoral degree.

Peculiarly, not all research on the matter agrees. Tuckman et al. (1990) found that, on the doctoral level, parents' education and income do not have a significant effect on time to completion. Moreover, Weiler (1991) showed that parental education has a negative and significant influence on a student's decision to enroll in a Ph.D. program.

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Private versus Public Institutions and Degree Completion

Doctoral degrees are awarded by both public and private educational institutions. The selectivity of programs in both sectors varies and highlights advantages and disadvantages. According to Dill and Soo's (2005) study, less selective public universities in the United States tend to offer academic majors with low income expectations as compared to selective institutions. The reputation of the institution is very important when enrolling in a program. As was mentioned before, the United States produces a substantial number of doctoral graduates. In fact, it is believed that 50% of the entire population of doctoral students around the world is studying in this country (Bloom, Hartley, & Rosovsky, 2007). Nearly 406 universities grant doctoral degrees, which differ amply by amount, type, and characteristics. According to Bloom et al., the top ten institutions that award the most doctoral degrees are divided into eight public and only two private institutions. The top two public institutions are the University of California-Berkeley and the University of Wisconsin-Madison; the only two private institutions that are placed in the list of the top ten are Nova Southeastern University and Stanford University. Although there are more public universities granting doctoral degrees, private universities have higher completion rates when compared to state universities (Dixon, 2015). In terms of time to completion, research has associated longer time to degree with less selective public institutions. Students who attend public institutions are employed more often than those at private schools, resulting in fewer credits taken per semester. The Bound, Lovenheim, and Turner (2010) study concluded that time to

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degree increases when students are enrolled in non-elite public institutions or in community colleges. Andrieu and St. John (1993) reported,

> Attending a private university was positively associated with persistence by graduate students. Supplemental analyses of private colleges, especially the fact that the logistical model for private colleges did not converge, suggest that prices are not as problematic for graduate students in private colleges as for those in public colleges. (p. 18)

Domestic and International Students and Time to Degree Completion

The diversity of doctoral students has significantly increased in terms of sex, race, age, and national origin. In many quantitative fields, international students serve as a vital source of talent for American corporations as well as American research universities. Many international students become unofficial world ambassadors of American beliefs and ideals when they leave the United States (Anderson, 2013).

In recent years, the number of doctoral degrees granted to international students has grown in large proportions. According to the National Science Board (2016), approximately 200,000 international students in 2013 were registered in science and engineering graduate programs. Also, the proportion of doctoral degrees conferred to foreign students is higher when compared to master's, bachelor's, or associate's degrees.

In addition, time to degree completion has been shown to be shorter for international students than domestic students (Dixon, 2015). Previous research about factors affecting time to doctoral degree completion at the University of Iowa stated that international students, who were twice are as likely to graduate than the other students, completed their degree faster. One reason was that international students

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were not able to work legally due to the visa restrictions. Therefore, they can devote their entire time to their studies (Lee, 2000).

Financial Support and Time to Degree Completion

Previous studies have identified financial support as an influential factor related to degree completion. According to Abedi and Benkin (1987), when the institution grants financial support to students, the time to doctorate completion tends to be shorter. Similarly, Seagram et al. (1998) found that an abundance of financial support is often related to a greater proportion of degree conferrals. Lacking financial resources can adversely impact students' degree completion. Graduate students who cannot meet their expenditures due to a lack of financial resources, including research assistantship, financial aid, teaching assistantship, and/or any other form of financial support, tend to abandon their course of study (Tucker et al., 1964). According to the Council of Graduate Schools (Sowel, Zhang, Bell, & Kirby, 2010), "Depending upon how financial support through assistantships and fellowships is structured, it can either enhance or inhibit academic and social integration" (p. 43). Ehrenberg, Jakubson, Groen, So, and Price (2007) investigated the characteristics of doctoral programs in the humanities and social sciences. They found that improvement in financial support decreases the odds of students' attrition in almost all years.

Dixon (2015) reported that many doctoral institutions offer financial funding at the time of entering the program, such as fellowships, scholarships, or teaching and research assistantship. However, many students must finance their doctoral studies

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using private or student loans. Lack of funds for some graduate students may negatively impact attainment percentages.

Ampaw and Jaeger (2012) reported, “Financial aid and labor market conditions have differential impacts on persistence, and among all financial aid types, students with research assistantships have the highest likelihood of completing the degree” (p. 656). Similarly, de Valero (2001) showed that the source of financial aid was a big issue in degree completion.

Other studies have indicated opposite findings. Andrieu and St. John (1993) found a negative association between assistantship and persistence. In their research, graduate student participants enrolled in public institutions did not benefit from assistantships. However, Kim and Otts (2010) reported, “Assistantship and fellowship support is also related to timeliness of doctoral degree completion” (p. 23).

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Chapter III

METHODOLOGY

The purpose of this study was to examine the factors related to doctoral degree completion by graduates in mathematics and mathematics education. Using a quantitative approach permitted the researcher to explore the statistical relationship between various background factors and times to completion between these two disciplines. This chapter aims to explain the research design, descriptive analysis, population, instrumentation, data, research ethics, and analysis involved in this investigation.

Research Questions

1. What are the changes in mathematics and mathematics education doctoral degrees awarded in terms of four factor variables (time to degree completion, sex, ethnic background/race and production of doctorates) over a span of 11 years?
2. What are the major associated factors (sex, marital status, primary source of support, ethnic background/race, doctoral institution public/private Carnegie, domestic and international students, master's degree at entry,

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advanced parents' education, and dependents) related to doctorate recipients in mathematics and mathematics education for the fiscal year 2013?

3. What is the relationship between time to degree completion and predictor factors (age at entry, sex, ethnic background/race, master's degree at entry, primary source of support, doctoral institution public/private Carnegie, marital status, advanced parents' education, domestic and international students, and dependents) for successful graduates that earned doctoral degrees in (a) mathematics and (b) mathematics education during fiscal year 2013?

In order to answer these questions, the Statistical Package for Social Science (SPSS) and Microsoft Excel programs were utilized for descriptive and inferential analysis.

Research Design

Based on the research questions and the purpose of this study, a quantitative research method was applied. According to Muijs (2010), a quantitative analysis uses mathematical techniques related to numerical data in order to understand a situation. A quantitative approach describes the data and finds similarities between the variables of interest. Therefore, clarifications, likelihoods, and conclusions can be derived (Walliman, 2006). For this study, data from the Survey of Earned Doctorates 2013 were used.

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The quantitative research conducted for this investigation was non-experimental. Belli (2009) explains that when the variables of interest, such as gender, ethnicity, and other personal attributes, represent the characteristics of a population, non-experimental research is used. She added, “Non-experimental research involves variables that are not manipulated by the researcher and instead are studied as they exist” (p. 60).

The type of quantitative method utilized was descriptive research. The main purpose of descriptive research is to analyze the collected data by connecting key variables and determining associations. Descriptive studies are relevant when the investigator wants to create new concepts (Conrad & Serlin, 2011.). Descriptive examination is appropriate for this study because the key characteristic of the doctoral graduates in mathematics and mathematics education can be organized around the time to degree completion variable.

Survey

One of the most common non-experimental study methods for research in education is a survey. According to Dodge (2008), surveys are very effective when collecting vast information from large populations. They are also convenient because many topics can be questioned. This study utilized the Survey of Earned Doctorates (SED) for the targeted population. The Survey of Earned Doctorates is an annual census completed yearly since 1957 by all persons who have received a doctoral degree from an accredited U.S. institution in such year. The National Science Foundation, National Institutes of Health, U.S. Department of Education, U.S. Department of Agriculture,

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National Endowment for the Humanities, and National Aeronautics and Space Administration sponsor this survey. The purpose of the SED is to gather valuable information about each recipient’s background, education, and post-graduation plans. The information collected is very important for educational and labor force planner utilization within the federal government and universities.

For this study, the researcher preferred to employ the SED survey data for its advantages. The SED survey comprises information that better represents the attributes and characteristics of the population of interest. The data collection for the SED survey is obtained by paper surveys, web-based surveys, and computer-assisted telephone interviews. Follow-up interviews are performed if critical questions from paper and/or web-based information are missing. The data collected do not contain imputation for missing data answers. Because the survey is a census, weighting is not used. The SED is a cross-sectional survey for the year 2013.

Population

The target population for this study consisted of all doctoral graduates that received a doctorate in mathematics and mathematics education from a United States academic institution for fiscal year of doctorates 2002 to 2013 (it included all doctorate recipients who graduated from July 1st of one year through-June 30th of the following year). For the year 2013, 92% of recipients completed the SED. According to the National Science Foundation, the SED has minimal coverage error because graduate institutions gather the survey soon after the individuals complete the doctorate.

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Likewise, measurement error (less than 1%) and coding error (0.34%) are minimal as well.

Instrument Design

The Survey of Earned Doctorates (SED) is divided into three parts: A, B, and C. Part A contains questions about graduates' education, part B contains questions related to post-graduation plans, and part C gathers demographic information.

For this research, doctoral degrees in mathematics include the following areas: Algebra, Analysis and Functional Analysis, Applied Mathematics, Computing Theory and Practice, Geometry/Geometric Analysis, Logic, Number Theory, Operation Research, Statistics, Topology/Foundations, Mathematics/Statistics, General and Mathematics/Statistics, and other. The recipients of doctoral degrees in mathematics education come from both Ph.D. and Ed.D. programs.

In 2013, there were a total of 52,760 individuals who received a doctoral degree from a U.S. institution. The population for this study comprises 1,699 doctorate recipients who obtained a doctorate in mathematics education (131) and a doctorate in mathematics (1,830).

Table 1. Total Number of Earned Doctorates in Mathematics and Mathematics Education

Doctorate	Frequency	Percent
Mathematics	1699	92.8
Mathematics Education	131	7.2

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One thousand two hundred twelve males and 487 females earned a doctoral degree in mathematical science for 2013. Forty-six males and 86 females graduated in mathematics education in the same year (see Table 2).

Table 2. Mathematics and Mathematics Education Doctorate Recipients by Gender

Gender	Mathematics	%	Mathematics Education	%
Male	1212	71.3	46	34.8
Female	487	28.7	85	65.2

Variables in the Study

The variables used in this study were informed by the literature review. A description of the variables used, as well as the researcher(s) who identified the variable(s), follows:

- Time to Degree Completion: Shows the amount of time in years since the first-time graduates enrolled in a doctoral program until the year the doctorate was awarded (fiscal year).
- Average Time to Degree Completion: This variable refers to average time in years of the time to degree completion variable.
- Sex: This variable shows the gender of the doctorate recipients (male and female).
- Production of Doctorates: Shows the number of doctorates awarded for each fiscal year.

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- Advanced Parent Education: This is a dichotomous variable code 1 if any of the parents had a bachelor's degree or higher advanced degree and coded 0 otherwise.
- Age at Entry: This variable was obtained by subtracting date of entry at doctoral program and date of birth.
- Dependents: This variable was generated by adding the number of dependents who were 6 years old or younger (DEPEND6), number of dependents who were between 7 years old and 18 years old inclusive (DEPEND18), and number of dependents who were 19 years old and older. Then it was recoded into a different variable coded 1 for having at least one dependent and coded 0 otherwise.
- Field of Degree Earned: refers to the selection of the cases that included mathematical science and mathematics education fields recorded in a new sample of the data. For the multiple regression models, mathematical science and mathematics education programs are split into two separate files.
- Male: A dummy variable coded 1 for males, with female as reference.
- Married or Living in a Marriage-like Relationship: dichotomous variable created by recoding Marital Status variable into a different variable where being married or living in a marriage-like relationship was coded 1 and 0 for otherwise.
- Master's Degree at Entry: This dichotomous variable is the result of a two-step calculation: First, recoding into a different variable the difference between the year of entry of doctoral program and the year that master's degree was

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conferred. Then assigning 1 for the years greater or equal to 0, and assigning 0 for years less than 0. Therefore, 1 represents those graduates with a master's degree at entry and 0 otherwise.

- Doctoral Institution Public/Private Carnegie: This a dichotomous variable coded 1 if graduated from a public graduate institution; coded 0 if graduated from a private graduate institution.
- Ethnic Background: This variable is obtained first by recoding into a different variable with five categories: Whites; Asians, including Asians and other Pacific Islander; Blacks or African American; Hispanics, including Mexican, Chicano, Puerto Rican, Cuban and other Hispanics; and Others, including non-Hispanic, Native Americans and Multiple Racial Responses and Unknown. Second, four separate dummy variables were created using Whites as reference variable.
- Primary Source of Support: This variable was obtained by performing two steps. First, the original variable SRCEPRIM was recoded into a different variable with four categories. Category 1 included those graduates who received Fellowship and Scholarship. Category 2 included graduates that answered to have Teaching Assistantship as primary source of support. Category 3 comprised all the graduates that reported Research Assistantship as primary support. Category 4 compassed Grants; Other Assistantship; Internship; Traineeship; Loans; Personal savings; Personal earnings; Spouse's, partner's, or family's earnings or savings; Employer reimbursement and assistance; and Foreign (non-U.S.) support and Other. The reason that category 4 has many categories recoded into one

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category was because many of these categories did not report any entry. Second, three dummy-variables were created using fellowship and scholarship as reference variable.

- Domestic vs International Students: The variable Citizen was recoded into a different variable where domestic students included: U.S. native born, U.S. naturalized, U.S. unspecified if native or naturalized, U.S. assumed for Puerto Ricans who did not report citizenship status, Non-U.S. applied for citizenship and Non-U.S. immigrant permanent resident. International students included: Non-U.S. immigrant temporary resident and Non-U.S. visa status unknown. Then variable domestic vs international was created coding 1 for domestic and 0 for international students.

Ethical Considerations

Even though this research involved secondary data and was exempt from the human subjects' protection regulations, the researcher had to participate in the training requirements. Also, the researcher complied with all the Institutional Review Board (IRB) ethical considerations in order to protect participants' confidentiality.

To access the SED restricted data, a license agreement was granted from the National Science Foundation after applying and meeting their guidelines. The restricted data were received on a password-protected CD. All electronic calculations were protected in the researcher's assigned room, with a password-protected computer with no Internet access. All physical information, such as printed data sheets and any other

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printed material that relates to the study, was maintained in a secured drawer where only the researcher had access. The CD was returned to the National Science Foundation when the study was complete.

Data Analysis

The analysis of the data for this investigation was completed using the Statistical Package for Social Sciences (SPSS). Descriptive, chi-square tests and regression analyses were performed to address research questions.

For research question 1, the researcher provided descriptive analysis of the changes in mathematics and mathematics education doctoral recipients' population in terms of time to degree completion, sex, ethnic background, and production of doctorates over a span of 11 years. The use of descriptive statistics is appropriate when summarizing meaningful data into explainable forms by interpreting and communicating results through simple statistics and graphic displays (Conrad & Serlin, 2011).

The chi-square test of independence was used to answer research question 2. According to Franke, Ho, and Christie (2011), this test determines if two categorical variables are associated which each other. Differences between doctorate recipients, from both majors by demographic and education factors, were explored using cross-tabulation tables and percentages.

For research question 3, the researcher applied multiple regression analysis. The purpose of this test is to find a mathematical model that relates the dependent variable to a set of independent variables (Mendenhall & Sincich, 2003). This method allows the

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simultaneous testing and modeling of multiple independent variables. Multiple regression analysis not only predicts the likelihood of a dependent outcome based on independent variables, but it also helps the researcher understand the functional relationships between the dependent and independent variables by seeing what might be causing the variation in the dependent variable. Since the information gathered for this study is a census, weighting the data was not necessary. The goal of this study was to understand the factors that better describe the population of doctoral graduates in mathematics and mathematics education using the survey of earned doctorates (SED). Regression models were created for the time to degree completion for mathematics and mathematics education graduates.

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Chapter IV

RESULTS

Introduction

This chapter provides results of the statistical analyses performed for the completion of this study. The first purpose of this research was to report changes between 2002 and 2013 in the fields of mathematics and mathematics education using four variables: Average Time to Degree Completion, Sex, Ethnic Background, and Production of Doctorates.

The second purpose of the study was to determine the impact of major factors on doctoral degree completion in mathematics and mathematics education including gender; marital status; racial/ethnic background; type of doctoral institution; domestic students (vs international students); master's degree at entry; parents' advanced education; and dependents.

The third purpose of this of the study was to determine which factors were meaningfully related to time to degree completion between mathematics and mathematics education doctoral programs. The variables used for this question were:

a. Time to degree completion

b. Age at entry to the program

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c. Sex: male and female

d. Ethnic Background/Race: White, Black or African American,

e. Asian, Hispanic, and Others

f. Dependents: At least one dependent

g. Domestic students (vs international students)

h. Marital Status: Married or living in a like marriage-relationship, and otherwise which includes never married, divorced, separated, and widowed.

i. Primary source of support: Fellowship and scholarship, teaching assistantship, research assistantship, and other type of support.

j. Master's degree at entry (vs not master's degree at entry)

k. Doctoral institution public Carnegie (vs private Carnegie)

l. Advanced parents' education: At least one of the parents had a bachelor's degree or higher

Research Question 1: Changes From 2002 to 2013

The purpose of this question was to describe whether factors hypothesized to be related to degree completion have changed over a span of 11 years. Research question 1 provides descriptive analysis of the mathematics and mathematics education doctoral recipients' population by production of doctorates, time to degree completion, sex, and ethnic background.

1. What are the changes in mathematics and mathematics education doctoral degrees awarded in terms of four factor variables over a span of 11 years?

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Production of Doctorates Awarded

The production of doctorates awarded in mathematics and mathematics education from 2002 to 2013 grew from 854 to 1,699 and from 83 to 131, respectively. These programs differ greatly in the number of doctorates granted. Table 3 shows the number of doctorates produced from 2002 to 2013.

Table 3. Production of Mathematics and Mathematics Education Doctorates, 2002-2013

	Total Doctorates in Mathematics	**Total Doctorates in Mathematics Education**
2002	854	83
2003	939	78
2004	1,007	85
2005	1,133	82
2006	1,243	90
2007	1,314	125
2008	1,309	119
2009	1,447	150
2010	1,483	134
2011	1,507	136
2012	1,603	108
2013	1,699	131
All years	**15,538**	**1,321**

An examination of the growth for the same period of time is shown in the following scatterplots (see Figures 1 and 2). The first scatterplot shows a strong positive linear relationship (r=0.99) for the number of mathematics doctorates awarded from 2002 to 2013. The R-squared value indicates that 98% of the variation in the number of mathematics doctorates awarded can be explained by the fiscal year of graduation. The slope indicates that for every 1 unit increase in fiscal year of graduation, it is expected

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that on average the number of doctorates awarded in mathematics will increase by 73.9 (see Figure 1).

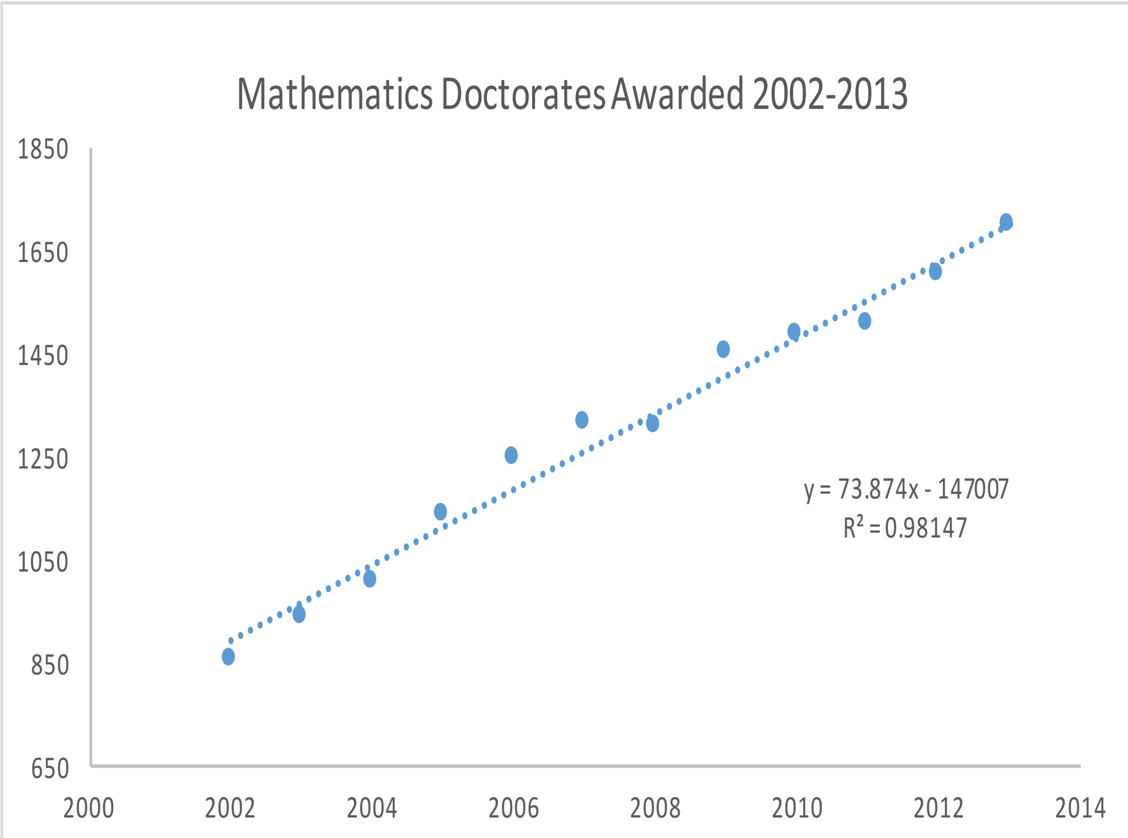

Figure 1. Scatterplot of mathematics doctorates awarded from 2002 to 2013

The second scatterplot shows a relatively strong positive linear association (r=0.79) between mathematics education doctorates awarded and fiscal year of graduation from 2002 to 2013. In addition, 62% of the variability of the number of mathematics education doctorates awarded is predictable from the fiscal year of graduation. The slope indicates that for each passing year increase in fiscal year of graduation, it is expected that on average the number of doctorates awarded in mathematics education will increase by 5.6 (see Figure 2).

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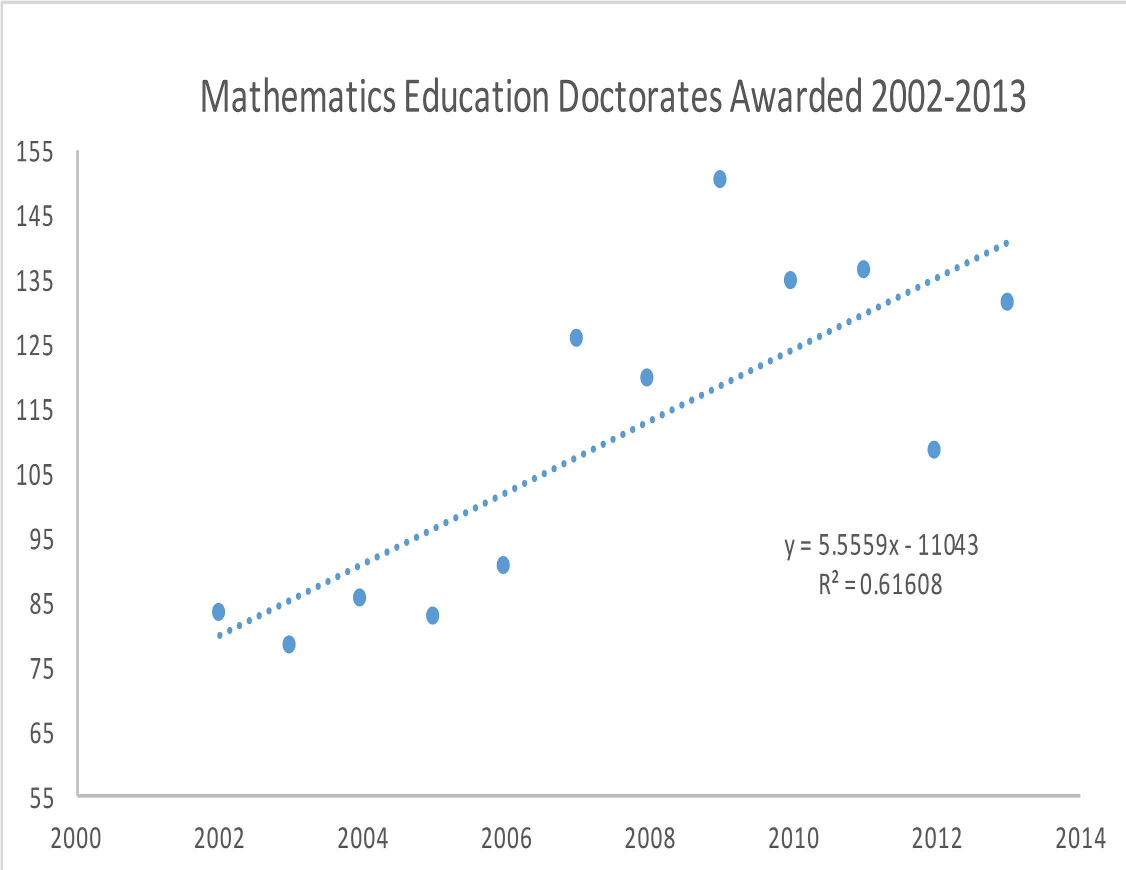

Figure 2. Scatterplot of mathematics education doctorates awarded from 2002 to 2013

The production of mathematics education doctorates has not increased as significantly as mathematics. The aggregate number of years is relatively small. Comparing the two fields of study in this investigation, the field that experienced the greatest increase in doctoral degrees granted from 2002 to 2013 was mathematics with a total of 99% growth. The field of mathematics education changed only by 58% during the same years.

Average Time in Years to Degree Completion

The average years of doctoral degree completion in mathematics and mathematics education from 2002 to 2013 are represented in Figure 3. The average

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time to completion in mathematics has been moderately stable since 2002, being obtained within six years. Figure 3 depicts a slight decrease in average years to degree completion for those in mathematics education from about eight and a half years in 2002 to almost eight years in 2013. In general, the time a graduate student takes to obtain a doctoral degree in mathematics is less than the time to obtain a doctorate in mathematics education.

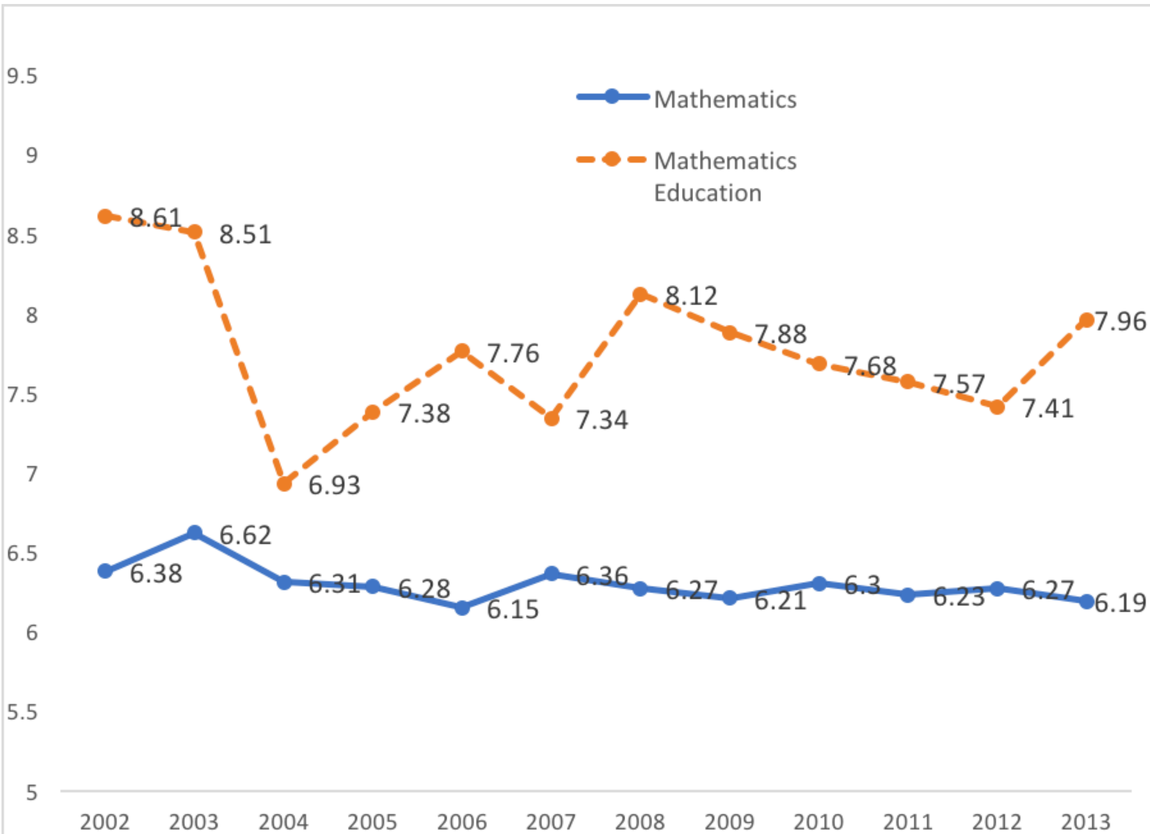

Figure 3. Average time in years to degree completion in mathematics and mathematics education, 2002-2013

Doctoral Degrees Awarded by Sex

Overall growth in the fields of Mathematics and Mathematics Education from 2002 to 2013, as stated earlier, was 99% and 58%, respectively. In 2002, females were

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awarded the minority share of doctorates in Mathematics (28%) and the majority of doctoral degrees in Mathematics Education (63%). Female annual representation in 2013 was only .9% above the 2002 percentage in Mathematics and 2.2% above the 2002 percentage in Mathematics Education. Thus, the share in growth in both fields by sex changed relatively slightly, with males continuing to dominate the field of Mathematics by a ratio of more than 2 to 1 and females dominating the education field by a ratio of slightly less than 2 to 1.

Table 4. Doctoral Degrees Awarded to Males and Females by Major Field, 2002-2013

	Mathematics				Mathematics Education			
Year	Male	% of Total Degrees	Female	% of Total Degrees	Male	% of Total Degrees	Female	% of Total Degrees
2002	614	72.2	237	27.8	31	37.3	52	62.7
2003	690	73.5	249	26.5	33	42.3	45	57.7
2004	721	71.6	286	28.4	33	38.8	52	61.2
2005	826	73.0	305	27.0	30	36.6	52	63.4
2006	874	70.3	369	29.7	37	41.1	53	58.9
2007	937	71.4	376	28.6	44	35.2	81	64.8
2008	911	69.6	397	30.4	46	38.7	73	61.3
2009	1,000	69.2	445	30.8	48	32.0	102	68.0
2010	1,051	70.9	432	29.1	53	39.6	81	60.4
2011	1,073	71.3	431	28.7	51	37.5	85	62.5
2012	1,145	71.6	455	28.4	30	27.8	78	72.2
2013	1,212	71.3	487	28.7	46	35.1	85	64.9

Doctoral Degrees Awarded by Ethnic Background/Race

The diversity of ethnicity in doctoral students has been changing over time, predominantly in the field of mathematics. 2004 was the last year in which one ethnic/racial group (White) earned a majority share of doctoral diplomas in

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mathematics. Within this field, Whites are the largest minority, followed by Asian-Pacific Islander. Within the field of mathematics education, Whites have historically and continue to earn the majority of doctoral diplomas – 60% of diplomas awarded over the 2002-2013 period and 64% in both 2002 and 2013.

According to the U.S. Census Bureau in 2010, the two major American minority groups are Blacks or African Americans and Hispanics. Black or African Americans represent 12.6% of the entire U.S. population. However, their participation in graduate education is underrepresented. Table 5 shows that the *number* of Blacks or African Americans who were awarded doctoral degrees in mathematics has changed from 13 to 36 during a period from 2002 to 2013. A similar situation occurred for doctoral degrees granted to Blacks or African Americans in mathematics education (see Table 6). Since 2002 to 2013, the number of degrees conferred to them increased by 2 (11 to 13). These marginal increases in numbers were negligible, as the portion of doctoral degrees earned by Black or African Americans decreased from 2.5% to 2.1% in mathematics and from 13.3% to 9.9% in mathematics education.

Hispanics represented 16.3% of the U.S. population (U.S. Census 2010). The number of doctoral diplomas in mathematics and mathematics education for this minority group has grown from 15 to 71 and from 2 to 7, respectively, for the period 2002 to 2013. These increases surpassed the increases of the Black or African American minority in both fields. The percent changes in earned doctoral diplomas for Hispanics of 373 in mathematics and of 250 in mathematics education exceeded the overall aggregate growth of 99% and 58%, respectively. Nevertheless, in 2013, Hispanics

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received only 4.5% and 5.3% of the total doctoral degrees in mathematics and mathematics education.

The number of doctoral degrees granted to Whites for mathematics increased from 407 in 2002 to 754 in 2013 – an increase of 85.3%. Over the same period, the percentage increase in number of degrees awarded to Whites in mathematics education was 60.4% (53 in 2002 and 85 in 2013). The majority in percent of doctoral degrees awarded in mathematics education by ethnic group belonged to Whites. Recipients of doctorates in mathematics have varied more from 2002 to 2013. In general, most of the doctoral degrees by field were earned by Whites.

Representation of Asians as a racial group has changed significantly in both number and percent of degrees granted, from 130 (21.2%) in 2002 to 683 (42.8%) in 2013 within the field of mathematics. The increase in the number of doctoral degrees conferred annually since 2002 indicates huge progress for Asians. The percent of change from 2002 to 2013 grew 425.4 %. For mathematics education doctorates awarded, Asian representation has increased from 9.6% to 15.2% (2002-2013). Although there was strong growth of 150% over the 2002 to 2013 period, it was not as dramatic as the growth in mathematics.

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Table 5. Mathematics Doctoral Degrees Awarded by Race, 2002-2013

		Black or African American	Asian-Pacific Islander	Hispanic	White	Other/Unknown
2002	No.	16	130	15	407	46
	%	2.61	21.17	2.44	66.29	7.49
2003	No.	10	213	26	333	51
	%	1.58	33.65	4.11	52.61	8.06
2004	No.	16	247	26	398	57
	%	2.15	33.20	3.49	53.49	7.66
2005	No.	16	236	26	387	66
	%	2.19	32.28	3.56	52.94	9.03
2006	No.	21	320	32	452	55
	%	2.39	36.36	3.64	51.36	6.25
2007	No.	15	313	23	362	90
	%	1.87	38.98	2.86	45.08	11.21
2008	No.	29	429	24	522	99
	%	2.63	38.89	2.18	47.33	8.98
2009	No.	36	352	34	593	86
	%	3.27	31.97	3.09	53.86	7.81
2010	No.	37	385	28	655	75
	%	3.14	32.63	2.37	55.51	6.36
2011	No.	26	430	32	641	86
	%	2.14	35.39	2.63	52.76	7.08
2012	No.	46	595	49	665	117
	%	3.13	40.42	3.33	45.18	7.95
2013	No.	36	683	71	754	51
	%	2.26	42.82	4.45	47.27	3.20
% of Change 2002 to 2013		125.00	425.38	373.33	85.26	10.87

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Table 6. Mathematics Education Doctoral Degrees Awarded by Race, 2002-2013

		Black or African American	Asian-Pacific Islander	Hispanic	White	Other/Unknown
2002	No.	11	8	2	53	9
	%	13.25	9.64	2.41	63.86	10.84
2003	No.	12	8	4	47	7
	%	15.38	10.26	5.13	60.26	8.97
2004	No.	10	4	7	59	5
	%	11.76	4.71	8.24	69.41	5.88
2005	No.	5	10	6	56	5
	%	6.10	12.20	7.32	68.29	6.10
2006	No.	5	15	2	63	5
	%	5.56	16.67	2.22	70.00	5.56
2007	No.	9	12	6	85	13
	%	7.20	9.60	4.80	68.00	10.40
2008	No.	15	8	4	86	6
	%	12.61	6.72	3.36	72.27	5.04
2009	No.	17	17	8	98	10
	%	11.33	11.33	5.33	65.33	6.67
2010	No.	18	9	5	89	13
	%	13.43	6.72	3.73	66.42	9.70
2011	No.	9	20	1	96	10
	%	6.62	14.71	0.74	70.59	7.35
2012	No.	13	11	5	72	7
	%	12.04	10.19	4.63	66.67	6.48
2013	No.	13	20	7	85	7
	%	9.85	15.15	5.30	64.39	5.30
% of Change 2002 to 2013		18.18	150.00	250.00	60.38	-22.22

Descriptive Statistics: Fiscal Year 2013

Descriptive statistics for Fiscal Year 2013 are summarized in Table 7. During this year, the shortest times to degree completion was 2 years for mathematics and 3 years

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for mathematics education. Only one student completed a doctoral degree in two years for mathematics. The longest time to degree completion by field was 34 years for mathematics education and 32 years for mathematics. The mean number of years to completion for mathematics was 6.2 years, while mathematics education graduates averaged almost 8 years to degree completion. As mentioned earlier, the mean time to degree completion was stable for mathematics and faster for mathematics education from 2002 to 2013.

The age of students when entering the program varied significantly for both majors. For those students who obtained a doctoral degree in 2013, only one of them registered in the program at 68 years old. This doctoral recipient belonged to mathematics education. With respect to mathematics, the oldest student started doctoral studies at 59 years old. In general, mathematics education doctoral students are older than mathematics students when starting the program. The mean ages when entering the doctoral programs were 24.9 and 32.3 years old for mathematics and mathematics education, respectively. Younger students enrolled were reported in mathematics rather than mathematics education for the data of study.

In terms of gender during fiscal year 2013, males earned 71.3% of the doctoral degrees in mathematics. Contradictory with mathematics education doctoral programs, most degree recipients were females (64.9%) compared to males (35.1%). Thus, there was a pronounced gender difference in both fields: On the one hand, more women earned doctorates in mathematics education than men, while in mathematics, more men earned doctorates than women.

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The racial composition of the data had different distributions for the two fields. African Americans received 9.9% of the mathematics education doctoral degrees, yet only 2.3% of doctoral degrees in mathematics. In the field of mathematics, they were the least represented racial group. Asians were heavily represented in mathematics, with 42.8% of doctoral degrees granted. Even though their representation was more modest in mathematics education, they still were the minority with the greatest percentage of doctoral degree granted in mathematics education for fiscal year 2013 (15.2%). Hispanics earned 4.5% and 5.3% of the doctoral degrees in mathematics and mathematics education, respectively. It should be noted that 3.2 % of the mathematics and 5.3% of the mathematics education doctoral recipients reported themselves as "Other" or "Unknown." For fiscal year 2013, 104 survey respondents did not answer the question regarding "Race." In fact, similar portions of respondents for each year between 2002 and 2012 did not report any race, including the categories of "Other" or "Unknown." The number of doctoral recipients for mathematics was relatively large, and the missing data do not affect the analysis.

In 2013, international graduate recipients represented 49% of the doctorates granted in mathematics and 12.4% in mathematics education. International graduates had almost half of the total degrees awarded in mathematical sciences. It is unknown why international students, who have earned almost half of the total degrees awarded in the field of mathematical sciences, chose to earn degrees in mathematical sciences rather than mathematics education. Such research is beyond the scope of this study.

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Most (76.4%) of doctoral recipients in mathematics education were married or living in a marriage-like relationship. For mathematics, almost half of the participants were not married. In terms of dependents, most graduates in mathematics did not have any dependents (82.5%). For mathematics education doctorates, almost half of them had at least one dependent (48%).

For both fields, most doctoral graduates came from homes where at least one of their parents had an advanced degree (bachelor's degree or higher educational achievement). The percentage of at least one parent with an advanced degree was 67.5% for mathematics and 72.1% for mathematics education doctorate recipients.

With respect to primary source of support, many mathematics doctorate recipients received financial support through teaching assistantships (56.3%). Mathematics education doctorates depended more on other types of primary support (46.2%). Most of the doctorates obtained in mathematics and mathematics education were from public institutions, with 73.9% and 84.1%, respectively.

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Table 7. Descriptive Statistics Fiscal Year 2013 by Field

Year 2013	**Earned doctorate recipients in mathematics (N=1699)**	**Earned doctorate recipients in mathematics education (N=131)**
Time to degree completion, mean (SD)	6.19 (1.779)	7.96 (4.736)
Age at entry to the program, mean (SD)	24.9 (4.2)	32.3 (8.8)
Male, %	71.3	35.1
Female, %	28.7	64.9
White race %	44.4	64.4
Black or African American race, %	2.1	9.9
Asian race, %	40.2	15.2
Hispanic race, %	4.2	5.3
Others, %	3.2	5.3
At least one dependent, %	17.5	48
No dependents, %	82.5	52
Domestic Students, %	51	87.6
International Students, %	49	12.4
Married or Living in a marriage-like relationship, %	51	76.4
Otherwise (Never married, divorce, widowed, separated, unknown), %	46.7	19.8
Fellowship, scholarship, %	12.8	11.4
Teaching assistantship, %	56.3	16.7
Research assistantship, %	13.6	21.2
Other type of support, %	7	46.2
Masters at entry, %	24.5	59.8
Doctoral institution public, %	73.9	84.1
Doctoral institution private, %	26.1	15.9
Advanced parents' education, %	67.5	72.1

Research Question 2: Chi-Square Results

2. What are the major associated factors related to doctorate's recipients in mathematics and mathematics education for the fiscal year 2013?

Major associated factors were:

(a) Sex

(b) Marital Status: Married or Living in a Marriage-Like Relationship, and Otherwise.

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(c) Primary Source of Support

(d) Ethnic Background or race

(e) Doctoral institution Public/Private Carnegie

(f) Domestic and International Students

(g) Master’s Degree at Entry

(h) Advanced Parents’ Education

(i) Dependents

The second purpose of this study was to identify and present comparison of the major categorical factors that contributed to students’ completion of doctoral degrees in mathematics and mathematics education. Chi-square tests of association or independence for categorical variables were conducted for mathematics and mathematics education. In order to use a chi-square test, the researcher checked for the required assumptions. First, sample size cells with expected count numbers of 5 or greater had been met. Second, each observation was independent of all the others due to the fact that participants are different from each major.

To answer Research Question 2, a Chi-Square test was performed to examine the association between sex and doctoral degrees awarded by field. There was a statistically significant association between sex and doctoral degree awarded by field, $\chi^2(1) = 74.26$, $p < 0.001$, $\phi = 0.20$. Specifically, females were more likely to obtain a doctoral degree in mathematics education, while males were significantly over represented among mathematics doctorates awarded (see Table 8).

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Table 8. Chi-Square Result for Sex and Doctoral Degree Awarded by Field

	Doctoral Degree Awarded by Field				
Classification	Mathematics	Mathematics Education	χ^2	df	Φ
Males	1212	46	74.26	1	0.20
	(8.6)	(-8.6)			
Females	487	85			
	(-8.6)	(8.6)			

Note p < .01. Adjusted standardized residuals appear in parentheses below group frequencies.

To answer Research Question 2b, a chi-square test of association was conducted between marital status and doctoral degree by field. There was a statistically significant association between marital status and doctoral degree by field $\chi^2(1) = 33.802$, $p < 0.001$, $\phi = 0.136$. Doctorate recipients in mathematics were less likely to be married or living in a marriage-like relationship than were doctorate recipients in mathematics education (see Table 9).

Table 9. Chi-Square Result for Marital Status and Doctoral Degree Awarded by Field

	Doctoral Degree Awarded by Field				
Classification	Mathematics	Mathematics Education	χ^2	df	Φ
Married or Living in a marriage-like relationship	777 (-5.6)	94 (5.6)	31.17	1	-0.14
Otherwise	703	25			
	(5.6)	(-5.6)			

Note p < .01. Adjusted standardized residuals appear in parentheses below group frequencies.

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To answer Research Question 2c, a chi-square test of independence was performed between primary source of support and doctoral degree granted by field. The contingency table analysis revealed a significant relationship between these variables, $\chi^2(3) = 214.343$, $p < 0.001$. The association was moderately strong (Cohen, 1988), Cramer's V=0.361. Examination of standardized residuals showed that the high proportion of teaching assistantships, as a primary source of support for mathematics and mathematics education doctorate recipients, contributed to the significant result (see Table 10).

Table 10. Chi-Square Result for Primary Source of Support and Doctoral Degree Awarded by Field

	Doctoral Degree Awarded by Field				
Classification	Mathematics	Mathematics Education	χ^2	df	V
Fellowship, assistantship	217	15	214.34	3	0.36
	(0.7)	(-0.7)			
Teaching assistantship	956	22			
	(9.9)	(-9.9)			
Research assistantship	231	28			
	(-2.1)	(2.1)			
Other type of primary support	120 (-13.8)	60 (13.8)			

Note $p < .01$. Adjusted standardized residuals appear in parentheses below group frequencies.

To answer Research Question 2d, African Americans, Hispanics, and other races were recoded into one variable since these three categories had the lowest numbers in count. Table 11 showed that there was a statistically significant association between races (African Americans or Blacks, Hispanics, and Others; Asians; and Whites) and

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doctoral degree by field $\chi^2(2) = 42.839$, $p < 0.001$. The association was small by field of study in mathematics and mathematics education and race (Cohen, 1988), Cramer's V = 0.160.

Table 11. Chi-Square Result for Race and Doctoral Degree Awarded by Field

	Doctoral Degree Awarded by Field				
Classification	Mathematics	Mathematics Education	χ2	df	V
Others	107	20	42.839	2	0.16
	(-3.7)	(3.7)			
Asians	683	20			
	(6.1)	(-6.1)			
Whites	754	85			
	(-4.1)	(4.1)			

Note p < .01. Adjusted standardized residuals appear in parentheses below group frequencies.

Concerning Research Question 2e, Table 12 shows a statistically significant association between Doctoral Institution Public/Private Carnegie and doctoral degree by field $\chi^2(1) = 6.826$, $p = 0.009$, $\phi = 0.061$. There was a small strength of association between doctoral Carnegie institution and degrees awarded by field. Doctorate recipients in mathematics and mathematics education were more likely to receive a doctoral degree from a public institution than a private one.

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Table 12. Chi-Square Result for Doctoral institution Carnegie Public/Private Indicator and Doctoral Degree Awarded by Field

	Doctoral Degree Awarded by Field				
Classification	Mathematics	Mathematics Education	χ2	df	Φ
Public	1254	110	6.62	1	-0.06
	(-2.6)	(2.6)			
Private	445	21			
	(2.6)	(-2.6)			

Note p < .01. Adjusted standardized residuals appear in parentheses below group frequencies.

In response to Research Question 2f, Table 13 shows that there was a statistically significant association between domestic and international students and the doctoral degree recipients in mathematics and mathematics education, $\chi2(1) = 55.528$, $p < 0.001$. There was a small strength of association between domestic and international students and degrees awarded by field, $\phi = 0.176$, $p < 0.001$.

Table 13. Chi-Square Result for Domestic and International Students and Doctoral Degree Awarded by Field

	Doctoral Degree Awarded by Field				
Classification	Mathematics	Mathematics Education	χ^2	df	Φ
Domestic	114	907	55.8	1	0.18
	(7.5)	(-7.5)			
International	17	792			
	(-7.5)	(7.5)			

Note p < .01. Adjusted standardized residuals appear in parentheses below group frequencies.

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In response to Research Question 2g, in terms of master's degree at entry and doctorate degrees awarded by fields**,** Table 14 shows that there was a statistically significant association between the variables, $\chi^2(1) = 44.811$, $p < 0.001$, $\phi = 0.187$. Having a master's degree at entry into the doctoral program was more likely for mathematics education doctorate recipients, while not having a master's degree at entry was significantly overrepresented among mathematics doctorate recipients.

Table 14. Chi-Square Result for Doctoral Recipients with Master's Degree and Doctoral Degree Awarded by Field

	Doctoral Degree Awarded by Field				
Classification	Mathematics	Mathematics Education	χ2	df	Φ
Master's at Entry	378	76	45.8	1	-0.19
	(-6.8)	(6.8)			
Otherwise	779	43			
	(6.8)	(-6.8)			

Note p < .01. Adjusted standardized residuals appear in parentheses below group frequencies.

To answer Research Question 2h, the Chi-square association test shows that there was not a statistically significant association between advanced parent education and mathematics and mathematics education doctoral degrees, $\chi^2(1) = 2.453$, $p = 0.117$.

To respond to Research Question 2i, a chi-square analysis of dependents with doctoral degrees granted revealed a significant relationship between these two variables $\chi^2(1) = 66.12$, $p < 0.001$, $\phi = -0.20$. Specifically, having at least one dependent was more likely for doctoral recipients in mathematics education, while not having dependents was significantly represented in mathematics doctorate recipients (see Table 15).

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Table 15. Chi-Square Result for Doctoral Recipients with at Least One Dependent and Doctoral Degree Awarded by Field

	Doctoral Degree Awarded by Field				
Classification	Mathematics	Mathematics Education	χ2	df	Φ
At Least one dependent	263	59	66.12	1	-0.20
	(-8.1)	(8.1)			
Otherwise	1236	64			
	(8.1)	(-8.1)			

Note p < .01. Adjusted standardized residuals appear in parentheses below group frequencies.

Research Question 3: Multiple Regression Results

3. What is the relationship between time to degree completion and predictor factors (age at entry, sex, ethnic background, master's degree at entry, primary source of support, doctoral institution public/private Carnegie, marital status, advanced parents' education, domestic and international students, and dependents) for successful graduates that earned doctoral degrees in (a) mathematics and (b) mathematics education fields during fiscal year 2013?

The third purpose of this study was to determine which factors influenced time to degree completion in mathematics and mathematics education. Therefore, multiple regression analysis was performed for each field separately.

Linear Regression Assumptions

The researcher checked if the assumptions of multiple regression analysis were met for both programs.

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Mathematics doctorates. The partial regression plot between the dependent variable Time to Degree Completion and independent variable Age at Entry did not show a linear relationship. Therefore, the researcher used natural logarithm transformation for the dependent variable (time to degree completion). According to Chatterjee and Hadi (2015), the use of transformation is helpful when trying to attain a linear model. After using transformations, the partial regression plot showed approximately a linear relation between both variables. Also, the residuals plot formed a horizontal band; as a result, the relationship is likely to be linear (see the Appendices).

Mathematics education doctorates. The dependent variable Time to Degree Completion and independent variable Age at Entry failed the assumption of linearity. The researcher only used natural logarithm transformation for the dependent variable. After this step, partial regression and residual plots showed a linear relationship.

Overall, the researcher looked at residual p-plots and histograms to prove normality of the residuals. The plots showed that the assumptions such as linearity and homoscedasticity were met for the mathematics and mathematics education regression models. The plots of each field are showed in the Appendices.

Regression Models by Field

A multiple regression analysis was conducted to predict the time to degree completion based on the independent variables (factors) by (a) mathematics and (b) mathematics education fields. The factors included age at entry, sex, marital status, primary source of support, ethnic background, doctoral Carnegie Institution public (vs.

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private), domestic (vs. international) students, master's degree at entry, advanced parents' education, and dependents.

For Research Question 3a (Mathematics), the overall model was significant, F (15, 1093) = 15.32, $p < 0.05$, with an R^2 of 0.07. The outcomes indicated that doctoral institution Carnegie, domestic students, master's degree at entry, and primary source of support (dummy variables = other type of primary support and teaching assistantship) were significant factors of the time to degree completion (see Table 16). The age at entry, sex, marital status, ethnic background, advance parents' education, and dependents were not significant factors of the time to degree completion for doctorates in mathematics. In other words, attending a public institution instead of private impacts time to degree completion by an average of 7.25% (ß=0.069, p<0.05). Other types of primary support compared to fellowships and scholarships have an increase in time to degree completion of 9.41%, controlling for the other factors (ß= 0.090, p<0.05). Teaching assistantships, compared to fellowships and scholarships, have an increase in time to degree completion of 4.74%, controlling for the other factors (ß= 0.046, p<0.05). Time to degree completion will be 8.82% less for those recipients that had a master's degree at entry than for those who did not (ß= -0.086, p<0.05). Finally, controlling for the other factor variables, being a domestic student compared to an international student will average 4.2% less in time to degree completion (ß= -0.043, p<0.05). Table 16 shows the significant variables highlighted in bold. Unstandardized and standardized beta coefficients of each independent variable are presented in Table 16 as well.

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Table 16. Regression Model for Mathematics

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		Collinearity Statistics	
Independent Variables	B	Std. Error	Beta			Zero-order	Part	Tolerance	VIF
Constant	1.75	0.05	0.00	32.24	0.00				
Age at Start Program	0.00	0.00	0.00	0.03	0.97	0.01	0.00	0.74	1.35
Advanced Parent Education	0.00	0.02	0.00	0.08	0.94	-0.01	0.00	0.87	1.15
Sex of Student									
Male	-0.01	0.02	-0.01	-0.50	0.62	-0.02	-0.01	0.97	1.03
Dependents	0.03	0.02	0.04	1.22	0.22	0.05	0.04	0.69	1.44
Doctoral institution Carnegie									
Public	**0.07**	**0.02**	**0.12**	**3.95**	**0.00**	**0.14**	**0.12**	**0.90**	**1.11**
Type of Student									
Domestic Student	**-0.04**	**0.02**	**-0.09**	**-2.29**	**0.02**	**-0.10**	**-0.07**	**0.58**	**1.73**
Marital status									
Married or in a Marriage-Like Relationship	-0.03	0.02	-0.05	-1.67	0.09	-0.03	-0.05	0.79	1.26
Master's at entry	**-0.09**	**0.02**	**-0.17**	**-5.29**	**0.00**	**-0.17**	**-0.15**	**0.88**	**1.14**
Primary Source of Support									
Research assistantship	0.01	0.03	0.02	0.38	0.71	-0.06	0.01	0.54	1.86
Teaching assistantship	**0.05**	**0.02**	**0.09**	**2.14**	**0.03**	**0.06**	**0.06**	**0.45**	**2.21**
Other Type of Support	**0.09**	**0.03**	**0.11**	**2.84**	**0.00**	**0.08**	**0.08**	**0.60**	**1.66**
Ethnic Background									
African American or Black	0.08	0.05	0.05	1.67	0.09	0.06	0.05	0.91	1.10
Asian	0.02	0.02	0.04	0.94	0.35	-0.03	0.03	0.55	1.83
Hispanic	0.04	0.03	0.04	1.16	0.25	0.02	0.03	0.90	1.11
Others	0.00	0.05	0.00	-0.01	0.99	0.00	0.00	0.97	1.03

For Research Question 3b (Mathematics Education), the mathematics education regression model was significant. This model summary produced F (15, 99) = 5.76, $p < .05$, with an R^2 of 0.47. The outcomes indicated that only having a master's degree

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at entry was a significant factor for time to degree completion (see Table 17). This significant variable showed a negative relationship. The rest of the factor variables (age at entry, sex, ethnic background, primary source of support, Doctoral institution Public/Private Carnegie, marital status, advanced parents' education, domestic and international students, and dependents) were not significant. Time to degree completion will be 39.74% less for those recipients that had a master's degree at entry than for those who did not ($ß = -0.507$, $p<0.05$). The unstandardized and standardized beta coefficients for each independent variable used in this model are shown in Table 17. The significant variable is highlighted in bold.

In summary, the two regression models were revealed to be statistically significant at $p<.05$ level.

- Seven percent of the variance of time to degree completion was explained by the independent variables in mathematics doctorate recipients.
- Forty-seven percent of the variance of time to degree completion was explained by the independent variables in mathematics education doctorate recipients.

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Table 17. Regression Model for Mathematics Education

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		Collinearity Statistics	
Independent Variables	B	Std. Error	Beta			Zero-order	Part	Tolerance	VIF
Constant	2.51	0.20		12.70	0.00				
Age at Start Program	-0.01	0.00	-0.13	-1.45	0.15	-0.24	-0.14	0.67	1.49
Advanced Parent Education	-0.15	0.08	-0.16	-1.92	0.06	-0.08	-0.19	0.78	1.29
Sex of Student									
Male	0.07	0.07	0.08	0.97	0.34	0.08	0.10	0.88	1.13
Dependents	0.00	0.07	0.00	0.00	1.00	-0.03	0.00	0.76	1.31
Doctoral institution									
Carnegie									
Public	-0.01	0.09	-0.01	-0.09	0.93	-0.04	-0.01	0.83	1.20
Type of Student									
Domestic Student	-0.14	0.11	-0.11	-1.31	0.19	-0.23	-0.13	0.74	1.36
Marital status									
Married or Living in a Marriage-Like Relationship	0.01	0.08	0.01	0.08	0.94	0.04	0.01	0.73	1.37
Master's at entry	**-0.51**	**0.07**	**-0.58**	**-7.10**	**0.00**	**-0.61**	**-0.58**	**0.82**	**1.22**
Primary Source of Support									
Research assistantship	0.07	0.12	0.07	0.58	0.56	0.00	0.06	0.40	2.50
Teaching assistantship	-0.09	0.12	-0.08	-0.72	0.48	-0.18	-0.07	0.45	2.20
Other Type of Support	0.13	0.11	0.15	1.18	0.24	0.15	0.12	0.33	3.07
Race									
African American or Black	0.08	0.12	0.05	0.66	0.51	0.04	0.07	0.84	1.19
Asian	0.03	0.09	0.03	0.37	0.71	-0.13	0.04	0.03	0.83
Hispanic	-0.15	0.15	-0.08	-1.01	0.32	0.02	-0.10	0.85	1.18
Others	0.13	0.11	0.15	1.18	0.24	0.15	0.12	0.33	3.07

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Chapter V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This final chapter consists of three parts. The first part starts with a summary of this study. In this part, the researcher provides a brief overview of the investigation and how it was conducted. The second part of this chapter presents research questions with their corresponding findings and conclusions. Finally, the third part provides a discussion with limitations and recommendations for future research.

Summary of the Study

Having a doctoral degree is one of the greatest investments in life. Previous research has recognized the importance of identifying factors related to doctoral degree completion. Keeping balance between already established responsibilities and doctoral studies is challenging (Golde & Dore, 2001). Many graduate students do not complete the doctoral program, and some of those who complete the program spend a lot of time enrolled. Frustration, waste of money, and time are just some of the difficulties graduate students face (Tucker et al., 1964).

Statistics show an increase in doctoral degrees awarded over the years. Indeed, the population of students has become more diverse in terms of: participation of

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women enrolled, more variety of participants from minority ethnic groups, and an increase of international students (Thurgood et al., 2006). However, the number of students receiving a doctoral degree in mathematics education has had a small change when compared to doctoral degrees in mathematics. Reys and Dossey (2008) reported that the number of programs in mathematics education has expanded in the last 40 years, but the number of doctorates awarded in mathematics education could be improved (495 in 1960s to 863 in 2000s). In fact, when compared to the number of those attaining a doctoral degree in mathematics, a huge disproportion is revealed.

This study aimed to address the factors related to degree completion from successful students who obtained a doctoral degree in mathematics and mathematics education. The data used for this study were obtained from the Survey of Earned Recipients. This survey is an annual census administered since 1957. The data collected from the survey are restricted. Therefore, to make this study possible, a license agreement was granted by the National Science Foundation.

The information provided from the survey contained important data on the participants, such as education, post-graduation plans, and background information. The population targeted was comprised of all the students who obtained a doctoral degree in mathematics education and mathematics from 2002 to 2013 (fiscal year) in an academic institution in the United States. For the mathematics program, the following majors were included: Applied Mathematics, Algebra, Analysis and Functional Analysis, Geometry/Geometric Analysis, Logic, Number Theory, Statistics, Topology/Foundations, Computing Theory and Practice, Operations Research, Mathematics General,

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Mathematics Other. For the mathematics education program, Ph.D. and Ed.D. recipients were included.

The variables used for this study were suggested from the literature review. Statistical analysis was implemented to answer the research questions. Some of these variables needed additional calculations; therefore, they were computed to fit this investigation.

Descriptive analysis, chi-square tests, and multiple regression analysis were utilized to answer the research questions. To answer Research Question 1, the researcher used descriptive analysis, which included frequencies and percentages to address the changes by field in doctorates awarded from 2002 to 2013. The variables used to address this first question were: time to degree completion, sex, ethnic background/race, and production of doctorates in mathematics and mathematics education.

The chi-square test of independence was used to answer the second research question. Examination of associations between mathematics and mathematics education doctorates across nine variables was conducted for fiscal year 2013. For the third research question, regression analyses by field of study were conducted to measure the relationship between time to degree completion and ten independent variables. A regression model with all independent variables was created for each program to examine the relationship between time to degree completion and the independent variables.

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Summary of Findings and Conclusions

Research Question 1

What are the changes in mathematics and mathematics education doctoral degrees awarded in terms of four factor variables (Production of Doctorates, Time to Degree Completion, Sex, and Ethnic background/Race) over a span of 11 years?

The goal of this question was to describe changes in doctorates awarded in mathematics and mathematics education from 2002 to 2013. The production of doctorates in mathematics overshadowed those awarded in mathematics education over a span of 11 years. The total degrees granted were 15,538 for mathematics and 1,321 for mathematics education. From 2002 to 2013, the number of doctorates awarded in mathematics has increased by 99% and by 58% in mathematics education. Based on the findings, the data suggest that graduate students are more attracted to earn a doctoral degree in mathematics than mathematics education.

In terms of time to degree completion for the same period of time, graduate students in mathematics doctoral programs take less mean time to earn their degrees than graduate students in mathematics education doctoral programs. Even though mean time to degree completion for mathematics is shorter than for mathematics education, its mean time has been quite stable over the span of 11 years. A small change for time to degree completion for mathematics education doctorates was revealed by the findings.

The responses of the survey also revealed that the number of females awarded a doctorate in mathematics was exceeded by males. Therefore, the field of mathematics continues to be dominated by males. On the other hand, the majority of doctoral

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degrees in mathematics education were earned by females. Although females were overrepresented in mathematics education doctorates, their representation in numbers (85) was considerably low when compared to the total number of doctoral degrees awarded in mathematics (487).

Minority representation in both doctoral programs has increased since 2002. Comparing the number of doctoral degrees received by field in terms of race, mathematics has made better increase. The number of Asians with doctorates in mathematics has grown significantly. The next minority after Asians with an increase in attainment of doctoral degrees is Hispanics. Based on the findings, Hispanics exceeded Blacks or African Americans in number of earned doctorates in mathematics.

For doctorates earned in mathematics education, results from the survey showed a small increase in the representation of minorities. Again, Asians demonstrated the greatest improvement in doctoral degrees. However, Whites continue to be the majority recipients of this doctorate. Even though Hispanic doctoral degree recipients in mathematics education have increased since 2002, Blacks or African Americans surpassed them in numbers for the same field.

For a span of 11 years, the population of doctoral degrees granted in mathematics and mathematics education has varied according to production of degrees, time to degree completion, sex, and race. The Survey of Doctorates Earned Recipients data has provided a meaningful overview of the changes occurred during this period of time. Although substantial progress has been reported for minorities, there is a considerable gap between Whites and Asians from members of the other minority groups.

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Research Question 2

> *What are the major associated factors (sex, marital status, primary source of support, ethnic background/race, doctoral institution public/private Carnegie, domestic and international students, master's degree at entry, advanced parents' education and dependents) related to doctorate's recipients in mathematics and mathematics education for fiscal year 2013?*

This study also compared each factor (independent variables) between doctorate recipients in mathematics and mathematics education. The chi-square test of independence was performed for each independent variable and field of study. The results indicated a statistically significant association between sex, marital status, primary source of support, ethnic background/race, public and private Carnegie institution, domestic and international students, master's degree at entry, dependents, and recipient's field of study. Having parents with a bachelor's degree or higher professional education is not statistically significant associated with completing the doctorate.

Based on the findings, sex was associated with doctorate recipients in mathematics and mathematics education. This result may indeed indicate that gender imbalance is still present. The percentage of doctorates in mathematics is overrepresented by males and underrepresented by females. For the fiscal year 2013, the number of degrees conferred to males represented 71%. Men outnumbered women among doctoral degree recipients in mathematics by more than two to one. Also, this research found that doctoral degrees in mathematics education were gender imbalanced with an overrepresentation of females. For the same fiscal year, the percentage of degrees granted in mathematics education for females was 64.9% and

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35.1% for males. For this field, women outnumbered men by slightly less than two to one.

The chi-square analysis revealed an association between marital status and recipients by field. Comparing the percentages within field of doctoral degree awarded (mathematics and mathematics education) and marital status showed that most doctoral degree recipients in mathematics education were married or living in a marriage-like relationship (71.8%). For mathematics doctorates, only 45.7% of the participants responded to be married or in a marriage-like relationship. This difference in percentages between field of study based on marital status could be influenced by the age of the respondents. The mean age at entry to the doctoral program is 24.9 for mathematics and 32.3 for mathematics education (refer to Table 7). Based on the responses from the survey, the population of mathematics education had a greater percentage of married recipients than mathematics, and they were older than mathematics doctorate recipients.

The actual versus the expected count of primary source of support showed statistical significance. The results indicated that the type of primary source of support (fellowship and scholarship; teaching assistantship; research assistantship; and other type of support) and doctorates awarded in mathematics and mathematics education were associated. For mathematics doctorates, their primary source of support relied on teaching assistantship (56.3%), and for mathematics education, doctoral students relied on other types of resources (46.2%).

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Ethnic background/race and doctoral degree attainment by field were shown to be related. Minority doctorate recipients for fiscal year 2013 increased compared to previous years. However, Blacks or African Americans and Hispanics are just not graduating at the same percentages as Whites and Asians. The gap within minorities in doctoral degrees awarded in mathematics has increased between Asians compared to Blacks or African Americans and Hispanics. Asians made up 40.2% of doctorates in mathematics, Blacks or African Americans (2.1%), and Hispanics (4.2%). The percentage of White doctoral recipients in mathematics was 44.4% and for other races was 9.1%. Similar findings were obtained for doctoral recipients in mathematics education with an increase in percentages of minorities. Although Asians continue to earn more doctoral degrees in mathematics education than Hispanics and African Americans, they are underrepresented compared to Whites. Added together, minorities including others made up only 35.7% of all those doctorates in mathematics education. When it comes to the gap between Whites and each minority group with doctoral degrees in mathematics education, the Hispanic population is the most underrepresented (5.3%).

The results of this study indicate that public and private doctoral institutions Carnegie are statistically associated with degrees granted in mathematics and mathematics education. The percentage of degrees awarded from public doctoral institutions for mathematics (73.9%) and mathematics education (84.1%) was greater than private doctoral institutions (26.1% and 15.9% for mathematics and mathematics education, respectively). Within the field of study, percentages of mathematics

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education doctorates earned from public universities were greater than for mathematics (84.1% and 73.9%, respectively).

The representation of international students that obtained a doctoral degree in mathematics is slightly less than one to one as compared to domestic students. However, the percentage of doctoral degrees granted in mathematics education is overrepresented by domestic students (87.6%). The result of the chi-square test of association between domestic/international students and doctorate recipients by field found that there is a significant relationship between them. As previously noted, the number of doctoral degrees granted to international students has grown in large proportion. The proportion of doctoral degrees conferred to foreign students is higher for mathematics than mathematics education. This result agrees with the study of Bloom et al. (2007), which indicates that the United States produces a substantial number of doctoral degrees, and about 50% of doctoral students from around the world are studying in this country.

Having a master's degree at entry versus not having one had a statistically significant association between mathematics and mathematics education doctorate recipients. This study identified that among recipients who hold a doctorate in mathematics education or mathematics, mathematics education recipients represented a clear majority, with a higher percentage of masters' degrees at entry (59.8%). The representation in percentage of masters' degrees at entry for recipients in mathematics was 24.5%. This disproportion between fields may be accounted for by doctoral

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program requirements. When entering a doctoral program, some institutions may require graduate students to have a master's degree already.

The relationship between doctoral degree attainment by field of study and having parents with advanced education presented no statistically significant association. This result agreed with the study of Weiler (1991), which indicated that parental education has an irrelevant influence on the opportunity to enroll in a Ph.D. program.

The final variable analyzed for chi-square test of independence was dependents. Being a doctorate recipient in either field and having dependents was found to be associated. The percentage of doctorates with dependents is underrepresented by mathematics doctoral students (17.5%). However, the comparison in percentage between having dependents and no dependents was slightly less than one to one for doctorate recipients in mathematics education. This result could be attributed to a higher percentage of those married or living in a marriage-like relationship in the population of doctoral students in mathematics education.

Research Question 3

> *What is the relationship between time to degree completion and predictor factors (age at entry, sex, ethnic background, master's degree at entry, primary source of support, doctoral institution public/private Carnegie, marital status, advanced parents' education, domestic vs international students, and dependents) for successful graduates that earned doctoral degrees in a) mathematics and b) mathematics education during fiscal year 2013?*

The last purpose of this study was to identify how the independent variables can explain the variation in time to degree completion for each field of study. The regression analysis used ten independent variables to create a model that would best predict time

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to degree completion for each doctoral program (mathematics and mathematics education).

The regression model for mathematics found that the variables public/private Carnegie institution, domestic/international students, master's degree at entry, and primary source of support were significant predictors of time to degree completion. Even though this model presented a low R-squared value, this full regression model matches with factors related to time to degree completion addressed previously in the literature review. This regression model explains 7% of the variation of time to degree completion for successful students that obtained a doctoral degree in mathematics for fiscal year 2013.

Time to degree completion was significantly significant shorter for graduates who entered the program already with a master's degree and were domestic students. More years in time to degree completion was shown to be attributed to public institutions more than private institutions. Also, spending more time in a doctoral program is influenced by the type of primary source of support provided. Time to degree completion increases as the student's primary source of support comes from a teaching assistantship and other type of assistantship when compared to fellowship/scholarship.

The regression model for mathematics education was analyzed to learn more about the relationship between all the predictor variables and the time to degree completion. Results from this regression model indicated that out of the ten predictor variables, only the variable master's degree at entry was statistically significant. This regression model explained 47% of the variation of the time to degree completion for

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doctorate recipients in mathematics education. This predictor variable agreed with one of the predictor variables that was statistically significant in the regression model for mathematics. Having a master's degree at entry had been previously recognized as an influence for the time to degree completion (Lightfoot, 2007). Time to degree completion was reduced meaningfully by 39.7% when doctorate recipients in mathematics education had a master's degree at entry.

The results of this study found that having a master's degree at entry is related to time of doctoral degree completion for both programs—mathematics and mathematics education. This finding agrees with Lightfoot's (2007) study of doctoral degree attainment in which he concluded that students who completed a master's degree at the Florida State University obtained a doctoral degree in less time. Recall that the population used for this research is a census. Therefore, this result is meaningful across doctoral academic institutions in this country.

Based on the findings of this research, the type of primary source of support that students received when enrolled in mathematics doctoral programs was shown to affect the time to degree completion. For this program, receiving a teaching assistantship and another type of primary source of support other than fellowship/scholarship was related to more time until doctoral degree completion. This conclusion agrees with the study of Andrieu and St. John (1993), who found a negative impact between assistantship and persistence for doctoral students.

The result of this study also revealed that ethnic background/race is not a predictor of time to degree completion. The population of mathematics and

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mathematics education doctorate recipients agreed that race is not relevant for time to completion. This unexpected finding contradicts some studies that have indicated the influence of the race of a student with time to degree completion. For example, Nettles and Millett (2006) found that Black students took longer to complete a doctoral degree. Still, the representation of disadvantaged minorities such as Black or African American and Hispanic students in doctoral programs in mathematics and mathematics education remains underrepresented. Even though this study concluded that students' race is not related to time to doctoral degree completion, students' ethnic background is associated to mathematics and mathematics education doctoral programs.

With respect to the sex of the participants, time to completion for mathematics and mathematics education doctoral programs showed no relationship. Independently of the gender gap between male overrepresentation and female underrepresentation in the numbers of doctoral degrees awarded in mathematics, the gender of students did not affect time to completion. Previous studies have reported that women take more time to obtain a doctoral degree compared to men. However, this research found no relationship. Despite no relationship found in time to degree completion, the gender of the students was associated with doctoral degree programs in mathematics and mathematics education.

Recommendations

This study examined factors related to doctoral degree completion in mathematics and mathematics education. Additionally, this research identified factors

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affecting time to degree completion for both doctoral programs. Nevertheless, there are always issues that limit any study and provide highlights for improvements in future investigations.

One limitation of this study is related to the data used. As mentioned earlier, secondary data provided from the National Science Foundation were used to conduct this investigation. The disadvantage of using secondary data is that a researcher does not have control over the collection of the participants' information. However, the six federal agencies (the National Science Foundation, National Institutes of Health, U.S. Department of Education, U.S. Department of Agriculture, National Endowment for the Humanities, and National Aeronautics and Space Administration) that sponsor the Survey of Earned Doctorates perform excellent work in collecting this material. The survey provides quality measures with less than 1% in measurement error. In addition, they provide researchers with a valuable opportunity to conduct investigation based on an enormous amount of data.

The survey collects information of doctoral degree recipients for approximately 326 different fields of degree earned. For this study, this researcher decided to limit the data to only those doctorate recipients in mathematics and mathematics education from 2002 to 2013. The findings are significant to all U.S. doctoral institutions that awarded doctoral degrees in the fields of mathematics and mathematics education. It is important to mention that the findings of this investigation cannot be generalized for other disciplines of study. Nevertheless, these results can highlight essential factors for improvement in completion of doctoral degrees other than the two fields studied.

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This study focused on factors related to successful students that earned doctoral degrees in the two programs of interest. This study did not evaluate factors related to attrition in doctoral degree programs. In addition, this research specifically centered on some demographic factors related to degree completion. The thoughts, feelings, and interests of the doctorate recipients were out of the scope of this investigation. This study only dealt with selected demographic factors that were acknowledged to be related to degree completion. Another limitation of this study was that the data from the survey did not break down doctoral recipients in mathematics education according to Ph.D. and Ed.D recipients. Analyzing those recipients of Ph.D. and Ed.D. degrees into only one category may have missed important findings.

The chi-square and regression analysis was limited to the fiscal year 2013. From 2002 to 2012, this study provided specifically a descriptive analysis. Changes in the population for those years were examined by gender, race, production of doctoral degree, and mean time to degree completion. The results of these analyses have significant suggestions for mathematics and mathematics education doctorate recipients. Further regression analysis based on the same factors related to doctoral degree completion from previous years may offer significant trends for next generations.

The regression model for time to degree completion for mathematics doctorate recipients showed a low R-squared value (0.07). The outcome for this model could be related to a high amount of variability between the predictor variables and the dependent variable. Another explanation for a low R-squared value can be credited to

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the lack of inclusion of more predictor variables that have influenced the result from the model. Lastly, there is sometimes a lot of variation other than the predictor variables that may affect the dependent variable. This variation may come from a confounding variable. It is not uncommon that surveys are vulnerable to confounding. It is possible that the way participants completed the survey could lead to the inclusion of confounding variables. Even if participants agree to complete the survey, they may intentionally or not provide erroneous answers. Unfortunately, this researcher does not have control over this situation. It would be important to the agencies that collect this information to analyze what could produce this variation and manipulate it for better results.

At the beginning of this investigation, the most recent raw data available from the Survey of Earned Doctorates were for fiscal year 2013. More time than expected took this researcher to obtain a license agreement that permitted her to access these restricted data and to complete this study. An improvement for this study would be to work with more recent data.

The literature review and findings from this research agreed that there is still gender imbalance in the number of doctoral degrees awarded. Males are overrepresented in degree completion in mathematics. Even though the number of doctoral degrees awarded to women in mathematics has been increasing, it has been improving at a slow rate. Therefore, additional efforts are needed to encourage more women to pursue a doctoral degree in mathematics. Institutions offering doctoral programs for this field need to ensure that equal opportunities for their students are

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provided. It is also important to suggest an analysis that includes pre-doctoral students. A better understanding of the factors that lead them to this academic pathway may help in improving female students' retention and successful completion of their doctoral degree.

This research provides important information not only for individuals that are considering enrolling in a doctoral program but also for faculty members and programs. The use of these findings can explain better some of the factors that influenced successful students to earn the diploma. Also, the findings address potential factors that can increase or decrease the time to degree completion.

According to the factors related to doctoral degree completion, the age and the marital status of the successful graduates were not related to time to degree completion. Therefore, those aspirants to a doctoral degree should not stress about their age and marital status. Besides, having a master's degree before entering the doctoral program can reduce valuable years until degree completion, especially if one decides to pursue a doctoral degree in mathematics education. In fact, a high proportion of the variance in the time to degree completion was revealed by the variables obtained from the mathematics education data.

The results of this study highlight continued challenges for educators and institutions at the doctoral level. Low production of doctoral degrees in mathematics and mathematics education is still evident for Hispanics and Blacks or African Americans. It is important for instructors and academic institutions to acknowledge that there are still systemic barriers in the education system. Promoting more inclusive

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programs is the first step. The creation of practices that will not exclude minority groups may produce better achievement.

This research informs higher education institutions that strive to reduce the time to completion rate within their doctoral program. First, the *type* of primary source of support influencing time to degree completion was statistically significant for mathematics doctorate recipients. This result is consistent with previous research studies that have identified type of financial support as a concern (Abedi & Benkin, 1987; de Valero, 2001; Seagram et al.,1998). The inclusion of more financial support, such as fellowships and scholarships, may improve time to completion rates. Second, having a master's degree at entry was statistically significant for improving time to degree completion rates for both fields (mathematics and mathematics education). Higher education institutions should address their admissions requirements into doctoral programs if they wish to reduce their programs' degree completion time. These factors are important attributes that decrease time in the program.

Finally, this study contributes to the information of work on this topic that might be relevant for improving and creating more innovative programs, not only at the doctoral but at the master's and bachelor's levels. According to Wendler et al. (2010), innovative programs could improve the retention of graduate students. Having better higher education programs will promote achievable goals and better completion rates.

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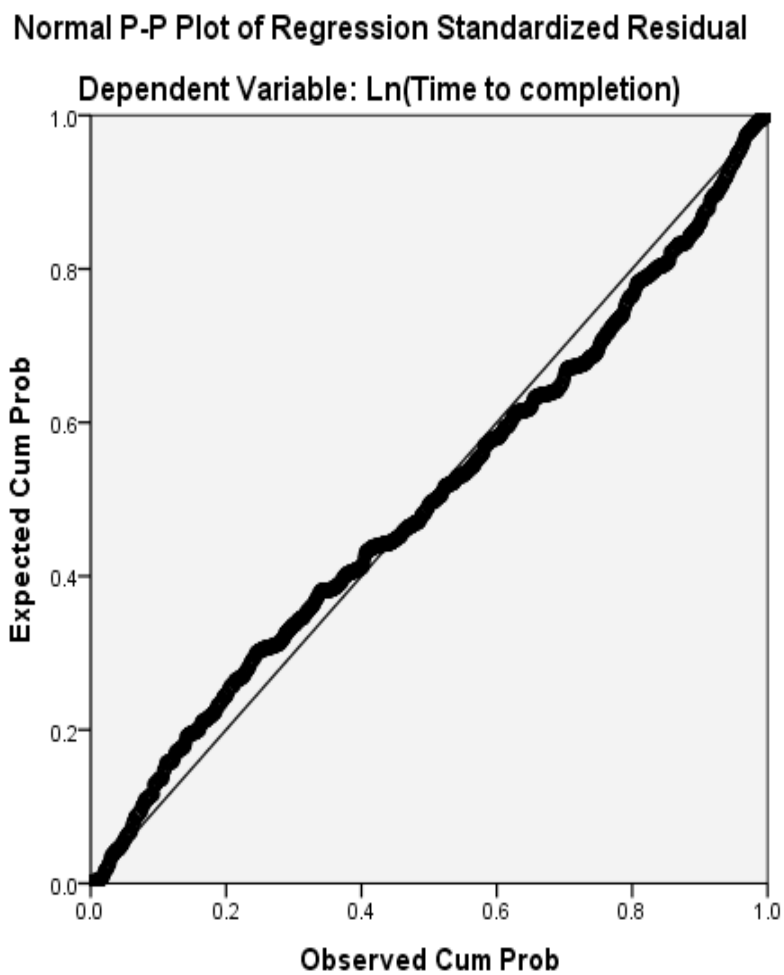
Appendix A

Program Field: Mathematics—

Normal P-P Plot of Regression Standardized Residual in Mathematics



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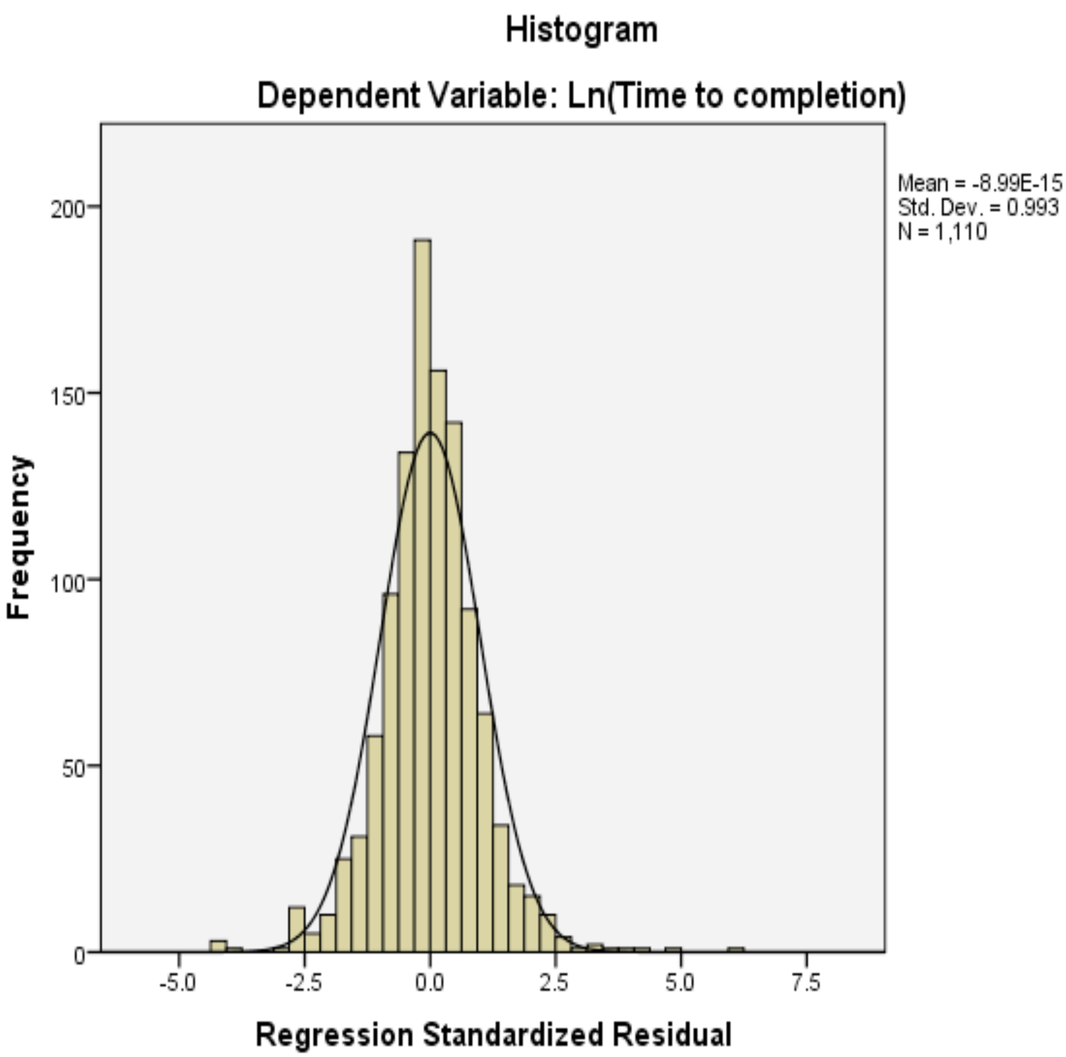
Appendix B

Program Field: Mathematics—

Regression Standardized Residual Histogram in Mathematics



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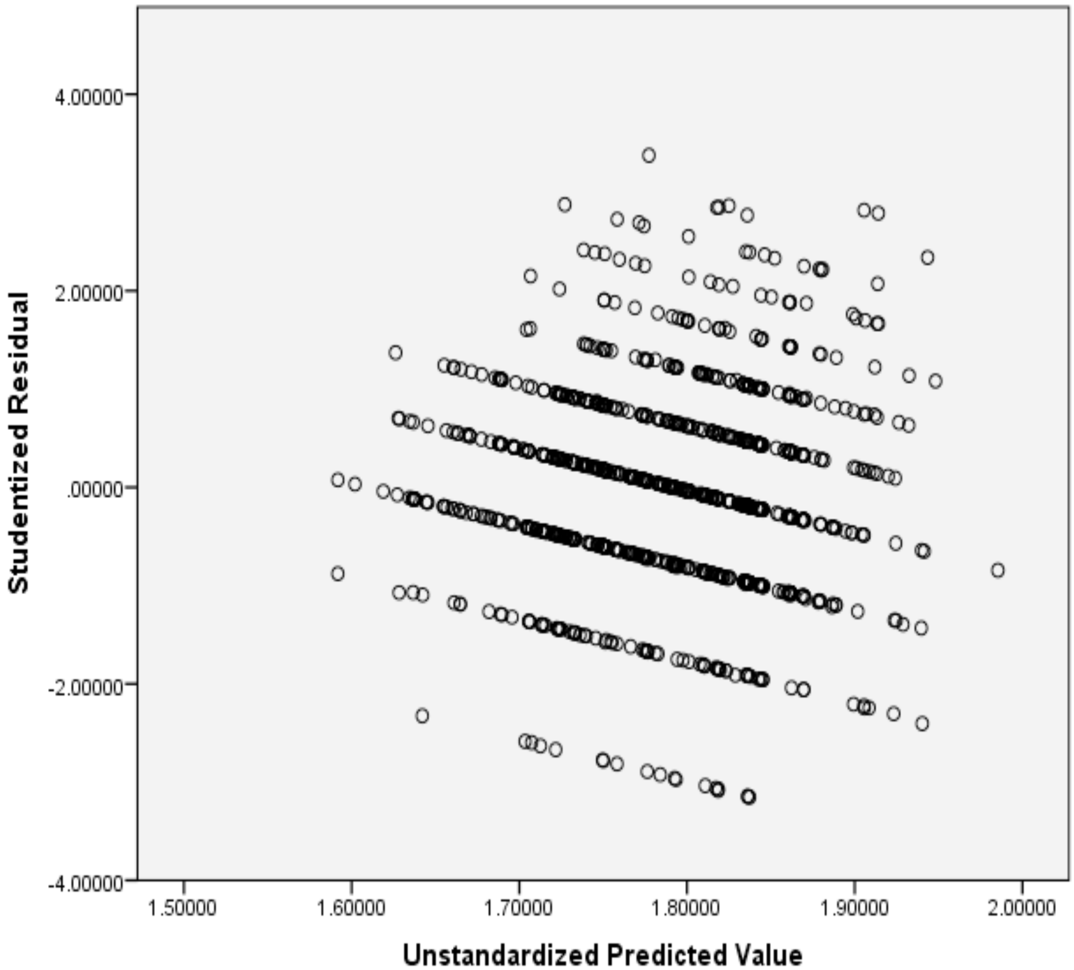
Appendix C

Program Field: Mathematics—

Studentized Residual Plot for Mathematics



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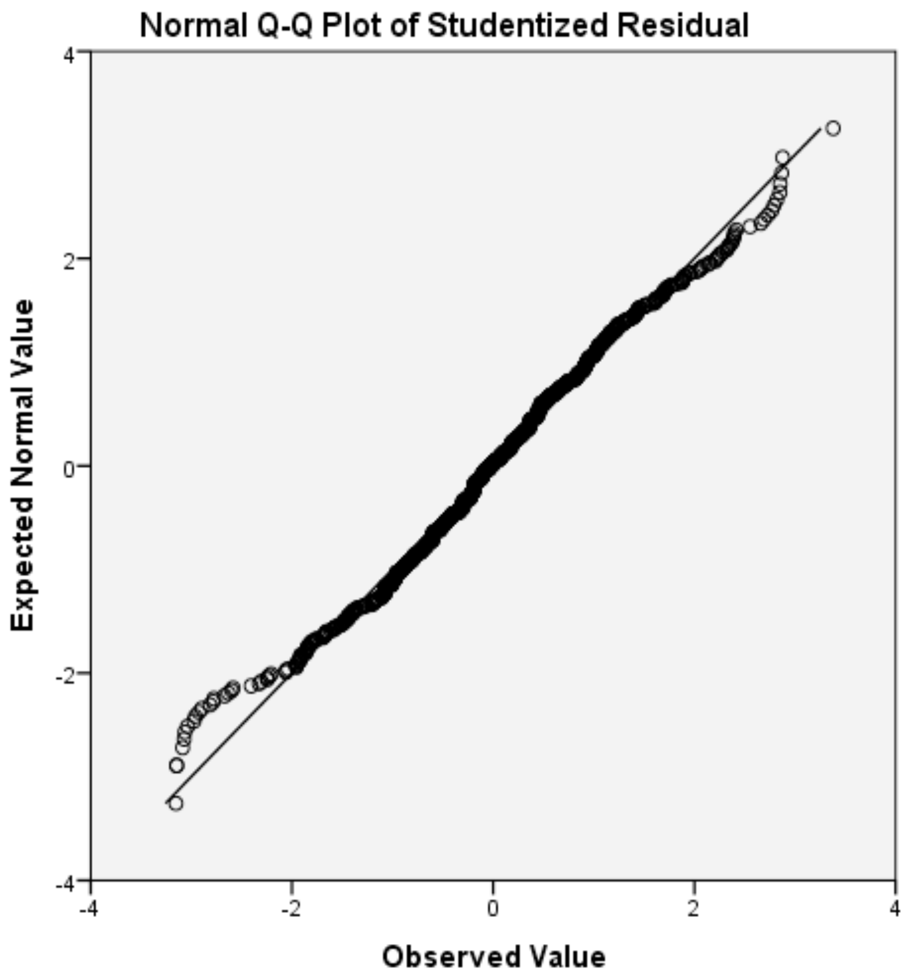
Appendix D

Program Field: Mathematics—

Plot of Leverage for Mathematics



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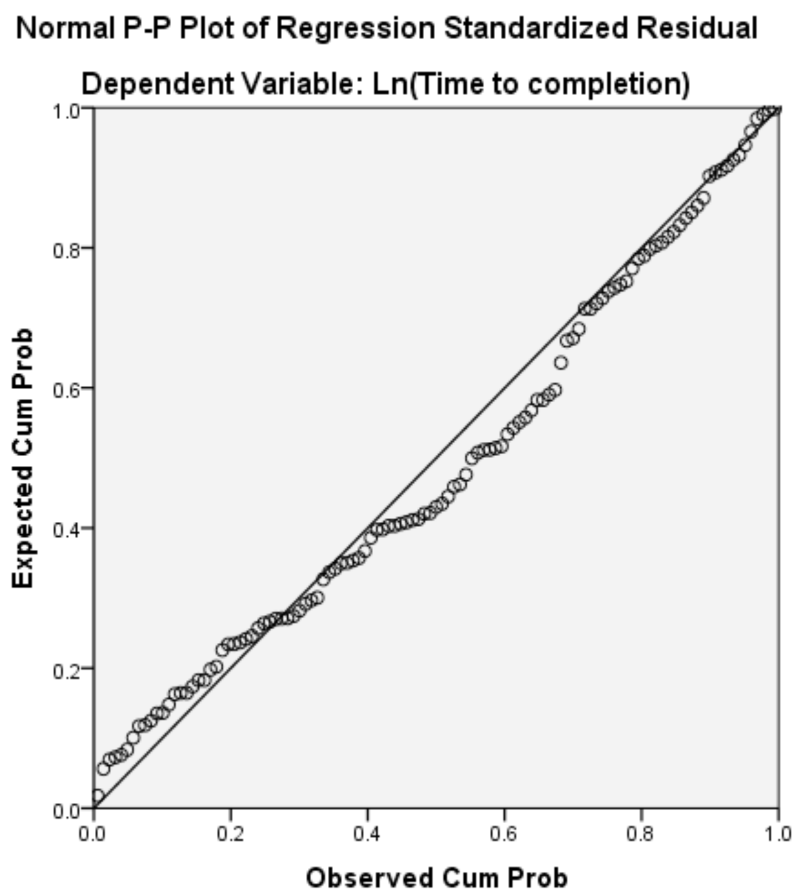
Appendix E

Program Field: Mathematics Education—

Normal P-P Plot of Regression Standardized Residual in Mathematics Education



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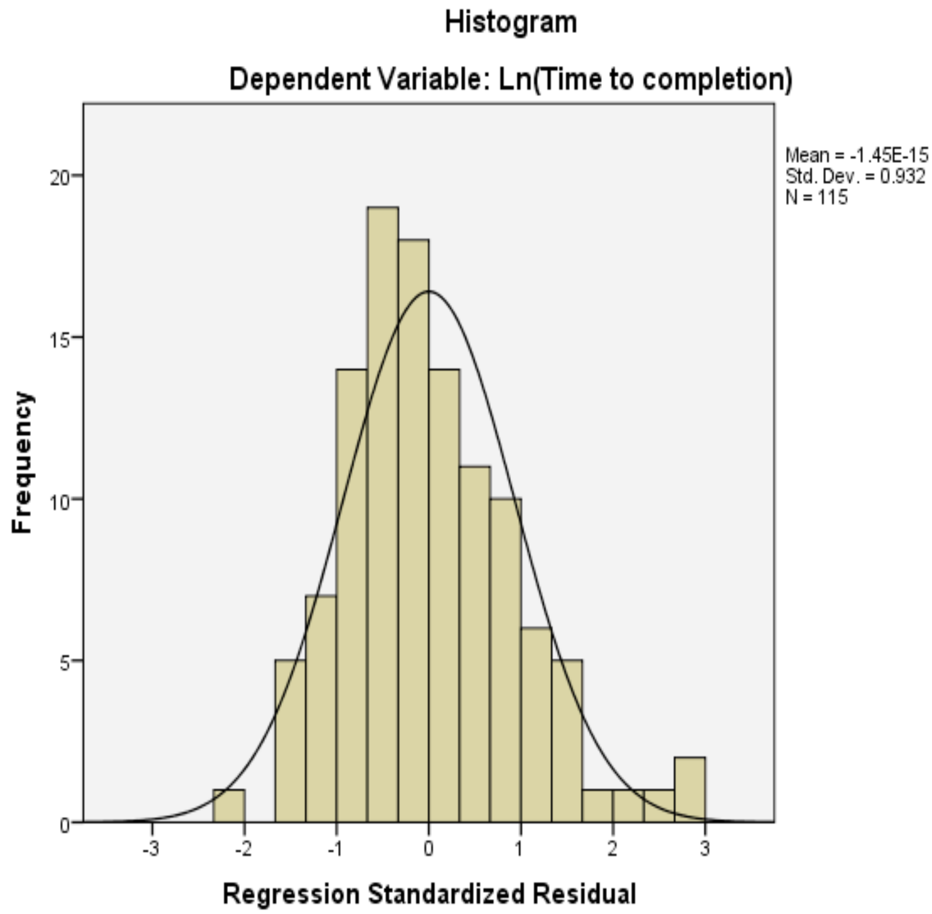
Appendix F

Program Field: Mathematics Education—

Regression Standardized Residual Histogram in Mathematics Education



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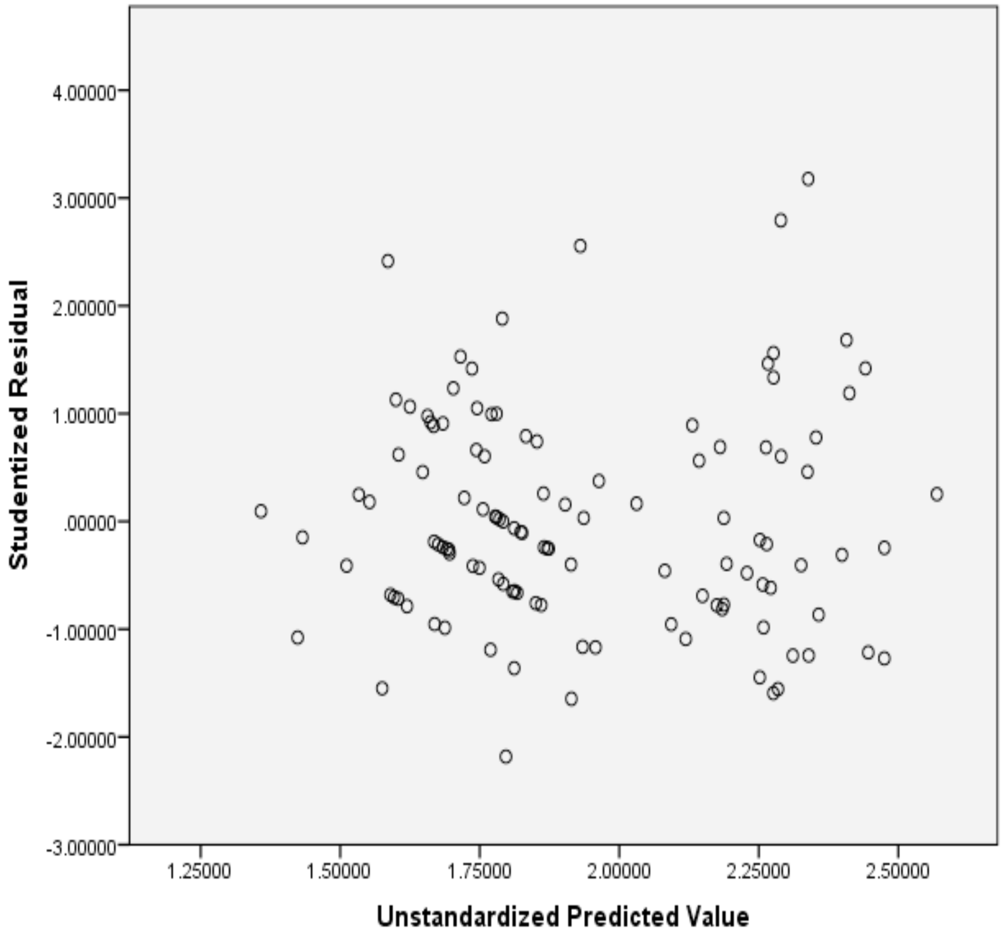
Appendix G

Program Field: Mathematics Education—

Studentized Residual Plot for Mathematics



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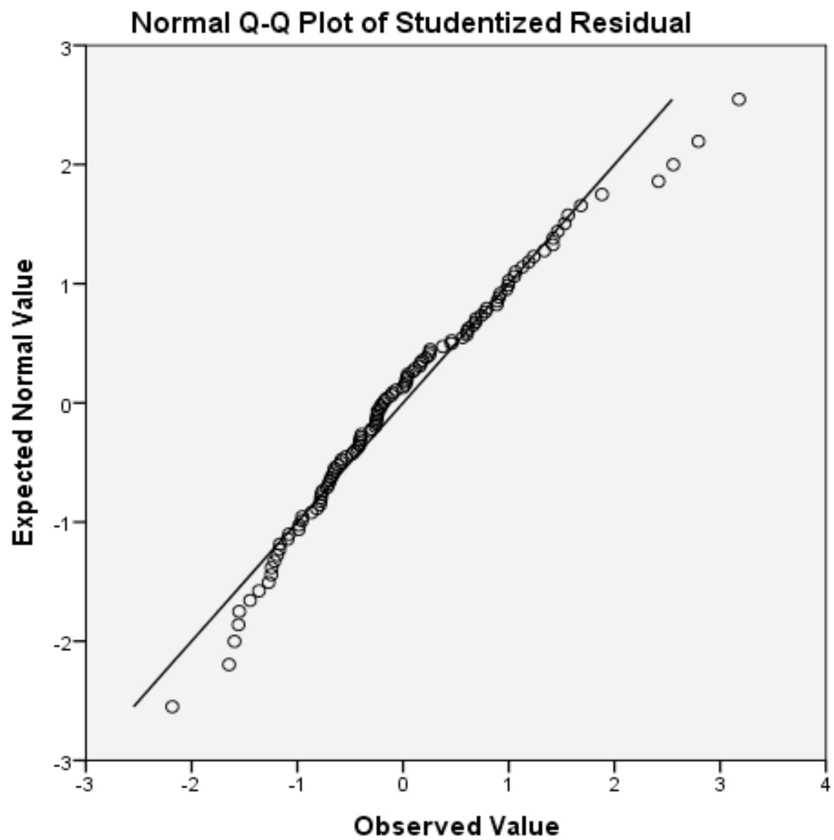
Appendix H

Program Field: Mathematics Education—

Plot of Leverage for Mathematics Education



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Appendix I

2013 Paper Questionnaire

SED

Survey of Earned Doctorates

July 1, 2012 to June 30, 2013

Conducted by

NORC at the UNIVERSITY of CHICAGO

for

NSF · National Institutes of Health · Department of Education · USDA · National Endowment for the Humanities · NASA

Please complete:

First Name	Middle Name	Last Name	Suffix (e.g., Jr.)
Cross Reference: Birth name or former name legally changed			Today's Date
Doctoral Institution		City or Branch	
Type of Research Doctoral Degree (e.g., Ph.D, Ed.D, etc.)			Date Degree Granted (mm/yyyy)

This information is solicited under the authority of the National Science Foundation Act of 1950, as amended. All information you provide is protected under the NSF Act and the Privacy Act of 1974, and will be used only for research or statistical purposes by your doctoral institution, the survey sponsors, their contractors and collaborating researchers for the purpose of analyzing data, preparing scientific reports and articles and selecting samples for a limited number of carefully defined follow-up studies. The last four digits of your Social Security Number are also solicited under the NSF Act of 1950, as amended; provision of it is voluntary. It will be kept confidential. It is used for quality control, to assure that we identify the correct persons, especially when data are used for statistical purposes in Federal program evaluation. Any information publicly released (such as statistical summaries) will be in a form that does not personally identify you or other respondents. Your response is voluntary and failure to provide some or all of the requested information will not in any way adversely affect you.

The time needed to complete this form varies according to individual circumstances, but the average time is estimated to be 20 minutes. If you have comments regarding this time estimate, you may write to the National Science Foundation, 4201 Wilson Blvd., Arlington, VA 22230, Attention: NSF Reports Clearance Officer. A Federal agency may not conduct or sponsor a collection of information unless it displays a currently valid OMB control number.

For more information about the Survey of Earned Doctorates, go to www.nsf.gov/statistics/doctorates

OMB No.: 3145-0019 Approval Expires 05/31/2014

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Part A - EDUCATION

INSTRUCTIONS: Please PRINT your name on the front cover. Please print all responses; you may use either a pen or a pencil.

A1. What is the title of your dissertation?

☐ *Please mark (X) this box if the title below refers to a performance, project report or musical or literary composition required instead of a dissertation.*

Title

A2. Please write the name of the primary field of your dissertation research.

Name of Field

Using the list on pages 6-7, choose the code that best describes the primary field of your dissertation research.

Number of Field ☐☐☐

If your dissertation research was interdisciplinary, list the name and number of your secondary field.

Name of Field

Number of Field ☐☐☐

If there were more than two fields, please list these additional fields.

Name of Field

Number of Field ☐☐☐

Name of Field

Number of Field ☐☐☐

A3. Please name the department (or interdisciplinary committee, center, institute, etc.) of the university that supervised your doctoral studies.

Department/Committee/Center/Institute/Program

A4. Did you receive full or partial tuition remission (waiver) for your doctoral studies?

Mark (X) one

1 ☐ No, I did not receive any tuition remission
2 ☐ Yes, I received for less than 1/3 of tuition
3 ☐ Yes, I received between 1/3 and 2/3 of tuition
4 ☐ Yes, I received more than 2/3 of tuition, but less than full
5 ☐ Yes, I received full tuition remission

A5. Which of the following were sources of financial support during graduate school?

Mark (X) Yes or No for each

	Yes	No
a Fellowship, scholarship	☐	☐
b Grant	☐	☐
c Teaching assistantship	☐	☐
d Research assistantship	☐	☐
e Other assistantship	☐	☐
f Traineeship	☐	☐
g Internship, clinical residency	☐	☐
h Loans (from any source)	☐	☐
i Personal savings	☐	☐
j Personal earnings during graduate school (other than sources listed above)	☐	☐
k Spouse's, partner's, or family's earnings or savings	☐	☐
l Employer reimbursement/assistance	☐	☐
m Foreign (non-U.S.) support	☐	☐
n Other - Specify	☐	☐

A6. Which TWO sources listed in A5 provided the most support?

*Enter **letters** of primary and secondary sources*

1 ☐ Primary source of support
2 ☐ Secondary source of support ☐ *Mark (X) if no secondary source*

A7. When you receive your doctoral degree, how much money will you owe that is directly related to your undergraduate and graduate education?

Mark (X) one in each column

a UNDERGRADUATE	b GRADUATE
1 ☐ None	1 ☐ None
2 ☐ $10,000 or less	2 ☐ $10,000 or less
3 ☐ $10,001 - $20,000	3 ☐ $10,001 - $20,000
4 ☐ $20,001 - $30,000	4 ☐ $20,001 - $30,000
5 ☐ $30,001 - $40,000	5 ☐ $30,001 - $40,000
6 ☐ $40,001 - $50,000	6 ☐ $40,001 - $50,000
7 ☐ $50,001 - $60,000	7 ☐ $50,001 - $60,000
8 ☐ $60,001 - $70,000	8 ☐ $60,001 - $70,000
9 ☐ $70,001 - $80,000	9 ☐ $70,001 - $80,000
10 ☐ $80,001 - $90,000	10 ☐ $80,001 - $90,000
11 ☐ $90,001 or more	11 ☐ $90,001 or more
Please Specify → $	Please Specify → $

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A8. The next few questions ask about the degrees you have received. Please provide the following information for this doctoral degree, your most recent master's degree and your first bachelor's degree in the appropriate columns below.

	This research doctoral degree	Most recent master's degree (e.g. MS, MA, MBA) or equivalent	First bachelor's degree (e.g. BA, BS, AB) or equivalent
a. Have you received a degree of this type?	X Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
b. Month/year degree granted	Month / Year	Month / Year	Month / Year
c. Month/year that you started your degree	Month / Year	Month / Year	Month / Year
d. Primary field of study			
e. Field number from list on p. 6			
f. Institution name			
g. Branch or city			
h. State or province			
i. Country	USA		

A9. Excluding those above, have you attained any additional postsecondary degrees?

☐ Yes ☐ No

If yes, please list the additional degree(s), granting institution(s), and years.

First Additional Degree

Degree type ____
Degree field ____
Field number, pp. 6-7 ____
Month/Year granted ____
Institution ____
Branch or city ____
State or country ____

Second Additional Degree

Degree type ____
Degree field ____
Field number, pp. 6-7 ____
Month/Year granted ____
Institution ____
Branch or city ____
State or country ____

If there are more than two degrees, additional degrees should be reported on the back cover.

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A10. Was a master's degree a prerequisite for admission to your doctoral program?

Yes No

A11. In what month and year did you first enter any graduate school in any program or capacity?

Month

Year

A12. How many years were you:

a. taking courses or preparing for exams for this doctoral degree (including a master's degree, if that was part of your doctoral program)?

Years *(round to whole years)*

b. working on your dissertation after coursework and exams (non-course related preparation and research, writing and defense)?

Years *(round to whole years)*

A13. Was there any time from the year you entered your doctoral program and the award of your doctorate that you were not working on your degree (that is, not taking courses or working on your dissertation)?

Yes No

If yes, please provide the number of years

Years *(round to whole years)*

A14. Did you earn college credit from a community or two-year college?

1 Yes 2 No

A15. Are you earning, or have you earned, an MD or a DDS?

	a HAVE EARNED?		b ARE EARNING?	
MD	Yes	No	Yes	No
DDS	Yes	No	Yes	No

Part B - POSTGRADUATION PLANS

B1. In what country or state do you intend to live after graduation (within the next year)?

1 in U.S. → State or territory

2 not in U.S. → Country

B2. Do you intend to take a "postdoc" position?

(A "postdoc" is a temporary position primarily for gaining additional education and training in research, usually awarded in academe, industry, government, or a non-profit organization.)

1 Yes 2 No

B3. What is the status of your postgraduate plans (in the next year)?

Mark (X) one

1 Returning to, or continuing in, predoctoral employment
2 Have signed contract or made definite commitment for a "postdoc" or other work
→ GO TO B4

3 Negotiating with one or more specific organizations
4 Seeking position but have no specific prospects
5 Other full-time degree program (e.g., MD, DDS, JD, MBA, etc.)
6 Do not plan to work or study (e.g., family commitments, etc.)
7 Other - Specify
→ SKIP TO C1, P.10

B4. What best describes your postgraduate plans (within the next year)?

Mark (X) one

1 "Postdoc" or further training → GO TO B4a
2 Employment → GO TO B4b

B4a. What best describes the nature of your further training or study?

Mark (X) one

1 "Postdoc" fellowship
2 "Postdoc" research associateship
3 Traineeship
4 Internship, clinical residency
5 Other Training - Specify
→ GO TO B5

B4b. What best describes the nature of your employment?

Mark (X) one

1 Employment (other than military service)
2 Military service
3 Other Employment - Specify
→ SKIP TO B6

Section B continues on Page 9.

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Please turn this page for the Field of Study List

The Field of Study listing on pages 6 and 7 is to be used in responding to items A2, A8, and A9. Please choose the code that best describes the name of your field.

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BUSINESS MANAGEMENT/ADMINISTRATION

900 Accounting
910 Business Administration & Management
915 Business/Managerial Economics
901 Finance
921 Human Resources Development
912 Hospitality, Food Service & Tourism Management
916 International Business/Trade/Commerce
920 Marketing Management & Research
917 Management Information Systems/Business Statistics
930 Operations Research *(also in ENGINEERING & in MATHEMATICS)*
935 Organizational Behavior *(see also PSYCHOLOGY/Industrial & Organizational)*
938 Business Management/Administration, General
939 Business Management/Administration, Other

COMMUNICATION

940 Communication Research
957 Communication Theory
950 Film, Radio, TV & Digital Communication
947 Mass Communication/Media Studies
958 Communication, General
959 Communication, Other

COMPUTER & INFORMATION SCIENCES

400 Computer Science
410 Information Science & Systems
415 Robotics
419 Computer & Information Science, Other

EDUCATION

RESEARCH & ADMINISTRATION

840 Counseling Education/Counseling & Guidance
800 Curriculum & Instruction
805 Educational Administration & Supervision
820 Educational Assessment/Testing/Measurement
804 Educational & Human Resource Studies/Development
810 Educational/Instructional Media Design
812 Educational/Instructional Technology
807 Educational Leadership
822 Educational Psychology *(also in PSYCHOLOGY)*
808 Educational Policy Analysis
815 Educational Statistics/Research Methods
845 Higher Education/Evaluation & Research
833 International Education
825 School Psychology *(also in PSYCHOLOGY)*
830 Social/Philosophical Foundations of Education
835 Special Education
806 Urban Education and Leadership

TEACHER EDUCATION

858 Adult & Continuing Teacher Education
852 Elementary Teacher Education
850 Pre-elementary/Early Childhood Teacher Education
856 Secondary Teacher Education

TEACHING FIELDS

860 Agricultural Education
861 Art Education
865 Bilingual & Multilingual Education
864 English Education
870 Family & Consumer/Human Science *(also in Fields Not Elsewhere Classified)*
866 Foreign Languages Education
868 Health Education
882 Literacy & Reading Education
874 Mathematics Education
876 Music Education
878 Nursing Education
880 Physical Education & Coaching
884 Science Education
885 Social Science Education
889 Teacher Education & Professional Development, Other

OTHER EDUCATION

898 Education, General
899 Education, Other

ENGINEERING

300 Aerospace, Aeronautical & Astronautical Engineering
303 Agricultural Engineering
306 Bioengineering & Biomedical Engineering
309 Ceramic Sciences Engineering
312 Chemical Engineering
315 Civil Engineering
318 Communications Engineering
321 Computer Engineering
324 Electrical, Electronics & Communications Engineering
376 Engineering Management & Administration
327 Engineering Mechanics
330 Engineering Physics
333 Engineering Science
336 Environmental/Environmental Health Engineering
337 Geotechnical & Geoenvironmental Engineering
339 Industrial & Manufacturing Engineering
342 Materials Science Engineering
345 Mechanical Engineering
348 Metallurgical Engineering
351 Mining & Mineral Engineering
357 Nuclear Engineering
360 Ocean Engineering
363 Operations Research *(also in MATHEMATICS & in BUSINESS MANAGEMENT)*
366 Petroleum Engineering
369 Polymer & Plastics Engineering
316 Structural Engineering
372 Systems Engineering
373 Transportation & Highway Engineering
398 Engineering, General
399 Engineering, Other

HUMANITIES

HISTORY

706 African History
700 American History (U.S. & Canada)
703 Asian History
705 European History
710 History, Science & Technology & Society
707 Latin American History
708 Middle/Near East Studies
718 History, General
719 History, Other

FOREIGN LANGUAGES & LITERATURE

768 Arabic
758 Chinese
740 French
743 German
746 Italian
762 Japanese
750 Latin American
752 Russian
749 Spanish
769 Other Languages & Literature

LETTERS

732 American Literature (U.S. & Canada)
720 Classics
723 Comparative Literature
735 Creative Writing
734 English Language
733 English Literature (British & Commonwealth)
724 Folklore
737 Rhetoric & Composition
736 Speech & Rhetorical Studies
738 Letters, General
739 Letters, Other

OTHER HUMANITIES

770 American/U.S. Studies
773 Archaeology
776 Art History/Criticism/Conservation
792 Bible/Biblical Studies
795 Drama/Theater Arts
784 Ethics
778 Film/Cinema/Video Studies
777 Jewish/Judaic Studies & History
780 Music
786 Music Theory & Composition
787 Music Performance
788 Musicology/Ethnomusicology
789 Music, Other
785 Philosophy
790 Religion/Religious Studies
798 Humanities, General
799 Humanities, Other

LIFE SCIENCES

AGRICULTURAL SCIENCES/NATURAL RESOURCES

005 Agricultural Animal Breeding
000 Agricultural Economics
025 Agricultural & Horticultural Plant Breeding
020 Agronomy & Crop Science
010 Animal Nutrition
014 Animal Science, Poultry (or Avian)
019 Animal Science, Other
081 Environmental Science
055 Fishing & Fisheries Sciences/Management
043 Food Science
044 Food Science & Technology, Other
066 Forest Sciences & Biology
070 Forest/Resources Management
079 Forestry & Related Science, Other
050 Horticulture Science
074 Natural Resources/Conservation
003 Natural Resource/Environmental Economics *(also in SOCIAL SCIENCES)*
030 Plant Pathology/Phytopathology *(also in BIOLOGICAL SCIENCES)*
039 Plant Sciences, Other
046 Soil Chemistry/Microbiology
049 Soil Sciences, Other
080 Wildlife/Range Management
072 Wood Science & Pulp/Paper Technology
098 Agriculture, General
099 Agricultural Science, Other

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LIFE SCIENCES (continued)

BIOLOGICAL/BIOMEDICAL SCIENCES

130 Anatomy
110 Bacteriology
100 Biochemistry *(see also PHYSICAL SCIENCES/ Chemistry, other)*
102 Bioinformatics
103 Biomedical Sciences
133 Biometrics & Biostatistics
105 Biophysics *(also in PHYSICS)*
107 Biotechnology
129 Botany/Plant Biology
158 Cancer Biology
136 Cell/Cellular Biology & Histology
104 Computational Biology
142 Developmental Biology/Embryology
139 Ecology
145 Endocrinology
148 Entomology
167 Environmental Toxicology
137 Evolutionary Biology
170 Genetics/Genomics, Human & Animal
151 Immunology
152 Marine Biology & Biological Oceanography
157 Microbiology
154 Molecular Biology
160 Neurosciences & Neurobiology
163 Nutrition Sciences
166 Parasitology
175 Pathology, Human & Animal
180 Pharmacology, Human & Animal
185 Physiology, Human & Animal
115 Plant Genetics
120 Plant Pathology/Phytopathology *(also in AGRICULTURAL SCIENCES)*
125 Plant Physiology
155 Structural Biology
169 Toxicology
168 Virology
189 Zoology
198 Biology/Biomedical Sciences, General
199 Biology/Biomedical Sciences, Other

HEALTH SCIENCES

210 Environmental Health
220 Epidemiology
227 Gerontology *(also in SOCIAL SCIENCES)*
217 Health Policy Analysis
212 Health Systems/Service Administration
222 Kinesiology/Exercise Physiology
240 Medicinal/Pharmaceutical Sciences
230 Nursing Science
207 Oral Biology/Oral Pathology
215 Public Health
245 Rehabilitation/Therapeutic Services
200 Speech-Language Pathology & Audiology
250 Veterinary Sciences
298 Health Sciences, General
299 Health Sciences, Other

MATHEMATICS

425 Algebra
430 Analysis & Functional Analysis
420 Applied Mathematics
460 Computing Theory & Practice
435 Geometry/Geometric Analysis
440 Logic
445 Number Theory
465 Operations Research *(also in ENGINEERING & in BUSINESS MANAGEMENT/ADMIN.)*
450 Statistics *(also in SOCIAL SCIENCES)*
455 Topology/Foundations
498 Mathematics/Statistics, General
499 Mathematics/Statistics, Other

PHYSICAL SCIENCES

ASTRONOMY

500 Astronomy
505 Astrophysics
509 Astronomy, Other

ATMOSPHERIC SCIENCE & METEOROLOGY

510 Atmospheric Chemistry & Climatology
512 Atmospheric Physics & Dynamics
514 Meteorology
518 Atmospheric Science/Meteorology, General
519 Atmospheric Science/Meteorology, Other

CHEMISTRY

520 Analytical Chemistry
522 Inorganic Chemistry
526 Organic Chemistry
530 Physical Chemistry
532 Polymer Chemistry
534 Theoretical Chemistry
538 Chemistry, General
539 Chemistry, Other *(see also BIOLOGICAL/Biochemistry)*

GEOLOGICAL & EARTH SCIENCES

542 Geochemistry
540 Geology
552 Geomorphology & Glacial Geology
544 Geophysics & Seismology
548 Mineralogy & Petrology
546 Paleontology
550 Stratigraphy & Sedimentation
558 Geological & Earth Sciences, General
559 Geological & Earth Sciences, Other

OCEAN/MARINE SCIENCES

585 Hydrology & Water Resources
590 Oceanography, Chemical & Physical
595 Marine Sciences
599 Ocean/Marine, Other

PHYSICS

560 Acoustics
576 Applied Physics
561 Atomic/Molecular/Chemical Physics
565 Biophysics *(also in BIOLOGICAL SCIENCES)*
574 Condensed Matter/Low Temperature Physics
577 Medical Physics/Radiological Science
568 Nuclear Physics
569 Optics/Photonics
564 Particle (Elementary) Physics
570 Plasma/Fusion Physics
572 Polymer Physics
578 Physics, General
579 Physics, Other

PSYCHOLOGY

602 Behavioral Analysis
600 Clinical Psychology
603 Cognitive Psychology & Psycholinguistics
609 Counseling
612 Developmental & Child Psychology
618 Educational Psychology *(also in EDUCATION)*
615 Experimental Psychology
620 Family Psychology
614 Health & Medical Psychology
613 Human Development & Family Studies
621 Industrial & Organizational *(see also BUSINESS MANAGEMENT/Organization Behavior)*
627 Neuropsychology/Physiological Psychology
624 Personality Psychology
633 Psychometrics & Quantitative Psychology
636 School Psychology *(also in EDUCATION)*
639 Social Psychology
648 Psychology, General
649 Psychology, Other

SOCIAL SCIENCES

650 Anthropology
652 Area/Ethnic/Cultural/Gender Studies
657 Criminal Justice & Corrections
658 Criminology
662 Demography/Population Studies
668 Econometrics
667 Economics
670 Geography
684 Gerontology *(also in HEALTH SCIENCES)*
674 International Relations/Affairs
676 Linguistics
665 Natural Resource/Environmental Economics *(also in AGRICULTURAL SCIENCES)*
678 Political Science & Government
682 Public Policy Analysis
686 Sociology
690 Statistics *(also in MATHEMATICS)*
694 Urban Affairs/Studies
695 Urban/City, Community & Regional Planning
698 Social Sciences, General
699 Social Sciences, Other

FIELDS NOT ELSEWHERE CLASSIFIED (NEC)

960 Architecture/Environmental Design
964 Family/Consumer Science/Human Science *(also in EDUCATION)*
968 Law
972 Library Science
974 Parks/Sports/Rec./Leisure/Fitness
976 Public Administration
980 Social Work
984 Theology/Religious Education *(see also OTHER HUMANITIES/Religion/Religious Studies, Ethics)*
989 Other Fields, NEC

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B5. *(If postdoc or further training)* **What will be the main source of financial support for your "postdoc" or further training within the next year?**
Mark (X) one

1 U.S. government
2 Industry/business
3 College or university
4 Private foundation
5 Nonprofit, other than private foundation or college
6 Foreign government
7 Other - Specify
8 Unknown

B6. What one type of principal employer will you be working for (or training with) in the next year?

EDUCATION
1 U.S. 4-year college or university other than medical school
2 U.S. medical school *(including university-affiliated hospital or medical center)*
3 U.S. university-affiliated research institute
4 U.S. community or two-year college
5 U.S. preschool, elementary, middle, secondary school or school system
6 Foreign educational institution

GOVERNMENT ***(other than educational institution)***
7 Foreign government
8 U.S. federal government
9 U.S. state government
10 U.S. local government

PRIVATE SECTOR ***(other than educational institution)***
11 Not for profit organization
12 Industry *(for profit)*

OTHER
13 Self-employed
14 Other - Specify

B7. Please name the organization and geographic location where you will work or study.

Organization
State or territory *(if U.S.)*
Country *(if not U.S.)*

Is this a college or university? Yes No

B8. What will be your basic annual salary for this principal job (in the next year)? Do not include bonuses or additional compensation for summertime teaching or research. If you are not salaried, please estimate your earned income.

$

If you prefer not to report an exact amount, please indicate into which range you expect your salary to fall:
Mark (X) one

1	$30,000 or less	7	$70,001 - $80,000
2	$30,001 - $35,000	8	$80,001 - $90,000
3	$35,001 - $40,000	9	$90,001 - $100,000
4	$40,001 - $50,000	10	$100,001 - $110,000
5	$50,001 - $60,000	11	$110,001 or above
6	$60,001 - $70,000	12	Don't know

B9. How many months does this salary cover?

Number of Months

B10. What will be your primary and secondary work activities?
Mark (X) one in each column

	a PRIMARY	b SECONDARY
Research and development	1	1
Teaching	2	2
Management or administration	3	3
Professional services to individuals	4	4
Other - Specify	5	5

Mark (X) if no secondary work activities

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Part C - BACKGROUND INFORMATION

C1. Are you -

1 ☐ Male 2 ☐ Female

C2. What is your marital status?
Mark (X) one

1 ☐ Married
2 ☐ Living in a marriage-like relationship
3 ☐ Widowed
4 ☐ Separated
5 ☐ Divorced
6 ☐ Never married

C3. Not including yourself or your spouse/partner, how many dependents (children or adults) do you have - that is, how many others receive at least one half of their financial support from you?

Write in number of dependents

5 years of age or younger ☐
6 to 18 years ☐
19 years or older ☐
☐ *Mark (X) if none*

C4. What is the highest educational attainment of your mother and father?

Mark (X) one for each parent

	a MOTHER	b FATHER
Less than high/secondary school graduate	1 ☐	1 ☐
High/secondary school graduate	2 ☐	2 ☐
Some college	3 ☐	3 ☐
Bachelor's degree	4 ☐	4 ☐
Master's degree (*e.g., MA, MS, MBA, MSW, etc.*)	5 ☐	5 ☐
Professional degree (*e.g., MD, DDS, JD, D.Min, Psy.D., etc.*)	6 ☐	6 ☐
Research doctoral degree	7 ☐	7 ☐
Not applicable/Unknown	8 ☐	8 ☐

C5. What is your place of birth?

State or territory *(if U.S.)* ____
OR
Country *(if not U.S.)* ____

C6. What is your date of birth?

Month ☐☐ Day ☐☐ Year 1 9 ☐☐

C7. What is your citizenship status?
Mark (X) one

U.S. CITIZEN

1 ☐ Since birth
2 ☐ Naturalized
→ **SKIP TO C9**

NON-U.S. CITIZEN

3 ☐ With a Permanent U.S. Resident Visa ("Green Card")
4 ☐ With a Temporary U.S. Visa
→ **GO TO C8**

C8. (If a non-U.S. citizen) **Of which country are you a citizen?**

____
Specify country of present citizenship

C9. In what state or country was the high school/secondary school that you last attended?

State or territory *(if U.S.)* ____
OR
Country *(if not U.S.)* ____

C10. Are you Hispanic or Latino?
Mark (X) one

1 ☐ No, I am not Hispanic or Latino
2 ☐ Yes, I am Mexican or Chicano
3 ☐ Yes, I am Puerto Rican
4 ☐ Yes, I am Cuban
5 ☐ Yes, I am Other Hispanic or Latino - Specify

____

C11. What is your racial background?
Mark (X) one or more

a ☐ American Indian or Alaska Native

____
Specify tribal affiliation(s)

b ☐ Native Hawaiian or other Pacific Islander
c ☐ Asian
d ☐ Black or African-American
e ☐ White

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C12. The following several questions are designed to help us better understand the educational paths of individuals with specific functional limitations. What is the USUAL degree of difficulty you have with...

Mark (X) one in each column

	NONE	SLIGHT	MODERATE	SEVERE	UNABLE TO DO
1 SEEING words or letters in ordinary newsprint (with glasses/contact lenses, if you usually wear them)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
2 HEARING what is normally said in conversation with another person (with hearing aid, if you usually wear one)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
3 WALKING without human or mechanical assistance or using stairs	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
4 LIFTING or carrying something as heavy as 10 pounds, such as a bag of groceries	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
5 CONCENTRATING, REMEMBERING, or MAKING DECISIONS because of a physical, mental or emotional condition	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

C13. ☐ **Mark this box (X) if you answered "NONE" to all the activities in Question C12, and go to Question C15.**

C14. What is the earliest age at which you first began experiencing any difficulties in any of these areas?

Age ☐☐ **OR** ☐ Since birth

C15. Please fill in the last four digits of your Social Security Number.

X X X - X X - ☐☐☐☐

C16. In case we need to clarify some of the information you have provided, please list your current address, an e-mail address and telephone number where you can be reached.

Your Current Street Address

City/State/Country/Zip or Postal Code

Email Address

Daytime or Cell Telephone Number (including area or country code)

C17. Please provide the name and address of a person who is likely to know where you can be reached in case your address changes in the near future.

Name of person who will know where you can be reached

Street Address

City/State/Country/Zip or Postal Code

Email Address

Telephone Number (including area or country code)

Thank you for completing this questionnaire. Please use the back cover to make any additional comments you may have about this survey. The results of this survey will be published in an annual report; the annual reports on earlier surveys are available at: **www.norc.uchicago.edu/sed**

Please return this questionnaire to your GRADUATE SCHOOL for forwarding to:

Survey of Earned Doctorates
NORC at the University of Chicago
1 N. State Street, Floor 16
Chicago, IL 60602

If you have questions or concerns about this survey, you may contact us by e-mail at: **4800-sed@norc.uchicago.edu**

Or phone at: **1-800-248-8649**

For more information about the SED, go to: **www.nsf.gov/statistics/doctorates**

If you have questions about your rights as a study participant you may call the NORC IRB Administrator toll-free at: **1-866-309-0542**

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