

UNDERGRADUATE RESEARCHERS' ATTAINMENT OF GRADUATE DEGREES

by

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ABSTRACT

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The existing literature suggests that faculty-student interactions have a positive effect on students' pursuits to attain undergraduate and graduate degrees. However, some scholars argue that the type of interactions and the extent to which students benefit vary between student sub-populations. Understanding who engages in undergraduate research at urban research universities and who goes on to attain graduate degrees are essential to expanding the knowledgebase and policy-making at the institutional level. Investigating the efficacy of undergraduate research programs at urban institutions that have access to diverse populations will allow for analyses with different samples. The goal of this research was to create a dataset that allowed for the documentation of the demographic and academic makeup of a population of students that engaged in a university wide centralized undergraduate research intervention at an urban research university. The descriptive analysis included demographic and academic performance information, as well as timing and duration of engagement in undergraduate research. This study included a logistic regression analysis to examine differences in likelihood of graduate degree attainment, in relationship to race/ethnicity, financial need, timing, duration, and academic performance.

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CHAPTER 1: Introduction

Introduction

During the late 20th century, there was a call for education reform to address the changing economy and demographics. From 1985 to 1995, different groups (i.e.; American Council on Education, National Research Council, National Science Foundation, Sigma Xi, National Endowment for the Humanities, & National Association of Colleges & Employers) argued that the country's economic and technological competitiveness was at stake (Boyer, 1988). This concern was rooted in the argument that U.S. students lagged behind top international performers in science and mathematics (Mancha & Yoder, 2014). Consequently, officials and leaders in education, government, and the private sector questioned if baccalaureate graduates had adequate preparation for the current workforce and the demands of the twenty-first century (Katkin, 2003). Groups also discussed the need for more female and minority representation in science, technology, and mathematics (STEM). In 2014, women earned approximately 57% of the bachelor's degrees as a whole, but only earned 19% of the engineering and 18% of the computer science bachelor's degrees (Espinosa, 2015). Espinosa (2015) argues the percentage of bachelor's degrees granted to minority women declined during the past 20 years because in 2012, minority women earned 4.8% of computer science degrees compared to 6.5% in 1993.

During this time, studies examined aspects of undergraduate education in the United States "driven by current and projected demographic, economic, and technological changes in this country" (Katkin, 2003, p. 19). Some of the most influential studies and publications suggested that the traditions and practices in higher education

were no longer relevant (American Council on Education, 1988; Cheney, 1989; National Science Foundation, 1993; Seymour & Hewitt, 1994), such as learning from transmission of knowledge. This was partially due to the increasing types of academic programs and professional degrees at postsecondary institutions, an increasingly diverse student population, and faculty pressures to teach and conduct research (Boyer, 1998).

While four-year liberal arts colleges responded through experimentation, research universities were slower to respond (Katkin, 2003). It was during this time the Boyer Commission formed (initially named the National Commission on Educating Undergraduates in the Research University). Boyer (2001) argued for an inquiry-based approach to teaching and learning where both faculty and students learn from each other. The Boyer Commission (1998), funded by the Carnegie Foundation (an independent policy and research center that publishes reports about all levels of education) and made up of people from academia, government, and the arts, formed to address the call for research universities to engage students and help them develop critical thinking skills. The commission was different from other groups because it argued the need to distinguish research universities from other postsecondary institutions.

Boyer (1998) suggested there was “a new and broader arena for learning” in higher education (partially due to the increasing use of technology and expanding curricular needs) and “recognition of those and other changes would form a starting point for the Commission’s deliberations” (p. 1). The Boyer Commission’s report, *Reinventing Undergraduate Education: A Blueprint for America’s Research Universities*

addressed the national call for action. The report suggested the need to change higher education and make research-based learning the standard. This included engaging students in research beginning in the first year (Boyer Commission, 1998). Boyer argued that higher education was becoming less elite; the first year was repetitive of high school curriculum; students and parents were questioning traditional modes of education; and there were more undergraduate professional degrees available.

The report suggested the new modes for teaching and learning would engage students, help them make connections across academic disciplines, and enhance critical thinking skills. Wilson (1998) argued two effects that the report would have on research universities. One perspective argued that there was not a need for improvement. Vice president Ted Marchese, of the American Association for Higher Education, claimed that universities have improved and the pressure to increase the quality of higher education had lessened. Another perspective claimed the report was timely and hoped it would inform debate. President Arthur Levine, of the Teachers College at Columbia University, argued that undergraduate students were the real bread and butter and if universities were going to maintain their enrollments, they would need to offer more innovative programs. President Shirley Strum Kenny, of the State University of New York Stony Brook, was cautious with her expressed optimism. She argued that although universities have done a lot to improve undergraduate education, such as engaging students in undergraduate research, the interventions had not become a part of the system as a whole. Kenny succeeded Boyer and became the chair of the commission. The idea of incorporating undergraduate research into the undergraduate experience resonated with faculty and administrators, but some

education and teaching organizations opposed the research focus because they argued research universities focused too much on research (such as graduate training and publishing articles in scholarly journals) and too little on teaching undergraduate students (Boyer Commission, 1998).

In 2001, the Reinvention Center at Stony Brook conducted a follow-up study to examine the extent to which research universities implemented the Boyer Commission's recommendations. The study consisted of a survey (administered to 123 research universities), follow-up interviews (with academic administrators at 40 institutions), and facilitated meetings with faculty and administrators across the country. The follow-up interviews further investigated what, if any, changes took place in response to the recommendations. There was an approximate 74% response rate to the survey. The findings suggested widespread support for undergraduate research among faculty and administrators (Boyer Commission, 2001). In addition, the findings included examples of interventions at major research universities, to serve as models, and described the challenges research universities face in implementing campus-wide initiatives (Boyer Commission, 2001).

Although the follow-up study suggested widespread support for undergraduate research, the findings did not include empirical evidence to suggest institutional level change. The majority of responses (by academic administrators) were based on estimates and anecdotes and the findings did not suggest undergraduate research had become a part of the system as a whole (Katkin, 2003). The findings did not provide a definitive answer to how many undergraduate students in different research universities were involved in research. There is a need for more studies to measure how many

students are engaging in undergraduate research and going on to attain graduate level degrees.

Problem Statement

Since the publication of the Boyer report at the State University of New York-Stony Brook, research universities around the United States have implemented institution wide centralized efforts to engage students in undergraduate research. Although there is mounting evidence regarding the benefits of undergraduate research programs, the majority of studies are limited due to a lack of vigor (Jones, Barlow, & Villarejo, 2010). Few universities have collected data that allow for rigorous investigations of their efficacy (Katkin, 2003).

The expansion of undergraduate research at the systemic level at urban research universities creates a need to document and describe engagement among diverse groups of students (for students who did and did not attain college degrees). Although past research findings, provide a snapshot of engagement in undergraduate research and the benefits of it, the findings tend to rely on student and faculty perceptions at selective institutions (Fechheimer, Webber, & Kleiber, 2011). For example, Einarson and Clarkberg's (2010) sample consisted of students from 14 private, selective research universities in the United States. Similarly, the sample from Ishiyama's (2002) study consisted of students that were from a highly selective public school. Russell, Hancock, and McCullough's (2007) study helps explain who engages in undergraduate research (in different academic majors) at a national level, but the findings are limited to bachelor degree recipients and the study was conducted nearly 10 years ago.

There are conflicting reports pertaining to who is most likely to engage in undergraduate research (Einarson & Clarkberg, 2010; Kim & Sax, 2009; Russell, Hancock, & McCullough, 2007) and who benefits (Kinzie et al., 2008; Lopatto, 2010). While one perspective supports the ideology that all students benefit from engagement (Kuh, G. D., Kinzie, J., Schuh, J. H., Whitt, E. J., & Associates, 2010), another perspective argues that the affect of undergraduate research varies between student groups (Taraban & Logue, 2012). The latter argument claims that it is “not clear whether engagement in research is better suited for higher ability undergraduates late in their programs or for all undergraduates” and if there are differences between academic disciplines (Taraban & Logue, 2012, p. 499). There are limits to the existing literature because studies lack variance in timing and duration of engagement in undergraduate research (Hakim, 1998; Jones, Barlow, & Villarejo, 2010; Levis-Fitzgerald & Denson, 2005).

Existing research support the argument that undergraduate research engages students and provides them with a wealth of professional, practical, and personal gains that contribute to student success (Kuh, 2008). There are associations between undergraduate research participation and student success (i.e.; academic performance and persistence) (Jones, Barlow, & Villarejo, 2010), but the majority of studies focus on participation that occurs in the natural sciences (Ishiyama, 2002) and the complexity of the undergraduate research experience makes it difficult to quantify the benefits (Lopatto, 2010). Research universities are key to preparing a diverse workforce for occupying high-skill and high wage jobs that require expert knowledge and service (Carter, Mandell, & Maton, 2009; Mattern & Radunzel, 2015). Diverse student

populations at urban research universities are challenging higher education leaders to develop and implement innovative learning opportunities that ultimately qualify diverse student populations for graduate programs and higher paying jobs. Jones, Barlow, and Villarejo (2010) suggest that undergraduate research is a means to improve pedagogical practice, increase female and minority representation in the science disciplines, and prepare students for occupying jobs that require graduate degrees. It is essential to examine institutional efforts to engage diverse student bodies because increased levels of meaningful faculty-student interactions engage students in activities that potentially contribute to the retention of students from non-majority groups (Ishiyama, 2002).

The goal to prepare students for graduate school is especially important because of the demand to increase the number of STEM PhDs. There have been efforts in the policy, scientific, and educational communities to increase STEM PhDs with a “focus on underrepresented minorities as populations of attention because of their chronic underrepresentation in science and engineering on all levels” (Carter, Mandell, & Maton, 2009, p. 441). The development of 21st century research skills among diverse groups of students is an important reason to develop, examine, and expand these opportunities. The potential for undergraduate research to increase student learning in science and technology and the pool of graduate students in research universities is promising (Mancha & Yoder, 2014). More studies to determine who engages in undergraduate research at urban research universities and which students are actually attaining graduate degrees, not just aspiring to pursue will shed light on this area of research.

Purpose of the Study

A quantitative research study was conducted at an urban research university with students who engaged in undergraduate research at some point during 2008 through 2015 was conducted. The goal of this study was to create a dataset using student-level data from various sources, which allowed for descriptive and inferential analyses. More specifically, this study described the demographic and academic makeup (gender, race/ethnicity, Pell grant eligibility, high school GPA, ACT composite score, timing (college grade level at initial time of participation), and duration (number of years participated)), for students who engaged in undergraduate research at an urban research university. This study also conducted a regression analysis to examine the differences in likelihood of graduate degree attainment in relationship to race/ethnicity, financial need, timing, duration, and academic performance.

There are undergraduate research interventions where students are engaged, but empirical research findings pertaining to engagement in undergraduate research and students' pursuits to degree attainment are limited (Jones, Barlow, & Villarejo, 2010). This study involved the creation of a database containing information gathered from different sources that allowed for descriptive and inferential analyses pertaining to who engaged in undergraduate research through a centralized university wide intervention during a seven-year span and which student sub-populations were more likely to attain graduate degrees. The lack of evidence regarding the extent to which timing and duration in undergraduate research matter, as it pertains to graduate degree attainment, make it necessary to examine university wide interventions where timing and duration vary. The evidence will suggest if there are differences in graduate degree

attainment for student sub-populations. The empirical evidence from this study may inform future research and policy that aim to improve university wide centralized undergraduate research interventions that serve diverse student bodies. If the findings from this study suggest specific characteristics increase or limit students' likelihood to attain graduate degrees, urban research universities may adapt their efforts.

Definition of Terms

Several key terms appear repeatedly throughout this study. The definitions for these terms are below to clarify their meaning and create consistency throughout.

Diversity

“Individual differences (e.g., personality, learning styles, and life experiences) and group/social differences (e.g., race/ethnicity, class, gender, sexual orientation, country of origin, and ability as well as cultural, political, religious, or other affiliations) that can be engaged in the service of learning” (O’Neill, 2009, p. 36).

Research Universities

The Carnegie Classification of Institutions of Higher Education defines research (doctoral) universities as “institutions that awarded at least 20 research/scholarship doctoral degrees during the update year” (Carnegie Classifications, 2015). The classification includes three different levels of doctoral universities (R1: highest research activity; R2: higher research activity; R3: moderate research activity). According to the Carnegie Classification there are 334 research universities (R1=115; R2=107; R3=112). Although research universities only accounted for 3% of all higher education institutions in 1994 according to the Carnegie Classifications, 32% of all undergraduates graduate from R1 and R2 universities (Boyer Commission, 1998).

Undergraduate Research

“An inquiry or investigation conducted by an undergraduate in collaboration with a faculty mentor that makes an original intellectual or creative contribution to the discipline” (Wenzel, 1997, p. 163).

Urban

“Urban areas represent densely populated urban centers dominated by skyscrapers that symbolize the tremendous wealth and prosperity of some urban dwellers, yet they stand in sharp contrast and are often in proximity to inner-city communities that are sometimes populated by the poorest of the poor” (Martin, 2004, p. 4), which are often racial and ethnic minorities.

Chapter Summary

Reports and national forums have led to many campus reform efforts consisting of curricular and pedagogical experimentation in many research universities. Fifteen years after the follow-up activities to the Boyer report, research universities are collecting more information that allow for more thorough investigations of undergraduate research. The findings from this study answer the question to who engages in undergraduate research and the extent to which different characteristics relate to the attainment of graduate degrees. The goal of this research was to document an urban research university’s centralized effort to engage students from different groups in undergraduate research and identify which groups were more likely to attain graduate degrees.

The following literature review includes a review of graduate education, enrollment in graduate school, and student characteristics that potentially affect the

attainment of a graduate degree. It also includes an overview of engagement in undergraduate research, the benefits of engagement, and the potential impact of engagement in undergraduate research on enrollment in graduate school. A synthesis of empirical research studies on undergraduate research as it pertains to students' pursuits to attain graduate level degrees is included. The following literature review will provide groundwork for future research.

CHAPTER 2: Literature Review

Introduction

This literature review includes three major topics to provide the groundwork for this study. First is an examination of student demographic, academic preparation and performance, and institutional characteristics in relation to graduate school enrollment. Next is an overview of engagement in undergraduate research and the benefits of it. Last is a synthesis of empirical research on the impact of engagement in undergraduate research as it pertains to students' pursuits to attain graduate degrees. This review is limited to research findings and variables that are often associated with graduate school enrollment.

This study searched research databases to identify research studies and literature for this review using Academic Search, EBSCO Host, ERIC, Google Scholar, and Dissertations and Theses. Keywords used to search for research studies and literature include undergraduate research, faculty-student interactions, persistence, post-baccalaureate and graduate school enrollment, degree attainment, postsecondary education, research universities, race/ethnicity, gender, age. Articles that were cited for the following literature review included peer reviewed journals, dissertations, government reports, and books dating from 1952 – 2015.

Graduate Education

The type and level of education Americans receive plays a key role in equipping everyone with the skills they need to prosper and be employable (Carter, Mandell, & Maton, 2009). Higher levels of education have been associated with monetary benefits as well as better occupational opportunities (Mattern & Radunzel, 2015). Workers with

higher levels of education tend to have higher income levels. In 2011, the median income for full-time, full-year wage and salary workers ages 25-34 with a master's degree or higher was \$59,230 compared to \$44,970 for workers with a bachelor's degree (Aud, Wilkinson-Flicker, Kristapovich, Rathbun, Wang, & Zang, 2013). People with higher levels of education also tend to have lower levels of unemployment. In 2013, 2.2% of individuals with a doctoral degree were unemployed compared to 4.0% for individuals with a bachelor's degree or 7.5% for individuals with a high school diploma (U.S. Bureau of Labor Statistics, 2014). Besides the monetary benefits and occupational opportunities of obtaining advanced degrees, the benefits of graduate degrees may go beyond the individual level. Longtine and Jones (2011) suggest that the attainment of doctoral degrees is important to the stability and sustainability of the U.S. economy.

The pursuit for a graduate degree has greatly increased over the past 50 years. The number of students enrolling in U.S. based graduate degree programs from 1967 to 2010 increased 227% (less than 900,000 to almost three million students) (Snyder & Dillow, 2012). Rising rates of enrollment among different demographic groups (low-income, underrepresented minority, and first generation) and population growth partially attribute to increases in enrollment (Kelderman, 2011).

Data collected from a national representative sample from the Baccalaureate and Beyond Longitudinal Study (B&B) suggest that 40% of the students who completed a bachelor's degree in 1992-93, enrolled in a graduate degree program by 2003 (Nevill and Chen, 2007). The B&B is a longitudinal study of 1992-93 bachelor's degree recipients (which tracked students' progress to enroll in graduate school and/or complete a graduate degree within 10 years). For the majority of graduates, the highest

degree they enrolled in was a master's degree program (31% vs. 5% for a first professional degree program and 4% for a doctoral degree program). Within the 10-year span, 62% had earned at least one graduate degree. Clune, Nuñez, and Choy (2001) suggest that enrollment in graduate school is highest during the first year after completion of a bachelor's degree.

Although more students are pursuing graduate degrees, research suggests there are different factors associated with enrollment in graduate school. Researchers have examined the relationship between graduate school enrollment and students' sociodemographic and institutional characteristics, academic preparation, and educational aspirations. Scholars argue that factors such as academic preparation, undergraduate grade point average, academic major, and selectivity of the undergraduate institution may relate to graduate school enrollment (Nevill & Chen, 2007). While research findings consistently suggest academic preparation (such as high school and undergraduate grade point average) relates to enrollment in graduate school, further examination with different groups of students who engage in interventions such as undergraduate research will shed light on the differences.

Demographic Characteristics

Actual enrollment numbers suggest more students from different racial/ethnic groups are pursuing graduate degrees than they were fifty years ago (Snyder & Dillow, 2012). An ACT research report suggests that the percentage of post-baccalaureate enrollees increased (11%) among African American and Hispanic students (Mattern & Radunzel, 2015). Specifically, the numbers tell us that in 2010, African Americans and Hispanics accounted for approximately 19% of all post-baccalaureate enrollees,

compared to less than 8% in 1976. From 1976 to 2012, the percentage of White students decreased (84% to 60%) while it rose for Hispanic students (4% to 15%), African American students (10% to 15%), Asian/Pacific Islander students (2% to 6%), and American Indian/Alaska Native (0.7% to 0.9%) (National Center for Education Statistics, 2016). One reason for this increase may result from the fact that there are larger numbers of these students in the overall demographic population (Kelderman, 2011).

Although more students from different racial/ethnic groups are pursuing graduate school, Perna (2004) found there were no statistically significant differences in graduate enrollment rates between African American and White students. Nevill and Chen (2007) did find a difference between African American and White students. They found that African American students were more likely to enroll in graduate school (45% vs. 39%), but when other variables (such as undergraduate major and GPA) were controlled for, the differences disappeared. Nevill and Chen (2007) also found that Asian/Pacific Islander students were more likely than other racial/ethnic groups to enroll in a professional degree program even after controlling for financial, academic, and demographic variables.

Growth in graduate school enrollment is more dramatic for females as well as racial/ethnic students. Even though more females are enrolling in graduate programs than males, some research findings suggest that gender does not relate to graduate school enrollment. In 1967, 65% of the students enrolled in a graduate program were male (Mattern & Radunzel, 2015). Since female enrollment surpassed male enrollment in 1988, the majority of enrollees continue to be female. In 2011, 59% of graduate

program enrollees were female (Mattern & Radunzel, 2015). Scholars argue enrollment rates by gender vary by the type of academic program. For example, Nevill and Chen (2007) did not find statistically significant differences in the overall enrollment rate between genders, but they found that males were more likely than females to enroll in MBA programs, professional programs, and doctoral degree programs. Their findings from the B&B suggest that females are more likely to enroll in medical education development programs.

Similarly, Perna (2004) found that after controlling for financial, academic, and demographic variables using multinomial logit analyses, differences in enrollment between males and females at the master's level disappeared. Like Nevill and Chen (2007), Perna found that males were more likely than females to enroll in professional programs and doctoral programs. These results suggest that although the majority of graduate school enrollees are female, the difference in enrollment between males and females is not statistically significant when analyzing overall enrollment rates.

Therefore, the findings suggest that gender is not a predictor of graduate school enrollment, until taking into account the type of program students enroll in. Similarly, the findings from another study suggest that the relationship between graduate enrollment and socioeconomic variables vary by type of graduate program (Mullen, Goyette, & Soares, 2003).

Although scholars support the argument that a student's socioeconomic status (when measured by parents' education level) tends to be positively related to enrollment in graduate school (Heller, 2001; Mullen, Goyette, & Soares, 2003; Nevill & Chen, 2007; Perna, 2004), research findings regarding other measures such as household income

and undergraduate indebtedness are inconsistent in relation to graduate enrollment (Mattern & Radunzel, 2015). The findings from numerous studies suggest socioeconomic variables such as household income may indirectly relate to graduate enrollment. For example, the findings from one study suggest that the effect of household income on graduate enrollment may indirectly relate through the influence it has on the social and academic integration experienced at the undergraduate institution the student chooses to attend (Ethington & Smart, 1986).

Academic Preparation, Performance, & Institutional Characteristics

Research findings consistently suggest that academic achievement and preparation (such as high school and undergraduate GPAs) are associated with graduate school enrollment (Heller, 2001; Millett, 2003; Mullen, Goyette, & Soares, 2003; Nevill & Chen, 2007; Perna, 2004). For example, Nevill & Chen (2007) found that higher achieving students were more likely than lower achieving students to enroll in graduate school. Their findings suggested that students with undergraduate GPAs of 3.5 or above were more likely than students with lower GPAs to enroll in graduate school.

Research suggests that a student's undergraduate major may also relate to the likelihood of that student enrolling in graduate school. Nevill and Chen (2007) found that students who majored in business were less likely than students with other majors to enroll in graduate school. Conversely, they found that students who majored in biological sciences were more likely than students with other majors to enroll in graduate school. Scholars argue that graduate enrollment rates are higher for students with undergraduate majors such as biological, social, and physical sciences and lower

for students with more applied majors such as engineering, computer science, and business (Heller, 2001; Millett, 2003; Nevill & Chen, 2007).

Similar to research findings regarding the relationship between parental education level and enrollment in graduate school, Goyette & Mullen (2006) suggest that a student's choice of an academic major varied according to parental education level. For example, Goyette and Mullen found that students whose parents had high levels of education (some graduate training) were more likely to earn a bachelor's degree in the arts or sciences (i.e.; humanities, science, math, and social science) than students whose parents had low levels of education (high school degrees or less). The majority (50.5%) of students whose parents had high levels of education earned an arts or science degree (versus 32.9% of students whose parents had low levels of education).

Nevill and Chen (2007) found that students who graduated with a bachelor's degree from private not-for-profit institutions were more likely than those attending different types of institutions to enroll in graduate school. Scholars argue that one reason for this increase in enrollment is that selective (such as private not-for-profit) institutions offer environments that foster students' pursuits to obtain graduate degrees through undergraduate research opportunities and interactions with faculty (Eagan, Hurtado, Chang, Garcia, Herrera, & Garibay, 2013; Hathaway, Nagda, & Gregerman, 2002; Hearn, 1987; Russell, Hancock, & McCullough, 2007). Scholars argue that the social integration (involvement with peers and faculty) experienced during a student's undergraduate program is a predictor of graduate school enrollment (Choy & Geis, 1997; Ethington & Smart, 1986; Hearn, 1987; Millett, 2003).

Undergraduate Research: Who Engages & Benefits

Stated broadly, undergraduate research is based on a model of learning where undergraduate students work collaboratively with faculty to conduct authentic, original research (Hunter, Laursen, & Seymour, 2006) that contribute to the discipline (Osborn & Karukstis, 2009). Undergraduate research is different from other types of undergraduate experiences because it consists of undergraduate students working closely in mentored relationships with faculty and peers. The faculty-student interactions that occur when students engage in undergraduate research are key because interacting with faculty inside or outside of the classroom is associated with student development (Kim & Sax, 2009) and can “be the single most important role in student learning” (Umbach & Wawrzynski, 2005). Craney et al. (2011) suggest the faculty-student relationship is a key aspect of the undergraduate research experience, especially for underrepresented researchers.

Psychologist Ann Roe wrote about the impact working independently on undergraduate research had on the scientists she studied (Roe, 1952). Approximately two decades later (in 1969), the Massachusetts Institute of Technology administration formally introduced undergraduate research. The goal of this intervention was to foster faculty-student relationships at the undergraduate level, similar to faculty-mentored relationships at the graduate level. This intervention also aimed to provide students with opportunities to gain recognition as an important part of the scholarly community by co-authoring scholarly journal articles and/or presenting research at symposiums and conferences (Carter, Mandell, & Maton, 2009). Other research universities, the National Science Foundation, and private and professional organizations followed suit and

created a culture of undergraduate research. One example is the Council on Undergraduate Research (founded in 1978). The Council on Undergraduate Research supports and promotes high-quality undergraduate research across academic disciplines and different types of higher education institutions.

Undergraduate research is a growing phenomenon (Hu, Kuh, & Gayles, 2007) with important implications for higher education (Boyer Commission, 1998; National Research Council, 2003; National Science Foundation 2003; Doyle, 2000). A large-scale national study measured college student engagement at four-year colleges and universities and found that student engagement in research increased since 1999 in all major academic fields (Hu, Kuh, & Gayles, 2007) to approximately 25% (Kuh, Kinzie, Schuh, Whitt, & Associates, 2010), compared to the 3% of respondents who indicated they engaged in undergraduate research nearly 50 years ago (Astin, 1969). The National Science Foundation and other federal and private organizations continue to fund undergraduate research programs at postsecondary institutions across the country because scholars and practitioners working within academia and government agree that a good undergraduate research experience may lead to a science career (Lopatto, 2010). The McNair Scholars Program is one example of public funding for undergraduate research.

McNair is a U.S. Department of Education TRIO Program aimed to prepare disadvantaged students for doctoral studies. During the 2015 fiscal year, the funding allocation for McNair was \$35,701,197 (U.S. Department of Education, 2016). During this year, 151 postsecondary institutions received funding (the total number of participants was 4,293). The average award per institution was \$236,432. The average

number of participants at each institution was 28. The average cost per participant was \$8,316. Some states allocate funding for undergraduate research as a means to prepare students for work in the 21st century (Katkin, 2003). At one urban research university (site of study), the state provides approximately \$1 million a year for undergraduate research. There is significant funding for undergraduate research and data suggest more students are engaging in undergraduate research than they were 15 years ago.

Although different groups (i.e.; Boyer Commission, 1998; National Research Council, 2003; National Science Foundation) argue all students should engage in undergraduate research, scholars suggest that students who engage in research tend to be higher performing (Astin, 1969; Craney et al., 2011; Russell, Hancock, McCullough, 2007). Craney et al. (2011) found that the students who participated in a summer undergraduate research program had a mean GPA of 3.47. Similarly, Astin (1969) found participants from a national sample to be significantly superior to nonparticipants concerning academic and extracurricular achievements during high school and academic ability (measured by standardized tests).

Not only do students who engage in undergraduate research tend to be higher performing, research also suggests that students with certain academic majors may be more likely to engage in undergraduate research. In a nationally representative sample of STEM and SBES bachelor degree recipients, Russell, Hancock, and McCullough (2007) found that the rates students participate in undergraduate research vary across academic disciplines. For example, the researchers found STEM participation rates were highest in environmental sciences (74%) and chemistry (72%) and lowest in

mathematics (34%) and computer sciences (37%). They found that SBES participation rates were highest in psychology (63%) and lowest in economics and political science (38%).

Although findings from a national sample of bachelor degree recipients suggest females, African Americans, and Hispanics (who graduated with a bachelor's degree in the STEM or SBES fields) participate in undergraduate research "at rates at least equivalent to their rates in the overall college population" (Russell, Hancock, & McCullough, 2007, p. 548), findings from other studies suggest otherwise. Einarson and Clarkberg (2010) found that African American students were less likely than any other racial/ethnic group to work with faculty on research projects. Similarly, Kim and Sax (2009) found that African American students interact more frequently with faculty for course-related matters, but are least likely to assist faculty with research. Their findings, from a sample of 58,281 students from nine campuses at the University of California, also suggest that middle- or upper-class students have higher levels of satisfaction with faculty interaction and lower-class and first-generation students are more often excluded from meaningful faculty interactions (Kim & Sax, 2009).

Even though the majority of students who engage in undergraduate research say they benefit from their experience (Kuh, G. D., Kinzie, J., Schuh, J. H., Whitt, E. J., & Associates, 2010), research findings pertaining to which student sub-populations benefit the most are inconsistent and conflicting. Some argue the benefits of undergraduate research programs are pronounced for traditionally underrepresented groups compared to students from majority groups (Osborn & Karukstis, 2009). For example, while a large-scale study found that all students benefit from faculty-student interaction (Astin,

1993) outside of the classroom, other studies suggest the effects of specific forms of contact vary by race/ethnicity (Einarson & Clarkberg, 2010).

Einarson and Clarkberg's (2010) research findings suggest that although African American students are least likely to work with faculty on research, they gain greater benefits from this type of interaction than other (White, Asian American, and Latino) racial/ethnic groups. More specifically, Einarson and Clarkberg's research suggest working on research with faculty statistically significantly correlates to intellectual gains (and the relationship of this type of faculty-student interaction is slightly stronger for African American students). Kinzie et al. (2008) explored the relationship between persistence and student engagement among underrepresented populations and found that African American students were more likely than White students to return for a second year as their engagement increased. Similarly, results from a participant control group research design agree that participation is most effective in promoting retention among students at greater risk (African Americans and students with low GPAs) for college attrition (Nagda et al., 1998). The findings from Ishiyama's (2002) study coincide with findings from the two previous studies that high impact activities particularly benefit non-majority group students by enhancing college retention, grades, and preparation for future work or post-graduate education (Ishiyama, 2002).

In a longitudinal study of undergraduate students at the University of California, Kim and Sax (2009) examined the effects of faculty-student interactions on degree aspirations between different student groups (sample of 58,281 students from nine campuses). On the contrary, they found that although undergraduate research led all racial groups to aspire for postgraduate education, it was greater for White students.

Some research findings suggest that race is not a factor and students with higher GPAs gain the most from engagement in undergraduate research.

Findings from other studies suggest engagement in undergraduate research is better suited for higher performing students or there are no significant differences between groups. Findings from a survey of 597 undergraduates at a large research university indicated that students who had lower levels of academic performance (measured by GPAs), later in their college careers, showed a decline in growth. On the contrary, students who had high GPAs showed an increase in growth, and students with mid-GPAs showed no growth as measured by the mean Undergraduate Research Questionnaire score (Taraban & Logue, 2012). The Undergraduate Research Questionnaire included 32 items that measured concepts pertaining to research mindset, faculty support, research methods, academic mindset, and peer support.

Jones, Barlow, & Villarejo (2010) examined the role of undergraduate research in persistence and performance among different student groups at a large research university. Using transcript and admission application data for students who majored in biology, they found undergraduate research participation to be positively associated with academic performance for all racial/ethnic groups. Similarly, the findings from a survey of undergraduate research experiences from 41 institutions, suggest that race/ethnicity was not a factor (Lopatto, 2004). The results suggest there were no significant differences in reported levels of benefits or plans to continue with postgraduate education between ethnic groups (Lopatto, 2004).

Findings from pre- and post-surveys (administered to students who participated in a summer undergraduate research program at Occidental College) suggest that the

one of the general benefits of the program was preparation for graduate school (Crane et al., 2011). The results also suggested the mentor-protégé relationship was a key aspect of the undergraduate research experience, especially for underrepresented researchers. Similarly, Mancha and Yoder (2014) found faculty mentorship and research team dynamics were important to the success of undergraduate research initiatives and the impact it has on preparing students for graduate school. In a qualitative study with 16 faculty and 32 students at Trinity University, Texas, the majority of faculty (56%) cited the number one goal of undergraduate research was preparing motivated students for graduate school (Mancha & Yoder, 2014). The researchers utilized semi-structured interviews with faculty and students in different fields of study (i.e.; natural sciences, computer science, engineering, social sciences, humanities, and business).

Even though the National Research Council (2003), the National Science Foundation (2003), and the National Research Corporation (Doyle, 2000) recommend that all students should participate in research projects as early as practical in their programs, many students do not engage in undergraduate research until their junior or senior year (Lopatto, 2010). Lopatto (2010) explains that although a number of reports suggest students who engage in undergraduate research go onto science programs or careers, the majority were juniors or seniors who had already declared a science major and intended on going to graduate school. For example, Lopatto (2004) found that the majority (75%) of students who engaged in undergraduate research during the summer (at four liberal arts colleges) was juniors or seniors and approximately 90% had existing plans to continue in science, which did not change after the undergraduate research

experience. Similarly, Russell, Hancock, & McCullough (2007) found that the majority of the science, technology, engineering, and mathematics (STEM) and social, behavioral, or economic science (SBES) graduates participated in undergraduate research as juniors and seniors.

Jones, Barlow, and Villarejo (2010) suggest that participation in research early on could positively influence retention because “involvement in formal campus activities during the first two years leads to greater academic success, college satisfaction levels, and retention rates among students of different racial/ethnic backgrounds and majors” (p. 107). They suggest that undergraduate research interventions should target students early on, during their first two years when they are most likely to dropout. More research to confirm if this is an effective strategy to increasing retention are necessary because many studies lack variance in timing and duration (Hakim, 1998; Jones, Barlow, & Villarejo, 2010; Levis-Fitzgerald & Denson, 2005). In addition, samples with students who are most likely to drop out are essential to demonstrating the impact of undergraduate research on different groups. Recruiting students who are most likely to drop out is a challenge because higher performing students are the ones who stay and engage in research.

Identified Gaps in the Literature

Even as scientific research has shed more light on undergraduate research interventions and factors that impact enrollment in graduate education, further analyses are needed in urban research universities where there are centralized efforts to engage diverse groups of students and prepare them for graduate school and future work. There are a number of factors associated with students' pursuits to attain graduate

degrees as well as numerous qualitative reports of student, faculty, and administrator perspectives regarding the benefits and challenges of undergraduate research.

Although qualitative studies help explain different perspectives regarding the effectiveness of undergraduate research, the findings are not generalizable to broader groups (Carter, Mandell, & Maton, 2009). Existing research suggests undergraduate research is a promising intervention, but more analyses with different student samples that allow for more descriptive and inferential analyses pertaining to student characteristics, engagement in research, and the attainment of graduate degrees are necessary.

Carter, Mandell, and Maton (2009) examined the impact of on-campus, academic year undergraduate research on students' pursuits to attain STEM PhDs. Their measurement of the dependent variable (pursuit to attain STEM PhD) did rely on actual enrollment or completion of a graduate degree data (from transcripts and registrars' offices). Through a series of probit regression models, the researchers found that participants who engaged in any form of on-campus, academic year research were significantly more likely than participants who did not engage in this type of research to pursue a STEM PhD. Although this study contributes to the empirical base of research regarding the relationship between undergraduate research and a student's pursuit to attain a graduate degree, the sample (even though majority minority) consists of a highly selective group of STEM students in the Meyerhoff Scholarship Program.

Similarly, Bauer and Bennett (2003) found that alumni who engaged in research through the Undergraduate Research Program at the University of Delaware pursued graduate school at higher rates than alumni with self-reported research experience and

alumni with no research experience. More specifically, findings from a probit analysis suggested that engagement in research increased the likelihood of pursuing a graduate degree such that alumni with undergraduate research experience had a 67% probability of pursuing graduate school, which was significantly higher than alumni with no research experience (whom had a 57% probability of pursuing a graduate degree). Bauer and Bennett administered a mail survey to 2,444 alumni from the University of Delaware (865 engaged in research through the Undergraduate Research Program). There was a 42% response rate. The findings from this study suggest that the duration of undergraduate research interventions matter. They found that the time spent (measured by semesters) engaging in undergraduate research affected the perceived benefit. Benefit was measured using a 5-point likert scale (1 = not at all important; 5 = extremely important). In general, as the time spent increased, the perceived benefit increased. Alumni who engaged in research for one semester had a mean (benefit) score of 3.94, while alumni who engaged in research for eight semesters had a mean score of 4.90. Although this study provides insight into undergraduate research and the subsequent pursuit of a graduate degree, the sample consists of alumni who graduated 20+ years ago (during 1982 and 1997).

The findings from Craney et al.'s (2011) study coincide with prior research that the majority of students benefit from engagement (Astin, 1969), but what about the 32% of participants who did not complete the survey (response rate is 68%)? We do not know if there is something unique about the students who did not respond or if their lack of response is random. Current studies are limited due to their reliance on data collected through surveys. Low response rates make it necessary to assess

engagement at research universities using systematically collected data to analyze student engagement in undergraduate research and enrollment in graduate for all students who engaged through a centralized effort.

There is significant funding going into undergraduate research programs both from private and public sources to prepare students for graduate school and future careers. While most scholars argue the benefits of participation, there is a need for more research to demonstrate the differential impact of these interventions on different sub-populations. The contradictory findings pertaining to who is more likely to engage and benefit from the experience, and the lack of documentation regarding timing and duration of engagement, raise the question of whether it is more effective for administrators to focus their efforts on all undergraduate students or certain sub-populations. This makes it necessary to track students over time using data gathered from various sources to analyze student characteristics, the level of engagement in undergraduate research (timing and duration), and whether students actually attain graduate degrees. The following study addressed two gaps in the literature by documenting a centralized effort aimed to engage undergraduate students across academic and demographic groups in research at an urban research university, and by analyzing the statistical relationship between graduate degree attainment and certain student characteristics for a sample of participants. The following research questions guided this research:

- 1) What is the demographic and academic makeup for students who engage in undergraduate research at an urban research university (using descriptive

- statistics for gender, race/ethnicity, Pell grant eligibility, high school GPA, ACT composite score, timing, and duration)?
- 2) What are the differences in likelihood of graduate degree attainment within five or more years, in relationship to academic performance, race/ethnicity, financial need, timing, and duration?

Chapter Summary

The literature review examined student characteristics related to engagement in undergraduate research, benefits of participation, and the pursuit of graduate degrees. Although one goal of undergraduate research is to increase the pool of graduate students (Mancha & Yoder, 2014), this outcome variable tends to be measured using participants' self-reports of highest degree planned (Kim & Sax, 2009). Nevill and Chen (2007) found that "less than one-half (35 percent) of graduates who expected to earn a master's degree enrolled in a graduate degree program" (p. 17). Nevill and Chen's quantitative study employs regression analysis to analyze the relationship between student characteristics and graduate enrollment using data collected from a national sample. Their findings provide empirical evidence for indicators that predict graduate enrollment, but the study does not address student engagement in undergraduate research. The goal to increase the pool of graduate students among students who engage in undergraduate research requires further examination.

While national surveys, such as the National Survey of Student Engagement, are used to measure engagement in undergraduate research at the institutional level, responses and findings are limited. Survey responses often consist of students' perceptions or aspirations and low response rates make it impossible to generalize

findings to broader populations. Although surveys are one research method used to collect information about student engagement at the institutional level, more studies that analyze university wide undergraduate research interventions using different methods and measures are needed (Katkin, 2003). Significant resources have been expended on undergraduate research programs, but few studies have rigorously investigated their efficacy” (Jones, Barlow, & Villarejo, 2010, p. 84) and few universities have created databases from various sources that allow for such investigations (Katkin, 2003). The creation of a database is essential to analyzing such relationships.

Studies have examined the benefits of undergraduate research and the attainment of graduate degrees, but few studies have documented university wide efforts to engage students in undergraduate research or analyzed the relationship between the two (Katkin, 2003). Overall, undergraduate research is a promising intervention to help prepare students for graduate school and future careers (Craney et al., 2011), but more empirical evidence is needed to test its relationship with graduate degree attainment. This study adds to the literature by documenting and measuring student engagement at an urban research university and examining the subsequent attainment of an advanced degree.

The need to describe and analyze populations at urban research universities is essential to expanding the knowledgebase because past findings rely on samples at selective institutions (Fechheimer, Webber, & Kleiber, 2011) and focus on students in the natural sciences (Ishiyama, 2002). The expansion of undergraduate research (Craney et al., 2011) in the liberal arts and social sciences (Buckley, 2010; Taraban &

Logue, 2012) requires the examination of university wide efforts at universities where there is variation among students.

This study examined the implementation of a university wide undergraduate research intervention at an urban research university using student-level data from a large population and sample of students. The goal of this study was to document demographic and academic characteristics of a population of undergraduate researchers at an urban research university. The creation of a database with systematically collected data was essential to conducting descriptive and inferential analyses. This study measures actual degree attainment (not students' aspirations), because the percentage of students who say they would like to attain a graduate degree is greater than the percentage who actually enroll (Nevill & Chen, 2007). This study has practical value and may inform policy-making that aims to increase degree attainment of advanced degrees. This study used a quantitative research approach to describe who engaged in undergraduate research through a centralized university wide intervention and analyze differences in likelihood of attaining a graduate degree, as it relates to academic performance, race/ethnicity, financial need, timing, and duration.

CHAPTER 3: Methodology

Introduction

The goals of this study were to: gather systematically collected student-level data from different sources; organize and recode the data to create a database with variables that allow for quantitative analyses; document who engaged in undergraduate research during a seven-year span (2008 – 2015); and analyze differences in likelihood of graduate degree attainment, as it relates to race/ethnicity, financial need, timing, duration, and academic performance. This study described a population of undergraduate researchers at an urban research university and analyzed the likelihood of degree attainment among different student sub-populations.

Research Questions

This study addressed the following research questions (see Table 1 for a quick overview of the research questions and type of analysis):

- 1) What is the demographic and academic makeup for students who engage in undergraduate research at an urban research university (using descriptive statistics for gender, race/ethnicity, Pell grant eligibility, high school GPA, ACT composite score, timing, and duration)?
- 2) What are the differences in likelihood of graduate degree attainment within five or more years, in relationship to academic performance, race/ethnicity, financial need, timing, and duration?

Table 1. Summary of Research Questions and Statistical Analyses

| Main Research Question | Statistical Analysis |
|--|---|
| What is the demographic and academic makeup for students who engage in undergraduate research at an urban research university? | Descriptive statistics (such as frequencies, percentages, means, and standard deviations) are provided for each variable (gender, race/ethnicity, Pell grant eligibility, high school GPA, ACT composite score, timing, and duration) when applicable |
| What are the differences in likelihood of graduate degree attainment within five or more years, in relationship to race/ethnicity, financial need, timing, and duration, while controlling for academic performance? | Multiple logistic regression analysis was employed to predict the likelihood of graduate degree attainment by 2015 at any institution, five or more years after completing a bachelor's degree at the Midwestern urban research university |

Population & Sample

This study collected data for all students who engaged in undergraduate research at some point during 2008 – 2015 at a Midwestern urban research university. This university is one of only 115 of the nation's 4,600 post-secondary institutions designated as a R1. There are 14 schools and colleges and 180+ degree programs at the university. It is the most diverse institution in this University System and enrolls more than 21,000 undergraduate students annually. One third of freshmen are students of color.

This study gathered information from the Office of Undergraduate Research and the Office of Assessment and Institutional Research and created a database that included information from both sources. The information in this database was organized and coded to allow for quantitative analyses. The removal of identifiers occurred prior to accessing the student-level data to ensure confidentiality. This study included information pertaining to an individual's: race/ethnicity, financial need, academic

performance (such as GPA and ACT score), and degree attainment. This study used SPSS software to organize and recode the data into variables that allowed for descriptive and inferential analyses. The Institutional Review Board at the urban research university approved this study.

The Office of Undergraduate Research began collecting student data in 2008 in an effort to track engagement in undergraduate research at the Midwestern urban research university. The Office of Undergraduate Research serves as an institution wide, centralized location for undergraduate students seeking on-campus research opportunities and for faculty seeking to collaborate with students. This office engages students in a wide range of undergraduate research programs every year and promotes their programs at campus wide tabling events, during the new student orientation, and campus tour. The two main programs are the Undergraduate Research Opportunity Program (UROP) and the Support for Undergraduate Research Fellows (SURF).

UROP consists of a credit-bearing introduction to research for freshman and sophomore year students. During UROP, students participate in weekly seminars about the culture of university research and earn credit for their participation. Students who are interested in conducting research with faculty may submit an online form and attend an initial meeting. Faculty and staff review students' transcripts (academic performance) and reason statements for pursuing undergraduate research. Of the total 60-80 students who express interest each semester, the committee selects approximately one third of the applicants to engage in UROP.

SURF consists of a paid research assistantship for undergraduate students. Faculty and academic staff may apply for SURF funding to pay students as hourly

employees to assist with research projects. The Office of Undergraduate Research recruits faculty through emails sent to department chairs. A committee (consisting of majority faculty) reviews applications and selects faculty/student pairs that have strong statements of interest. Faculty members recruit most SURF students from their academic discipline. Most of the students are already involved in research. Of the total 120-180 applicants, approximately 85-90% receives funding each semester. This program aims to foster a culture of faculty-student research collaborations. It encourages engaging students as early as possible (during freshman and sophomore year) and students who are underrepresented in undergraduate research (such as students of color, students with disabilities, and in some disciplines, women).

Both UROP and SURF promote mentored relationships with faculty through research projects that are outside of degree curricula. The Office of Undergraduate Research does not account for students who engage in research as part of existing curricular degree requirements and/or engagement in informal research with faculty. Approximately half of the undergraduate researchers enrolled in an undergraduate program in letters and science. UROP and SURF students commit approximately 6-10 hours per week for undergraduate research. The Office of Undergraduate Research also hosts an annual Undergraduate Research Symposium. The symposium is a university wide celebration of undergraduate research accomplishments. The centralized undergraduate research office also provides funding for students to engage in research projects overseas, grants for domestic travel to attend disciplinary research conferences, and invites a small group of incoming students to engage in a summer research program.

This study also gathered data from the Office of Assessment and Institutional Research at the Midwestern urban research university. The Office of Assessment and Institutional Research collects data through PeopleSoft (pertaining to individual student characteristics such as demographics, academic performance, and bachelor degree attainment from the urban research university and type of degree obtained). The Office of Assessment and Institutional Research has access to the National Student Clearinghouse postsecondary enrollment data.

The National Student Clearinghouse reports data pertaining to the attainment of postsecondary degrees for students who attend more than 3,600 colleges and universities. The data from this source measured graduate degree attainment. The information from the National Student Clearinghouse consisted of 19,600 student records that pertained to the 2,325 participants. This study involved matching the 19,600 records from one file, with the 2,325 records in a separate file. The files from the three sources allowed for the compilation of demographic, academic performance, engagement in undergraduate research, and degree attainment information into one dataset.

Participants

The target population for this study consisted of all students who engaged in undergraduate research. The accessible population consisted of all students who enrolled at the Midwestern urban research university and engaged in research through the Office of Undergraduate Research at some point during the seven-year span. This population included 2,325 undergraduate students who engaged in research through the centralized university wide intervention. The subset included in the regression

analysis consisted of 424 participants who graduated with a bachelor's degree from the urban research university within five or more years after attaining a bachelor's degree from the Midwestern urban research university during 2010 or earlier.

The population and sample consisted of the following:

Target population: All students who engage in undergraduate research in the United States.

Accessible population: 2,325 students who engaged in undergraduate research at a Midwestern urban research university.

Subset: 424 students who engaged in undergraduate research and completed a bachelor's degree at the Midwestern urban research university by 2010

Data Analysis

A quantitative research approach was employed to descriptively and inferentially analyze which students at an urban research university engage in undergraduate research and who goes on to attain graduate degrees. The analysis of quantitative data was advantageous for this study because it allowed for descriptive and inferential analyses of student-level data gathered from a large sample (Creswell, 2012). This study used descriptive statistics to describe demographic and academic performance characteristics of participants using percentages to observe group differences. This study employed a logistic regression model to analyze differences in likelihood of graduate degree attainment, in relationship to race/ethnicity, financial need, timing, duration, and academic performance

Descriptive Analysis

The descriptive analysis answered, “Who engages in undergraduate research at an urban research university”? The variables examined were: gender (male or female); race/ethnicity (African American, American Indian, Asian American, International, Latino/a, Multi Ethnic, Other, Southeastern Asian American, Unknown, or White); Pell grant eligibility (no or yes); high school GPA (0.0 – 4.0); ACT composite score (0.0 – 36); the college grade level during initial time of engagement (freshman, sophomore, junior, or senior); and the number of years engaged (1 – 5 years). The results for this analysis were interpreted using descriptive statistics such as central tendencies and variations. The results described were frequencies, percentages, means, and standard deviations. The descriptive analysis included a number of variables that were not included in the inferential analysis. These variables were not included in the inferential analysis because preliminary examination suggested their bivariate associations with the dependent variable (graduate degree attainment) were statistically insignificant (at the .05 significance level).

Inferential Analysis

The inferential analysis addressed “what are the differences in likelihood of graduate degree attainment within five or more years, in relationship to academic performance, race/ethnicity, financial need, timing, and duration?” The inferential analysis consisted of individual characteristics and research participation variables. The individual characteristics included were financial need, academic performance, and race/ethnicity.

Financial need was defined operationally as whether or not the individual student qualified for the Pell Grant. The academic performance variable measured undergraduate GPA. This was measured as a continuous variable that ranged from 0 to 4. Race/ethnicity consisted of a series of dichotomous variables to examine differences in graduate degree attainment between different racial/ethnic groups (i.e.; African Americans, Asian Americans, Multi Ethnics, and Whites. White was the reference category. Latino/as were not included in the analysis because there were only two observations.

The research participation variables were college grade level at initial time of engagement (timing) and number of years of research experience (duration). The current study measured timing and duration of engagement in undergraduate research using numerous dichotomous variables. The timing variable measured the college grade level the student was in when s/he initially engaged in undergraduate research. Timing included two dichotomous variables: junior or senior. Duration measured the number of years students engaged in undergraduate research. This variable included two dichotomous variables: one year or two years of undergraduate research. The dichotomized independent variables examined differences in graduate degree attainment between students who began research junior year and senior year. Freshman and sophomore were not included in the analysis because there were too few cases for these two groups. Table 2 includes a summary of the conceptual and operational definitions.

The dependent variable in this study was the attainment of a graduate degree from any institution by 2015. This binary variable measured whether or not an individual

attained a master's or PhD (i.e.; did not attain graduate degree or attained graduate degree). The sample was limited to participants who graduated with a bachelor's degree during or before 2010. Although some participants may be excluded from the sample because they did not have enough time to complete a doctoral degree, findings from a nationally representative sample suggest that enrollment in graduate school is highest during the first year after completion of a bachelor's degree (Clune, Nuñez, & Choy, 2001). Clune, Nuñez, and Choy (2001) suggest that for the majority of graduates, the highest degree they enrolled in was a master's degree program (31% vs. 5% for a first professional degree program and 4% for a doctoral degree program). The participants in this sample had at least five years to complete a graduate level degree, after completion of an undergraduate degree.

Table 2. Variable Definitions

| Dependent Variable | Conceptual Definition | Operational Definition |
|--|---|--|
| Attainment of a graduate degree | This variable indicates if a participant attained a graduate degree from any institution by 2015 | 0 = No graduate degree (reference category) 1 = Graduate degree |
| Independent Variable | Conceptual Definition | Operational Definition |
| Timing of engagement in undergraduate research | This variable indicates the timing/college grade level at initial time of engagement in undergraduate research using two dichotomous variables for junior or senior | |
| Duration of engagement in undergraduate research | This variable indicates the number of years of research experience using two dichotomous variables for one or two years | |
| Financial need | This variable indicates if a participant was eligible for a Pell grant using one dichotomous variable | 0 = Not eligible 1 = Eligible |
| Academic performance | This variable indicates the participant's undergraduate cumulative GPA using a ratio level variable | 0.0 (lowest possible) - 4.0+ (highest possible) |
| Race/ethnicity | This variable indicates the participant's race/ethnicity using a series of dummy variables for African American, Asian American, Multi Ethnic, and White | White is the reference category |

The unit of analysis for this study was the undergraduate researcher (individual student). This study conducted a multiple logistic regression analysis because it allowed testing for statistical relationships between one dependent variable (the attainment of a graduate degree) and multiple independent variables (Creswell, 2012). Peng, So, Stage, and St. John (2002) suggest educational research is increasingly applying logistic regression. This logistic regression analysis in this study explored “what are the differences in likelihood of graduate degree attainment within five or more years, in relationship to race/ethnicity, financial need, timing, and duration, while controlling for academic performance?”

A logistic regression model analyzed the relationship between each independent variable and dependent variable (attainment of a graduate degree), while controlling for all other variables in the model. The odds ratio assessed the likelihood of graduate degree attainment for different sub-populations (in comparison to the reference categories). Multiple logistic regression analysis was suitable for this study because of the nature of the binary outcome variable (graduate degree attained or not) and mixture of continuous and categorical independent variables (Peng, So, Stage, & St. John, 2002). Researchers have recognized that logistic regression produces accurate results in terms of classification and prediction (Fan & Wang, 1999; Lei & Koehly, 2000). Peng et al. suggest that logit and probit models produce similar results.

Timing and duration were of particular interest because although scholars and different groups argue the need to engage students in research as early as possible (Boyer Commission, 1998; Doyle, 2000; Kuh, 2008; National Research Council, 2003; National Science Foundation 2003), empirical evidence regarding timing and duration

are conflicting. The knowledgebase is limited to studies that lack identification of timing and duration (Hakim, 1998; Jones, Barlow, & Villarejo, 2010; Levis-Fitzgerald & Denson, 2005) or lack variation because they take place during the summer or before the senior year (Hunter et al., 2007; Kardash, 2000; Seymour et al., 2004).

Chapter Summary

This chapter discussed the research methodology used to examine graduate degree attainment among a sample of students who engaged in a centralized university wide undergraduate research intervention. The creation of a new dataset allowed for descriptive and inferential analyses pertaining to individual demographic characteristics, academic performance information, timing and duration of engagement in undergraduate research, and degree attainment variables that pertain to a population and sample of students at an urban research university. The descriptive analysis contributed to the literature by documenting who engaged in undergraduate research at an urban research university at the institutional level using precise measures, not estimates. The findings from this study answered questions pertaining to who engages in undergraduate research and goes on to attain graduate level degrees. The evidence from the inferential analysis provided evidence regarding differences in graduate degree attainment, as it relates to timing and duration of engagement in undergraduate research, race/ethnicity, financial need, and academic performance.

CHAPTER 4: Findings

Introduction

The purpose of this chapter was to document the demographic and academic makeup of a population of students who engaged in undergraduate research through a centralized university wide intervention at the Midwestern urban research university during 2008 – 2015. A descriptive profile of the entire population provides a step toward understanding who engages in research at the institutional level. Another purpose was to interpret the findings from the inferential analysis as it relates to graduate degree attainment rates by financial need, race/ethnicity, timing, duration, and academic performance.

Descriptive Analysis

This section included who engaged in undergraduate research as it related to participants' gender, race/ethnicity, Pell grant eligibility, high school GPA, and ACT composite score. It also included the college grade level (timing) participants were in during initial time of engagement and the number of different years (duration) participants engaged in undergraduate research. A review of the data showed that 2,325 undergraduate students participated in faculty-mentored research through a centralized institutional effort during 2008 – 2015 at the Midwestern urban research university.

Gender

The gender distribution was almost uniform. There were 1,160 (50.1%) females and 1,154 males (49.9%) who engaged in undergraduate research (Table 3).

Table 3. Gender

| Gender | Frequency | Percent |
|--------|-----------|---------|
| Male | 1154 | 49.9 |
| Female | 1160 | 50.1 |
| Total | 2314 | 100% |

Race/Ethnicity

The majority of participants were White and they accounted for 1,789 (76.9%) of the undergraduate researchers. There were: 162 (7%) Multi Ethnic participants; 125 (5.4%) African American participants; 67 (2.9%) Asian American participants; 54 (2.3%) Southeast Asian American participants; 50 (2.2%) Latino/a participants; 48 (2.1%) International participants; 14 (0.6%) American Indian participants; and 15 (0.6%) unknown (Table 4).

Table 4. Race/Ethnicity

| Race/Ethnicity | Frequency | Percent |
|-------------------|-----------|---------|
| African American | 125 | 5.4 |
| American Indian | 14 | 0.6 |
| Asian American | 67 | 2.9 |
| International | 48 | 2.1 |
| Latino/a | 50 | 2.2 |
| Multi Ethnic | 162 | 7 |
| Other Race | 1 | 0 |
| SE Asian American | 54 | 2.3 |
| Unknown | 15 | 0.6 |
| White | 1789 | 76.9 |
| Total | 2325 | 100% |

Pell Grant Eligibility

More than one-half, 1,321 (56.8%) participants, were not eligible for the Pell grant. The remaining 1,004 (43.2%) participants were Pell grant eligible (Table 5).

Table 5. Pell Grant Eligibility

| Pell Grant | Frequency | Percent |
|--------------|-----------|---------|
| Not eligible | 1321 | 56.8 |
| Eligible | 1004 | 43.2 |
| Total | 2325 | 100% |

High School GPA & ACT Composite Score

The mean high school GPA was 3.067. The mean ACT composite score was 24.14 (Table 6).

Table 6. High School GPA & ACT Composite Score

| | N | Minimum | Maximum | Mean | Standard Deviation |
|---------------------|------|---------|---------|---------|--------------------|
| High School GPA | 2058 | 0 | 4 | 3.067 | 0.93131 |
| ACT Composite Score | 1734 | 0 | 36 | 24.1373 | 3.89544 |

Timing

More than one-half, 1,302 (56.3%) participants, initially engaged in undergraduate research during senior year, 478 (20.7%) engaged during junior year, 277 (12%) engaged during sophomore year, and 256 (11%) engaged during freshman year (Table 7).

Table 7. Timing (College Grade Level)

| Grade Level | Frequency | Percent |
|-------------|-----------|---------|
| Freshman | 256 | 11 |
| Sophomore | 277 | 12 |
| Junior | 478 | 20.7 |
| Senior | 1302 | 56.3 |
| Total | 2313 | 100% |

Duration

The majority, 1,487 (64%) participants, engaged in undergraduate research during one year, 646 (27.8%) engaged during two years, 160 (6.9%) engaged during three years, 27 (1.2%) engaged during four years, and 5 (0.2%) engaged during five years (Table 8).

Table 8. Duration (Number of Years)

| Duration (Years) | Frequency | Percent |
|------------------|-----------|---------|
| One | 1487 | 64 |
| Two | 646 | 27.8 |
| Three | 160 | 6.9 |
| Four | 27 | 1.2 |
| Five | 5 | 0.2 |
| Total | 2325 | 100% |

The participants in this study are higher performing, have a higher rate of bachelor degree attainment, and are less diverse than the general population at the

Midwestern urban research university. The mean ACT composite score (mean score = 24) places the participants almost in the 75th percentile at the urban research university (25% of the general undergraduate population scored 20 or below; 25% of the general undergraduate population scored 25 or above). The bachelor degree attainment rate for the general undergraduate population is 47% (within eight years), compared to 88% for the participants who engaged in undergraduate research. Although non-White students account for approximately one-third of the general undergraduate population, they only represent approximately 23% of the participants who engaged in undergraduate research.

Inferential Analysis

The independent variables included in the logistic regression analysis are undergraduate GPA, Pell grant eligibility, race/ethnicity, timing, and duration. The outcome variable is the attainment of a graduate degree within five or more years after completion of a bachelor's degree. Overall, the graduate degree attainment rate for participants in this subset was 39.9%. The descriptive statistics for the subset provide a first step toward understanding how the subset compares to the population of undergraduate researchers at the urban research university and graduate degree attainment rates for student sub-populations.

Table 9 shows that the mean ACT composite score was 23.9. The mean high school GPA was 2.95. Less than one-half (37.7%) of the participants were Pell grant eligible. Participants who were not eligible for the Pell grant attained a graduate degree at a rate of 43.2%, while participants who were eligible for a Pell grant attained a graduate degree at a rate of 34.4%. The majority (89.9%) was White; 3.8% were African

American; 3.3% were Multi Ethnic; and 3.1% were Asian American. Asian Americans had a 69.2% graduate degree attainment rate; Multi Ethnics had a 64.3% graduate degree attainment rate; African Americans had a 43.8% graduate degree attainment rate; and Whites had a 37.8% graduate degree attainment rate. Participants who initially engaged in undergraduate research senior year account for 87.3%. Participants who initially engaged in undergraduate research junior year account for 12.5%. Juniors had a 41.5% graduate degree attainment rate. Seniors had a 39.7% graduate degree attainment rate. Participants who engaged in undergraduate research for one year account for 80.4% and participants who engaged in undergraduate research for two-years account for 19.6%. Participants who engaged for two years had a 42.2% graduate degree attainment rate. Participants who engaged for one year had a 39.3% graduate degree attainment rate.

Table 9. Descriptive Statistics of Subset (N = 424)

| | Mean/Percent (Frequency) | Attainment Rate (Frequency) |
|------------------------|-----------------------------|--|
| ACT Composite Score | 23.9 | |
| High School GPA | 2.95 | |
| Undergraduate GPA | 3.36 | |
| Pell Grant Eligibility | 37.7% (160) | 43.2% (114 not eligible); 34.4% (55 eligible) |
| African American | 3.8% (16) | 43.8% (7) |
| Asian American | 3.1% (13) | 69.2% (9) |
| Multi Ethnic | 3.3% (14) | 64.3% (9) |
| White | 89.9% (381) | 37.8% (144) |
| Junior | 12.5% (53) | 41.5% (22) |
| Senior | 87.3% (370) | 39.7% (147) |
| One Year Research | 80.4% (341) | 39.3% (134) |
| Two Years Research | 19.6% (83) | 42.2% (35) |

Logistic Regression

The logistic regression analysis assessed whether there were differences in graduate degree attainment within five or more years after bachelor degree attainment, in relationship to academic performance, timing and duration of engagement in undergraduate research, financial need, and race/ethnicity. The odds ratio (Exp(B)) is interpreted to suggest likelihood of graduate degree attainment compared to the reference category, when controlling for the other variables. The Cox and Snell pseudo R-squared statistic suggests that undergraduate GPA, Pell eligibility, race/ethnicity,

timing, and duration (the seven independent variables) in the logistic model together account for 4.5% of the variation in whether or not an undergraduate researcher attains a graduate degree, five or more years after attaining a bachelor's degree. Although this model accounts for a significant amount (p -value = 0.006) of the variation in whether or not an undergraduate researcher attains a graduate degree, the low pseudo R-squared (0.045) suggests there are a lot of other variables not in the model which influence graduate degree attainment. Table 10 presents the results of the regression analysis.

After controlling for Pell grant eligibility, race/ethnicity, timing, and duration, undergraduate GPA is a significant predictor of graduate degree attainment (p = 0.013). The odds ratio (2.005) suggests that for each full grade increase in undergraduate GPA (one full point on the four-point grading scale), the odds of attaining a graduate degree increases by two times.

After controlling for all the other variables, the odds of attaining a graduate degree for Asian Americans are four times the odds of graduate degree attainment for Whites. The p -value is 0.017, which suggests the difference in graduate degree attainment between Asian Americans and Whites is statistically significant at the 0.05 significance level. Similarly, after controlling for undergraduate GPA, Pell grant eligibility, timing, and duration, the odds of attaining a graduate degree for Multi Ethnic is three times the odds of graduate degree attainment for Whites. The p -value is 0.032, which suggests the difference in graduate degree attainment between Multi Ethnic and Whites is statistically significant. Although the odds of attaining a graduate degree for African Americans is almost two times the odds of graduate degree attainment for Whites, the p -value is 0.218 which suggests the difference in graduate degree

attainment between African Americans and Whites is not statistically significant (after controlling for undergraduate GPA, Pell grant eligibility, timing, and duration).

After controlling for all the other variables, the odds of attaining a graduate degree for participants who are Pell eligible is 0.687 less than the odds of graduate degree attainment for participants who are not Pell eligible. The p-value is 0.084, which suggests the difference in graduate degree attainment between being Pell eligible and not being Pell eligible is not statistically significant.

After controlling for all the other variables in the model, the odds of attaining a graduate degree for participants with two years of research experience is 1.052 greater than the odds of graduate degree attainment for participants with one year of research experience. The p-value is 0.85, which suggests the difference in graduate degree attainment between having one and two years of undergraduate research is not statistically significant.

After controlling for all the other variables, the odds of attaining a graduate degree for participants who begin undergraduate research junior year is 1.038 greater than the odds of graduate degree attainment for participants who begin undergraduate research senior year. The p-value is 0.906, which suggests the difference in graduate degree attainment between juniors and seniors is not statistically significant.

Table 10. Logistic Regression Model (N = 424)

| Variable Name | B | S.E. | Sig. | Odds Ratio |
|--|--------|-------|--------|------------|
| Undergraduate GPA | 0.696 | 0.28 | 0.013* | 2.005 |
| Pell eligible | -0.376 | 0.218 | 0.084 | 0.687 |
| <i>Not eligible (reference category)</i> | | | | |
| African American | 0.662 | 0.538 | 0.218 | 1.939 |
| Asian American | 1.491 | 0.626 | 0.017* | 4.443 |
| Multi Ethnic | 1.246 | 0.582 | 0.032* | 3.476 |
| <i>White (reference category)</i> | | | | |
| Two research years | 0.05 | 0.266 | 0.85 | 1.052 |
| <i>One year (reference category)</i> | | | | |
| Junior | 0.038 | 0.318 | 0.906 | 1.038 |
| <i>Senior (reference category)</i> | | | | |
| Constant | -2.75 | 0.969 | 0.005 | 0.064 |

In this model, 61.8% of the 424 cases were correctly classified and the Cox & Snell R-squared was equal to 0.045 and the Nagelkerke R-squared was equal to 0.061 ($p = 0.006$).

* $p < 0.05$

Chapter Summary

This chapter presented the descriptive and inferential analyses used to answer the two research questions. The descriptive statistics for the accessible population explain who engaged in undergraduate research at an urban research university during a seven-year span (2008 – 2015). Approximately 50% of the participants were female; more than 75% were White; approximately 57% were not eligible for the Pell grant; the mean high school GPA was 3.067; the average ACT composite score was approximately 24; more than 75% initially engaged in undergraduate research junior or senior year; and over 90% engaged in research for one or two years. The academic performance of the subset is similar to that of the population in this study. The ACT composite score for the subset was 23.9 (compared to 24 for the population) and the mean high school GPA was 2.95 (compared to 3.067). The percentage of participants who were Pell grant eligible was greater for the population than the subset (43.2% and

37.7%, respectively). The descriptive statistics also suggest that the subset consists of a higher percentage of White participants than the population of undergraduate researchers. Approximately 75% of the population was White, while almost 90% of the subset was White.

The logistic regression analysis confirms that undergraduate GPA is a significant predictor of graduate degree attainment and there are differences in graduate degree attainment between racial/ethnic groups. After controlling for all other variables, undergraduate GPA is a statistically significant predictor of graduate degree attainment. The odds of attaining a graduate degree within five or more years after attaining a bachelor's degree were statistically significantly higher for Asian Americans and Multi Ethnicity compared to Whites, after controlling for other variables.

CHAPTER 5: Conclusion

Introduction

This chapter reviews the findings and discusses them in the context of research on engagement in undergraduate research and the pursuit of graduate degrees. This chapter includes implications of the research findings, potential research questions, and research designs that could follow-up on this area of research. This section concludes with a chapter summary.

Discussion of Findings

There are four conclusions drawn from this study. First, the findings from this study suggest that 2,325 undergraduate students engaged in research during 2008 – 2015 through the university wide intervention. Similar to Lopatto (2004), the findings from the current study suggest that over 75% of the students who engaged in research at the Midwestern urban research university were juniors or seniors. The documentation of student engagement in undergraduate research is pertinent because past research findings pertaining to engagement in university wide interventions tend to rely on administrator estimates (Katkin, 2003). A descriptive analysis documenting student characteristics at an urban research university was of particular interest because past studies often examined interventions at selective institutions (Fechheimer, Webber, & Kleiber, 2011) and there is conflicting evidence regarding which students are most likely to participate in undergraduate research (Einarson & Clarkberg, 2010; Kim & Sax, 2009; Russell, Hancock, & McCullough, 2007).

The descriptive findings pertaining to who engages in undergraduate research are somewhat consistent with past research. The findings from the current study

confirm that females engage in research at a rate equivalent to the general population (approximately 50%), which coincide with Russell, Hancock, and McCullough's (2007) findings that females participate in research at rates equivalent to their rates in the overall population. The findings from the current study are not consistent with their findings that suggest African Americans and Hispanics participate at equivalent rates.

The findings from this study suggest that non-White students engage in undergraduate research at rates slightly lower than their proportion in the general population. For example, although non-Whites represent one-third of the general population at the urban research university, they only represent approximately 23% of the population of students who engaged in undergraduate research. These findings suggest that non-majority racial/ethnic groups engage in research at lower rates and confirm other findings that suggest African Americans are less likely than other racial/ethnic groups to assist faculty with research (Einarson & Clarkberg, 2010; Kim & Sax, 2009). Findings from the current study suggest there were a larger percentage of White participants in the subset than in the population (90% and 77%, respectively). The subset was limited to participants who graduated with a bachelor's degree during or before 2010. Further analysis is needed to examine why there are a smaller percentage of non-White participants in the subset.

Unlike previous research findings that suggest lower income students tend to be excluded from meaningful faculty interactions (Kim & Sax's, 2009), findings from the current study suggest otherwise. Kim and Sax (2009) measured this variable by participants' self-reported social class. Approximately 43% of the participants at the urban research university were Pell grant eligible, which suggests a significant

proportion of students who have financial need engage in undergraduate research at the urban research university.

Similar to past research findings which suggest the highest performing students (measured by GPA or standardized tests) are the ones doing research (Astin, 1969; Craney et al., 2011; Merkel, 2003; Russell, Hancock, & McCullough, 2007), the students who engaged in undergraduate research at the Midwestern urban research university were higher performing than their peers. The participants' mean ACT composite score put them in the 75th percentile (mean score = 24) and the students who engaged in research through the university wide intervention had higher degree attainment rates. The majority of participants (88%) attained a bachelor's degree within six or more years (compared to 48% of the general population at the urban research university).

Second, the current study contributes to existing literature because the findings indicate that approximately 40% of the population subset of undergraduate researchers attained a graduate degree (within five or more years after bachelor degree attainment). Studies that measure actual degree attainment are necessary because although one goal of undergraduate research is to increase the pool of graduate students (Craney et al., 2011; Mancha & Yoder, 2014), this outcome variable tends to be measured using participants' self-reports of highest degree planned (Kim & Sax, 2009). Nevill and Chen (2007) also found that 40% of the students (from a national representative sample) who graduated with a bachelor's degree in 1992-1993 enrolled in a graduate degree program, but only 62% of those who enrolled earned at least one graduate degree. Nevill and Chen's (2007) quantitative study employed regression analysis to analyze the relationship between student characteristics and although their findings provide

empirical evidence for indicators that predict graduate enrollment, their study does not address student engagement in undergraduate research.

Bauer and Bennett (2003) measured differences in levels of engagement in undergraduate research and the perceived benefit among alumni. They found that alumni with undergraduate research experience had a significantly higher probability of pursuing graduate school, compared to alumni with no research experience (67% and 57%, respectively). Although alumni who participated in undergraduate research had a 67% probability of pursuing graduate school, the findings were based on respondents' self-reports of intentions to enroll. Carter, Mandell, and Maton (2009) found that 31% of the participants in their study of on-campus academic year research on STEM PhD outcomes were pursuing or have completed a STEM PhD or M.D./PhD program. Findings from the current study suggest that undergraduate researchers attain graduate degrees at a rate comparable to the overall enrollment rate (40%), but may attain graduate degrees at a higher rate (than the overall population of bachelor degree recipients) because only 62% (of those who enrolled) earned at least one graduate degree within 10 years (Nevill & Chen, 2007).

Third, the findings from this study coincide with existing research which consistently suggest that students with higher GPAs are the ones pursuing graduate school (Heller, 2001; Millett, 2003; Mullen, Goyette, & Soares, 2003; Nevill & Chen, 2007; Perna, 2004). Findings from the current study confirm that academic achievement (measured by undergraduate GPA) is statistically significantly associated with the pursuit of a graduate degree (after controlling for Pell grant eligibility, race/ethnicity, timing, and duration), even among a subset of undergraduate researchers. Similarly,

Nevill and Chen (2007) found that students with undergraduate GPAs of 3.5 or above are more likely to enroll in graduate school.

Fourth, this research suggests there are statistically significant differences in graduate degree attainment for Asian Americans and Multi Ethnic (when compared to Whites). After controlling for undergraduate GPA, Pell grant eligibility, timing, and duration, the graduate degree attainment rates for Asian Americans (69%) and Multi Ethnic (64%) are statistically significantly different from Whites (38%). On the contrary, some research suggests White students who engage in undergraduate research are more likely to aspire for postgraduate education or race is not a factor. Kim and Sax (2009) found that undergraduate research led all racial/ethnic groups to aspire for postgraduate education, but it was greater for White students (compared to African American, Asian American, Latino, and other race). Lopatto (2004) did not find a significant difference between racial/ethnic groups' reported plans to continue postgraduate education.

Although the descriptive statistics suggest African Americans have a higher graduate degree attainment rate than Whites (43.8% and 37.8%, respectively), findings from the logistic regression analysis suggest the difference is not statistically significant (when controlling for undergraduate GPA, Pell grant eligibility, timing, and duration). Similarly, Nevill and Chen (2007) found that African Americans were more likely than Whites to enroll in graduate school (45% and 39%, respectively), but the differences disappeared when undergraduate GPA and major were controlled for. Perna's (2004) findings are consistent with the two previous studies and suggest there are no statistically significant differences between African American and White students.

Implications & Future Research

Although scholars argue all students should engage in undergraduate research early on (Boyer Commission, 1998; Doyle, 2000; Kuh, 2008; National Research Council, 2003; National Science Foundation 2003), opportunities are limited to select students. Research consistently suggests that higher performing students who are further along in their academic pursuit are the ones engaging in undergraduate research (Carter, Mandell, & McCullough, 2007; Lopatto, 2004). This makes it challenging to conduct quantitative analyses regarding the impact of undergraduate research for different sub-populations because samples often consist of predominately-White participants who engage junior or senior year. For example, the current study consisted of a subset of participants that were 90% White (n = 424). There were only 16 African American participants, 14 Multi Ethnics, and 13 Asian Americans. Findings from studies that consist of homogenous groups may not generalize to diverse populations.

Engaging more students at urban research universities inside of the classroom is essential to expanding undergraduate research opportunities. Jacoby (2009) and Kim and Sax (2009) suggest that campus-based initiatives may not attract, be appropriate for, or effectively serve minority students or students from working-class backgrounds, so engagement in the classroom is essential to expanding such opportunities. Although past research shows that socioeconomic status (i.e; parental education level) is associated with graduate school enrollment (Heller, 2001; Millett, 2003; Mullen, Goyette, & Soares, 2003; Nevill & Chen, 2007; Perna, 2004), findings regarding other measures of socioeconomic status (i.e; household income and undergraduate indebtedness) are inconsistent in relation to graduate enrollment (Mattern & Radunzel, 2015). More

research that analyzes the relationship between socioeconomic status and degree attainment using different measures is necessary to confirm or disconfirm its impact.

The findings from the current study suggest there is not a statistically significant difference in graduate degree attainment between participants who began undergraduate research junior year compared to participants who began senior year. This study adds to the research because it is one more attempt to measure different levels of engagement (timing and duration) and analyze differences in graduate degree attainment among undergraduate researchers. Although these findings suggest there is not a statistically significant difference between different levels of engagement in undergraduate research and graduate degree attainment, the lack of statistical significance may be due to the measurements used for timing and duration. More studies with larger samples, using additional measurements for level of engagement is challenging, but necessary.

Although findings from the current study suggest there are no statistically significant differences in graduate degree attainment for students who engaged junior year compared to senior year or for two years compared to one year, some research suggest that the level of engagement matters. Both faculty and students in Mancha and Yoder's (2014) qualitative study discussed the importance of having sufficient time for the research project. Although the majority of faculty and students in Mancha and Yoder's study discussed the importance of having enough time, measurements for the level of engagement are often limited to select groups of students in programs that take place during the summer or before the senior year (Hunter et al., 2007; Kardash, 2000; Seymour et al., 2004). While other studies lack any identification of the timing or

duration of the undergraduate research program (Hakim, 1998; Levis-Fitzgerald & Denson, 2005). Findings from studies that suggest there are statistically significant differences between different levels of engagement included more indicators for different levels of engagement.

For example, Carter, Mandell, and Maton (2009) measured on-campus, academic year research using three separate indicators: participation in a highly selective scholarship program aimed to increase STEM PhDs among underrepresented minorities; research course credits; and participation in an annual undergraduate research symposium. Their study also measured participation in research in summer (following freshman, sophomore, junior, and senior years). They found that participants who engaged in any form of on-campus, academic year research were significantly more likely than students who did not engage in on-campus, academic year research to pursue a STEM PhD. They conducted a series of probit regression models and found that students who engaged in a more intensive intervention were significantly more likely to pursue a PhD.

Similarly, Bauer and Bennett (2003) suggest that the duration of engagement in undergraduate research matters. They found that alumni who reported spending more time conducting undergraduate research (measured by semester), also reported higher levels of perceived benefit (measured using a 5-point scale, 1 = not at all important to 5 = extremely important). This study relies on alumni's self-reports, but it provides information regarding their perceived benefits of engagement in undergraduate research.

The faculty-student relationship and the interactions that occur through collaborating with other undergraduate and graduate students are key aspects of the undergraduate research experience (Craney et al., 2011). Scholars argue that such interactions are important because supportive environments that promote faculty-student interactions foster students' pursuits to obtain graduate degrees (Craney et al., 2011; Eagan et al., 2013; Guterman, 2007; Hathaway, Nagda, & Gregerman, 2002; Hearn, 1987; Russell, Hancock, & McCullough, 2007). Research suggests that social integration (involvement with peers and faculty) is a predictor of graduate school enrollment (Choy & Geis, 1997; Ethington & Smart, 1986; Hearn, 1987; Millett, 2003), but more research is needed to examine what this concept looks like in an undergraduate research context. The goal to increase the pool of graduate students among students who engage in undergraduate research requires further examination.

Both qualitative and quantitative studies are necessary to conceptualize and operationalize the quality and quantity of interactions that occur during the undergraduate research experience. A mixed method research approach may examine, "How frequently do undergraduate researchers interact with faculty and other students during the undergraduate research experience and what are the quality of such interactions?" This study may quantify the interactions by counting how many times students engage with faculty and students on a weekly basis through face-to-face encounters, team meetings, and electronic means. This study may also quantify the time spent on undergraduate research each week by tracking the number of hours students devote to undergraduate research. This study may help to explain the quality of interactions by describing the content of such interactions and the collaborations that

occur during the undergraduate research experience. Findings from the future study may inform research and practice by describing what faculty-student interactions look like at the qualitative level and aiding in the development of measures that serve as accurate indicators for different levels of engagement in undergraduate research.

There is mounting evidence regarding the benefits of undergraduate research, however, empirical evidence regarding the extent to which student sub-populations benefit the most is conflicting. While one perspective argues all students benefit from engagement (Kuh, Kinzie, Schuh, Whitt, & Associates, 2010) and interventions should target students early on (Lopatto, 2010), another perspective suggests that undergraduate research is better suited for undergraduates later in their programs (Taraban & Logue, 2012). Ishiyama (2002) explains that “very little work has been done on how early engagement in undergraduate research affects social science and humanities students” (p. 380). Although undergraduate research is expanding beyond the sciences, less is known about undergraduate research in the liberal arts and social sciences (Buckley, 2010; Taraban & Logue, 2012).

Future research may examine differences in engagement among undergraduate researchers in the soft and hard sciences. More specifically, a qualitative approach may answer, “What does the undergraduate research experience look like in the soft and hard sciences”? This approach may consist of focus groups, interviews, and observations with students and faculty from different academic disciplines to analyze the differences between daily tasks, the physical environment in which undergraduate research occurs, and the types of interactions that occur.

Limitations

It is challenging to find rigorous experimental or quasi-experimental research designs. This is a non-experimental study and there are limitations to the claims made from the findings. Non-experimental designs increase the likelihood of threats to external validity. In this study, the undergraduate research intervention already existed and the measurements rely on existing data. Therefore, the subset consisted of students were faculty selected and who chose to engage in undergraduate research. The findings from this study confirm that students who engage in undergraduate research are higher performing (academically) than their peers are, so the findings may generalize to a select population of students at the urban research university. There was no random selection and therefore no control group. This study used preexisting data to measure levels of engagement in undergraduate research.

This study did not measure all forms of undergraduate research. Many participants began conducting research with faculty through other means (i.e.; coursework and independent studies) and this study did not account for undergraduate research that occurred solely through academic coursework. Therefore, the dataset was not all-inclusive and did not account for engagement in research that occurred aside from the centralized effort. An ideal dataset would include more indicators for the level of engagement in undergraduate research. Such data would include the number of hours students engaged in undergraduate research each semester, whether students conducted research for pay or credit, and research focused coursework.

Additionally, there were limitations pertaining to the duration and degree attainment variables. The duration variable indicated if a student engaged in research at

any point in time during a given year. Information for this variable was collected on an annual basis (during the spring semester) and did not measure if students engaged in research during individual semesters or both semesters. This means that duration did not fully capture how many (full) years students engaged in research. Although this variable did not truly measure the number of years, it did indicate if students engaged in research during multiple years. More measures of the quality and quantity of faculty-student interactions are essential to analyzing the relationship between different levels of engagement and degree attainment.

The estimate of the coefficient of engagement in undergraduate research in the logistic regression model may be biased. This bias would be due to the exclusion of variables that may affect the likelihood of engagement in undergraduate research and the pursuit of a graduate degree. Information pertaining to parental level of education and Expected Family Contribution (level of financial need) may inform the knowledgebase regarding the impact of socio demographic variables.

The findings from this study applied to a population of students who engaged in undergraduate research at one urban research university. Although there were limitations, the information collected from the different sources was vital to describing and documenting student engagement in undergraduate research through a centralized effort and analyzing differences in graduate degree attainment. There is a need for more studies with different student populations and samples to investigate who engages in undergraduate research, the quality of the undergraduate research experience, and potential relationships between engagement in undergraduate research and students'

pursuits to attain graduate degrees, using systematically collected data that measures actual enrollment, not students' intentions to enroll.

This study was limited to participants who began undergraduate research through the centralized effort junior or senior year. A dataset with information for a larger subset of participants that includes participants who began engaging in research freshman and sophomore years would allow for a more in-depth analysis regarding the impact of timing. A larger subset that also includes more racial/ethnic minorities is essential to examining the impact of engagement between student sub-populations. The subset was limited to a small number of observations for non-White students.

The degree attainment variable was limited to whether a participant obtained a graduate degree. This variable did not measure if a participant enrolled in a graduate degree program. This dataset did not include student data beyond 2015, so a student may have obtained a graduate degree after this date. A study that consists of a lengthier timeframe is essential to including a larger subset.

Chapter Summary

Researchers have examined the relationship between graduate school enrollment and students' demographic and institutional characteristics, academic preparation and performance, and educational aspirations. Few studies have investigated the efficacy of undergraduate research interventions (Jones, Barlow, & Villarejo, 2010). It is not clear if students who engage in undergraduate research earlier on (freshman and sophomore year) benefit more than students who engage later on (Jones, Barlow, & Villarejo, 2010) as it relates to students' pursuits to attain advanced level degrees. The findings from the current study suggest that students who engage in

undergraduate research junior year are no more likely than students who engage in undergraduate research senior year to attain graduate degrees.

We know that graduate enrollment rates for different racial/ethnic groups and women are increasing by simply looking at the numbers, but research findings on engagement in undergraduate research by race/ethnicity are mixed, and both engagement and enrollment vary by type of academic program (Heller, 2001; Mattern & Radunzel, 2015; Millet, 2003; Nevill & Chen, 2007; Perna, 2004). Who engages in undergraduate research and the timing of engagement in undergraduate research are important factors to examine because some argue the students who are less likely to engage may gain the most (Einarson & Clarkberg, 2010; Ishiyama, 2002; Nagda et al., 1998). There must be more opportunities to engage students who have lower levels of academic performance in order to examine the impact undergraduate research has on such groups.

The question of whether the benefits of undergraduate research vary between academic disciplines is also an area of concern because the expansion of undergraduate research programs in the social sciences and other disciplines has broadened the undergraduate research learning environment to one that occurs in various settings (lab, classroom, and community-based) and academic disciplines (Craney et al., 2011). Findings from previous studies may not generalize to students at urban research universities where there are centralized efforts to engage students from different academic disciplines. This study addressed the gap in the literature by providing insight into student engagement in a centralized undergraduate research intervention at an urban research university located in the Midwestern United States.

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APPENDIX A:

Curriculum Vitae

EDUCATION

University of Wisconsin-Milwaukee (UWM)

PhD in Urban Education

Spring 2017

Master of Arts in Political Science

Bachelor of Arts in Journalism, Advertising and Media Studies

Awards, Scholarships & Skills

- Advanced Opportunity Program Fellowship
- Chancellor's Graduate Student Award
- Eric Sevareid Awards for Journalistic Excellence
- Jane Bradley Pettit Foundation Scholarship
- Latino Press Club Scholarship
- Skilled in Microsoft Office and statistical analysis software

Conference Presentations

- Presented research at Academy of Human Resource Development International Research Conference that evaluated group decision-making processes aimed to improve school performance
- Created over 75 research presentations for UWM's Undergraduate Research Symposiums in collaboration with students and faculty from different academic programs
- Guest panelist at the Urban Initiatives Conference to discuss student success in higher education and challenges college students face

PROFESSIONAL EXPERIENCE

Center for Urban Initiatives and Research (UWM)

Milwaukee, Wisconsin

2006-2014

Program Coordinator/Research Assistant

Program Planning, Development & Improvement

- Designed, implemented and managed an undergraduate research program that engaged more than 100 students in research in the community and served as a pathway for future work and education
- Recruited faculty and student cohorts from different academic programs to engage in yearlong collaborative projects with local schools, government, nonprofits and foundations
- Developed curriculum for professional development seminars and workshops
- Coordinated and scheduled meetings with faculty, students and community-based organizations
- Conducted student and faculty evaluations to increase program effectiveness

Leadership, Mentoring & Teaching

- Interviewed, selected, hired and trained more than 100 students
- Monitored student and faculty engagement in the program
- Facilitated professional development seminars and workshops tailored to diverse needs
- Provided supplemental counseling to enhance career readiness and improve student retention
- Taught research methods and statistics in applied settings using a high impact learning practice
- Conducted on-the-job training for individuals and groups in academic and community-based settings

Research & Evaluation

- Managed a wide range of research projects
- Conducted observations in schools to evaluate learning team cycles (with administrators, teachers & staff) aimed to improve school performance
- Facilitated focus groups and conducted interviews in public and private sectors – analyzed and interpreted results for oral and written presentations
- Administered a national school-based survey to assess health-risk behaviors among youth
- Developed a survey and interview questions in collaboration with a local municipality to investigate employment, competitiveness, business location and partnerships with postsecondary institutions
- Evaluated decision-making processes with different coalitions whose efforts aimed to formulate policy and advance community change – utilized a variety of research methods to examine and improve group effectiveness

Strategic Planning & Collaborative Partnerships

- Established and maintained effective partnerships with local governments, foundations, nonprofit organizations and schools
- Collaborated with public and private sectors to develop training curriculum for small business owners and employees
- Partnered with a local foundation to examine views of stakeholders about philanthropy, charitable giving interests and the foundation – assisted with efforts to develop regional action plan
- Coordinated and facilitated economic development efforts with businesses and government officials – scheduled and facilitated meetings, surveyed businesses, boards and local governments to aid in the development of a strategic roadmap aimed to impact policy

SITE Staffing Agency

Milwaukee, Wisconsin

1996-2006

Recruiter/Administrator

Management & Job Performance

- Collaborated with a team to achieve Top 500 Hispanic Business and placed approximately 10,000 people in technical, service, administrative, professional and manufacturing jobs
- Recruited potential hires and evaluated skill sets for potential jobs
- Monitored attendance and job performance
- Resolved human resource and logistical issues
- Created and maintained electronic files and databases used to organize and analyze information

Workforce Development

- Taught African American and Hispanic adult learners basic math and soft skills in a classroom setting
- Assessed employer needs, prepared potential employees to meet those needs and connected people with jobs in the region

COMMUNITY INVOLVEMENT

- Served as a volunteer at Wisconsin Women's Business Initiative Corporation, Pathfinders Luther Manor, and Guest House
- Partnered with a local workforce board to assess job readiness of workforce
- Member of Hispanic Professionals of Greater Milwaukee

APPENDIX B:

IRB Approval

Date: February 18, 2016

To: Larry Martin, PhD

Dept: School of Education

Cc: Sarah Aragon

IRB#: 16.239

Title: Undergraduate Research in an Urban Access Research University

After review of your research protocol by the University of Wisconsin – Milwaukee Institutional Review Board, your protocol has been granted Exempt Status under Category 1 as governed by 45CFR 46.101(b).

This protocol has been approved as exempt for three years and IRB approval will expire on February 17, 2019. If you plan to continue any research related activities (e.g., enrollment of subjects, study interventions, data analysis, etc.) past the date of IRB expiration, please respond to the IRB's status request that will be sent by email approximately two weeks before the expiration date. If the study is closed or completed before the IRB expiration date, you may notify the IRB by sending an email to irbinfo@uwm.edu with the study number and the status, so we can keep our study records accurate.

Any proposed changes to the protocol must be reviewed by the IRB before implementation, unless the change is specifically necessary to eliminate apparent immediate hazards to the subjects. The principal investigator is responsible for adhering to the policies and guidelines set forth by the UWM IRB, maintaining proper documentation of study records and promptly reporting to the IRB any adverse events which require reporting. The principal investigator is also responsible for ensuring that all study staff receive appropriate training in the ethical guidelines of conducting human subjects research.

As Principal Investigator, it is also your responsibility to adhere to UWM and UW System Policies, and any applicable state and federal laws governing activities which are independent of IRB review/approval (e.g., FERPA, Radiation Safety, UWM Data Security, UW System policy on Prizes, Awards and Gifts, state gambling laws, etc.). When conducting research at institutions outside of UWM, be sure to obtain permission and/or approval as required by their policies.

Contact the IRB office if you have any further questions. Thank you for your cooperation and best wishes for a successful project

Respectfully,

Melissa C. Spadanuda
IRB Manager