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Beyond Traditional Measures of Success in STEM: Predictors of STEM Bachelor's Degree Recipients' Values Toward Using Research and Sociopolitical Involvement to Promote a More Equitable Society

Author

Garibay, Juan

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Beyond Traditional Measures of Success in STEM:

Predictors of STEM Bachelor's Degree Recipients' Values Toward Using Research and Sociopolitical Involvement to Promote a More Equitable Society

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Education

by

Juan Carlos Garibay

2014

ABSTRACT OF THE DISSERTATION

Beyond Traditional Measures of Success in STEM:

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Sociopolitical Involvement to Promote a More Equitable Society

by

Juan Carlos Garibay

Doctor of Philosophy in Education

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Professor Mitchell J. Chang, Chair

Recent figures on the state of poverty within the U.S. and throughout the world suggest that even though advancements in science and technology (S&T) have had a tremendous impact on human capacity, the overall impact of S&T on creating a more equitable world remains limited. Despite the importance of preparing socially responsible graduates in science, technology, engineering, and mathematics (STEM) to address the current state of poverty and inequality, higher education research focused on STEM education has predominantly framed notions of student success with respect to the maintenance of U.S. global economic competitiveness, largely focusing on steering more students into the STEM disciplines and solely developing their STEM competencies to specifically fill workforce roles. The few studies that have examined the development of STEM students' outcomes critical to promoting a more equitable society have generally examined the impact of one program or course.

To address this gap in the literature, this study used frameworks of undergraduate socialization (Vreeland & Bidwell, 1966; Weidman, 1989, 1979) to examine the individual experiences and institutional contexts that affect STEM bachelor's degree recipients' development of two democratic educational outcomes seven years after college entry: social agency and values toward conducting research that will have a meaningful impact on underserved communities. In order to properly account for the nested structure of the data, this study employed multilevel modeling on a national sample of 6,341 STEM bachelor's degree recipients across 271 institutions. Longitudinal student data from the 2004 CIRP Freshman Survey and 2011 Post-Baccalaureate Survey was merged with institutional data from the Integrated Postsecondary Educational Data System and CIRP Faculty Surveys.

Various undergraduate socialization experiences and institutional contexts were found to influence STEM students' democratic educational outcomes, including academic majors, participation in student organizations and research, experiences with faculty, and peer and STEM faculty normative contexts. Findings suggest the importance of taking a comprehensive approach to supporting long-term student development by providing individual experiences and promoting institutional contexts that facilitate students' democratic educational outcomes. The findings have implications for curriculum and program development in STEM education to maximize the development of STEM students' values toward using research and sociopolitical involvement to promote a more equitable society.

The dissertation of Juan Carlos Garibay is approved.

Sylvia Hurtado

Mark Kevin Eagan

Paul M. Ong

Mitchell J. Chang, Committee Chair

University of California, Los Angeles

2014

DEDICATION

Para mi familia- pasado y presente, cuyas luchas sentaron las bases para hacerme creer que esto era posible, y futuro, para ayudarles a llegar aún mayores alturas.

For my family- past and present, whose struggles laid the groundwork for me to believe that this was possible, and future, to help them reach even greater heights.

Para mi comunidad de Wilmington y todas las Comunidades de Color, cuyas tierras y gente frecuentamente son sacrificados en nombre del desarollo económico y científico.

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VITA

2008	B.S., Applied Mathematics University of California, Los Angeles Los Angeles, California
2009	Coordinator of Student Internships & EJ Campaigns Coalition For a Safe Environment Wilmington, California
2009	Teaching Assistant Los Angeles Harbor Community College Wilmington, California
2009-2013	Research Analyst Higher Education Research Institute University of California, Los Angeles Los Angeles, California
2010	M.A., Education University of California, Los Angeles Los Angeles, California
2010-2011	Graduate Student Volunteer University of California Center for New Racial Studies University of California, Santa Barbara Santa Barbara, California
2013	Teaching Assistant Department of Education University of California, Los Angeles Los Angeles, California
2013	Faculty Award Higher Education & Organizational Change University of California, Los Angeles Los Angeles, California
2013-2014	Research Analyst Office of Faculty Diversity & Development University of California, Los Angeles Los Angeles, California

PUBLICATIONS AND PRESENTATIONS

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CHAPTER 1: INTRODUCTION

Background

Not many will dispute the enormous impact scientific and technological development has had on parameters of the human condition, including increased standards of living, life expectancy, health care, among many others. Despite tremendous growth in new technologies and advances in science over the last several decades, however, severe poverty and inequities remain throughout the world. The United Nations (2011) estimates that in the developing world 1.4 billion people live in extreme poverty, 2.6 billion people still lack adequate sanitation, 828 million urban residents live in slum conditions, 837 million people are undernourished, and 884 million people lack access to clean water. In the U.S., 46.2 million Americans were reported living in poverty in 2011 – the highest point in U.S. history (DeNavas-Walt, Proctor, & Smith, 2012) – and many Americans still lack access to healthy and affordable food (Baker, Schootman, Barnidge, & Kelly, 2006; Walker, Keane, & Burke, 2010) as well as safe water and adequate sanitation (UN News Centre, 2011). Additionally, it must be noted that poverty and inequities continue to disproportionately impact minorities and indigenous groups both around the world (Ali Khan, 2010) and in the U.S. (Bakers et al., 2006; DeNavas-Walt, Proctor, & Smith, 2012; UN News Centre, 2011; Walker et al., 2010). These figures suggest that while advancements in science and technology have had a profound impact on human capacity, the overall impact of science and technology on creating a more equitable society remains limited.

Two common explanations for the limited impact of science and technology on social progress and equity emerge in the literature. On the one hand, research shows that the benefits of science have been uneven and exclusive. For example, many communities and populations continue to have unequal access to medical care (National Center for Health Statistics, 2012; U.S. Department of Health and Human Services, 2012) and digital technologies (Pew Research Center, 2011), while their needs have also been under-researched (Institute of Medicine, 1999). On the other hand, research has shown that science and technology, while capable of having progressive advancements for society, have often been used in socially and environmentally regressive ways, which has created and perpetuated many inequalities (Hammonds & Herzig, 2008; Harding, 1993, 2006). Many scholars contend that in order to improve the impact of science and technology on equity and the human good, higher education must develop science, technology, engineering, and mathematics (STEM) students' democratic educational outcomes (e.g., Lima, 2000; Holdren, 2008; Vaz, 2005), which include the attitudes, knowledge, and skills that prepare college students for meaningful participation in a pluralistic and diverse democracy (Gurin, Dey, Hurtado, & Gurin, 2002; Hurtado, 2003). As eventual actors in the creation and implementation of science and technology in helping to solve pressing societal issues, many of which transcend national boundaries and require global solidarity (Serageldin, 2002), it is critical that STEM graduates be better trained to be socially responsible and equality-oriented decision-makers if science and technology is to improve its impact on the welfare for all.

Statement of the Problem

While many agree that science and technology can and should play an integral role in addressing challenges for human rights, much of the mainstream discourse in the U.S. on the purpose of STEM education is centered on the need to maintain U.S. global economic competitiveness. Deriving from various policy reports including the 2007 report titled *Rising Above the Gathering Storm*, which suggests the U.S. is not keeping pace with other countries in terms of STEM academic preparation and the production of STEM degrees, many argue that we need to steer more students into STEM fields to specifically fill workforce roles and address corporate needs. Without a more scientifically- and technically-oriented workforce, it is suggested, how can the U.S. continue to dominate the world economically through scientific innovation?

Defining the maintenance of economic competitiveness as the purpose of STEM education allows corporate interests to dictate the goals of STEM education (Gutstein, 2006). By centering the economic competitiveness rationale in STEM education research, scholars may perpetuate a culture within STEM education that has been described as fostering individualism and exclusivity (Pawley, 2009; Seymour & Hewitt, 1997), lacking concern for the development of students' social responsibility (Beckwidth & Huang, 2005; Ramsey, 1993), and more closely aligned with the culture of White middle class men (Johnson, 2007). Furthermore, many of these calls for maintaining economic competitiveness grossly ignore the current state of poverty throughout the world and leave unexamined how STEM education can support hegemonic ideologies of society (Anderson, 1997; Bishop, 1990; Frankenstein, 1983; Gutstein, 2006). If advancements in science and technology are to improve humanity, we must express caution in the U.S. global economic competitiveness rationale because it may, as Newman (2011) states, "propogat[e] a nationalistic and colonialist rhetoric, which may focus on domination and continued subordination of 'third world' countries and peoples of color" (p. 6).

In fact, the literature analyzing the preparation and training of STEM students reveals that STEM academic departments rarely focus on developing students' democratic educational outcomes. Vreeland and Bidwell's (1966) early study on academic departments classified STEM disciplines as heavily endorsing the technical goals of education as opposed to developing students' morals, values, or attitudes. Despite being published nearly half a century ago, recent studies on STEM education suggest that Vreeland and Bidwell's (1966) findings are still pertinent today.

According to Beckwidth and Huang (2005), "few students of science receive as an integral part of their scientific education an analysis of the social impact of science and rarely is there any mention of social responsibility" (pp. 1479-1480). Nicholls et al. (2007) found that students who pursue STEM majors tend to have lower civic and multicultural dispositions than their non-STEM peers. Likewise, undergraduate STEM students are more likely to report that working for social change is less important to their career goals than non-STEM students, and majoring in a STEM field corresponds with lower social agency, or the belief that it is important to be active in the community and take action toward improving society, at the end of college (Garibay, under review). Similar findings have also been shown for engineering majors (e.g., Astin, 1993a; Sax, 2000) and health professional students (e.g., Crandall, Volk, & Cacy, 1997; Crandall, Volk, & Loemker, 1993; White-Means, Dong, Hufstader, & Brown, 2010; Wieland et al., 2010), specifically. These studies have identified important limitations in the preparation of STEM students with respect to democratic educational outcomes, however, lack an examination of the specific factors that may positively contribute to STEM students' democratic educational outcomes.

Despite the importance of understanding how STEM education may develop students' democratic outcomes, higher education research in STEM education has predominantly focused on the factors that influence STEM students' science and math learning, persistence, retention, degree completion, and other traditional measures of academic success. These studies are critical to better understand the experiences and contexts that help students achieve success within STEM disciplines. However, by solely focusing on traditional measures of academic success this body of literature does not address the importance of developing future leaders in STEM fields who are committed to working toward a more democratic society. Thus, while various experiences and contexts have been shown to positively relate to academic success within STEM disciplines, much is still unknown about how many of these factors may influence STEM students' democratic educational outcomes.

Finally, one body of higher education literature has focused on specific practices and programs being implemented in STEM departments to promote students' social and civic responsibility. This research has largely focused on one program or course (e.g., service-learning, science and society courses) and tends to be small in scope (e.g., within one or a few institutions) (e.g., Baillie, Pawley, & Riley, 2011; Brown, Heaton, & Wall, 2007; Gadbury-Amyot, Simmer-Beck, McCunniff, & Williams, 2006; Jordan, 2006; Lima, 2000; Ritter-Smith & Saltmarsh, 1998; Ropers-huilman, Carwile, Lima, 2005; Vaz, 2005). Moreover, these studies have measured student democratic outcomes solely at the end of the course or educational program. This body of literature provides an important foundation for understanding what types of education reforms STEM departments are implementing to try to develop STEM students' democratic outcomes, yet under-examine additional college experiences and contexts that may influence STEM students' democratic educational outcomes, especially over the long-term.

These bodies of literature demonstrate that although there is broad agreement in the need to prepare STEM students who are socially responsible citizens, there is considerable lack of clarity on the various college experiences and contexts that may develop STEM students' democratic educational outcomes. This study seeks to fill this gap in the literature and inform recent calls for democratic educational goals in STEM education (e.g., Anderson, Cohen, Hallock, Kassebaum, Turnbull, & Whitcomb, 1999; Committee on Public Understanding of

Engineering Messages, 2008; Holdren, 2008, Ritter-Smith, 1998; Vaz, 2005) by examining a national longitudinal sample of STEM bachelor's degree recipients between their freshman year of college and seven years after college entry. This study investigated the influence of undergraduate experiences and contexts on students' (1) social agency and (2) attitudes toward conducting research that will have a meaningful impact on underserved communities, both measured seven years after college entry.

Purpose of the Study

Given that prior research has identified the limitations of STEM education with respect to the development of STEM students' democratic outcomes, empirical research on the educational experiences and contexts that may promote STEM students' democratic outcomes is critical. Despite recent calls for developing students' democratic outcomes in STEM education, there is a dearth of empirical evidence on what college experiences and contexts may help develop STEM students' democratic outcomes, especially over the long-term. Such calls require higher education researchers to broaden research objectives from primarily focusing on traditional measures of academic success in STEM. In order to help inform STEM educational policy and practice, this study explores the impact of college on two democratic outcomes of STEM bachelor's degree recipients seven years after college entry.

First, this study examines the college experiences and institutional contexts that predict the social agency, or the belief that it is important to be active in the community and take action toward improving society, of STEM bachelor's degree recipients seven years after college entry. Second, this study investigates the undergraduate experiences and institutional-level variables that promote or inhibit STEM bachelor's degree recipients' attitudes toward conducting research that will have a meaningful impact on underserved communities seven years after college entry.

In this study, these two educational outcomes are considered democratic outcomes given that both assess the level of importance students place on helping to create a more democratic society through community involvement and research, respectively.

Research Questions

This study is guided by the following general research questions:

1. What undergraduate experiences and institutional contexts contribute to the social agency of STEM bachelor's degree recipients seven years after college entry?
2. What undergraduate experiences and institutional contexts contribute to the level of importance STEM bachelor's degree recipients place toward conducting research that will have a meaningful impact on underserved communities seven years after college entry?

Scope of the Study

This study utilizes merged data from several national databases including longitudinal student data from the 2004 Cooperative Institutional Research Program's (CIRP) Freshman Survey and the 2011 Post-Baccalaureate Survey (PBS), and institutional data from the Integrated Postsecondary Educational Data System (IPEDS) and the 2007 and 2010 CIRP Faculty Surveys. The CIRP is the nation's oldest and largest national longitudinal study of college students, and is administered by the UCLA Higher Education Research Institute (HERI). The TFS survey was administered in the fall of 2004 to entering freshmen and collected information about students' background characteristics, precollege experiences and achievement, expectations for college, attitudes, values, and future educational and career goals.

HERI longitudinal data was supported by grants from the National Science Foundation (0757076) and the National Institutes of Health (R01 GMO71968-05 and 1 R01 GMO71968-01), which allowed for the recruitment of colleges known for graduating large numbers of undergraduate students with STEM degrees as well as Minority Serving Institutions (MSIs) that normally do not collect longitudinal data on their students. In 2011, HERI researchers followed up with students seven years after college entry to learn more about their specific educational and career pathways using the PBS instrument. The 2011 PBS also gathered information about participants' undergraduate experiences, perceptions, and posttest data on many of the attitudinal and behavioral items collected on the 2004 TFS.

The dataset for this study includes 6,341 STEM bachelor's degree completers starting out at 271 non-profit four-year undergraduate institutions to help examine how undergraduate experiences and institutional contexts influence STEM bachelor's degree recipients' social agency and research values measured seven years after college entry. This study utilizes multilevel modeling given the continuous nature of the dependent variables and the clustered, multilevel nature of the data (i.e., students nested within institutions) (Raudenbush & Bryk, 2002). Robust statistical techniques, such as hierarchical linear modeling (HLM) are necessary to account for the complexity of the sample design and provide better estimates for the standard errors of the parameters (Raudenbush & Bryk, 2002).

Significance of the Study

The significance of this study lies within the current context of STEM education reform and national calls for preparing future leaders in STEM to improve the impact of science and technology on humanity (e.g., Holdren, 2008; Vaz, 2005). In 2004, the Accreditation Board for Engineering and Technology (ABET) established new education standards requiring that students learn about contemporary issues and the impact of engineering solutions in a global and societal context (Vaz, 2005). Since then, goals of "social relevance" and "making a difference" have also emerged in engineering education (Committee on Public Understanding of Engineering Messages, 2008). While various STEM disciplines seek to promote these student outcomes (e.g., Middlecamp, Jordan, Shachter, Lottridge, & Oates, 2006; Jordan, 2006), there is a dearth of literature focused on investigating the college experiences and contexts that promote STEM students' democratic educational outcomes.

Most higher education research focused on students in the STEM fields tends to examine the effects of various support programs, college experiences, and classroom or institutional structures on traditional measures of success (i.e., scores on standardized exams, grades, retention, degree completion, etc.). Although retention and degree completion in STEM are important indicators of student success, these measures do not fully capture how higher education institutions are preparing STEM students for participation in democracy and to work for the betterment of society. Improving the impact of science and technology on the human good requires a more comprehensive examination of the impact of college on STEM students' democratic educational outcomes.

This study's methodological approach utilizing multilevel modeling on a national longitudinal dataset contributes to the emerging literature on STEM education and democratic outcomes. In terms of analyses, previous higher education studies have utilized descriptive and simple inferential statistics (e.g., Brown et al., 2007; Crandall, Davis, Broeseker, & Hildebrandt, 2008; Crandall, Volk, & Cacy, 1997; Crandall, Volk, & Loemker, 1993; Gadbury-Amyot et al., 2006; Lima, 2000), correlations or multivariate analyses (e.g., Astin, 1993; Sax, 2000), or a combination of basic inferential statistics with qualitative analyses (e.g., Rubin, 2004) to examine the development of STEM students' democratic outcomes. In terms of scope, previous research has primarily examined students within one (e.g., Crandall, Volk, & Cacy, 1997; Crandall, Volk, & Loemker, 1993) or few institutions (e.g., Crandall, Davis, Broeseker, & Hildebrandt, 2008; Wieland et al., 2010), or documented the impact of one program or course usually within one school (e.g., Brown et al., 2007; Gadbury-Amyot et al., 2006; Rubin, 2004; Tsang, 2000; Vaz, 2005). The sample of 6,341 STEM bachelor's degree recipients beginning their postsecondary education at 271 institutions provided a large scope for the examination of democratic outcomes using multilevel modeling to properly account for the multilevel nature of the data.

In addition, this study contributes to the STEM education literature by examining the democratic outcomes of STEM bachelor's degree recipients seven years after college entry, or roughly 2-3 years after students completed their undergraduate STEM degree. By examining democratic outcomes seven years after college entry, this study provides a better understanding of the long-term impact of undergraduate experiences and contexts on students' social agency several years after college. Previous studies on STEM students have primarily focused on the short-term impact of educational experiences and contexts by measuring democratic outcomes immediately after a program of interest or at the end of college (e.g., Brown et al., 2007; Gadbury-Amyot et al., 2006; Lima, 2000 Rubin, 2004; Tsang, 2000). Likewise, this study extends the general higher education literature on the long-term impact of college on democratic outcomes as previous research on the impact of undergraduate experiences and contexts on democratic outcomes has primarily used outcomes measured at the end of a course semester or senior-year of college (e.g., Astin, 1993; Astin, Vogelgesang, Ikeda, & Yee, 2000; Chang, 2002; Gurin, Dey, Hurtado, & Gurin, 2002; Hurtado, 2003; Milem, 1994; Nelson Laird, 2005; Sax, 2000).

Furthermore, this study provides a foundation for future research on the development of social agency and research values for students in STEM disciplines, including separate studies for students in the various academic majors within STEM and how other democratic educational outcomes may vary across departmental and institutional contexts. Additionally, given that this study measures democratic outcomes roughly 2-3 years after college, while many students are in the workforce or in graduate school, this study provides an important foundation for future research interested in exploring the sources and contexts that helped agents of change in the STEM fields develop a critical consciousness. Other studies may also examine how STEM students organize around social issues and to democratize the positive impact of science, whether it is more difficult for students within certain STEM academic majors to organize around these issues and why, and how STEM departments support students during this process.

Finally, this study provides an important foundation for researchers interested in utilizing critical STEM education perspectives within higher education contexts. Previous critical STEM education research has highlighted the significance and development of these outcomes for low-income students and Students of Color (SOC) specifically within middle school and high school contexts (e.g., Barton, 2001, 2003; Frankenstein, 1983; Gutstein, 2003, 2006; Roth & Barton, 2004; Secada, 1995). Using African American notions of education for liberation (e.g., Du Bois, 1935; Ladson-Billings, 1995; Murrell, 1997; Perry, 2003; Provenzo, 2002), these scholars contend that developing the transformative potential of SOC and low-income students to use their STEM knowledge to critique and rectify structural inequities is particularly important as a process of liberation. Given the limitations of STEM college education in developing students' democratic outcomes and the underrepresentation of SOC in the STEM fields, it is of great import to extend critical STEM education perspectives into higher education research as well. Future research may examine notions of empowerment for SOC within STEM undergraduate and graduate contexts, whether STEM academic departments support SOC in this process, and the impact of STEM-related race/ethnic student organizations (e.g., Black Society for Engineers, Chicanos for Community Medicine, etc.) on the empowerment of SOC. This study examines a broad range of experiences and contexts in order to provide a strong foundation for such research.

CHAPTER 2: REVIEW OF LITERATURE AND THEORY

This chapter provides an overview of current notions of student success in STEM education, presents the theoretical frameworks of undergraduate student socialization that guide the study, and discusses existing literature on STEM undergraduate education and student experiences in STEM. First, this chapter draws attention to how student success has traditionally been defined within the STEM education literature and how definitions of STEM student success have been expanded to include democratic outcomes. Then, the chapter presents how theories of undergraduate socialization help inform this research study on the development of STEM undergraduate students' democratic outcomes. Finally, the chapter discusses existing literature on types of environments students often encounter in STEM and various practices typical within STEM educational contexts, and highlights gaps in the literature on the subject of democratic outcomes in STEM undergraduate education.

Perspectives on Student Success in Science, Technology, Engineering, and Mathematics

The next subsections will present various perspectives on how student success is defined in STEM education. First, I will discuss how student success is predominantly defined in the STEM education literature and how solely focusing on these educational outcomes limits the potential of STEM education to prepare students for participation in creating a more democratic society. Then, I will present alternative perspectives on student success that focus on students' democratic outcomes.

Traditional Notions of Success in STEM: Academic Achievement and Degree Attainment

The array of societal and economic benefits emerging from science and technological (S&T) development situates STEM education as a U.S. national priority (Obama, 2010). According to many policy reports and scholars, the U.S. is in dire need of a more scientifically- and technically-oriented workforce not only to fill private and public sector needs, but also to maintain U.S. global economic competitiveness and global leadership in S&T development. Despite the fact that the U.S. accounts for one-fourth of the world's economic output and is likely to remain the world's strongest economy for decades (Nye, Jr., 2010), many fear that as several nations begin to gain ground or even surpass the U.S. in STEM degree production, the U.S. faces an imminent threat to national prosperity. Such economic-centered perspectives have largely framed the purpose of STEM education and definitions of STEM student success to focus on steering more students into the STEM disciplines and solely developing their STEM capacities to specifically fill workforce roles.

The STEM education literature mostly considers students' STEM proficiencies and degree attainment as the ultimate measures of STEM student success (e.g., National Academy of Engineering [NAE], 2005; National Academy of Sciences [NAS], 2007; National Science Board [NSB], 2004; President's Council of Advisors on Science and Technology [PCAST], 2012). In addition to the emphasis given to STEM proficiency and degree attainment, a vast body of research in STEM education has focused on the factors that influence STEM students' grades, self-efficacy, persistence, and retention as these measures are critical toward progressing towards degree attainment goals (e.g., Daempfle, 2002; Harris, Bransford, & Brophy, 2002; Hilton & Lee, 1988; Hutchison, Follman, Sumpter, & Bodner, 2006; Hutchison-Green, Follman, & Bodner, 2008; Maltese & Tai, 2010; Marra, Rodgers, Shen, & Bogue, 2012; Ro, 2011; Vogt, 2008). Many STEM reform models and efforts in the precollege and undergraduate literature are also primarily focused on increasing students' chances towards ultimately completing a STEM degree (e.g., National Science Resources Center [NSRC], 2007; PCAST, 2012).

Similarly, others have focused on post-college pipeline measures as indicators of student success, including aspirations and matriculation into STEM graduate programs and STEM careers (e.g., Felder, Felder, & Dietz, 1998; Felder, Felder, Mauney, Hamrin, Dietz, 1995; Hearn, 1987; Mau, 2003). These measures, as with degree attainment, confer benefits to the individual and society. Earning a bachelor's and/or graduate degree provides economic and social returns to an individual through employment and other means. Additionally, having more employed STEM graduates can generate societal benefits that come with S&T innovation (PCAST, 2012), as well as revenue from taxes and expenditures that fuel the economy (Carnevale & Fry, 2000).

In addition to retaining students in STEM pathways both during and after college, many scholars articulate the need to develop additional skills in STEM education, including effective communication skills, problem-solving skills, and students' ability to work collaboratively (e.g., Dannels, Anson, Bullard, & Peretti, 2003; National Science Foundation [NSF], 1996; Heller, Keith, & Anderson, 1992; Humphris & Kaney, 2001; Mestre, Dufresne, Gerace, Hardiman, & Touger, 1993; Norman, 1988; Sageev & Romanowski, 2001). While these skills are important for all students, including those who intend to use their STEM degrees to help create a more democratic society, scholars often frame the need to develop these additional skills in individualistic and dominance-oriented ways. Some argue that these skills are necessary in order to increase students' competitiveness, ensure their success in a global economy, and maintain

U.S. global economic competitiveness (e.g., Sageev & Romanowski, 2001; Stine & Matthews, 2009).

Diversifying the STEM Population: Goals of Equity Within STEM. An additional body of literature has examined these traditional measures of student success, but – unlike in the studies cited above – these scholars have specifically focused on the needs of underrepresented students and center equity within STEM education as a main goal of their work. These studies have primarily focused on the college experiences and institutional factors that influence and contribute to the academic success of Students of Color and women in the STEM fields, specifically (e.g., Barlow, & Villarejo, 2004; Carlone & Johnson, 2007; Chang, Cerna, Han, & Saenz, 2008; Chang, Eagan, Lin, Hurtado, 2011; Cole & Espinoza, 2008; Crisp, Nora, Taggart, 2009; Eagan, 2010; Eagan, Hurtado, Chang, Garcia, Herrera, Garibay, 2013; Ellington, 2006; Espinosa, 2011; Fries-Britt, Younger, Hall, 2010; Harper & Newman, 2010; Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009; Hurtado, Chang, Saenz, Espinosa, Cabrera, & Cerna, 2007; Johnson, 2007a, 2007b; Jones, Barlow, Villarejo, 2010; May & Chubin, 2003; Museus, Palmer, Davis, & Maramba, 2011; Ong, Wright, Espinosa, & Orfield, 2011; Palmer, Maramba & Dancy, 2011; Perna, 2004; Perna, Gasman, Gary, Lundy-Wagner, & Drezner, 2010; Sax, 2001; Seymour & Hewitt, 1997; Slovacek, Whittinghill, Flenoury, & Wiseman, 2012; Strayhorn, 2010; Tobias, 1990). This significant body of research has shed light on the specific racialized and gendered experiences of Students of Color and women in STEM fields and how departments and institutions support or inhibit their success to debunk stereotypical and erroneous explanations for their underrepresentation. This literature provides an important foundation to develop new theories and models for academic success that are specifically tailored to the needs and realities of these student populations (Harper & Newman, 2010).

While equity *within* STEM has become a national focus, many scholars argue that the status of African American, Latino, American Indians, and poor students is not a primary determinant driving education reform in the STEM fields as increasing the participation of these student populations is largely framed from the perspective of maintaining U.S. economic competitiveness (Martin, 2003; Gutstein, 2006; Secada, 1989a, 1989b). Major policy reports from the leading national STEM associations have bounded equity to economic competition (e.g., American Association for the Advancement of Science [AAAS], 2001; NAS, 2007, 2011), and signal what Secada (1989b) calls "enlightened self-interest." According to Gutstein (2003), "to discuss equity from the perspective of U.S. economic competition is to diminish its moral imperative and urgency" (p. 38). Garibay (2012) argued that bounding equity to economic competitiveness is problematic in several ways: (1) it narrows the socialization process to one that is focused on simply developing more productive workers and the needs of capital, (2) perpetuates a culture within STEM that often pressures Students of Color to negotiate away important aspects of their identity (which may ultimately limit goals of equity within STEM), and (3) doesn't express the need to develop students' democratic outcomes (which is critical given that modern Western sciences have often been used in socially and environmentally regressive ways) (Garibay, 2012). Additionally, Garibay (2012) poses the critical question: with many corporations looking to maintain economic dominance by expanding into new and untapped global markets, what then becomes the role of students of color in STEM fields?

Goals of equity within STEM fields can provide important steps toward creating a more democratic society. However, confining equity in an economic competitiveness discourse is shortsighted and problematic especially when many Students of Color have themselves experienced oppression, may actually emerge from or have familial connections in disenfranchised nations, and may view their purpose for majoring in STEM as a means to create a more democratic world (Garibay, 2012). Also, increasing the economic growth within a country does not necessarily lead to an increase in the living conditions of all people within that country. The World Health Organization (2008) notes: "without equitable distribution of benefits, national growth can even exacerbate [health] inequities."

Broadening Notions of Success in STEM Education

Despite the various benefits that come with STEM degree attainment, STEM proficiencies, and retention in STEM pathways after college, solely defining these key measures as indicative of student success limits the focus of STEM education to only one of the many purposes of higher education. In particular, these forms of success in higher education do not necessarily tap into the depth of learning or quality of the college experience for students (Cuellar, 2012). Additionally, these traditional measures of success do not address the importance of developing future leaders in STEM fields who are committed to creating a more democratic society, and thus largely ignore the current state of poverty throughout the world nor do they critique how prioritizing capital's needs in STEM education can easily serve to reproduce the dominant social order (Frankenstein, 1983; Gutstein, 2006).

Democratic Outcomes: Goals of Equity Within and Beyond STEM. Critical and social justice perspectives in STEM education have advocated for a more comprehensive definition of STEM student success (e.g., Baillie, Pawley, & Riley, 2011; Frankenstein, 1989, 1990, 1994, 1995, 2009; Powell & Brantlinger, 2008; Skovmose, 1994, 1998a, 1998b; Gutstein, 2003, 2006; Vaz, 2005). These scholars articulate the need to include democratic outcomes in STEM student success given the current state of poverty throughout the world and since science and technology can be and has been utilized to harm others, perpetuate social inequalities, and destroy the natural environment (Harding, 2006; Holdren, 2008; Lima, 2000; Vaz, 2005). Additionally, many critical STEM scholars whose research is focused on Students of Color and low-income students in middle school and high school contexts stress the importance of centering the realities and needs of marginalized groups within STEM education and developing these students' transformative potential to improve the conditions of their lives (e.g., Barton, 2001, 2003; Frankenstein, 1983; Gutstein, 2006; Martin, 2003). Grounded on Freireian and African American notions of education for liberation (e.g., Du Bois, 1935; Ladson-Billings, 1995; Murrell, 1997), these scholars express the need to move beyond traditional, practical skills-focused approaches to STEM teaching and learning toward developing students' agency and critical consciousness in hopes to empower them to critique and positively change their world using science and mathematics.

Gutstein's (2006) framework for understanding mathematics education for social justice provides a helpful tool for educators interested in not only helping low-income Students of Color succeed academically in STEM fields, but also in developing their transformative power to rectify structural inequalities (see Figure 2.1). His framework describes two sets of pedagogical goals: (1) one focused on mathematics – where student learning, success on exams and in courses, and having a higher orientation to mathematics are necessary to equitably gain access to advance mathematics and mathematically-related careers, and (2) one focused on social justice – where students use mathematics to understand and deconstruct relations of power, inequities, disparate opportunities, and discrimination (reading the world with mathematics); use mathematics to change the world (writing the world with mathematics); and develop positive cultural and social identities.

Figure 2.1. Gutstein's (2006) Goals for Student Learning in Teaching Math for Social Justice

Teaching Mathematics for Social Justice	
Social Justice Pedagogical Goals	**Mathematics Pedagogical Goals**
Reading the world with mathematics	Reading the mathematical word
Writing the world with mathematics	Succeeding academically in the traditional sense
Develop Positive Cultural/Social Identities	Changing one's orientation to mathematics

Within the higher education literature, several scholars have articulated the need to develop democratic outcomes in STEM education (e.g., Astin, 1993b; Baillie et al., 2011; Jordan, 2006; Lima, 2000; Vaz, 2005). In order to prepare students to tackle the science, engineering, and technological challenges of the 21st century and have a positive impact on social well-being, many STEM educators recognize the importance of developing a different set of competencies than traditional measures of success that include perspective-taking and understanding of social issues (Baillie et al., 2011). Other scholars have focused on additional democratic student outcomes such as civic and social responsibility, civic awareness, and civic engagement (e.g., Jordan, 2006; Lima, 2000; Vaz, 2005).

Overall, such efforts to redefine and broaden notions of student success in STEM education have prompted STEM education scholars and practitioners to reflect on and examine the ways in which the STEM education community values a particular set of educational outcomes (while marginalizing others) and to challenge the dominant view that STEM fields are objective and value-free disciplines (Apple, 1992/1999; Atweh & Brady, 2009; Burton, 2003; Gutierrez, 2010; Martin, 2003; Mellin-Olson, 1987; Tate & Rousseau, 2002). These perspectives have stressed the importance of exploring the ways STEM education can better train students for participation in democracy and help create a better world. Additionally, these efforts have pressed scholars, educators, and practitioners to not only center equity in policy debates about

STEM education (given the underrepresentation of Students of Color in STEM and the marginalization of their voices in these debates), but to also expand equity issues from focusing solely on equity as a goal within STEM education to also include goals of equity *and* eliminating inequity *beyond* STEM (Burton, 2003; Gutierrez, 2002; Gutstein, 2006; Martin, 2003; Tate, 1995).

Martin (2003) notes:

> "Ensuring that marginalized students gain access to quality curriculum and teaching, experience equitable treatment, and achieve at high levels should mark the *beginning* of equity efforts, not the end. If these students are not able to use mathematics knowledge in liberatory ways to change and improve the conditions of their lives outside of school, they will continue to be marginalized… Underrepresented students may experience equal access to mathematics, have equal learning opportunities, and quantitative data could show equal outcomes. However, these students may still be disempowered if they are not able to use mathematics to alter the power relations and structural barriers that continually work against their progress in life" (p. 13-15).

While Gutstein's (2006) goals for teaching and learning math for social justice serve as an important framework to expand definitions of student success to include democratic outcomes, this frameworks does not expand into undergraduate education and consider how college experiences and contexts may influence the development of these important outcomes. Martin's (2003) concept of *mathematics socialization* focuses on the experiences that individuals and groups have within a variety of mathematical contexts, including school and the workplace, and that legitimize or inhibit meaningful participation in mathematics, yet primarily focuses on equity outcomes within mathematics. In order to better understand how STEM students' democratic educational outcomes may develop during their undergraduate years the next sections describe how scholars have theorized undergraduate student socialization.

Undergraduate Student Socialization Theory

Weidman's (1989) model of undergraduate socialization offers an important framework for understanding the influence of various factors on college student outcomes. This framework takes into consideration a student's background, the normative influences (both formal and informal) of the academic and social contexts of the college, and the mediating impacts of off-campus normative groups (i.e. parents, peers). Weidman posits that while the college environment plays a significant role in student socialization, the values, goals, and other student characteristics that students enter college with set the stage for development. Thus, Weidman's framework (1989) helps shed light on how students may negotiate their own democratic values and predispositions with the social and institutional contexts they encounter in college and how students' background characteristics continues to play an important role during their undergraduate development.

As students enter into the college environment, they encounter various socialization forces that may influence the development of their democratic outcomes. These socialization forces vary in type and in impact depending on individual and contextual factors. While navigating their particular college environment, students balance both contextual factors with their personal values as they develop a sense of personal and social equilibrium (Weidman, 1989). In the adjustment and socialization process within their particular environment, students may be affected by and adapt to the norms of that social structure. Interactions with others within the various college environments play an important role in shaping the experiences students have and outcomes they attain (Weidman, 1989).

In college, two major agents of socialization are professors and peers (Feldman & Newcomb, 1969; Weidman, 1989). Interactions with faculty and other students are likely to exert some form of influence on the development of students' educational outcomes and value systems, especially as students' relationships with those individuals or groups strengthen (Weidman, 1989). According to Weidman (1989), students compare themselves to their peers as well as their expectations to the expectations of their role models, which may pressure students to reconsider their beliefs, values, and statuses. Given professors' role in imparting knowledge to students, faculty may represent the primary agents of socialization with higher education institutions and thus may influence a variety of student outcomes (Feldman & Newcomb, 1969), including students' social agency and values toward conducting research that will have a meaningful impact on underserved communities. Weidman suggests that the quantity, strengths, and types of interactions in which students engage are critical in the socialization of undergraduates.

Weidman's (1989) model of undergraduate socialization specifies that not only are a student's life experiences and individuals one interacts with important sources of socialization, but organizational environments and structures are also influential in this process. By including characteristics of the institution in his model, Weidman posits that students are also socialized by the structural forces they encounter within an institution. Weidman (1989) notes, "just as students differ in their patterns of interaction and personal orientations upon entrance, colleges differ in their structuring, intentionally or not, of both normative contexts such as student residences and classrooms, and of opportunities for social interaction among college students, faculty, and staff" (p. 298). Thus, structural characteristics of an institution shape students' experiences in college and impact various student outcomes.

While Weidman's (1989) model of undergraduate socialization provides an important foundation for understanding the wide range of socialization forces within and beyond institutions of higher education, including on- and off-campus normative groups, institutional structures, and college experiences, this study's specific focus on STEM undergraduate education necessitates a more focused understanding of undergraduate socialization within academic majors. A student's major becomes a significant part of the academic normative context as students take the majority of their college courses within their specific major. Indeed, Weidman's (1989) model places an additional emphasis on the interpersonal relationships within a student's academic major. These contexts within an academic department can play a critical role in student success. For example, in their study on women in STEM, Sonnert, Fox, and Adkins (2007) conclude, "the level of [women among the professoriate in] individual [STEM] fields and departments appears to matter much more than the level of the whole institution" (p. 1352). In order to better understand how STEM students' democratic values may develop within STEM contexts, the next subsection presents frameworks of undergraduate socialization within academic departments by Vreeland and Bidwell (1966) and Weidman (1979).

Undergraduate Socialization Within Academic Departments

A student's academic major is an important normative reference point given that she or he takes more courses in the major than in any other field and becomes exposed to the culture and values of the department through her or his interactions with both faculty and peers (Weidman, 1979). Academic departments can influence a wide range of student outcomes, including students' aspirations, goals, values, and attitudes (Vreeland & Bidwell, 1966; Weidman, 1979). According to Vreeland and Bidwell (1966) there are two critical components that one must consider in order to understand the influence that academic departments exert on their students: (1) the specific goals academic departments have for undergraduate education and (2) the means and resources available to achieve those goals.

Departmental Goals for Undergraduate Education. Academic departments vary in their definition of undergraduate education (Vreeland & Bidwell, 1966). While some departments focus exclusively on increasing students' competence in the technical aspects of the discipline, or technical goals, others also emphasize moral goals as they attempt to positively influence students' values and attitudes (Vreeland & Bidwell, 1966). Vreeland and Bidwell's (1966) early study on academic departments classified STEM departments as heavily endorsing technical goals as opposed to moral goals.

Vreeland and Bidwell (1966) hypothesized that when technical goals predominate an academic department's definition of undergraduate education, any change in student values and attitudes is likely to be an unanticipated consequence of technical instruction. Since STEM departments have been found to emphasize technical goals and not moral goals in their undergraduate education, Vreeland and Bidwell's (1966) hypothesis suggests that any change in STEM students' values and attitudes is not expected. However, many STEM educators and policymakers have articulated in influential policy reports that the basis for STEM education is the maintenance of U.S. economic competitiveness (AAAS, 2001; NAS, 2007, 2011). This articulation suggest that while STEM academic departments may not explicitly define moral goals for undergraduate students there exists overarching values in STEM education that may influence STEM students' values and attitudes.

Many scholars argue that underlying values exist in academic departments that may influence students' values, regardless of whether there are explicitly defined moral goals for undergraduate education. For example, although the goals of "social relevance" and "making a difference" have recently emerged in engineering education (Committee on Public Understanding of Engineering Messages, 2008), Pawley (2009) found that faculty in engineering continue to define engineering in narrow and universalized ways within educational contexts. According to Pawley (2009), these professors' limited definitions of engineering ultimately perpetuate the notion to students that engineering is an exclusive discipline that focuses on the "first world" using high-tech solutions, as opposed to solving problems that affect communities in need. Additionally, the underlying values of STEM education are also demonstrated in the academic reward structures of departments. The next section describes the reward structures that have been cited in the STEM education literature as well as additional ways STEM disciplines may socialize STEM undergraduates.

Departmental Means and Resources to Achieve Departmental Goals for Undergraduate Education. Academic departments influence students through various methods and practices. Vreeland and Bidwell (1966) argue that faculty and students within an academic department are the primary agents through which academic departments socialize undergraduates. Through these social interactions undergraduates learn more about the culture of their respective fields and the characteristics that are valued within their departments (Weidman, 1979). A department's socializing power through faculty is dependent on the degree to which a department's faculty is involved in intimate and frequent interaction with students, while the socializing power of student peer interaction to foster the attainment of departmental goals is dependent on the consistency of faculty and student norms (Vreeland & Bidwell, 1966).

In addition to the social interactions within academic departments that may influence undergraduate socialization, other structures and practices within the academic normative context also play an important role in undergraduate socialization, particularly reward structures (i.e. grading policies) (Weidman, 1989). An academic department's ability to differentially reward students through the assignment of grades can be a significant normative influence on students within the academic major (Weidman, 1989). A grade practice that is commonly utilized by faculty in STEM disciplines is grade normalization, or grading on a curve (Hurtado, Eagan, Pryor, Whang, & Tran, 2012; Reyes, 2011). Grading on a curve creates and exacerbates competitive atmospheres in classrooms as students objectify their colleagues as opponents and may impede the development of empathy and altruism (Fines, 1997).

Overall, these frameworks emphasize the importance of institutional and departmental structural and socialization forces. As students are clustered within institutional environments, it is important to include traits characterizing these specific overarching environments. Using these frameworks, one may consider how aggregate values and experiences of STEM peers as well as aggregate values and teaching practices of STEM faculty may influence STEM students' social agency and values toward conducting research that will have a meaningful impact on underserved communities. Including these institutional measures helps in understanding how the STEM campus community plays a role in the development of students' democratic outcomes, and to avoid placing the sole responsibility on students over their democratic development. In understanding student success more responsibility needs to, as Carter (2001) states, "be placed on the members of the campus community who have constructed and maintained the campus environment" (p. 27), as opposed to placing the burden on students to adapt to the norms and assimilate into the campus environment.

It is also important to note that students do not necessarily have an unconstrained choice in the type of college environment into which they become socialized, as Weidman's model seems to suggest (Carter, 2001). For example, students may be set on majoring in a STEM discipline even before they make their college choice, yet various factors may prevent students an unconstrained free choice in their college choice decision-making, including admissions

(Carter, 2001), financial, regional and other factors that often relegate students to apply to and ultimately enroll in a specific institution. Additionally, Weidman's model (1989) does not highlight that institutional characteristics might limit or mediate students' access to and participation in various college experiences (DeAngelo, 2008). These limitations are important to articulate in order to avoid placing the onus on students in the development of their democratic outcomes. Entering STEM students with higher democratic orientations may ultimately enter particular STEM environments within particular institutions that place less emphasis or may not provide the means to develop students' democratic outcomes. In such environments, STEM students may be obliged to find ways to develop their own democratic dispositions without critical departmental support, be forced to adapt to the norms of their field and reduce their democratic dispositions, or leave their field altogether in order to find an academic department that is more suitable to their democratic orientations.

Socialization Forces, Student Experiences, and Democratic Outcomes in STEM Education

Research has shown that students who major in a STEM discipline have lower democratic outcomes at the end of college (Astin, 1993a, 1993b; Garibay, under review; Sax, 2000). As college students enter into educational environments within STEM they are exposed to an array of socializing forces that may influence their development (Vreeland & Bidwell, 1966; Weidman, 1979, 1989). In order to better understand these socialization forces within the context of STEM undergraduate education, the current section explores the research literature on STEM faculty, classroom environments, as well as curricular and co-curricular experiences. This multitude of experiential and contextual forces shapes STEM students' development and may influence the value they place on creating a more democratic world through their involvement in society or research.

First, this section does not aim to essentialize the experience of "all" students in STEM. Research often contributes to essentialized notions of particular racial/ethnic (or other social groups) that may further perpetuate notions that humans are biologically different along racial lines (Zuberi & Bonilla-Silva, 2008). Thus, while this section presents the breadth of literature on STEM undergraduate education and student experiences in STEM, I attempt to be particularly cognizant of the fact that there is not "one STEM experience" for all students or any particular group. For example, not everyone, even members of the same social groups, experiences the same contexts the same way. Second, while there is not "one STEM experience" for any particular group, there are often similarities in experiences along social group lines (i.e., discrimination and "chilly" climate based on race/ethnicity, gender, and other social identities). Furthermore, these differences in experiences (including those based on students' race/ethnicity, gender, other social identities) often differ by departmental and institutional context. This section aims to discuss the present literature on STEM education to provide a better understanding of the various practices and experiences that have been documented within the STEM context, while trying to recognize the heterogeneity within STEM disciplines wherever possible and paying a particular emphasis on how these contexts may influence students' democratic outcomes.

STEM Faculty: Characteristics and Influences on Students

Faculty are considered to have major roles in the socialization process of students within academic departments (Vreeland & Bidwell, 1966). Through their role in imparting knowledge to students, shaping the delivery of STEM curricula, and their social interactions with undergraduates, students learn more about the culture of their respective fields and the characteristics that are valued within their departments (Handelsman, Miller, & Pfund, 2007; Miller, Pfund, Pribbenow, & Handelsman, 2008; Weidman, 1979). Additionally, by establishing the goals of undergraduate education along with influencing many of the means to achieve those goals within their department, faculty may directly and indirectly influence a variety of student outcomes (Vreeland & Bidwell, 1966).

National statistics on the STEM professoriate reveal that the majority of STEM faculty are white males (National Science Foundation, 2011). This majority representation by white males in the STEM fields influences the cultural values espoused within the STEM disciplines (Johnson, 2007b), which may, in turn, influence the socialization process of STEM students. Although professors tend to keep personal information about themselves out of class, Johnson (2007b) notes, “this does not mean that science does not have status and hierarchies, or that no personal characteristics are important in science” (p. 816). While many STEM faculty may value and utilize various means to promote students’ democratic outcomes (Baillie, Pawley, & Riley, 2011; Jordan, 2006; Lima, 2000), the culture of university STEM education has been described as fostering individualism, exclusivity, and competition (Pawley, 2009; Seymour & Hewitt, 1997) and lacking concern for the development of students’ social responsibility (Beckwith & Huang, 2005; Vaz, 2005). Additionally, Women of Color at a PWI in Johnson’s (2007b) study described a conflict between the altruistic motivations that drew them to the study of science and their professors’ valuing science in and of itself (p. 818). STEM faculty members play a key role in the development of departmental structures and cultures, which ultimately facilitate the success of those students who “fit” within those organizational arrangements (Johnson, 2007b; Seymour & Hewitt, 1997).

Through their role in influencing classroom environments and imparting knowledge to students, faculty may also influence a variety of student outcomes (Feldman & Newcomb, 1969). STEM faculty have been shown to be more likely than their counterparts in other fields to grade on a curve, however, differences are found by gender (Hurtado et al., 2012). In a national study of STEM faculty, Hurtado et al. (2012) found that 16.6% of women compared to 30.6% of male faculty in STEM disciplines use grading on a curve in their courses. Aside from grading practices, faculty can influence student outcomes through knowledge content and pedagogy. Karakas (2009) interviewed science faculty at one northeastern university and found that participants' main concern was to cover more content, develop the problem solving skills of their students, and prioritized teaching the fundamental principles of their subjects without paying special attention to the nature of science and history of science. This focus on content and "decontextualized science" in STEM courses was also expressed by students in Johnson's (2007b) study. In terms of pedagogy, Johnson (2007) describes, "Ironically, while science professors teach students to be objective and logical, and to reason in ways which are neutral as to race, ethnicity, class, gender, and any other personal characteristic, the methods with they teach these skills are often not neutral to those same characteristics" (p. 806). Indeed, STEM faculty heavily use teacher-centered pedagogy (Hurtado et al., 2012; Karakas, 2009), yet women faculty in STEM are more likely than their male counterparts to use student-centered pedagogy (Hurtado et al., 2012). These practices and behaviors by faculty, which will be discussed in further detail in later sections, inside the classroom can communicate to students a professor's accessibility and willingness to interact with them outside the classroom (Eagan, Figueroa, Hurtado, & Gasiewski, 2012). These "accessibility cues" shape students' decisions in whether, when, and how to interact with faculty (Cotton & Wilson, 2006; Eagan et al., 2012).

A department's socializing power through faculty is dependent on the degree to which a department's faculty is involved in intimate and frequent interaction with students. Weidman suggests that the quantity, strengths, and types of interactions in which students engage are critical in the socialization of undergraduates. Indeed, student-faculty interaction and mentorship has been shown to predict a variety of student outcomes (Cotton & Wilson, 2006; Hernandez, 2000; Jackson, Smith, & Hill, 2003; Maton, Hrabowski, & Schmitt, 2000; Pascarella & Terenzini, 2005; Perna, Lundy-Wagner, Drezner, Gasman, Yoon, Bose, & Gary, 2009; Thompson, 2001; Wai-Ling Packard, 2005). STEM faculty, however, are often not given sufficient incentives to mentor undergraduates (Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011). Additionally, Landefeld (2009) argues that the paucity of faculty members that are familiar with the concerns of Students of Color coupled with the extremely low numbers of Professors of Color in STEM results in a lack of sufficient mentorship opportunities for Students of Color in STEM. Faculty members often decide which students to support based on perceptions of student's motivation and achievement (Ragins, 1999; Ragins & Cotton, 1993; Singh, Ragins, & Tharenou, 2009; Wanberg, Welsh, & Hezlett, 2003) or likeness to themselves (Landefeld, 2009). Moreover, while the quantity and quality of student-faculty interactions are important, there is evidence that some groups of students receive more or less interactions with faculty depending on institutional context. For example, research has shown that Black students at HBCUs have stronger connections with faculty than their Black counterparts at PWIs (Allen, 1992; Hurtado et al., 2011; Nelson Laird, Bridges, Morelon-Quainoo, Williams, & Holmes, 2007).

Students in STEM Majors

A student's same-major peers are also critical to the socialization of students within academic departments (Vreeland & Bidwell, 1966). When compared to their non-STEM counterparts, research has shown that undergraduate STEM students tend to have lower civic and multicultural dispositions (Nicholls et al., 2007) and have lower social agency at the end of college (Garibay, under review). Garibay's (under review) study, however, highlights the need to disaggregate STEM majors by racial/ethnic groups in order to better understand the nuances among STEM students' goals and dispositions. For example, while a lower proportion of Underrepresented Students of Color (USC) in STEM (50.1%) report that working for social change is "very important" or "essential" to their career goals when compared to USC in non-STEM majors (60.5%), a higher proportion of USC in STEM report that working for social change is more important to their career goals than both their majority peers in STEM (37.3%) and non-STEM majors (44.3%). Additionally, Carlone and Johnson's science identity (2007) theory, based on a multi-year ethnographic study of Women of Color in the sciences, reveals that many Women of Color view their pursuit of science careers as a service to humanity and a "vehicle for altruistic ambitions" (p. 1199). The fact that these *altruistic scientists* in Carlone and Johnson's (2007) study primarily aspired to health-related careers and were in pre-professional programs further reveals possible differences between students in different STEM majors.

While previous research suggest that STEM majors, overall, have lower democratic dispositions (e.g., Nicholls, et al., 2007), there is also evidence that suggests differences between students pursuing specific STEM majors and careers, showing the heterogeneity between disciplines within STEM. For example, higher education research has shown that engineering undergraduates are more likely than students in other fields to believe that individuals cannot change society, and less likely to describe themselves as altruistic or socially concerned (Astin, 1993a, 1993b). Engineering majors also expressed less of a commitment to promoting racial understanding (Astin, 1993a, 1993b) and were found to have significantly lower levels of commitment to social action than students in other academic majors (Sax, 2000). Garibay (under review) found that students who aspired to become engineers, scientific researchers, and computer scientists had significantly lower levels of social agency at the end of college. While these studies demonstrate general differences between students in various STEM majors, many students within these academic majors do pursue their specific career for altruistic motivations. For example, Newman (2011) found that many African American engineering and computer science students pursue their fields with goals of working for social justice.

For students pursuing health-related professions, however, Antony (1996) indicates that one reason why students may initially aspire to become physicians is by altruistic motivations, manifested through a desire to help and serve others. In other words, some STEM careers, particularly health-related professions, may seem more attractive to students who are driven to promote the social good (Carlone & Johnson, 2007). Indeed, Antony (1998) found supporting evidence as premedical students were found to possess social/altruistic personality types. Additionally, Garibay (under review) found that students who had aspirations for a career in the health professions had significantly higher levels of social agency at the end of college.

Furthermore, while research shows possible differences between students' motivations for pursuing STEM majors, research also suggests that differences exist within the environment of particular STEM fields, particularly for premedical students. Premedical students describe their premedical years as more of a competition than a journey of self-discovery (De Vries & Gross, 2009) and have often been described as "gunners" (Woo, 2010), or excessively hard-working and competitive. Given that medical schools heavily weight students' grades in introductory STEM courses in the medical school application process, premedical students often intensely compete for higher college GPAs (Coombs & Paulson, 1990; Gross, Mommaers, Earl, & De Vries, 2008) and "concentrate on science with a fury" (Hackman, Low-Beer, Wugmeiter, Wilhelm & Rosenbaum, 1979) in hopes of maximizing their chances of medical school acceptance. This pressure may lead premedical students to be less sociable then others (Hackman et al., 1979) and may inhibit the development of their democratic outcomes.

Student Experiences in the STEM Classroom and Co-Curricular Opportunities

Pedagogy and Grading. In addition to the curriculum and content within STEM disciplines, other practices within STEM classrooms also play an important role in undergraduate socialization, particularly reward structures (i.e. grading policies) (Weidman, 1989) and pedagogy. An academic department's ability to differentially reward students through the assignment of grades can be a significant normative influence on students within an academic major (Weidman, 1989). Research has shown that as STEM students enter into a series of introductory courses that are required toward the completion of their degree, they enter into environments that are designed to "weed" students out of STEM majors (Barr, 2010; Baldwin, 2009). A grade practice that is more commonly utilized by faculty in STEM disciplines is grade normalization, or grading on a curve (Hurtado et al., 2012; Reyes, 2011), which is a sifting mechanism that assumes that not all students are capable of succeeding (Baldwin, 2009).

Fines (1997) argues that grading on a curve creates and exacerbates competitive atmospheres in classrooms as students objectify their colleagues as opponents, promotes individualism, and may impede the development of empathy and altruism. These competitive environments may force students to exercise behaviors that may skew the competition in their favor (e.g., not sharing notes, cheating on exams, etc.) (see Fines, 1997) and influence their interactions with their peers. For example, Gasiewski, Eagan, Garcia, Hurtado, and Chang (2012) found that pre-medical students were often unwilling to help fellow pre-medical colleagues with questions or information about important opportunities. Therefore, grading on a curve promotes a competitive climate, which conflicts with student collaboration and interpersonal relationship-building (Seymour & Hewitt, 1997).

Pedagogy may also influence STEM students' democratic outcomes (Baillie et al., 2011; Gutstein, 2006; Jordan, 2006). An array of active learning pedagogical strategies are now being implemented in STEM programs to try to promote students' retention, degree completion, including group projects and presentations, peer-led learning, and problem-based learning (Allen & Tanner, 2005). Students who felt that faculty provided them more opportunities to apply classroom learning to "real life" issues report higher social agency at the end of college (Garibay, under review). While new pedagogical practices are being implemented in STEM programs throughout the country (Baldwin, 2009), many STEM faculty have demonstrated a reluctance to embrace active learning teaching methods (Brainard, 2007; National Research Council [NRC], 2003; Wood, 2003) and are often not given institutional support to use active teaching methods (Baldwin, 2009). A recent national report on college faculty revealed STEM faculty to heavily utilize extensive lecturing in all or most of their classes (Hurtado et al., 2012). A higher proportion of both men and women teaching in STEM fields use extensive lecturing as a teaching method in their classes compared to their male and female colleagues in non-STEM disciplines (Hurtado et al., 2012). Not only does extensive lecturing negatively influence student engagement and achievement (Astin, 1993a), it also encourages one-way, passive, superficial learning (Bransford, Brown, & Cocking, 2000; Moore, Sherwood, Bateman, Bransford, & Goldman, 1996; Seymour & Hewitt, 1997). In addition, faculty in non-STEM fields use student-centered teaching practices more often than STEM faculty (Hurtado et al., 2012). More specifically, STEM faculty are less likely to use reflective writing/journaling, student inquiry to drive learning, and student-selected topics for course content than their non-STEM colleagues (Hurtado et al., 2012).

The limited use of student-centered pedagogical practices by STEM faculty may be a reflection of the often large classes in STEM. Hurtado et al. (2012) suggest that it is possible to use particular student-centered pedagogical practices within large classes and that STEM faculty tend to use student-centered pedagogy less often that non-STEM faculty, regardless of the class size. Additionally, Brainard (2007) suggests that there may be institutional differences to the use of active learning teaching strategies, where faculty at research universities may be more likely to resist change.

Service-Learning and Courses Connecting STEM and Social Issues. A variety of co-curricular programs and courses are found in STEM that are geared toward influencing STEM students' democratic outcomes, including service-learning opportunities and courses that focus on STEM and social issues (e.g. Baillie et al., 2011, Jordan, 2006). Service-learning opportunities are designed to have students work alongside community members with the intent to empower community partners while also providing opportunities for students to utilize their classroom learning to solve real-world problems (Baillie et al., 2011; Ward & Wolf-Wendel, 2000). One service-learning program within engineering is the Engineering Projects in Community Service (EPICS), which requires students to solve technology-based problems for not-for-profit organizations in the local community while earning academic credit (Coyle, Jamieson, & Oakes, 2005). Scholars have found service-learning courses to increase participants' awareness of inequality, commitment to social justice, and concern for the public good (Einfeld & Collins, 2008; Hurtado, 2003); to increase students' attitudes about volunteering and working in a diverse community (Gadbury-Amyot, Simmer-Beck, McCunniff, & Williams, 2006); and to significantly change students' perceived knowledge and understanding of social issues and health disparities (Brown, Heaton, & Wall, 2007). Additionally, Astin, Vogelgesang, Ikeda, & Yee (2000) found a strong correlation between students enrolled in a service-learning course and their commitment to addressing social problems and developing civic responsibility. These results have led scholars to conclude that exposing students to social issues in the community has a positive influence on students' knowledge of the broader issues facing society (Brown et al., 2007; Lima, 2000).

Courses are also being implemented at many institutions that are making connections between science and society (McClure & Lucius, 2010; Middlecamp, Jordan, Shachter, Lottridge, & Oates, 2006; Jordan, 2006). For example, NSF-sponsored Science Education for New Civic Engagement and Responsibilities (SENCER) courses "invite students (as well as their instructors) to engage in the complex social issues that face us today locally, regionally, and globally" (Middlecamp et al., 2006, p. 1301). SENCER courses often bridge various science fields (e.g., chemistry, biomedical sciences, environmental sciences) and span a range of topics including "Biomedical Issues of HIV/AIDS," "Uranium and American Indians," and "Geology and Development of Modern Africa" (Middlecamp et al., 2006). Middlecamp et al.'s (2006) study found that students who participate in SENCER courses are more likely to engage in civic activities, however, the majority of students in the study were non-science majors. McClure & Lucius (2010) found that students enrolled in a chemistry course titled "Chemistry in Culture and Ethics" (which was designed to include discussion of responsible conduct in research as well as ethical considerations in applying science to challenges in society) were, on average, more likely to participate in civic activities after completing the course. Several articles that have appeared in the *Journal for College Science Teaching* further demonstrate how many STEM faculty are having students explore the connection between science and civic engagement within their classes (Jordan, 2006), including understanding genetics to promote human rights (Chamany, 2001), examining the role of science in the development of racial categories (McGowan, 2005), understanding the complex genetics of skin color (Schneider, 2004), as well as environmental issues in a civic context to encourage sustainability (McDonald & Dominguez, 2005; Pratte & Laposata, 2005; Walsh, Jenkins, Powell, & Rusch, 2005).

Another way colleges can support students' development of democratic outcomes are through curricular requirements that infuse community-based problem solving (i.e., project-based learning) that help students better understand science and technology in the larger contexts of society. For example, Worchester Polytechnic Institute, where about 90 percent of students major in a STEM discipline, requires all students to complete a series of three projects throughout their undergraduate experience that are designed to help students bridge theory and practice and gain a better understanding of themselves and the world (Vaz, 2005). Through the *Interactive Qualifying Project* (IQP), a junior-year requirement that can be taken either in the U.S. or abroad, students work in small multidisciplinary teams and are guided by faculty advisors to help solve problems posed by an external sponsor, usually not-for-profit organizations, governmental agencies, and nongovernmental agencies (Vaz, 2005). Educational goals of the IQP include developing students' critical and contextual thinking skills as well as their understanding of the interrelationship between scientific and technological advancement, societal structures, and human need (Vaz, 2005). These opportunities may be able to help students use their STEM knowledge to create positive change in communities in need, and may positively contribute to students' democratic outcomes.

Undergraduate Research. NIH initiatives have provided substantial funds in support of undergraduate research training at institutions that graduate high numbers of diverse science baccalaureates. Participation in formal research opportunities provide important opportunities and have been shown to promote STEM students' academic success (e.g., Barlow & Villarejo, 2004; Bauer & Bennett, 2003; Eagan et al., 2013, Hurtado et al., 2009; Kardash, 2000; Lopatto, 2004; MacLachlan, 2006; Maton, Hrabowski, & Schmitt, 2000; Russell, Hancock, & McCullough, 2007; Seymour, Hunter, Laursen, & DeAntoni, 2004; Summers & Hrabowski, 2006; Villarejo, Barlow, Kogan, Veazey, & Sweeney, 2008). Seymour et al.'s (2004) qualitative study found that over 40% of students reported gained confidence in their research abilities and 27% reported increased confidence in feeling like a scientist. Laursen, Hunter, Seymour, DeAntoni, De Welde, & Thiry (2006) describe that they found no evidence that undergraduate research had prompted students to choose to pursue a research career or graduate school, but rather, it confirmed and reinforced students' career interests. Eagan et al. (2013) found that participation in undergraduate research is significantly related to higher graduate school aspirations for STEM students. While participation in research has been extensively examined with respect to traditional measures of success, such as STEM graduate school aspirations and matriculation, these experiences may also provide students with opportunities that may influence their democratic outcomes.

Research opportunities provide students the ability to inquire, learn about other content areas, and actively engage with knowledge (NSRC, 2007). Undergraduate research may also promote students' agency as participants describe having the independence to decide on the problems they want to tackle, propose their own solutions, and set their own goals (Laursen et al., 2006, p. 64). According to Laursen et al. (2006), many students also reach broader epistemological conclusions as they shift from understanding science as a body of received knowledge and facts to understanding science as a set of methods for exploring and explaining natural phenomena. A student in Laursen et al.'s (2006) study states: "I think a lot of people think science is truth, this all-encompassing certainty…And what I found out is that often what research does is just to explain how something could happen, or probably happens, and not necessarily how it does happen" (p. 60). Additionally, these experiences provide students opportunities for collaboration, helped students become better problem-solvers and investigators, and gave them opportunities to think about problems critically and creatively to find solutions. Indeed, Garibay (under review) found that students who participated in a structured undergraduate research program demonstrated higher social agency at the end of college.

Student Clubs and Organizations. Participation in student organizations and clubs can also influence student socialization and outcomes (Espinosa, 2011; Guiffrida, 2003; Harper, 2005). For students in the STEM fields, numerous national societies exist that allow undergraduate students to become members; however, colleges and universities vary with respect to established chapters on their respective campuses. STEM students, especially at institutions with larger STEM student populations, often have various STEM-related student organizations on their campus that are either affiliated with these national societies or are smaller-scale organizations. STEM-related student organizations and societies are important opportunities that allow students to establish and access academic and social networks within their disciplines and the general STEM community. Through these social interactions with members of the STEM community, undergraduates may learn more about the culture of their respective fields and adapt characteristics that are deemed valuable within their departments (Weidman, 1979). These organizations may provide additional contexts where STEM students can further accentuate or develop their values along with their STEM identities as their predispositions may be appreciated and nurtured within these settings (Eagan, Hurtado, Garibay, & Herrera, 2012; Feldman & Newcomb, 1969).

While many STEM-related student organizations may solely focus on academic success and networking opportunities, there are a variety of STEM-related organizations that have been established to incorporate STEM students' multiple social identities (Tran, 2011), including STEM-related student organizations grounded on students' racial/ethnic identities (i.e., Minority Association of Pre-medical Students [MAPS]), gender (i.e., Society of Women Engineers [SWE], Association for Women in Mathematics), and sexual orientation (i.e., PRIDE in Healthcare). Many of these organizations were created to challenge stereotypes of these various groups in the STEM fields and provide important networks and resources for underrepresented populations in STEM. An institution with a higher composition of diverse students is likely to have an array of academic student organizations that blend or merge students' multiple social and academic identities (Chang, 2002b). Additional STEM-related race/ethnic student organizations include: Chicano's for Community Medicine (CCM), The National Black Society for Engineers (NSBE), Society of Hispanic Professional Engineers (SHPE), American Indian Science and Engineering Society (AISES), National Society of Black Physicists (NSBP), National Society of Hispanic Physicists (NSHP), Society for the Advancement Chicanos and Native Americans in Science (SACNAS), and the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE).

In Newman's (2011) study, many black engineering students involved in NSBE described the important impact this organization's community service opportunities had on their personal growth and academic success. Many of these organizations describe in their mission statements goals of academic success, celebrating cultural heritage, developing agents of change, as well as empowering their communities. For example, SHPE's statement of values states, "*We are brought together by heritage, social responsibility and desire to improve the equality of all people through the use of science and technology. We value excellence in education, professional pursuits and leadership. We obtain excellence through integrity, empowerment, achievement, diversity and continuous improvement*" (SHPE, n.d.). Additionally, the NSBP, founded in 1977 at Morgan State University, describes its mission as: "*NSBP is a global professional society uniting African American, Afro-Caribbean and African physicists and astronomers in their pursuit of understanding matter and energy, and using that to benefit mankind"* (NSBP, n.d.). These organizations provide important networks and spaces that can facilitate academic success, but also provide students with important opportunities to engage with communities in ways that may influence their democratic outcomes.

Additional Factors Associated with Democratic Outcomes in Higher Education

While there is a dearth of higher education literature focused on the factors that influence STEM students' democratic outcomes, specifically, many studies have examined the development of democratic outcomes for the wider college student population. Generally, students increase in their awareness of social justice and social conscience throughout their college years (Pascarella & Terenzini, 2005). Previous studies have documented the importance of background characteristics, curricular and co-curricular experiences, as well as experiences with diversity on various democratic outcomes, including students' interest in becoming involved in social action activities, social activism, and concern for the public good, among others. Previous studies have consistently found that pre-college social agency is the most significant predictor of social agency at the end of college (Astin, 1993a; Nelson Laird, Engberg

& Hurtado, 2005; Zuñiga, Williams, & Berger, 2005). Misa, Anderson, & Yamamura (2005) found that students who place greater importance on influencing the political structure and social values (two social agency items) were strongly correlated with involvement in political organizations and contacting elected officials on political matters in the post college years.

Research has shown that women are significantly more likely than males to value social action engagement (Hurtado, Engberg, Ponjuan, & Landreman, 2002) and indicate a social justice orientation (Dugan & Komives, 2010; Dugan, Komives, & Segar, 2008; Dugan, 2006; Zuñiga et al., 2005). Nelson Laird's (2005) single time-point study of largely first and second-year students found that female students reported higher levels of social agency, however, Garibay's (under review) longitudinal study found a non-significant relationship between gender and social agency outcomes at the end of college. Other important background characteristics that predict democratic outcomes include whether the student is an Underrepresented Student of Color (Garibay, under review), a student's high school grade-point average (Hurtado et al., 2002), political orientation (Garibay, under review), parental income, and parent's education (Hurtado et al., 2002; Verba, Schlozman, & Brady, 1995). While studies have found inconsistent results with respect to whether there are differences between students' racial/ethnic identity and democratic outcomes (e.g., Dugan et al., 2008; Gonzalez, 2008, Gurin et al., 2002), Zuñiga et al. (2005) argue that studies should disaggregate based on race/ethnicity given that past research (i.e., Gurin et al., 2002) has found differences between racial/ethnic groups on democratic dispositions. Students of Color have been shown to demonstrate more complex views of their privileged and oppressed status than white students, which may affect motivational differences in influencing social change (Chizhik & Chizhik, 2005).

College experiences and institutional contexts have also been shown to significantly relate to students democratic outcomes. Volunteering and service-learning opportunities have been shown to influence student democratic outcomes (Astin et al., 2000; Brown et al., 2007; Einfeld & Collins, 2008; Gadbury-Amyot et al., 2006; Hurtado, 2003). Additionally, past research on the educational benefits of diversity have shown several types of diversity experiences to influence students' democratic outcomes, including diversity courses, extra-curricular diversity events, and cross-racial interactions (e.g., Astin, 1993a, 1993b; Chang, 2002a; Garibay, under review; Gurin, 1999; Gurin, Dey, Hurtado, & Gurin, 2002; Milem, 1994; Hurtado, 2003; Nelson Laird, 2005).

Considering Institutional Factors on Democratic Outcomes

Very few studies consider institutional effects on students' democratic outcomes (Dugan & Komives, 2010). Pascarella and Terenzini (2005) suggest that research in higher education generally indicates no relationship between institutional characteristics with changes on students' sociopolitical attitudes (Pascarella & Terenzini, 2005). However, Dugan and Komives (2010) found small, yet critical evidence that larger institutions have a negative relationship with students' citizenship outcomes. Additionally, Garibay's (under review) study found a significant negative relationship between attending a private institution and students' social agency at the end of college, but like in the Dugan and Komives (2010) study these effects are very small. Moreover, other studies have shown that peer contexts within an institution may influence student changes on commitment to social activism (Sax, 2004) and that students' democratic outcomes may increase in the absence of a hostile campus racial climate (Pascarella & Terenzini, 2005).

Despite previous research that suggest minimal or no relationship between institutional characteristics and students' democratic outcomes, Weidman's (1989) model of undergraduate socialization suggests that organizational environments and structures need to be considered as structural characteristics of an institution shape students' experiences in college. Since colleges differ in their structuring of both normative contexts and of opportunities for social interaction among college students, faculty, and staff (Weidman, 1989, p. 298), structural characteristics of an institution impact various student outcomes. Institutional factors that may shape students' experiences may include peer normative contexts, whether the university is a research institution (which may influence students' research opportunities), and whether the institution is a Minority Serving Institution (MSIs; i.e., Historical Black College or University, Hispanic Serving Institution), among many others.

MSIs are important higher education pathways for many Students of Color and have shown substantial results in graduating high numbers of underrepresented STEM students (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2010). HBCUs represent less than 5% of the nation's colleges and universities, yet graduate over one-fourth of the country's African American students in STEM, and contribute to black STEM graduates' post-college success (Babco, 2003, p. 4). Research has shown that these institutional contexts play an important role in the socialization of Black students, as HBCUs tend to promote stronger connections between Black students and faculty than PWIs (Allen, 1992; Hurtado et al., 2011; Nelson Laird et al., 2007).

While the impact of HBCUs on African American student success in STEM is generally consistent (Palmer, Maramba, & Gasman, 2013), research on the impact of HSIs on Latina/o success demonstrates mixed results. Researchers have often alluded to the fact that many HSIs were initially PWIs and thus are still in the process of changing institutional practices and policies to help better serve Latina/o students' educational needs (e.g., Hurtado et al., 2007; Nelson Laird et al., 2007). Previous studies have shown that four-year HSIs produce a disproportionately low rate of Latina/o STEM baccalaureates given their overall enrollment at these institutions (Contreras, Malcom, & Bensimon, 2008; Malcolm, 2008). Additionally, only a few Latina/o STEM students at the HSIs in Hurtado, et al.'s (2011) study mentioned having strong connections with faculty and no significant associations were found related to Latina/o STEM students at HSIs and their interactions with faculty in the quantitative aspect of the study. In contrast, a multi-institutional case study of HSIs by Stanton-Salazar, Macias, Bensimon, & Dowd (2012) found many examples of institutional agents who used their power and influence to expand educational opportunities for Latina and Latino STEM students. Many of these professors used their positions and academic networks to help create opportunities for many students, such as working in a research lab, qualifying for a scholarship, or attending conferences, that otherwise may not have been given a chance. For example, a Latino professor from their study is quoted as saying:

> "…some students who do average in coursework have excellent potential…You can tell when the lights are going off and on and they're excited by the material. Those are the kind of students that I want to attract to conduct research because the research experience can tell students, 'you can do this kind of professional work given the chance' (Dowd, Sawatzky, Rall, & Bensimon, 2013, p. 157)."

Additionally, Nelson Laird et al. (2007) found that despite not differing significantly in their engagement and postsecondary outcomes, Latina/os at HSIs and non-HSIs differed in some educational aspects, with Latina/os at HSIs demonstrating significantly higher levels of collaborative learning and larger gains in overall development. Furthermore, Cuellar (2012) found that HSIs and Emerging HSIs do provide important contexts that contribute to Latina/o students' development of social agency by the end of college. Thus, HSIs may provide important contexts for understanding the development of STEM students' democratic outcomes.

Summary of the Literature and Identifying Gaps

The literature reviewed in this chapter demonstrates the need to consider multiple student and institutional factors in understanding the development of STEM students' democratic outcomes. Guided by theories of undergraduate student socialization and acknowledging that academic departments are particularly important settings through which undergraduate socialization occurs, one can begin to better understand the importance of specific college experiences and institutional contexts on the development of STEM students' democratic outcomes. While the STEM culture is often considered in the aggregate, research indicates the need to account for disciplinary differences between the STEM fields with respect to democratic outcomes. Additionally, participation in undergraduate research and student organizations are also important to consider in studies of STEM students' democratic outcomes. The literature suggests that not only are these experiences critical to STEM students' academic success, but may also provide contexts that facilitate the development of democratic outcomes for STEM students. Measures that can account for the STEM culture, including faculty values, pedagogical practices, and grading methods, may also help provide a better understanding of STEM students' democratic outcomes.

In addition to these and other critical experiences, the literature underscores the need to consider measures of the institutional environment in which undergraduate students attend college. Examining the influence of these institutional characteristics on democratic outcomes can reveal how successful institutions are at developing talent, as democratic outcomes represent broader measures of institutional success than simply degree completion (Astin, 1993a). A competitive climate, whether the institution is a research university, whether or not the institution is a Minority Serving institution, among other characteristics, may influence STEM students' democratic outcomes. Past studies on STEM students' democratic outcomes have generally been single-institution studies that have focused on the influence of a single college experience (e.g., Baillie et al., 2011; Lima, 2000; Middlecamp et al., 2006) or have utilized a student's major as a control variable in comparing these students' democratic outcomes to their non-STEM peers (e.g., Astin, 1993a, Garibay, under review; Sax, 2000). Thus, much of the research on the development of STEM undergraduate students' democratic outcomes remains under-developed. The present study aims to explore these and other factors in hopes to provide a better understanding of the various institutional and student predictors of STEM students' democratic outcomes. This study will examine how STEM contexts and experiences may work in conjunction or isolation in affecting students' democratic outcomes.

CHAPTER 3: METHODOLOGY

Introduction

The literature reviewed in Chapter 2 reveals that STEM educators and researchers have yet to explore the breadth of experiences and contexts that may contribute to STEM students' democratic outcomes. Postsecondary research has much to explore on the subject of STEM students' development of democratic outcomes as previous studies have largely ignored the influence of the range of undergraduate experiences STEM students participate in and how differing institutional environments may affect STEM students' democratic outcomes. More research is needed to better understand the undergraduate experiences and institutional contexts that promote STEM students' democratic educational outcomes.

Given the gap in the literature, this quantitative study on STEM bachelor's degree completers explores important undergraduate experiences and institutional contexts that influence the development of two democratic outcomes: social agency and importance of conducting research that will have a meaningful impact on underserved communities (which I often refer to as "conduct meaningful research" for brevity). These outcomes assess a students' desire to promote a more democratic society through their involvement in society and research, respectively. For both of these outcomes, the study applied the same model to allow for comparisons and understand the specific factors associated with each dependent variable.

This chapter provides a detailed description of the methodology employed in this study. First, the chapter states the study's research questions and provides specific hypotheses associated with each question. The chapter then describes the research design, data source, sample, and analyses that are used to address the research questions. To conclude, the chapter details specific limitations with respect to the study's data and analyses.

Research Questions

This study addressed the following research questions:

1. To what extent do STEM bachelor's degree recipients' social agency and value toward conducting meaningful research vary within and between institutions?

2. Controlling for background characteristics and precollege characteristics and experiences, how do undergraduate socialization experiences with academic disciplines, faculty, and peers contribute to the social agency and the importance of conducting meaningful research of STEM bachelor's degree recipients seven years after college entry?

3. Controlling for individual characteristics and experiences, how do institutional factors such as structural characteristics, peer-context, and STEM faculty context contribute to the social agency and the importance of conducting meaningful research of STEM bachelor's degree recipients seven years after college entry?

4. Are any of the effects of undergraduate socialization experiences on STEM bachelor's degree recipients' social agency and values toward conducting meaningful research moderated by institutional factors?

Hypotheses

In this section, specific hypotheses along with a statement of rationale that correspond to each of the aforementioned research questions are provided. The two dependent variables assess similar student values (i.e., desire to promote a more democratic society), yet differ with respect to how students aspire to be involved in this process (through sociopolitical involvement and/or research). Generally, I expect few differences between the predictors of the two dependent variables and thus many of the following explanations of the hypotheses are discussed conjointly. Where I expect additional or different relationships in the models, I will address each dependent variable by its specific name and provide explanations of these hypotheses.

Hypothesis 1- Democratic outcomes will vary within and between institutions

The within-institution variation relates to differences between students attending the same institution in the development of their democratic outcomes. I hypothesize that I will find significant variation within institutions with respect to students' development of democratic outcomes. Prior research on students' democratic development during college has documented differences in students' democratic outcomes with respect to race/ethnic identification, gender, and other characteristics (Dugan & Komives, 2010; Dugan et al., 2008; Dugan, 2006; Garibay, under review; Gonzalez, 2008, Gurin et al., 2002; Hurtado et al., 2002; Zuñiga et al., 2005). The large and diverse sample of students found within this study's sample provided the foundation for this hypothesis.

Additionally, I hypothesize that democratic outcomes will vary significantly across institutions. Previous studies have identified differences in democratic outcomes across institutional control (Garibay, under review), size (Dugan & Komives, 2010), and peer contexts (Sax, 2004). Given the substantial number and diversity of institutions included in the study, I anticipate that the average in students' democratic outcomes will significantly differ across institutions.

Hypothesis 2- Student-level variables will predict democratic outcomes seven years after college entry

Given the literature demonstrating significant relationships between college experiences and democratic outcomes, as well as theoretical underpinnings of undergraduate student socialization (Vreeland & Bidwell, 1966; Weidman, 1979, 1989), it is hypothesized that STEM bachelor's degree recipients' background characteristics, precollege experiences, and experiences over the college years will be significantly related to democratic outcomes seven years after college entry. Background characteristics such as race/ethnicity, gender, and socioeconomic status are hypothesized to predict STEM bachelor's degree recipients' social agency and values toward conducting meaningful research. Past research has found differences between racial/ethnic groups (e.g., Gurin et al., 2002) and men and women (Hurtado et al., 2002) on democratic dispositions and outcomes. Chizhik and Chizhik (2005) argue that students of color have more complex views of privilege and oppression than white students, which may ultimately propel their motivations to affect social change. The literature presented in the first two chapters shows that students lived experiences in the wider society, within college, and within STEM departments are largely impacted by their background characteristics such as race/ethnicity, gender, and class. Given that these environments privilege some groups over others, it is expected that STEM bachelor's degree recipients who are from social groups that have been historically marginalized in the US will have greater desire to affect positive social change through sociopolitical involvement and conducting research.

Both Vreeland and Bidwell's (1966) and Weidman's (1989) theory of undergraduate socialization recognize experiences with faculty, peers, and academic disciplines as impacting college student outcomes, including the development of students' values. Thus, while students may have particular democratic dispositions prior to entering higher education institutions, this study hypothesizes that the college environment is a crucial point of influence that impacts the long-term development of STEM students' values toward promoting a more democratic society. Given the nature of the two dependent variables, which examine two different ways students may want to be involved in promoting positive change in society, it is also hypothesized that elements of the college environment will impact these two different dependent variables differently. This study includes various measures of experiences with these socializing agents to capture how colleges and universities are preparing STEM students to participate in promoting a more equitable society. Prior research on STEM undergraduate student outcomes has largely focused on traditional measures of academic success. This study seeks to broaden the discussion on how STEM students' democratic outcomes, as opposed to traditional academic outcomes, may also be impacted by their socialization experiences with faculty, peers, and academic disciplines.

Hypothesis 3- Institutional-level variables will predict democratic outcomes seven years after college entry

Weidman's (1989) undergraduate student socialization model posits that institutional settings, such as structural characteristics and normative pressures from faculty and peers contribute to the process of undergraduate socialization. Thus, it is hypothesized that institutional characteristics related to structural characteristics, STEM faculty norms, and peer normative contexts will have a significant effect on STEM students' democratic outcomes seven years after college entry. Institutions have differing missions, cultures, and resources dependent on various structural characteristics including institutional control, type, and MSI-status. HBCUs and HSIs are hypothesized to have a positive influence on STEM students' democratic outcomes as prior research indicates that these institutions provide important contexts for Black and Latina/o students to develop their democratic outcomes (e.g., Cuellar, 2012; Newman, 2011).

STEM faculty normative pressures that may influence STEM undergraduates' democratic outcomes include STEM faculty values, pedagogical strategies in classrooms, and grading practices, which have been shown to influence educational climates (i.e., competition, lack of concern for development of social and civic responsibility in STEM) and student outcomes (see Beckwidth & Huang, 2005; Fines, 1997; Johnson, 2007a). Student peer characteristics that are hypothesized to influence students' democratic outcomes include the proportion of STEM undergraduates on a campus as well as the institutional average of peer social agency, given previous research that suggests that STEM students generally have lower civic and multicultural dispositions and outcomes (Garibay, under review; Nicholls et al., 2007). These various elements of the institutional setting can impact STEM undergraduate students' access to specific resources and programs, their interactions with faculty, and their relationships with peers- all of which can ultimately influence their development. Furthermore, given differences in the two democratic outcomes, it is also hypothesized that some elements of the institutional setting will impact the dependent variables differently.

Hypothesis 4- Institutional Factors Moderate the Effects of Undergraduate Experiences

Given theoretical underpinnings of undergraduate student socialization (Vreeland & Bidwell, 1966; Weidman, 1979, 1989), it is hypothesized that the effect of undergraduate socialization experiences on democratic outcomes will significantly vary across institutional contexts. More specifically, it is hypothesized that the effect of academic major will vary across institutional factors such as whether the institution is a research institution and whether the institution is a Minority Serving institution. Additionally, it is hypothesized that the effect of faculty and peer socialization on STEM bachelor's degree recipients' democratic outcomes will be moderated by STEM faculty and peer contexts, as well as structural characteristics, including whether the institution is a Minority Serving Institution given the literature on the impact of MSIs on the success of students of color in STEM (e.g., Palmer et al., 2013). Prior literature on Black STEM students attending HBCUs acknowledge an "HBCU effect" that helps produce a high number of Black scientists and engineers (McNair, 2009, p. 90). This effect is hypothesized to go beyond academic success and affect democratic outcomes through students' undergraduate experiences given that, as LeMelle (2002) states, "college for the Negroes has a double responsibility. It must prepare the youth for good lives as American citizens and it must also fit them to tackle their peculiar racial problems with intelligence and courage" (p. 193). While the mission of HSIs developed differently than that of HBCUs, there is some research that provides examples of institutional agents within STEM at HSIs (e.g., Dowd et al., 2013) that may suggest differing impacts of faculty-student interactions between Hispanic Serving and predominantly white institutions.

Conceptual Model

Drawing from frameworks of undergraduate student socialization (Vreeland & Bidwell, 1966; Weidman, 1989, 1979), as well as prior empirical research outlined in Chapter 2, the following multilevel conceptual model was developed and helped to guide this study (see Figure 3.1). The conceptual model illustrates the hypothesized direct relationship between STEM bachelor's degree recipient's background characteristics (measured at college entry), precollege characteristics and experiences (measured at college entry), undergraduate experiences (measured seven years after college entry), post-undergraduate experiences (measured seven years after college entry, and institutional characteristics (measured by institutional data, student norms, and STEM faculty norms) on social agency and values toward conducting meaningful research seven years after college entry. Undergraduate experiences are categorized under peer, faculty, and departmental socialization, and STEM educational/career preparation variables. It is further hypothesized that institutional characteristics moderate the relationship between undergraduate experiences and the dependent variables. Adapted from Kreft and de Leeuw's (1998, p.72) depiction of cross-level effects in multilevel models, these cross-level interactions are represented by the dotted line intersecting with the line connecting the undergraduate experiences and democratic outcomes. The following sections in the chapter will provide further details on the selection of variables.

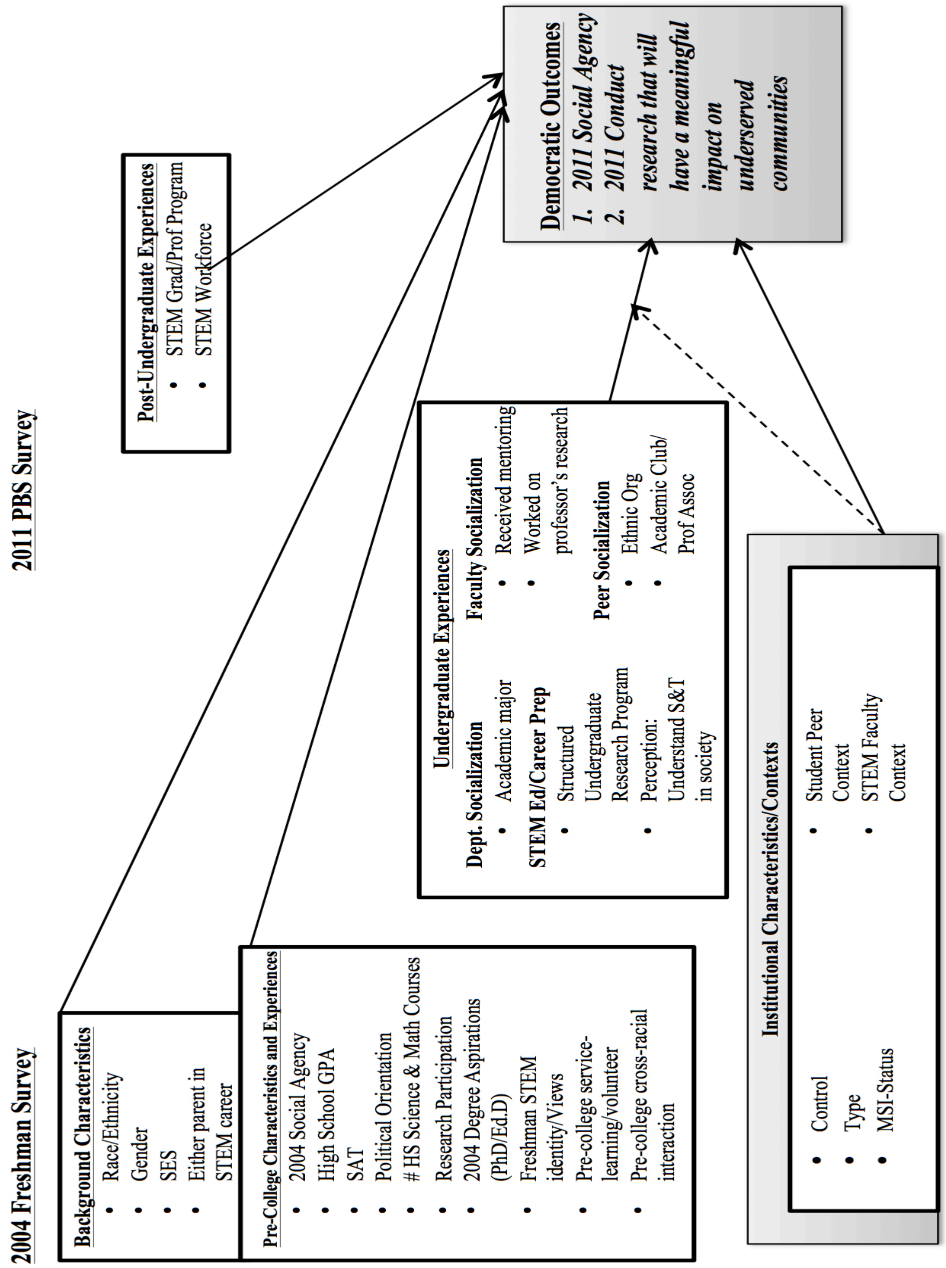

Figure 3.1 Conceptual Model for HLM Analyses

Research Design

This study consists of a longitudinal model design using a 2004 cohort of entering college students. The longitudinal model assesses the influence of various factors on two outcomes: social agency and the importance of conducting research that will have a meaningful impact on underserved communities. Each outcome was measured in 2011, roughly 2-3 years after students graduated from college. The following sections provide important details regarding the data sources, sample, dependent and independent variables, and analyses used in the study. Finally, the chapter concludes with limitations of the research study.

Data Source and Sample

This study uses merged data from several national databases including longitudinal student data from the 2004 Cooperative Institutional Research Program's (CIRP) Freshman Survey (TFS) and the 2011 Post-Baccalaureate Survey (PBS), as well as institutional data from the Integrated Postsecondary Educational Data System (IPEDS) and the 2007 and 2010 CIRP Faculty Surveys. The CIRP, which has been collecting college student data since 1966, is the nation's oldest and largest national longitudinal study of college students, and is administered by the UCLA Higher Education Research Institute (HERI). The data for this study came from two sponsored projects based at the Higher Education Research Institute at the University of California, Los Angeles (UCLA): A project initially sponsored by the National Institutes of Health (NIH) titled *Access and Engagement in Biomedical and Behavioral Science Research Preparation* and a related project funded four years later by the National Science Foundation (NSF) titled *Becoming Scientists: Practices in Undergraduate Education that Contribute to Degree Completion and Advanced Study in STEM*. Funds by NIH and NSF allowed for the selection, recruitment, and subsidization of specific institutions and student populations within those institutions to fulfill the needs of the respective projects. Further details are explained below.

The TFS survey was administered in the fall of 2004 to entering freshmen and collected information about students' background characteristics, precollege experiences and achievement, expectations for college, attitudes, values, and future educational and career goals. With funds from the NIH in 2004, HERI researchers targeted Predominantly White Institutions (PWIs) and Minority Serving Institutions (MSIs) known for graduating large numbers of undergraduate students with biomedical and behavioral science (BBS) degrees and that normally do not collect longitudinal data on their students to examine how underrepresented racial minority (URM; African American, American Indian, and Latina/o) students navigated through BBS pipelines during and beyond their undergraduate career. NIH funding also allowed the project to target CIRP-participating institutions that had NIH-funded undergraduate research programs. These strategies yielded an institutional sample of 160 institutions. Given the specific focus of the study, the project identified a second sampling strategy within each institution targeted by the study. Matched samples of URM BBS majors, URM non-BBS majors, and White and Asian American BBS majors were specifically targeted within each institution. Each institutional sample was derived by identifying the total number of URM BBS majors who responded to the 2004 Freshman Survey and then matching that sample with equal numbers of White and Asian American BBS majors and URM non-BBS majors. In the case of several of the MSIs, the project occasionally did not identify a matched sample of White and Asian American BBS majors.

In the spring of 2008, the HERI-based project received funding from NSF to examine URM STEM students' experiences in college. This funding allowed for additional CIRP-participating institutions that produced high numbers of STEM baccalaureates as well as a select set of MSIs to be included in the initial sample of institutions. This project identified institutions that had a minimum of 75 qualifying students who had completed the 2004 Freshman Survey and were distributed across three categories: URM STEM majors, URM non-STEM majors, and White and Asian American STEM majors. These strategies allowed for the inclusion of an additional 80 institutions. In addition, NSF funding allowed for the inclusion of additional students majoring in other science fields, engineering, mathematics, and technology at the 160 institutions initially targeted with NIH funding.

In 2011, HERI researchers followed up with students seven years after college entry to learn more about their specific educational and career pathways using the PBS instrument. The 2011 PBS also gathered information about participants' undergraduate experiences, perceptions, and posttest data on many of the attitudinal and behavioral items collected on the 2004 TFS. For this survey, we began with the original intended sample for the 2008 CSS, which included 240 institutions. HERI researchers then added all 2004 TFS respondents who had indicated on the TFS that they intended to pursue a STEM major (see Appendix A for a list of majors defined as STEM) and had enrolled at an institution that had provided degree information. Our final targeted sample for this survey was 66,080 students across 533 institutions. Of the 57,790 reachable participants, a total of 13,671 participants responded to the survey, which resulted in a response rate of 23.7%. These 13,671 respondents were located across 500 undergraduate institutions when they completed the 2004 Freshman Survey. This study used non-response weighting techniques to adjust for survey non-response bias, which are described later in this chapter.

In addition to the student data sources described above, this study uses IPEDS data and the 2007 and 2010 CIRP Faculty Surveys for institutional variables. IPEDS provides the most comprehensive data available on higher education institutions in the U.S. and allows for the examination of the influence of institutional characteristics on students' democratic outcomes in this study. Including data from the 2007 and 2010 administrations of the CIRP Faculty Surveys helps provide contextual information about faculty goals and instructional strategies on each campus during the time period of the study.

Data Collection. As part of CIRP's annual administration of the TFS, the 2004 CIRP Freshman Survey was administered to all entering first-time, full-time freshmen during the summer before or fall orientation of college at institutions that have entering freshman classes and responded to the U.S. Department of Education's (DOE) Higher Education General Information Survey (since 1986 known as IPEDS- Integrated Postsecondary Education Data System). As mentioned in the previous section, grants from the NIH and NSF provided funds for a targeted sampling strategy in order to best examine the experiences of underrepresented racial minority students majoring in the biomedical and behavioral sciences and STEM disciplines, respectively. The project did not provide any incentives to students to complete the 2004 TFS, however, individual institutions may have provided incentives to their students.

The 2011 Post-Baccalaureate Survey administration process involved web- and paper-based surveys and included several components. HERI researchers sent email invitations to participate in the survey to participants whose emails were on file or whose undergraduate institutions provided updates of students' contact information. HERI researchers tracked emails that bounced back to the sending account in order to identify participants who were unreachable. Students received an initial invitation email with three reminder emails for a maximum of four emails. While these emails were being sent to participants, postcards were also sent to all students in the sample. HERI researchers used an address updating service to update participants' US Postal Service (USPS) address and postcards that were returned to the HERI office as undeliverable were coded as unreachable. A second wave of postcards was sent to non-respondents roughly three weeks after the initial wave. Each postcard contained a unique login ID and a link to a website for students to complete the survey.

After the second wave of postcards, HERI researchers proceeded with additional efforts to improve their chances of getting correct addresses for undeliverable postcards and increase participation. HERI researchers ran participants' information through the address update service again to try to get correct addresses for undeliverable postcards. Afterward, HERI researchers sent paper surveys to all students with USPS addresses who had yet to respond to the survey. In this first round of mailing paper surveys, participants also received a $2 incentive, which they kept regardless of survey response or completion. A second and final wave of paper surveys was sent to non-respondents roughly three weeks after the initial wave of paper surveys was sent. This second round of paper surveys did not include a $2 incentive. Post-Baccalaureate Survey responders received $10 for their participation.

Analytical Sample

The dataset for this study includes 6,341 students whose undergraduate major was in STEM starting out at 271 non-profit four-year undergraduate institutions. This study's specific focus limited the final analytic sample in several ways. First, the sample only includes first-time, full-time freshmen who first enrolled at a four-year college or university in the U.S. Second, the analytic sample was limited to those students who completed a STEM bachelor's degree. Third, given the importance of particular background characteristics (i.e., race/ethnicity, sex), students who never responded to the race/ethnicity and gender questions on either the Freshman Survey or the PBS were deleted from the sample. Additionally, the sample was limited to students who had complete data for the dependent variables. Furthermore, the sample was reduced by eliminating students for which there was no institutional data available on the institutional-level items of interest, and by deleting institutions with fewer than five students.

Variables

This study utilizes a hierarchical design with students clustered within institutions. The independent variables are included from two levels: the student level (level 1) and the institutional level (level 2). Using frameworks of undergraduate socialization during college, generally (Weidman, 1989), and within academic departments, specifically (Vreeland & Bidwell, 1966; Weidman, 1979), as well as findings from previous empirical research, the categories of independent variables examined include background characteristics, pre-college and undergraduate experiences, and institutional characteristics (see Table 3.1 for a complete description of variables and coding procedures). The following subsections further describe each dependent variable and the independent variables used in the study.

Table 3.1 Proposed Variables and Their Coding Schemes

Variables	Coding Description
Dependent Variables	
2011 Social Agency	Continuous
2011 Conducting Research that Will Have a Meaningful Impact on Underserved Communities	1=not important to 4=essential
Background Characteristics	
Race: Black/African American	2= yes, 1=no
Race: Latina/o	2= yes, 1=no
Race: American Indian/Alaska Native	2= yes, 1=no
Race: Asian American/Pacific Islander	2= yes, 1=no
Race: Other	2= yes, 1=no
Gender: Female	1=male, 2=female
Socioeconomic status	Scale of three items: Mother's education (1=grammar school or less to 8=graduate degree); father's education (1=grammar school or less to 8=graduate degree); and parental income (1=less than $10,000 to 14=$250,000 or more)
Either parent's career in STEM	2= yes, 1=no
Pre-college Characteristics and Experiences	

2004 Social Agency	Continuous
Composite SAT score	(Recoded: Divided by 100) Range: 4-16
Average High School GPA	1=D to 8=A or A+
Political Orientation	1=far right to 5=far left
Number of HS Science and Math Courses	Scale of three items: Physical Science (1=none, 7= five or more); Biology (1=none, 7=five or more); Math (1=none, 7=five or more)
Participated in health science research program sponsored by university	2= yes, 1=no
Degree Aspirations: Ph.D./Ed.D.	1= yes, 0=no
STEM Identity	1=not important to 4=essential
Act in the past year: Did community service as part of a class	1=not at all to 3=frequently
Act in the past year: Performed volunteer work	1=not at all to 3=frequently
Act in the past year: Socialized with someone of another racial/ethnic group	1=not at all to 3=frequently
Racial Discrimination is no longer a problem	1=disagree strongly to 4=agree strongly
Undergraduate Experiences	
Academic Discipline	
Undergrad Major: Environmental Science (ref. Biological Sciences)	1= yes, 0=no
Undergrad Major: Computer Science/Tech (ref. Biological Sciences)	1= yes, 0=no
Undergrad Major: Physical Science (ref. Biological Sciences)	1= yes, 0=no
Undergrad Major: Engineering (ref. Biological Sciences)	1= yes, 0=no
Undergrad Major: Health Professional Sciences (ref. Biological Sciences)	1= yes, 0=no
Undergrad Major: Math/Stats (ref. Biological Sciences)	1= yes, 0=no
Faculty Socialization	
Work with a faculty member on his/her research	2= yes, 1=no
Receive mentoring from a faculty member	2= yes, 1=no
Peer Socialization	
Participate in an ethnic or cultural club or organization	2= yes, 1=no
Participate in an academic club or professional association	2= yes, 1=no
STEM Educational/Career Preparation	
Participate in a structured undergrad research program	2= yes, 1=no

Undergrad Perception: Understand the role of science and technology in society	1=very poorly to 5=very well
Post-Undergraduate Experiences	
Grad School: STEM (ref: non-STEM post-college pathway)	2= yes, 1=no
Workforce: STEM (ref: non-STEM post-college pathway)	2= yes, 1=no
Institutional Level Variables	
Structural characteristics	
Control: Private	1=public, 2=private
HBCU	2= yes, 1=no
HSI (25% or more of undergraduates are Latino)	1= yes, 0=no
Institutional Type: Research (ref: masters comp or other baccalaureate institution)	1= yes, 0=no
Institutional Type: Liberal Arts (ref: masters comp or other baccalaureate institution)	1= yes, 0=no
Student Peer Context	
Average entering freshman Social Agency score	Continuous
Proportion of undergrads in STEM majors	Continuous
STEM Faculty Context	
Average of STEM Faculty: Grade on a curve	1=None, 2=Some, 3=Most, 4=All
Average STEM Faculty score on civic-minded values factor	Continuous
Average STEM faculty score on student-centered pedagogy factor	Continuous

Dependent variable 1: Social Agency. The first dependent variable is a factor called social agency, which consists of five items on the 2011 PBS instrument. The factor holds the same name as the CIRP construct of social agency, but only contains five of the six items in the construct as only these five items were included as part of the 2011 PBS instrument. Table 3.2 presents the factors, factor loadings, and reliabilities coefficients for all composite variables described in Table 3.1. The factor was scored using classical test theory and factor loadings were computed using principal axis factoring with promax rotation. The variables comprising the social agency factor are a set of questions that demonstrate whether a student believes being active in the community and improving society is important to her or his life. Students were asked to indicate whether "helping others who are in difficulty," "participating in a community action plan," "becoming a community leader," "helping to promote racial understanding," and "influencing social values" is personally "essential," "very important," "somewhat important," or "not important" to them. Each item in the factor is coded on a 4-point Likert scale (1=Not Important to 4=Essential) and higher values in the factor suggest a greater level of social agency. The questions composing the dependent variable were also asked on the 2004 TFS, which serve as a pre-test measure of students' 2011 social agency.

Table 3.2.
Factor Loadings and Reliability Coefficients for Factors in Multilevel Models

Factor	Items	Alpha Coef.	Loading
2011 Social Agency		0.837	
	Participating in a community action program		0.793
	Helping to promote racial understanding		0.730
	Becoming a community leader		0.728
	Influencing social values		0.695
	Helping others in difficulty		0.614
2004 Social Agency		0.783	
	Take part in a community action program		0.755
	Helping to promote racial understanding		0.676
	Become a community leader		0.645
	Influence social values		0.610
	Helping others in difficulty		0.557
2004 STEM Identity		0.693	
	Obtain recognition from colleagues		0.766
	Become an authority in my own field		0.646
	Make a theoretical contribution to science		0.585
	Work to find a cure for a health problem		0.445
Faculty Civic-Minded Values		0.851	
	Encourage students to become agents of social change		0.842
	Instill in students a commitment to community service		0.811
	Colleges should encourage students to be involved in community service activities		0.732
	Influence social values		0.679
	Colleges have a responsibility to work with their surrounding communities to address local issues		0.654

Colleges should be actively involved in solving social problems		0.482
Faculty Student-Centered Pedagogy	0.884	
Cooperative learning (small groups)		0.805
Student evaluations of each others work		0.764
Student presentations		0.741
Group projects		0.718
Using student inquiry to drive learning		0.687
Reflective writing/journaling		0.663
Class discussions		0.643
Experiential learning/Field studies		0.608
Student-selected topics for course content		0.476

Note: Data are weighted. Factor loadings were computed using principal axis factoring with promax rotation

Dependent variable 2: Conducting Research that Will Have a Meaningful Impact on Underserved Communities. The second dependent variable is a single item on the 2011 PBS instrument and represents students' desire to use research to help improve underserved communities. Students were asked to indicate whether "conducting research that will have a meaningful impact on underserved communities" is personally "essential," "very important," "somewhat important," or "not important" to them. This item is coded on a 4-point Likert scale (1=Not Important to 4=Essential), with a higher value indicating that conducting research that will have a meaningful impact on underserved communities is more important to a given student. This item was not asked on the 2004 TFS, and thus does not have a direct pre-test measure.

Background characteristics. Student background characteristics that are examined in the study include students' racial/ethnic identification, gender, socioeconomic status, and whether the student has a parent who is employed in a STEM field. As indicated by Weidman (1979), background characteristics and parents can have a strong influence on student values. In terms of race and ethnic identification, past research suggests an association between race/ethnic identification and democratic motivations for pursuing STEM majors (Carlone & Johnson, 2007; Garibay, under review; Johnson, 2007a; Newman, 2011). In this study, I examine the significance of racial/ethnic identification by a student's self-identification as Black/African American, Latina/o, American Indian/Alaska Native, Asian American/Pacific Islander, and Other (each measured as: 1=yes, 0=no), with white students as the reference group.

Precollege characteristics and experiences. Students' 2004 (freshman-year) measure of social agency is accounted for in the analyses as prior research has shown that STEM students enter college with lower civic dispositions (e.g., Nicholls et al., 2007) and freshman-year social agency is an important predictor of social agency at the end of college (Astin, 1993; Nelson Laird et al., 2005; Zuñiga et al., 2005). Students' average high school grade and composite SAT scores were included given that previous empirical research has shown a relationship between pre-college academic achievement and social action engagement (e.g., Hurtado et al., 2002). To account for the possible influence of pre-college experiences with science and math, the number of math and science courses a student completed in high school and whether a student participated in a health science research program sponsored by a university are also included in the models. Summer research programs in science during the pre-college years have been shown to impact students' understanding of the nature of science and scientific inquiry (e.g., Bell, Blair, Crawford, & Lederman, 2003; Moss, Abrams, & Kull, 1998; Moss, Abrams, & Robb, 2001; Sadler, Burgin, McKinney, & Ponjuan, 2010).

This study also includes measures of students' political orientation and the extent to which students agree with the statement "Racial discrimination is no longer a major problem in America". Students who identify as more politically liberal have higher social agency at the end of college (Garibay, under review). Additionally, students who believe that discrimination based on race continues to be a major issue in the U.S. may be more inclined to promote a more democratic society through their involvement in society and research. Furthermore, this study controls for freshmen doctoral degree aspirations (Ph.D./Ed.D.) as well as students' 2004 STEM identity, which includes the variables becoming an authority in my field, obtaining recognition for contributions to their field, making a theoretical contribution to science, and finding a cure to a health problem (see Table 3.2; for a detailed description of the science identity factor see Chang et al., 2011). McGee and Keller's (2007) study shows that many Ph.D.-bound students in the life sciences often want to help others indirectly through research as opposed to directly through medical practice. Carlone and Johnson (2007) found that for many science students altruistic motivations are an integral part of their science identity.

Additionally, this study accounted for pre-college experiences with service-learning, volunteering, and socializing with someone of another racial/ethnic group. Previous studies have shown a significant relationship between community service and diversity experiences on students' democratic outcomes (e.g., Astin, 1993a, 1993b; Brown et al., 2007; Chang, 2002; Einfeld & Collins, 2008; Garibay, under review; Gurin, 1999; Gurin et al., 2002; Hurtado, 2003; Milem, 1994; Nelson Laird, 2005). While these experiences measured in this study are not occurring within the college context, they are important to control for to account for a possible long-term impact of precollege experiences with diversity and community service and may also serve as proxies for students' likelihood of having these experiences in college.

Undergraduate experiences. Various undergraduate experiences are included in the study. This study examines the effect of students' undergraduate STEM major by including whether a student's senior-year major was environmental science, computer science/tech, physical science, engineering, health professional science, or math/statistics, with biological sciences serving as the reference group (see Appendix A for a list of STEM major groupings). These various STEM majors are included given the heterogeneity among fields within STEM (e.g., Antony, 1998; Astin, 1993; Sax, 2000) and to test whether there are differences in democratic outcomes among students who major in these fields. There is evidence that environmental science and health science fields often have a social justice leaning and seem to align with the democratic dispositions and outcomes of students (e.g., Antony, 1998; Littledyke, 2008; Stevenson, 2007; Vincent & Focht, 2011). Given that professors are important socializing agents that can influence student values (Weidman, 1979), the study included experiences such as receiving mentorship from a faculty member and working on a professor's research project to explore how these types of interactions with faculty may influence students on these two different types of democratic outcomes.

Participating in a structured undergraduate research program is also included in the models. As demonstrated in Chapter 2, participation in research has been extensively examined with respect to traditional measures of success, including STEM graduate school aspirations and matriculation, yet has been under-examined with respect to participants' democratic outcomes (Garibay, under review). Previous studies suggest that these research experiences may provide important contexts that may have an influence on STEM students' democratic outcomes. Participation in an academic club or professional association and participation in an ethnic or cultural club or organization are also included in the study given that involvement in these organizations may also influence students' democratic outcomes as noted in Chapter 2. Students' perception of whether their undergraduate institution prepared them to understand the role of science and technology in society is included as a proxy for STEM departments that have courses or co-curricular experiences that provide students the ability to make connections between science and social issues. These courses and co-curricular experiences (e.g., service-learning) have been implemented in many STEM departments to help develop STEM students' democratic outcomes (e.g., Baillie et al., 2011; Middlecamp et al., 2006).

Post-Undergraduate Experiences. Given that the dependent variables were collected several years after students completed their undergraduate studies, it is important to control for post-undergraduate experiences as it would help to account for any possible influences of post-undergraduate experiences on the dependent variables. Controlling for post-undergraduate experiences would allow for more accurate results of the effects of undergraduate experiences on the dependent variables of interest. This study includes whether a STEM bachelor's degree recipient entered into the STEM workforce (and had yet to enroll in a graduate or professional program), was enrolled in or completed a STEM graduate or professional program, or pursued a non-STEM post-undergraduate pathway as these post-undergraduate trajectories may influence students' democratic outcomes seven years after college entry.

Institutional characteristics. Institutional level characteristics can influence a variety of student outcomes (Weidman, 1989). This study accounts for various structural characteristics including institutional control, institutional type (research/doctoral or liberal arts compared to comprehensive/masters and other/general baccalaureate), and whether the institution is an HBCU or Hispanic Serving Institution (compared to predominantly white institutions). Additionally, guided by Weidman's (1989) and Vreeland and Bidwell's (1966) frameworks of undergraduate socialization, this study includes measures of peer and faculty normative contexts to account for possible variations in institutional contexts. Peer normative contexts included in the study are the proportion of undergraduates in STEM majors and the institutional aggregate of 2004 social agency for all entering freshmen from the original TFS sample. To account for variations in STEM faculty normative contexts this study includes the percentage of STEM faculty who grade on a curve, the average STEM faculty score on the student-centered pedagogy factor, and the average STEM faculty score on the civic-minded values factor. These factors were created using STEM faculty data from both the 2007 and 2010 CIRP Faculty surveys to allow for a greater representation of STEM faculty and institutions in the study, and given that this important faculty information was collected during the duration of the study (see Table 3.2).

Analyses

This study used several analytical techniques to examine the factors influencing students' democratic outcomes 7 years after college entry. First, to adjust for any possible non-response bias in the PBS, non-response weights were applied to the data. Second, a series of descriptive analyses were examined to better understand the characteristics of students and institutions in the analytical sample. These descriptive analyses helped to understand possible relationships between independent variables in addition to their relationship with the two dependent variables. During these descriptive and preliminary analyses, factors analyses, cross-tabulations, and correlations among the dependent variables were conducted. Then, given missing data, appropriate techniques for handling cases with missing values were applied. Finally, after adjusting the sample for non-response bias and missing data, and running descriptive analyses to better understand the data and detect any assumptions violations, multilevel modeling statistical techniques were conducted. Further details regarding each portion of the analytic process are described in the following subsections.

Analytic weights. Data weights are used to modify a set of respondents to look more like the original population targeted by the survey (Babbie, 2001). To account for any potential non-response bias present in the data, non-response weights were applied to adjust the 2011 PBS sample of respondents upward to look more like the original target sample of Freshman Survey

(TFS) respondents. The non-response weights were already created and the weighting process occurred in multiple steps.

First, the EM algorithm was used to account for missing data on key variables from the 2004 Freshman Survey as these variables were used in the creation of the weights. Then, a logistic regression was conducted to predict the probability of responding to the 2011 Post-Baccalaureate Survey (PBS) using predictors from the 2004 Freshman Survey. The products of variables' values and their predicted log odds were included in the regression equation to calculate the probability of responding to both the 2004 Freshman Survey and 2011 Post-Baccalaureate survey. The general formula for developing a non-response weight is:

weight= 1/(probability of response) (3.1)

Once these weights were calculated, the weighted 2011 PBS respondent sample was compared with the un-weighted target sample from 2004 to determine whether the weight inappropriately skewed any of the 2004 Freshman Survey variables. This comparison confirmed that that the weight had not inappropriately skewed distributions of variables from the 2004 Freshman Survey. Finally, a normalized weight, which accounted for sample sizes, was created to prevent the inflation of any t-statistics calculated in regressions or other analyses on the weighted sample.

Missing data. It is important to account for missing data before conducting statistical analyses as results could otherwise be biased. In analyzing the extent to which missing data occurred at the student level, no variable surpassed the acceptable range for missing data (15%; Allison, 2002; Little & Rubin, 2002). For those variables that had missing data, the percent missing ranged from 0.3 to 9.9%. In fact, only five variables had greater than 3.4% of data missing. The variable with the greatest percentage of missing data was socio-economic status (9.9%).

I utilized Little's MCAR test to analyze whether the data were missing completely at random (MCAR). Little's MCAR test (Chi-square= 1387.842, df=1,183, $p<0.001$) revealed that the missing data are not MCAR. The less rigorous assumption about the pattern of missingness is that the missing data are missing at random (MAR). If the missing data are MAR, the pattern of missingness seems to depend on some, but not all of the variables in the data set (Enders, 2010; Little & Rubin, 2002). Additionally, the missing data for a variable are MAR if the likelihood of missing data on the variable is not related to the participant's score on the variable, after controlling for other variables in the study (Acock, 2005). Given that it is very difficult to determine if the data are MAR and there is no way to test whether MAR holds in a dataset, unless one obtains follow-up data from non-respondents or by imposing an unverifiable model (Schafer & Graham, 2002), most research using missing data procedures relies on this assumption.

To preserve the full dataset, this study applied multiple imputation (MI) to impute missing values as missing data may provide a source of variation (Sinharay, Stern, & Russell, 2001) that is not accounted for when using a single imputation for missing values. While all imputation methods have limitations (Little & Rubin, 2002), multiple imputation was used in this study as MI is currently one of the best methods for handling missing data in studies using multivariate statistics (Allison, 2000) and can provide a more precise estimate of standard errors of parameter estimates (Little & Rubin, 2002). Additionally, MI has been recommended to be the first choice method for handling missing data for higher education quantitative researchers (Cox, McIntosh, Reason, & Terenzini, 2014) and the HLM 6.08 software is capable of handling multiply imputed datasets.

The multiple imputation procedure in SPSS Version 20 was used to impute the missing data. A total of five imputed datasets were created, which has been suggested to be a sufficient number of datasets on theoretical grounds (Allison, 2000). Key settings for the imputation modeling include: Mersenne Twister random number generators with the active generator initialization at the fixed default value, the automatic imputation method to allow SPSS to select the appropriate technique, allowed 2000 model parameters. The variables included in the imputation procedure are included in Appendix B.

Descriptive and Preliminary Analyses. A series of descriptive analyses were examined to better understand the characteristics of students and institutions in the analytical sample prior to analyzing the data using multilevel modeling techniques, including frequencies, correlations, and cross-tabulations. During these analyses I examined possible relationships between independent variables and paid particular attention to possible multi-collinearity between independent variables and other assumptions violations. I used factor analyses to explore factors presented in Table 3.1 and the results are presented in Table 3.2. I also created several scales, which are also presented in Table 3.1. These factors and scales were analyzed further in preliminary, descriptive, and multilevel analyses.

Multilevel Modeling. In order to test this study's hypotheses that democratic outcomes significantly vary within and between institutions, and that student-level and institutional-level factors predict STEM students' social agency and values toward conducting research that will have a meaningful impact on underserved communities seven years after college entry, this study utilizes a series of multilevel models. Multilevel modeling represents a robust statistical technique to analyze clustered data. While data for this study are not perfectly hierarchical as the PBS was administered roughly 2-3 years after students graduated from college where individuals are in multiple contexts (i.e., possibly in the workforce, graduate or professional school, or even both), this study uses a multilevel approach given that individuals were nested within higher education institutions for their undergraduate years. Given that individuals in the dataset are nested within higher education institutions, there is greater homogeneity in their responses within schools rather than if individuals had been selected randomly from the entire population.

In multilevel data the assumption of independence of observations, which conventional multivariate regression analyses depend heavily on, is usually violated which produces biased estimates for standard errors that are too small and leads to many erroneous 'significant' results (Hox, 2010). Multilevel modeling accounts for the homogeneity of errors within groups and provides robust standard errors, which helps prevent researchers from making a Type I statistical error (Raudenbush & Bryk, 2002). By partitioning the variance occurring at the individual, or student level, and the group, or institutional level, multilevel modeling more accurately identifies significant predictors of the dependent variable for multiple levels of observation and analysis (Raudenbush & Bryk, 2002). Multilevel modeling also allows for the examination of cross-level effects, which helps to analyze how an individual predictor may be moderated by an institutional-level variable.

In order to ensure the use of multilevel modeling is warranted, a fully unconditional model (the null model) was fit for each dependent variable to assess whether students' average values on the two dependent variables varied across the sample institutions, which helped to answer Hypotheses I. The simplest two-level model is a fully unconditional model as no predictor variables are specified at student-level or institutional-level. The fully unconditional model at the student level is represented as:

$$Y_{ij} = \beta_{0j} + e_{ij}, \tag{3.2}$$

where Y_{ij} is the outcome score on social agency and importance of conducting research that will have a meaningful impact on underserved communities for student i attending institution j; β_{0j} is the mean of the outcome measure for institution j; and e_{ij} is the level one residual which is assumed to be normally distributed with a mean of zero and a constant variance of σ^2.

The fully unconditional model at the institution-level is represented by:

$$\beta_{0j} = \gamma_{00} + u_{0j}, \tag{3.3}$$

where γ_{00} is the overall mean of the outcome measures and $u_{0\text{j}}$ is the level two residual which is assumed to be normally distributed with a mean of zero and a constant variance of τ_{00}.

In HLM, the intra-class correlation coefficient (ICC) is used to show the proportion of variance between institutions (Raudenbush, Bryk, Cheong, & Congdon, 2004). To calculate the ICC, values from the fully unconditional model are used in the ICC formula, which is given by:

$$\text{ICC} = \frac{\tau_{00}}{\sigma^2 + \tau_{00}} \tag{3.4}$$

where τ_{00} represents the variability between level 2 units and σ^2 is the variability between level 1 units. An ICC of any size in large samples can increase the probability of making a Type-I statistical error (de Leeuq & Meijer, 2008; Barcikowski, 1981). Ignoring a small ICC in this study by performing single-level analyses with multilevel data is likely to be problematic in the ability to accurately interpret results.

In order to answer Hypotheses II and Hypotheses III, student-level and institutional-level variables were then added to the multilevel models. Using Raudenbush and Bryk's (2002) formulation for presenting HLM, the level 1 models are given by:

$$Y_{ij} = \beta_{0j} + \beta_{1j}\,(\text{Background Characteristics})_{ij}$$
$$+ \beta_{2j}\,(\text{Precollege Characteristics and Experiences})_{ij}$$
$$+ \beta_{3j}\,(\text{Undergraduate Experiences})_{ij} + \beta_{4j}\,(\text{Post-Undergraduate Experiences})_{ij} + e_{ij}\,,$$
$$e_{ij} = N(0,\sigma^2) \qquad (3.5)$$

where Y_{ij} represents the outcome measures of social agency and importance of conducting research that will have a meaningful impact on underserved communities for student i attending institution j; β_{0j} is the mean of the outcome measure for institution j; and e_{ij} is the level one residual which is assumed to be normally distributed with a mean of zero and a constant variance of σ^2. Each block of variables is presented in Table 3.1. Equation 3.5 is simplified, presenting the general form of the level 1 equation rather than giving the specific equations for each of the four variable blocks.

The level 2 model is given by:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\,(\text{Institutional Characteristics})_j + u_{0j}\,,\;\; u_{0j} = N\,(0,\tau_{00}) \qquad (3.6)$$

where γ_{00} is the overall mean of the outcome measures and u_{0j} is the level two residual which is assumed to be normally distributed with a mean of zero and a constant variance of τ_{00}. Similar to the level 1 equation, Equation 3.6 is simplified, with the vector "institutional characteristics" referring to that variable block rather than giving the specific equation. Finally, a series of cross-level interactions were conducted in order to test Hypotheses IV.

Additional Modeling Considerations. In using multilevel modeling techniques it is important to describe how variables are centered in the analyses as centering impacts how individual parameters and intercepts are interpreted (Raudenbush & Bryk, 2002). This study used grand-mean centering for all variables except for the dichotomous variables. Grand-mean centering subtracts a variable's value for each individual observation by the variable's mean value of the entire sample (Porter & Umbach, 2006), which adjusts for between-group (institution) differences in student-level variables (Raudenbush & Bryk, 2002). Since dichotomous variables are not centered in the study, the parameter associated with a dichotomous variable represents how that particular value compared to the reference group in terms of the outcomes. Continuous variables were centered around the grand mean. This centering option facilitates the interpretation of the intercept in the model considering that in this study I am interested in conclusions about the overall sample of students (Raudenbush & Bryk 2002).

Limitations

As with any study, this research study is limited in several ways. First, given this study's use of secondary data, the variables used in the study are limited to those available in the datasets. Many important student experiences that the STEM undergraduate literature describes as providing critical opportunities to help STEM students develop democratic outcomes, including whether students participated in STEM-related race/cultural organizations or clubs, whether students enrolled in a course that connects science and social issues, whether they participated in service-learning during college, and student's experiences with diversity during college are unavailable in the dataset. Similarly, the study does not control for many additional post-college experiences (aside from entering the STEM workforce and enrolling in a STEM graduate or professional program) that may have contributed to students' democratic outcomes, which are measured roughly 2-3 years after completing their bachelor's degree. Moreover, despite the fact that many STEM degrees are increasing in complexity as emerging fields become interdisciplinary in nature (i.e., bio-mechanical engineering, sustainability), the study does not explore these interdisciplinary STEM majors given limitations to the selection of major on the PBS survey instrument. The study also does not account for double-majors, and such experiences would likely socialize students differently depending on the two chosen majors.

A second limitation of the study relates to the longitudinal response rate from the two student surveys, which is relatively low. Although methods were used to try to correct for non-response bias by weighting the data, the low response rate for the 2011 PBS may inappropriately bias the data and results. Thus, generalization of the study's results beyond this study's sample must be done with caution.

Related to the issue of sample generalizability, this study uses a threshold of at least five students per institution for inclusion in the analyses as HLM requires variation in the outcome variable within and between groups. This threshold dropped the sample from 6,977 students within 462 institutions to 6,605 students within 288 institutions. Additionally, many institutions did not participate in either of the HERI faculty surveys, which further required me to eliminate institutions from the study. Including HERI faculty data reduced the sample to 6,438 students within 272 institutions. After deleting students who had missing data on the dependent variables of interest, the final analytic sample included 6,341 students within 271 institutions. This sample had complete data on both dependent variables and had at least five students per institution.

Nonetheless, this study extends previous research on the development of STEM students' democratic outcomes. The following chapters will present the results of both multilevel models predicting the two democratic outcomes of interest among STEM bachelor's degree recipients. The final chapter will then provide a discussion of the findings along with their implications for future research, policy, and practice.

CHAPTER 4: RESULTS

This chapter reviews the results from the descriptive analyses and multilevel models used to examine predictors of STEM degree recipients' social agency and importance of conducting research that will have a meaningful impact on underserved communities seven years after college entry. The study is guided by prior empirical scholarship and theories of undergraduate student socialization (Vreeland & Bidwell, 1966; Weidman, 1989, 1979) described in Chapter 2. The following research questions are addressed in the sections that follow:

1. To what extent do STEM bachelor's degree recipients' social agency and value toward conducting meaningful research vary within and between institutions?

2. Controlling for background characteristics and precollege characteristics and experiences, how do undergraduate socialization experiences with academic disciplines, faculty, and peers contribute to the (a) social agency and (b) the importance of conducting meaningful research of STEM bachelor's degree recipients seven years after college entry?

3. Controlling for individual characteristics and experiences, how do institutional factors such as structural characteristics, peer-context, and STEM faculty context contribute to the (a) social agency and (b) the importance of conducting meaningful research of STEM bachelor's degree recipients seven years after college entry?

4. Are any of the effects of undergraduate socialization experiences on STEM bachelor's degree recipients' (a) social agency and (b) values toward conducting meaningful research moderated by institutional factors?

The chapter begins with descriptive statistics of the dependent variables and analysis of the relationships between the two dependent variables of interest: 2011 social agency and 2011 measure of individuals' level of importance placed on conducting research that will have a meaningful impact on underserved communities. These results provide important details about how the two outcomes are similar, yet distinct for STEM bachelor's degree recipients. Following a discussion of the relationship between the two dependent variables, the chapter provides a descriptive overview of the student and institutional sample. The next major section of the chapter presents the findings from the multilevel models. These results specifically address research questions 1 through 4. Then, the chapter provides a comparison of the results across the two final models and describes common predictors and differences between the final models predicting STEM bachelor's degree recipients' social agency and values toward conducting meaningful research. The final section provides a general summary of the results of the chapter.

Examination of the Dependent Variables

Descriptive Statistics

Figure 4.1 presents the descriptive statistics of the dependent variables. For these analyses the social agency outcome, which is a continuous variable (Min: -1.65, Max: 2.19), was recoded into three categories: high, moderate, and low. These three categories each represent one-third of the continuous range of the social agency outcome. The four categories in the conducting meaningful research variable were also recoded into three categories (the very important and essential categories were grouped together) to allow for easier comparison with the social agency variable.

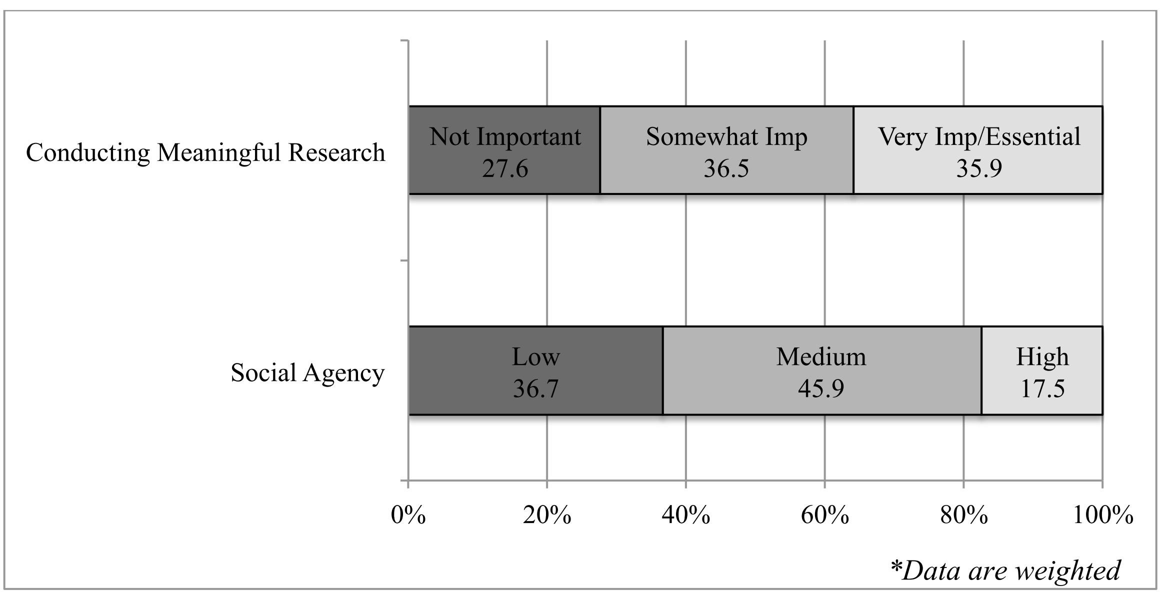

Figure 4.1. Percent 2011 Social Agency and Values Toward Conducting Meaningful Research (N=6,341).

The results in Figure 4.1 show that, overall, 17.5 percent of STEM bachelor's degree recipients had high social agency while 35.9 percent felt that conducting meaningful research was very important or essential. Likewise, a much higher proportion of STEM bachelor's degree recipients had low social agency (36.7%) than believing that conducting meaningful research was not important to her or him (27.6%). Overall, these results suggest that a large proportion of STEM bachelor's degree recipients do value making a positive impact on society, but would rather make this impact through conducting research as opposed to sociopolitical involvement. These results may also suggest that attaining high levels of social agency may be more difficult to achieve for STEM bachelor's degree recipients compared to attaining a higher value toward conducting meaningful research.

Figure 4.2 shows the percentage of individuals who had "high" social agency and believed conducting meaningful research was "essential or very important" disaggregated by STEM major and whether the student was white/other or a Student of Color (i.e., American Indian/Alaska Native, Asian American/Pac Islander, Black/African American, Latina/o). The high social agency and high values toward conducting meaningful research of biological science majors somewhat inflates the results for the overall sample of STEM bachelor's degree recipients shown in Figure 4.1. The table shows differences between academic majors, as well as differences between Students of Color and white/other students within and between academic majors. White/other students who majored in computer science/technology and engineering have the lowest rates across both dependent variables. Students of Color who majored in biological science have the highest values toward conducting meaningful research, while those in environmental science have the highest social agency seven years after initial college entry.

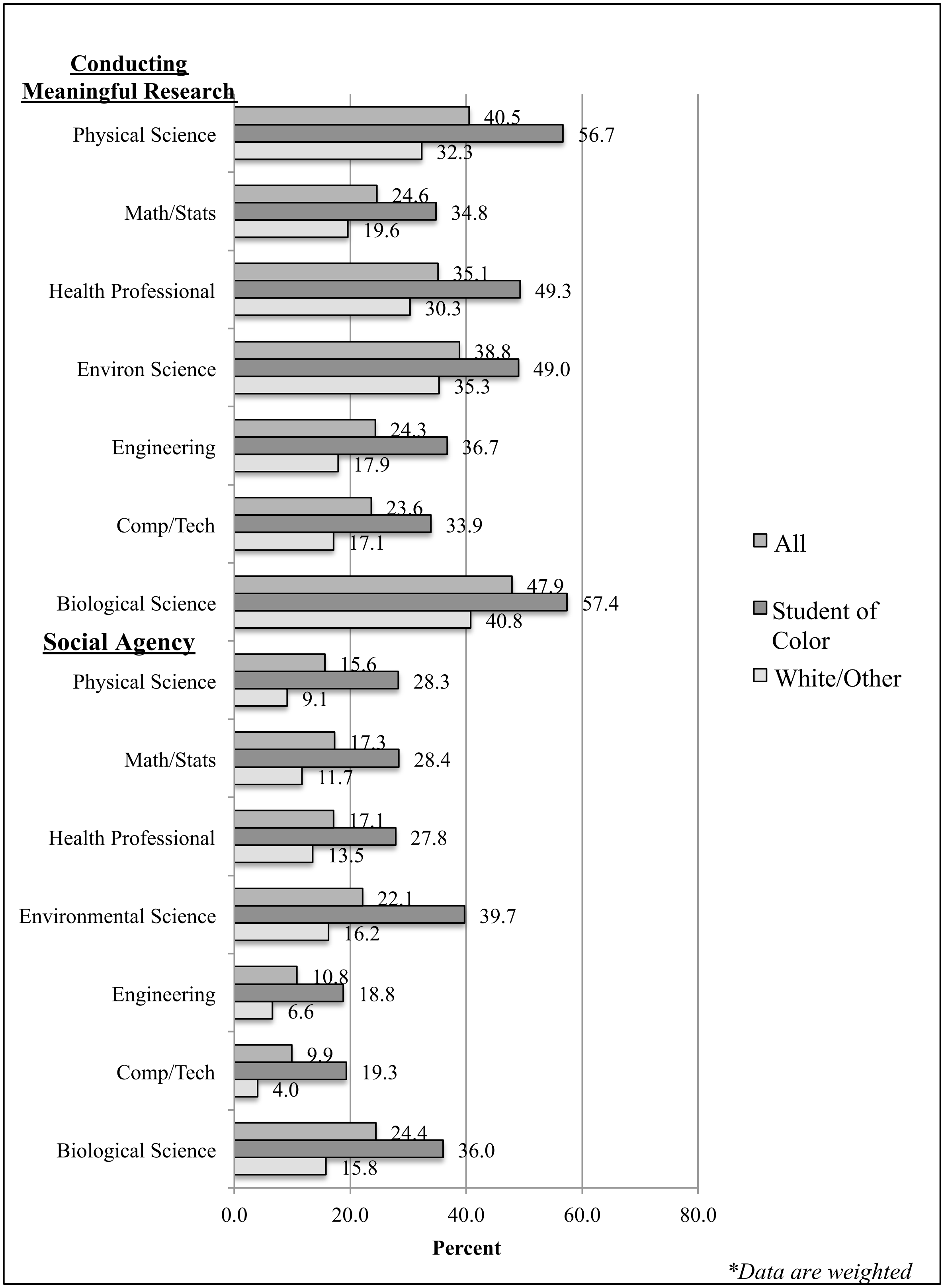

Figure 4.2. Percent Indicating "Essential/Very Important" on Conducting Meaningful Research and "High" on Social Agency by Undergraduate STEM Major and Race/Ethnicity (N=6,341)

Relationship Between the Dependent Variables

To examine the relationship between the two outcome measures, Social Agency and Importance of Conducting Meaningful Research, a Pearson product-moment correlation (pairwise) was conducted along with cross tabulations. The value of the Pearson correlation coefficient indicates a relatively strong positive relationship between the two outcome measures ($r=.568$; $p<.001$; $n= 6,341$) and the level of statistical significance shows that this finding is very unlikely to happen by chance. While there is a positive relationship between the two outcome measures, they do seem to measure something uniquely different.

In order to better understand how these two dependent variables are different for STEM bachelor's degree recipients, two sets of cross tabulations were conducted. Table 4.1 shows the percentage of individuals who have high, moderate, and low levels of social agency broken down by three categories of conducting meaningful research (the very important and essential categories were grouped together). This first set of cross-tabulations allow one to examine how specific values towards conducting meaningful research may convey specific levels of social agency for STEM bachelor's degree recipients. Results from Table 4.1 show that only 36.3% of the 2,191 STEM degree recipients who believe conducting meaningful research is "very important/essential" have a "high" level of social agency. A majority (63.7%) of those STEM degree recipients who believe conducting meaningful research is "very important/essential" have either "medium" or "low" levels of social agency. While having high values toward conducting meaningful research (i.e., very important/essential) does not necessarily translate to having "high" social agency for STEM bachelor's degree recipients, having low values toward conducting meaningful research (i.e., not important) does seem to translate into having "low" levels of social agency for this group. As shown in Table 4.1, over 71 percent of STEM bachelor's degree recipients who believe conducting meaningful research is "not important" also have a "low" level of social agency.

Table 4.1
Percent 2011 Social Agency by Conducting Meaningful Research (N=6,341)

	Conducting Meaningful Research		
Social Agency	Very Imp/Essential (n=2191)	Somewhat Imp (n=2348)	Not Imp (n=1802)
High	36.3	9.7	3.2
Medium	50.7	56.8	25.2
Low	13.0	33.4	71.6

Note: Data are weighted

In order to better understand how levels of social agency may convey specific values towards conducting meaningful research, Table 4.2 shows the percentage of individuals who reported that conducting meaningful research is very important or essential, somewhat important, or not important to them by their level of social agency. Interestingly, results from Table 4.2 indicate that 74.6% of STEM degree recipients who have a "high" level of social agency also believe conducting meaningful research is "very important/essential" to them. Also, over forty-five percent of STEM bachelor's degree recipients with a "medium" level of social agency believe conducting meaningful research is "somewhat important" to them, and nearly forty percent of them believe conducting meaningful research is "very important/essential." Thus, a large proportion of those with "medium" social agency actually place a "high" level of importance (i.e., very important or essential) on conducting meaningful research. Interestingly, having a low level of social agency does not necessarily mean one also places no importance on conducting meaningful research for STEM bachelor degree recipients as 46% of individuals who have a "low" level of social agency believe conducting meaningful research is "somewhat important" or "very important/essential" to her or him.

Table 4.2
Percent Conducting Meaningful Research by 2011 Social Agency (N=6,341)

Conducting Meaningful Research	Social Agency		
	High (n=1001)	Medium (n=2922)	Low (n=2418)
Very Imp/Essential	74.6	39.6	12.7
Somewhat Imp	20.4	45.2	33.3
Not Imp	5.0	15.2	54.0

Note: Data are weighted

On one hand, these results seem to suggest that STEM degree recipients who have "high" social agency are likely to believe conducting meaningful research is "very important/essential," but individuals who believe conducting meaningful research is "very important/essential" are not necessarily likely to have "high" social agency. On the other hand, these results indicate that STEM degree recipients who believe conducting meaningful research is "not important" to her or him are also likely to have "low" social agency, but only slightly more than half (54%) of individuals who have "low" social agency also believe conducting meaningful research is "not important" to her or him. Thus, while the Pearson product-moment correlation shows that the two dependent variables have a relatively strong positive relationship, the two sets of cross-tabulations provide more nuances as to how categories of the dependent variables are related.

Descriptive Statistics of All Variables in Multilevel Models

This section presents the descriptive statistics of both the student and institutional samples including the minimum and maximum values, mean, and standard deviations.

Student-level descriptive statistics

Table 4.3 shows the descriptive statistics for the dependent and independent variables included in the HLM analyses. The table shows the mean and standard deviations of both the non-imputed (original) and imputed data to show the results of the multiple imputation. Overall, there were no substantial changes to the mean and standard deviations of the variables that were

Table 4.3

Level-1 Descriptive Statistics

			Non-Imputed Data			Imputed Data (n=6341)	
	Min	Max	N	Mean	S.D.	Mean	S.D.
Dependent Variables							
2011 Social Agency	-1.65	2.19	6341	-0.02	0.91	-0.02	0.91
2011 Conducting Meaningful Research	1.00	4.00	6341	2.20	0.97	2.20	0.97
Background Characteristics							
Race: Black/African American	1.00	2.00	6341	1.10	0.30	1.10	0.30
Race: Latina/o	1.00	2.00	6341	1.10	0.30	1.10	0.30
Race: American Indian/Alaska Native	1.00	2.00	6341	1.03	0.16	1.03	0.16
Race: Asian American/Pacific Islander	1.00	2.00	6341	1.14	0.35	1.14	0.35
Race: Other	1.00	2.00	6341	1.02	0.13	1.02	0.13
Gender: Female	1.00	2.00	6341	1.47	0.50	1.47	0.50
Socioeconomic status	3.00	30.00	5714	20.59	5.40	20.54	5.36
Either parent's career in STEM	1.00	2.00	6218	1.36	0.48	1.36	0.48
Pre-college Characteristics and Experiences							
2004 Social Agency	-1.59	2.63	6123	-0.01	0.89	-0.01	0.89
SAT score	6.10	16.00	5831	12.44	1.61	12.39	1.62
Average High School GPA	2.00	8.00	6293	7.08	1.12	7.07	1.12
Political Orientation	1.00	5.00	6143	3.06	0.84	3.06	0.84
Number of HS Science and Math Courses	3.00	21.00	6197	13.85	1.73	13.85	1.75
Participated in health science research program sponsored by university	1.00	2.00	6257	1.05	0.21	1.05	0.21
Degree Aspirations: Ph.D./Ed.D.	0.00	1.00	5790	0.26	0.44	0.26	0.44
STEM Identity	-1.92	1.92	6136	-0.004	0.86	-0.003	0.86
Act in the past year: Did community service as part of a class	1.00	3.00	6268	1.68	0.72	1.68	0.72
Act in the past year: Performed volunteer work	1.00	3.00	6268	2.20	0.64	2.20	0.64
Act in the past year: Socialized with someone of another racial/ethnic group	1.00	3.00	6272	2.68	0.51	2.68	0.51
Racial Discrimination is no longer a problem	1.00	4.00	6204	1.96	0.78	1.96	0.78
Undergraduate Experiences							
Undergrad Major: Environmental Science	0.00	1.00	6341	0.03	0.16	0.03	0.16
Undergrad Major: Computer Science/Tech	0.00	1.00	6341	0.05	0.23	0.05	0.23
Undergrad Major: Physical Science	0.00	1.00	6341	0.08	0.27	0.08	0.27
Undergrad Major: Engineer	0.00	1.00	6341	0.31	0.46	0.31	0.46
Undergrad Major: Health Professional Sciences	0.00	1.00	6341	0.12	0.32	0.12	0.32
Undergrad Major: Math/Stats	0.00	1.00	6341	0.05	0.21	0.05	0.21
Undergrad Major: Biological Sciences	0.00	1.00	6341	0.37	0.48	0.37	0.48
Work with a faculty member on his/her research	1.00	2.00	6294	1.44	0.50	1.44	0.50

Table 4.3 (cont.)

	Min	Max	Non-Imputed Data			Imputed Data (n=6341)	
			N	Mean	S.D.	Mean	S.D.
Receive mentoring from a faculty member	1.00	2.00	6289	1.65	0.48	1.65	0.48
Participate in a structured undergrad research program	1.00	2.00	6259	1.18	0.39	1.18	0.39
Participate in an ethnic or cultural club or organization	1.00	2.00	6269	1.33	0.47	1.33	0.47
Participate in an academic club or professional association	1.00	2.00	6280	1.66	0.47	1.66	0.47
Undergrad Perception: Understand the role of science and technology in society	1.00	5.00	6324	4.10	0.90	4.10	0.90
Grad School: STEM	1.00	2.00	5756	1.37	0.48	1.39	0.49
Workforce: STEM	1.00	2.00	5845	1.25	0.43	1.27	0.44

Note: Data are weighted

imputed. This subsection will describe the mean and standard deviations of the imputed data, which was used for the HLM analyses.

Women composed of 47% of the sample and 36% of individuals in the sample had at least one parent who worked in a STEM-related career. Individuals identifying as Black/African American, Latina/o, American Indian/Alaska Native, Asian American/Pacific Islander, White, and "Other race/ethnicity" comprised 10%, 10%, 3%, 14%, 61%, and 2% of the sample, respectively. In terms of pre-college characteristics and experiences, the results in Table 4.3 show that the average combined math and verbal SAT score for students in the sample was 1238.74, 5% had participated in a health science research program sponsored by a university during high school, and 26% aspired to a Ph.D. or Ed.D. The mean high school GPA of 7.07 indicates that, on average, students entered college with a high school GPA that fell slightly above an A- and a mean of 3.06 on political orientation indicates that, on average, individuals in the sample entered college with a political orientation that was "middle of the road". Additionally, individuals in the sample, on average, disagreed somewhat at college entry with the view that racial discrimination is no longer a problem in America. Regarding acts during their senior-year of high school, individuals in the sample, on average, had participated in community service as part of a class between not-at-all and occasionally, had performed volunteer work occasionally, and had socialized with someone of a different race/ethnicity that fell between occasionally and frequently.

In terms of undergraduate experiences, environmental science, computer science/technology, physical science, engineering, health professional science, math/statistics, and biological science majors comprised of 3%, 5%, 8%, 31%, 12%, 5%, and 37% of the sample, respectively. Additionally, during their undergraduate studies 44% had worked with a faculty member on her/his research, 65% received mentoring from a faculty member, 18% participated in a structured undergraduate research program, 33% participated in an ethnic or cultural club or organization, and 66% had participated in an academic club or professional association. On average, individuals in the sample felt that their undergraduate institution had prepared them to understand the role of science and technology in society more than adequately. Finally, 39% of individuals in the sample entered or completed a STEM graduate or professional program, and 27% are employed in a STEM-related career and have yet to enter or complete a STEM graduate or professional program.

Institutional Descriptive Statistics

Table 4.4 provides the descriptive statistics for the institutional sample of 271 colleges and universities. Of the institutions represented in the study 65% were private institutions, 37% were research universities, and 21% were liberal arts institutions. With respect to minority-serving characteristics, 3% of institutions in the sample were HBCUs and 3% were HSIs. The undergraduate student body in the average institution was composed of 15% STEM majors. Finally, in the average institution represented in the sample, STEM faculty, on average, graded on a curve in some of the undergraduate courses they taught.

Table 4.4
Level-2 Descriptive Statistics (N=271)

	Min	Max	Mean	SD
Institutional Level Variables				
Control: Private	1.00	2.00	1.65	0.48
HBCU	1.00	2.00	1.03	0.17
Institutional Type: Research (ref: masters comp)	0.00	1.00	0.37	0.48
Institutional Type: Liberal Arts (ref: masters comp)	0.00	1.00	0.21	0.41
HSI (25% or more of undergraduates are Latino)	0.00	1.00	0.03	0.18

Average entering freshman Social Agency score	42.09	57.10	48.24	2.03
Proportion of undergrads in STEM majors	0.00	0.91	0.15	0.13
Average of STEM Faculty: Grade on a curve	1.00	3.75	1.83	0.46
Average STEM faculty score on civic minded values factor	-3.52	3.80	0.26	1.05
Average STEM faculty score on student-centered pedagogy factor	-3.92	4.22	0.30	1.06

Multilevel Model Results

The modeling process, which was described in Chapter 3, occurred in several stages to address the research questions presented at the beginning of the chapter. Initially, a fully unconditional model for each dependent variable was run to address the first research question and these results are presented in the first subsection. As described in Chapter 3, fully unconditional models contain no independent predictors and allow the level 2 intercept to vary across institutions. This analyses allows the researcher to determine the proportion of variance in the dependent variable that is explained by each level and whether multilevel modeling is warranted.

Then, the conditional multilevel models for each dependent variable are presented in separate subsections. First, the multilevel model results are presented for the social agency dependent variable, and this subsection addresses research questions 2a, 3a, and 4a. Second, the multilevel model results for the model predicting values toward conducting meaningful research are presented, and this subsection addresses research questions 2b, 3b, and 4b. These subsections review the significant predictors of each of the dependent variables.

The model for each dependent variable includes eight blocks of variables that correspond to the conceptual model presented in Chapter 3: (a) background characteristics, (b) pre-college characteristics and experiences, (c) academic discipline, (d) faculty socialization, (e) peer socialization, (f) STEM educational/career preparation, (g) post-undergraduate experiences, and (h) institutional contexts. In the model building process, these eight blocks of variables were entered in four stages and the results are presented across these four sub-models: background and pre-college characteristics, undergraduate experiences, all student-level predictors, and the full model with all level-1 and level-2 predictors. The first model included students' background/pre-college characteristics and pre-college experiences. The second model added all of the undergraduate experience variables. The third model added the post-undergraduate experience variables. The fourth model, which reflects the final model and addresses research questions 2 and 3 for each dependent variable, added individuals' undergraduate institutional contexts. After building the multilevel models, a series of cross-level interactions were tested to determine whether any of the significant undergraduate experiences had differing effects based upon any institutional contexts. The analyses of cross-level interaction effects address research question 4 for each dependent variable (4a and 4b).

Unconditional HLM results

The multilevel models examine predictors of STEM degree recipients' social agency and values toward conducting meaningful research. The fully unconditional models for each dependent variable were analyzed to address research question one, which asked: "To what extent do STEM bachelor's degree recipients' social agency and value toward conducting meaningful research vary within and between institutions?" Intra-class correlation coefficients (ICCs), which were described in Chapter 3, were calculated for each of the two dependent variables. Table 4.5 presents the initial level-2 variance components for each of the dependent variables and their associated ICCs, chi-square statistics, and significance levels. The results in Table 4.5 suggest that significant between-institution variation exists in STEM degree recipients' social agency and value toward conducting meaningful research. For the social agency unconditional model, the level-2 variance component (0.079) was significant at the $p<0.001$ level. The level-2 variance component (0.061) of the conducting meaningful research unconditional model was also significant at the $p<0.001$ level. The ICCs of each model reveal that approximately 9.3% of the variation in STEM degree recipients' social agency lies between institutions while 6.5% of the variation in their value toward conducting meaningful research is due to differences across higher education institutions. These analyses of the between-institution variances for each of the dependent variables confirmed the nested structure of the data warranting the use of multilevel modeling techniques to examine the predictors of STEM bachelor's degree recipients' social agency and values toward conducting meaningful research seven years after college entry.

Table 4.5
Description of the Between-Institution Variance of the Dependent Variables (N= 6,341 students, 271 institutions)

	Variance Component	Chi-square	Sig.	ICC
Social Agency	0.0789	891.2204	***	0.0932
Conducting Meaningful Research	0.0612	701.9197	***	0.0647

Note: Data are weighted. *$p<0.05$, **$p<0.01$, ***$p<0.001$

Predictors of Social Agency

Table 4.6 presents the results of the multilevel model predicting STEM bachelor's degree recipients' social agency seven years after college entry. The results are presented across four sub-models: (1) background and pre-college characteristics only, (2) includes undergraduate experiences, (3) includes all student-level predictors, and (4) the full model with all level-1 and level-2 predictors. This section addresses research questions 2a and 3a, which asked: "Controlling for background characteristics and precollege characteristics and experiences, how

Table 4.6

Multilevel Models Predicting Social Agency (N=6,341 students, 271 institutions)

	Model 1		Model 2		Model 3		Model 4	
Variables	Coef.	S.E. (Sig.)	Coef.	S.E.(Sig.)	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)
Background Characteristics								
Race: Black/African American	0.39	0.05***	0.32	0.06***	0.31	0.06***	0.27	0.06***
Race: Latina/o	0.18	0.04***	0.14	0.04**	0.14	0.04**	0.12	0.04**
Race: American Indian/Alaska Native	0.09	0.07	0.05	0.07	0.05	0.07	0.04	0.07
Race: Asian American/Pacific Islander	0.19	0.03***	0.13	0.03***	0.13	0.03***	0.12	0.03**
Race: Other	0.10	0.09	0.05	0.08	0.03	0.08	0.02	0.08
Gender: Female	0.19	0.02***	0.11	0.02***	0.10	0.02***	0.10	0.02***
Socioeconomic status	-0.001	0.00	-0.002	0.00	-0.003	0.00	-0.003	0.00
Either parent's career in STEM	0.06	0.02*	0.04	0.02	0.04	0.02	0.04	0.02
Pre-college Characteristics and Experiences								
2004 Social Agency	0.32	0.02***	0.30	0.01***	0.29	0.01***	0.29	0.01***
Composite SAT score (100)	-0.09	0.01***	-0.08	0.01***	-0.08	0.01***	-0.08	0.01***
Average High School GPA	-0.003	0.01	-0.01	0.01	-0.01	0.01	-0.01	0.01
Political Orientation	0.01	0.01	0.005	0.01	0.01	0.01	0.01	0.01
Number of HS Science and Math Courses	0.001	0.01	-0.003	0.01	-0.002	0.01	-0.001	0.01
Participated in health science research program sponsored by university	0.10	0.06	0.05	0.06	0.06	0.06	0.05	0.06
Degree Aspirations: Ph.D./Ed.D.	0.01	0.02	-0.003	0.03	-0.01	0.03	-0.01	0.03
STEM Identity	0.04	0.02*	0.01	0.02	0.02	0.01	0.01	0.01
Act in the past year: Did community service as part of a class	0.01	0.01	0.01	0.01	0.004	0.01	0.004	0.01
Act in the past year: Performed volunteer work	0.08	0.02***	0.05	0.02**	0.05	0.02*	0.05	0.02*
Act in the past year: Socialized with someone of another racial/ethnic group	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02
Racial Discrimination is no longer a problem	-0.03	0.02	-0.02	0.02	-0.02	0.02	-0.02	0.02
Undergraduate Experiences								
Academic Discipline								
Undergrad Major: Environmental Science (ref. Biological Sciences)			-0.17	0.09	-0.19	0.09*	-0.18	0.09*
Undergrad Major: Computer Science/Tech (ref. Biological Sciences)			-0.43	0.05***	-0.38	0.05***	-0.37	0.05***
Undergrad Major: Physical Science (ref. Biological Sciences)			-0.18	0.04***	-0.17	0.04***	-0.17	0.04***
Undergrad Major: Engineering (ref. Biological Sciences)			-0.30	0.03***	-0.25	0.03***	-0.25	0.03***
Undergrad Major: Health Professional Sciences (ref. Biological Sciences)			-0.16	0.04***	-0.09	0.04*	-0.10	0.04*
Undergrad Major: Math/Stats (ref. Biological Sciences)			-0.14	0.05**	-0.16	0.05**	-0.15	0.05**
Faculty Socialization								
Work with a faculty member on his/her research			0.01	0.02	0.01	0.02	0.01	0.02
Receive mentoring from a faculty member			0.04	0.03	0.04	0.03	0.04	0.03

Table 4.6 (cont.)

	Coef.	S.E. (Sig.)	Coef.	S.E.(Sig.)	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)
Peer Socialization								
Participate in an ethnic or cultural club or organization			0.21	0.02***	0.21	0.02***	0.21	0.02***
Participate in an academic club or professional association			0.06	0.02*	0.06	0.02*	0.06	0.02*
STEM Educational/Career Preparation								
Participate in a structured undergrad research program			0.06	0.03*	0.06	0.03*	0.06	0.03*
Undergrad Perception: Understand the role of science and technology in society			0.08	0.01***	0.08	0.01***	0.08	0.01***
Post-Undergraduate Experiences								
Grad School: STEM (ref: non-STEM post-college pathway)					-0.05	0.02*	-0.05	0.02*
Workforce: STEM (ref: non-STEM post-college pathway)					-0.18	0.03***	-0.18	0.03***
Institutional Level Variables								
Structural characteristics								
Control: Private							0.01	0.03
HBCU							0.14	0.10
Institutional Type: Research							0.09	0.03**
Institutional Type: Liberal Arts							0.02	0.04
HSI(25% or more of undergraduates are Latino)							0.12	0.09
Student Peer Context								
Average entering freshman Social Agency score							0.01	0.01
Proportion of undergrads in STEM majors							0.00	0.11
STEM Faculty Context								
Average of STEM Faculty: Grade on a curve							-0.01	0.04
Average STEM Faculty score on civic minded values factor							0.05	0.02**
Average STEM faculty score on student-centered pedagogy factor							-0.003	0.02
Intercept	-1.54	0.18***	-1.45	0.19***	-1.13	0.19***	-1.23	0.21***
Model Statistics								
Level 1 variance	0.605		0.573		0.569		0.568	
Level 2 variance	0.012		0.009		0.009		0.009	
Explained variance at level 1	0.211		0.253		0.258		0.260	
Explained variance at level 2	0.842		0.882		0.885		0.890	
Intercept Reliability	0.272		0.234		0.231		0.224	

Note: Data are weighted. *p<.05, **p<.01, ***p<.001

do undergraduate socialization experiences with academic disciplines, faculty, and peers contribute to the social agency of STEM bachelor's degree recipients seven years after college entry?" and "Controlling for individual characteristics and experiences, how do institutional factors such as structural characteristics, peer-context, and STEM faculty context contribute to the social agency of STEM bachelor's degree recipients seven years after college entry?" The individual-level variables are presented temporally with the findings related to background and precollege characteristics and high school experiences presented first, the undergraduate experiences presented second, and the post-undergraduate experiences presented third to help understand how each stage may influence student socialization.

Background characteristics. With respect to background characteristics, STEM bachelor's degree recipients' gender and racial/ethnic group identification significantly predicted their social agency after controlling for undergraduate and post-undergraduate experiences and institutional contexts. Specifically, compared to their male peers women had significantly higher levels of social agency seven years after college entry and this demographic characteristic retained its predictive power after all variables had been entered into the model. This finding is in line with prior research that has shown that female students are significantly more likely than males to value social action engagement (Hurtado et al., 2002) and to report higher levels of social agency (Nelson Laird, 2005). Additionally, students who identified as African American/Black, Latina/o, and Asian American/Pacific Islander had significantly higher levels of social agency seven years after college entry than their white counterparts. In comparing the four models presented in Table 4.6, these significant differences between these racial/ethnic groups were sustained even after controlling for undergraduate and post-undergraduate experiences and institutional factors, indicating that the college environment does not explain away these differences for STEM bachelor's degree recipients. The results related to gender and race/ethnicity seem to suggest a negative relationship between relative privileged status (i.e., male, white) in the U.S. and a desire to promote a more democratic society through socio-political involvement.

Model 1 shows that STEM degree recipients who have at least one parent in a STEM career have higher social agency seven years after college entry; however, this effect becomes non-significant after taking into account STEM bachelor's degree recipients' undergraduate experiences. Thus, undergraduate experiences have a much stronger effect on STEM bachelor's degree recipients' social agency than this measure of parental socialization. Having a parent in a STEM career may have an indirect relationship with the development of STEM students' social agency as these students may participate in certain activities during college that may have a more direct relationship with their social agency development. Future analyses should examine these potential indirect relationships and further disaggregate parental careers to examine whether parents in differing STEM careers may socialize their children differently.

Pre-college characteristics and experiences. Several precollege characteristics and experiences have a significant association with STEM bachelor's degree recipients' social agency seven years after college entry. STEM bachelor's degree recipients' freshman level of social agency significantly and positively predicted individuals' social agency seven years after college entry, which extends prior research that demonstrates that freshman-year social agency is an important predictor of social agency at the end of college (Astin, 1993; Nelson Laird et al., 2005; Zuñiga et al., 2005). Additionally, composite SAT scores had a significant and negative effect on STEM bachelor's degree recipients' social agency throughout all four models. This negative relationship between SAT scores and democratic outcomes has also been found by

Hurtado et al. (2002), who suggest that high test scores on the SAT do not necessarily translate into more complex thinking skills critical for participation in a diverse democracy. STEM bachelor's degree recipients' average high school GPA, their degree aspirations, and political orientation did not predict their level of social agency seven years after college entry.

Model 1 shows that STEM identity significantly and positively predicts social agency seven years after college entry; however, this effect becomes non-significant after controlling for STEM degree recipients' undergraduate experiences. While prior research by Carlone and Johnson (2007) has shown that for many science students altruistic motivations are an integral part of their science identity, this study suggests that the relationship between STEM identity and social agency may be a complex process that is affected by STEM students' undergraduate experiences. It may be that the relationship between STEM identity and social agency for many students is separated during the undergraduate socialization process. Future research should explore this relationship further.

The number of science and math courses STEM bachelor's degree recipients completed in high school and whether they participated in a health science research program sponsored by a university did not significantly predict their level of social agency seven years after college entry. The insignificance of the number of science and math courses may relate to the fact that national standards documents for science and math education, which serve as important guides for K-12 standards, lack any explicit mention of developing students' understanding of inequities or interest in rectifying structural inequalities (AAAS, 1993; Gutstein, 2006; NRC, 1996, 2012). The insignificance of health science research programs may relate to the nature of these programs focusing more on scientific inquiry rather than sociopolitical involvement. In addition, these pre-college experiences may lead students to certain pathways during college or may help to explain the social agency of STEM students at college entry, and therefore may indirectly influence STEM bachelor's degree recipients' social agency over the long term.

STEM bachelor's degree recipients who performed volunteer work in their senior year of high school had significantly higher levels of social agency seven years after college entry, yet this effect does lose some (but not all) predictive power as undergraduate and post-undergraduate experiences are controlled for. This finding is consistent with prior research showing a significant positive relationship between participation in community service and democratic outcomes (e.g., Astin, 1993a; Brown et al., 2007; Einfeld & Collins, 2008; Garibay, under review; Hurtado, 2003). Also, this finding is important as it shows the long-term impact precollege experiences with community service can have on STEM bachelor's degree recipients' social agency. STEM degree recipients' view on whether racial discrimination is no longer a problem in America, the frequency with which they socialized with someone of another racial/ethnic group during their senior of high school, and the frequency with which they participated in community service as part of a class in their senior year of high school did not predict their level of social agency seven years after college entry. It may be that these effects are indirect in their relationship to social agency, and these indirect effects should be tested in future analyses.

Undergraduate experiences. Many undergraduate experiences had a significant association with STEM bachelor's degree recipients' social agency seven years after college entry, including their academic major and socialization experiences with peers showing the importance of the college setting on the development of STEM bachelor's degree recipients' social agency. Model 4 shows that when compared to their counterparts in the biological sciences, STEM degree recipients who majored in environmental science, computer science/technology, physical science, engineering, health professional science, or math/statistics had significantly lower levels of social agency seven years after college entry.

Interestingly, when undergraduate experiences first enter the analyses in model 2, there is no significant difference between those who majored in environmental science and biological science. However, after controlling for individuals' post-undergraduate pathways, the difference between environmental science and biological science majors became significant ($p<0.05$), revealing a suppressor effect. A suppressor effect can be observed under two different situations, one of which is when two independent variables have the same relationship (both positive or both negative) with the dependent variable and a negative relationship with each other (Astin & antonio, 2012). When analyzing the correlations, majoring in environmental science and social agency are positively correlated (r=.011, $p<.05$), completing or enrolling in a STEM graduate or professional program and social agency are positively correlated (r=.014, $p<.05$), and majoring in environmental science and completing or enrolling in a STEM graduate or professional program are negatively correlated (r= -.043, $p<.001$). In this case, completing or enrolling in a STEM graduate or professional program suppresses the observed relationship between majoring in environmental science and social agency. The difference between environmental science and biological science bachelor's degree recipients' social agency is masked because environmental science bachelor's degree recipients tend to pursue non-STEM post-undergraduate pathways. Statistically removing these important differences in post-undergraduate pathways may underestimate the difference between environmental science and biological science bachelor's degree recipients' social agency over the long-term. Additionally, the difference between health professional science students and biological science students became less significant after controlling for their post-undergraduate pathways although this difference continued to stay significant at the $p<0.05$ level.

STEM bachelor's degree recipients who participated in an ethnic or cultural organization had significantly higher levels of social agency ($p<0.001$) seven years after college entry. Participation in an academic club or organization and participation in a structured undergraduate research program also had a significant and positive effect on STEM bachelor's degree recipients' social agency seven years after college entry. STEM bachelor's degree recipients who felt that their undergraduate institution better prepared them to understand the role of science and technology in society had significantly higher levels of social agency seven years after college entry.

Finally, both individual-level measures of faculty socialization included in this study (i.e., working with a faculty member on his/her research and receiving mentoring from a faculty member) did not have a significant relationship with STEM bachelor's degree recipients' social agency seven years after college entry. These findings may speak to the nature of these faculty-student interactions as STEM faculty may not be trying to develop students' social agency in their general mentoring of undergraduates or in their collaboration with students on research. It may be that students seek support from STEM faculty regarding their social agency but do not receive it, or may not seek this type of support from faculty perhaps knowing they will not receive it. Students, instead, may seek this support from peers in student organizations. Furthermore, the insignificance of faculty-student interactions found in this model may be due to the fact that these measures may be capturing different experiences with multiple faculty members either within and/or outside of STEM fields. Despite the insignificance of these individual-level experiences with faculty, STEM faculty play a critical role in the socialization of

STEM undergraduates beyond their interactions with students given their ability to influence the curriculum and other departmental and institutional practices (Handelsman et al., 2007; Miller et al., 2008; Weidman, 1979). Thus, the impact of faculty on students' social agency may also be captured indirectly through the effect of academic disciplines.

Post-undergraduate experiences. Both post-undergraduate experiences controlled for in the multilevel model significantly predicted STEM bachelor's degree recipients' level of social agency seven years after college entry. STEM bachelor's degree recipients who completed or were enrolled in a STEM graduate or professional program had significantly lower levels of social agency compared to those in a non-STEM pathway. Also, STEM bachelor's degree recipients who were employed in the STEM workforce and had yet to enroll in a graduate or professional program had significantly lower levels of social agency seven years after college entry compared to their peers in a non-STEM post-college pathway. Given that information on post-undergraduate trajectories and the dependent variables were collected at the same time point, it is impossible to infer causal effects of post-undergraduate experiences. On the one hand, it may be that those STEM bachelor's degree recipients who have higher social agency were more likely to pursue a non-STEM post-undergraduate pathway than be employed in the STEM workforce or enroll in a STEM graduate program. On the other hand, it may be that non-STEM post-undergraduate pathways help better develop STEM bachelor's degree recipients' social agency compared to STEM post-undergraduate pathways. The impact of these and other post-undergraduate experiences should be further explored in future analyses.

Institutional Factors. Two institutional factors had a significant relationship with STEM bachelor's degree recipients' social agency seven years after college entry supporting the importance of controlling for institutional contexts posited under Weidman's (1989) framework of undergraduate socialization. STEM bachelor's degree recipients who attended a research university had significantly higher levels of social agency compared to their peers who attended master's comprehensive and other baccalaureate institutions. Interestingly, while individual-level undergraduate experiences with faculty socialization (i.e., working with a faculty member on his/her research and receiving mentoring from a faculty member) did not significantly affect STEM bachelor's degree recipients' social agency, the contextual effect of being on a campus where STEM faculty, on average, have higher civic-minded values significantly and positively affects STEM bachelor's degree recipients' social agency. In other words, STEM degree recipients who attended an institution where STEM faculty, on average, have higher civic-minded values report significantly higher levels of social agency seven years after college entry.

This finding connects to Vreeland and Bidwell's (1966) theory of undergraduate socialization by academic departments, which indicates that faculty influence student outcomes within a department or field of study given their ability to define the goals of undergraduate education, establishing the means to achieve those goals within their department, and through their interactions with students. In this study, STEM faculty with higher civic-minded values tend to place greater importance on encouraging students to become agents of change as part of their educational goals for undergraduates (see Table 3.2 for a list of items that make up the civic-minded values factor). Thus, higher education institutions with STEM faculty who have higher civic-minded values may have a different STEM culture than one often described in the STEM college education literature. Having STEM professors that tend to have higher civic-minded values seems to contribute to a STEM culture, perhaps through curricular offerings, pedagogy, and programs, that supports the development of STEM students' desire to improve society through socio-political involvement.

Model Statistics. Table 4.6 also shows the model statistics of each of the four models predicting STEM degree recipients' social agency seven years after college entry. The results indicate that most of the between-institution variance was explained by variables included in the analysis. Model 1 accounted for 84.2% of the institutional variance. Adding undergraduate experiences to the model accounted for another 4% of the between-institution variance. Model 3 explained 88.5% of the level-2 variance. The final model accounted for 89% of the between-institution variance in STEM degree recipients' social agency seven years after college entry.

Effect Sizes. To help better understand the practical significance of the findings, effect sizes for the undergraduate and post-undergraduate experiences as well as the institutional variables were calculated. Effect sizes in multilevel models are not straightforward as they are in ANOVA and multiple regression analyses and currently there is no consensus to most appropriate way to calculate them (Peugh, 2010). The complexity with the concept "percent of variance explained" stems from the fact that residual variance can be attributed to any level, including those that were omitted from the model (Garson, 2013). Additionally, Nezlek (2008) notes:

> "…residual variance estimates and significance tests of individual coefficients are estimated separately within MRCM [multilevel random coefficient modeling], whereas within OLS analyses, significance tests are based upon reductions in residual variances. Within OLS regression, the F-ratio for a variable that is added to a model is directly related to changes in residual variance. Within MRCM, it is possible to add a significant predictor to a model with either no change (or even an increase) in residual variance, something that is not possible in OLS (p. 854)."

Given these issues some analysts avoid reporting effect size measures (Garson, 2013) and some analysts actually recommend not using variance estimates to describe effect sizes (see Kreft & deLeeuw, 1998, p. 119). Still, there are several generally accepted effect size indices for multilevel models (see Roberts & Monaco, 2006; Singer & Willett, 2003; Snijders & Bosker, 1999; Raudenbush & Bryk, 2002). To calculate the effect sizes this study used the method described in Raudenbush and Bryk (2002), and calculated effect sizes by adding single predictors and comparing the residual variance to the residual variance of the unconditional model, which is recommended by (Nezlek, 2008) as this method seems to produce fairly reliable estimates. Effect sizes for level-2 predictors were calculated using the same final level-1 model as recommended by Raudenbush and Bryk (2002). It is important to note that given the problems with effect size estimates in multilevel modeling, these estimates may not be totally accurate.

With regards to undergraduate and post-undergraduate experiences, participation in an academic club or professional association explained the largest proportion of variance at level 1, explaining 6.2%. Majoring in engineering and having entered the STEM workforce explained 1.8% and 1.7% of the variance at level-1, respectively. Perceptions of whether their undergraduate institution better prepared them to understand the role of science and technology in society explained 1.6% of the variance at level-1 and majoring in computer science or technology explained 1.5%. Participation in a structured undergraduate research program explained 0.95% of the variance in social agency at level 1. Each of the other undergraduate and post-undergraduate experiences explained less than 0.94% of the variance at level-1. With respect to institutional variables, STEM faculty members' average score on civic-minded values explained 10.1% of the variance in social agency attributed to differences across institutions while research institutions explained 2.0% of the variance in the level-2 intercept.

Cross-Level Interaction Effects. In addition to the first four models, several cross-level interaction effects were tested to address research question 4a. Question 4a asked: "Are any of the effects of undergraduate socialization experiences on STEM bachelor's degree recipients' social agency moderated by institutional factors?" The cross-level interactions were tested jointly in the same model as recommended by Aguinis, Gottfredson, and Culpepper (2013) and included only those significant undergraduate experiences (with the exception of individuals' perception of undergraduate preparation) with all level-2 variables. Testing the cross-level interaction effects as part of one combined model allows for each estimated effect to be adjusted for all theoretically relevant components and helps to reduce bias in the estimated effects (Aguinis et al., 2013). Table 4.7 presents only those cross-level effects that were significant.

Table 4.7
Predictors of Social Agency: Significant Cross-Level Interactions

	Coef.	S.E. (Sig.)
Undergraduate Experiences by Level-2 Variables		
Academic Discipline		
Undergrad Major: Computer Science/Tech (ref. Biological Sciences)		
Institutional Type: Research	0.27	.12*
Undergrad Major: Physical Science (ref. Bio Sci)		
Control: Private	0.27	.09**
Undergrad Major: Engineer (ref. Bio Sci)		
Control: Private	0.22	.06***
Undergrad Major: Health Professional Sci (ref. Bio Sci)		
Control: Private	0.26	.08**
Average STEM Faculty score on civic minded values factor	-0.09	.05*
Peer Socialization		
Participate in an academic club or professional association		
Control: Private	-0.11	.05*
Institutional Type: Research	-0.12	.06*

Note: Data are weighted. *p<.05, **p<.01, ***p<.001

The results show that the relationship between several undergraduate experiences and social agency significantly vary across several institutional variables. With respect to computer science and technology undergraduate majors, the negative relationship between majoring in computer science/technology (compared to biological science) and social agency is stronger for those individuals who attended master's comprehensive and other baccalaureate institutions compared to research institutions. Additionally, for STEM bachelor's degree recipients who attended a public institution versus a private institution, the negative effect of majoring in physical science, engineering, and health professional science (when compared to biological science majors) on social agency was even stronger. The negative relationship between majoring in a health profession (compared to biological science majors) and social agency is stronger ("more negative") for those individuals who attended institutions where STEM faculty, on average, had higher scores on civic-minded values.

With respect to the peer socialization experiences, two structural characteristics moderated the effect of participation in an academic club or professional association on STEM bachelor's degree recipients' social agency. The relationship between participating in an academic club or professional association on social agency was stronger for those who attended a public institution compared to a private institution during their undergraduate years. Finally, the effect of participating in an academic club or professional association on social agency was weaker for STEM bachelor's degree recipients who attended a research university compared to a master's comprehensive or other baccalaureate institution.

Predictors of Conducting Meaningful Research

Table 4.8 presents the results of the multilevel model predicting STEM degree recipients' values toward conducting research that will have a meaningful impact on underserved communities seven years after college entry. As with the previous multilevel analysis, the results are presented across four sub-models: (1) background and pre-college characteristics only, (2) includes undergraduate experiences, (3) includes all student-level predictors, and (4) the full model with all level-1 and level-2 predictors. This subsection addresses research questions 2b and 3b. Research question 2b asked, "Controlling for background characteristics and precollege characteristics and experiences, how do undergraduate socialization experiences with academic disciplines, faculty, and peers contribute to the importance of conducting meaningful research of STEM bachelor's degree recipients seven years after college entry?" Question 3b asked "Controlling for individual characteristics and experiences, how do institutional factors such as structural characteristics, peer-context, and STEM faculty context contribute to the importance of conducting meaningful research of STEM bachelor's degree recipients seven years after college entry?"

Background characteristics. Several background characteristics were significantly related to STEM bachelor's degree recipients' value toward conducting meaningful research seven years after college entry. STEM degree recipients who identified as Black/African American, Latina/o, and Asian American/Pacific Islander had a significantly higher value toward conducting meaningful research compared to their white counterparts. In comparing the four models presented in Table 4.8, socioeconomic status also retained its predictive power after all of the variables entered the model. Individuals' socioeconomic status was significantly and negatively related to the level of importance placed on conducting meaningful research. These findings related to race/ethnicity and socioeconomic status may relate to the relative privileged status associated with being white and of higher socioeconomic status in the U.S. These findings seem to suggest a negative relationship between being relatively privileged and having higher values toward conducting research that will have a meaningful impact on underserved populations. Model 1 shows that when compared to their male peers, women have a higher value toward conducting meaningful research, yet this effect disappears after accounting for STEM bachelor's degree recipients' undergraduate experiences.

Table 4.8

Multilevel Models Predicting Conducting Research That Will Have a Meaningful Impact on Underserved Communities (N=6,341 students, 271 institutions)

	Model 1		Model 2		Model 3		Model 4	
Variables	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)
Background Characteristics								
Race: Black/African American	0.31	0.06***	0.29	0.06***	0.30	0.06***	0.28	0.06***
Race: Latina/o	0.21	0.04***	0.20	0.04***	0.20	0.04***	0.17	0.04***
Race: American Indian/Alaska Native	0.07	0.09	0.02	0.09	0.03	0.09	0.03	0.09
Race: Asian American/Pacific Islander	0.25	0.03***	0.23	0.04***	0.22	0.04***	0.21	0.04***
Race: Other	0.17	0.10	0.13	0.08	0.13	0.08	0.12	0.08
Gender: Female	0.11	0.03***	0.04	0.03	0.05	0.03	0.04	0.03
Socioeconomic status	-0.01	0.00*	-0.01	0.00*	-0.010	0.00**	-0.010	0.00**
Either parent's career in STEM	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.03
Pre-college Characteristics and Experiences								
2004 Social Agency	0.20	0.02***	0.18	0.02***	0.18	0.02***	0.18	0.02***
Composite SAT score (100)	-0.06	0.01***	-0.06	0.01***	-0.07	0.01***	-0.08	0.01***
Average High School GPA	-0.004	0.01	-0.01	0.01	-0.02	0.01	-0.02	0.01
Political Orientation	0.04	0.02*	0.03	0.02	0.03	0.02	0.02	0.02
Number of HS Science and Math Courses	0.01	0.01	0.001	0.01	0.000	0.01	0.00	0.01
Participated in health science research program sponsored by university	0.23	0.06**	0.17	0.06**	0.17	0.06**	0.16	0.06**
Degree Aspirations: Ph.D./Ed.D.	0.08	0.03*	0.05	0.03	0.05	0.03	0.05	0.03
STEM Identity	0.11	0.02***	0.08	0.02***	0.07	0.02***	0.07	0.02***
Act in the past year: Did community service as part of a class	-0.001	0.02	0.002	0.02	0.002	0.02	0.003	0.02
Act in the past year: Performed volunteer work	0.01	0.02	-0.02	0.02	-0.01	0.02	-0.02	0.02
Act in the past year: Socialized with someone of another racial/ethnic group	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02
Racial Discrimination is no longer a problem	-0.04	0.02**	-0.04	0.02*	-0.04	0.01*	-0.04	0.02*
Undergraduate Experiences								
Academic Discipline								
Undergrad Major: Environmental Science (ref. Biological Sciences)			-0.16	0.09	-0.13	0.09	-0.13	0.09
Undergrad Major: Computer Science/Tech (ref. Biological Sciences)			-0.42	0.05***	-0.39	0.05***	-0.38	0.05***
Undergrad Major: Physical Science (ref. Biological Sciences)			-0.11	0.04*	-0.10	0.04*	-0.10	0.05*
Undergrad Major: Engineering (ref. Biological Sciences)			-0.35	0.03***	-0.33	0.03***	-0.32	0.03***
Undergrad Major: Health Professional Sciences (ref. Biological Sciences)			-0.21	0.04***	-0.22	0.05***	-0.21	0.05***
Undergrad Major: Math/Stats (ref. Biological Sciences)			-0.34	0.06***	-0.31	0.06***	-0.31	0.06***
Faculty Socialization								
Work with a faculty member on his/her research			0.13	0.03***	0.10	0.03**	0.10	0.03**
Receive mentoring from a faculty member			0.07	0.03**	0.07	0.03*	0.06	0.03*

Table 4.8 (cont.)

	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)
Peer Socialization								
Participate in an ethnic or cultural club or organization			0.09	0.03**	0.09	0.03**	0.09	0.03**
Participate in an academic club or professional association			-0.004	0.03	-0.02	0.03	-0.01	0.03
STEM Educational/Career Preparation								
Participate in a structured undergrad research program			0.08	0.03**	0.07	0.03*	0.07	0.03*
Undergrad Perception: Understand the role of science and technology in society			0.09	0.01***	0.09	0.01***	0.09	0.01***
Post-Undergraduate Experiences								
Grad School: STEM (ref: non-STEM post-college pathway)					0.16	0.03***	0.16	0.03***
Workforce: STEM (ref: non-STEM post-college pathway)					0.02	0.04	0.03	0.04
Institutional Level Variables								
Structural characteristics								
Control: Private							0.03	0.03
HBCU							-0.09	0.10
Institutional Type: Research							0.10	0.03**
Institutional Type: Liberal Arts							0.04	0.04
HSI(25% or more of undergraduates are Latino)							0.09	0.07
Student Peer Context								
Average entering freshman Social Agency score							0.02	0.01*
Proportion of undergrads in STEM majors							-0.04	0.11
STEM Faculty Context								
Average of STEM Faculty: Grade on a curve							0.01	0.04
Average STEM Faculty score on civic minded values factor							0.01	0.02
Average STEM faculty score on student-centered pedagogy factor							0.02	0.02
Intercept	0.62	0.18**	0.60	0.19**	0.39	0.20*	0.53	0.22*
Model Statistics								
Level 1 variance	0.781		0.743		0.739		0.738	
Level 2 variance	0.015		0.005		0.004		0.003	
Explained variance at level 1	0.117		0.160		0.164		0.166	
Explained variance at level 2	0.758		0.914		0.935		0.949	
Intercept Reliability	0.259		0.128		0.103		0.085	

Note: Data are weighted. *p<.05, **p<.01, ***p<.001

Pre-college characteristics and experiences. With respect to pre-college characteristics and experiences, STEM bachelor's degree recipients' level of social agency measured during their freshman year was significantly and positively related to the level of importance placed on conducting meaningful research seven years after college entry. STEM degree recipients' SAT composite score was a significant negative predictor of the value placed on conducting meaningful research. Having a political orientation that was more liberal was a significant positive predictor of placing greater importance on conducting meaningful research in model 1, but this effect went away after controlling for STEM bachelor's degree recipients' undergraduate experiences. STEM degree recipients who participated in a health science research program sponsored by a university during high school placed a greater level of importance on conducting meaningful research seven years after college entry. This finding supports prior research on the impact of summer research programs in science on students' understanding of the nature of science and scientific inquiry (e.g., Bell et al., 2003; Moss, Abrams, & Kull, 1998; Moss, Abrams, & Robb, 2001; Sadler et al., 2010) and shows that these experiences can have an important influence on STEM students over the long term.

Model 1 shows that individuals with aspirations for a Ph.D. or Ed.D. in their freshman year had a significantly higher value toward conducting meaningful research; however, this effect disappeared after controlling for undergraduate experiences. The effects of doctoral degree aspirations may be indirect as students with doctoral degree aspirations during their freshman year may be more likely to seek opportunities during college that more directly influence their values toward conducting meaningful research. These indirect effects should be tested in future analyses.

STEM degree recipients with a higher score on the STEM identity factor had a significantly higher value toward conducting meaningful research seven years after college entry and this effect was maintained even after controlling for undergraduate and post-undergraduate experiences as well as institutional factors. This finding connects to research by Carlone and Johnson (2007) who found that altruistic motivations are an integral part of many science students' science identity. STEM degree recipients who more strongly agreed with the statement that racial discrimination is no longer a problem in America placed a lower value on conducting research that will have a meaningful impact on underserved communities. This finding seems to suggest that STEM bachelor's degree recipients who have a deeper understanding of racial inequality are more inclined to conduct research that will have a meaningful impact on underserved communities.

Undergraduate experiences. Many undergraduate experiences had a significant relationship with STEM bachelor's degree recipients' value toward conducting meaningful research seven years after college entry, including academic major, measures of faculty socialization, and peer socialization. These findings largely support the guiding frameworks of undergraduate socialization (Vreeland & Bidwell, 1966; Weidman, 1989, 1979). In comparison to their counterparts who majored in a biological science field, STEM bachelor's degree recipients who majored in computer science/technology, physical science, engineering, health professional science, or mathematics/statistics had a significantly lower value towards conducting meaningful research seven years after college entry. There was no significant difference between STEM bachelor's degree recipients who majored in environmental science and biological science in their value toward conducting meaningful research. This finding was not surprising given that environmental science education often utilizes an interdisciplinary approach that integrates social and scientific issues (Littledyke, 2008; Vincent & Focht, 2011).

Both faculty socialization measures examined in this study had a significant positive relationship with STEM bachelor's degree recipients' value toward conducting meaningful research. STEM bachelor's degree recipients who worked with a faculty member on her/his research and received mentoring from a faculty member had significantly higher values toward conducting meaningful research. With regards to peer socialization, STEM bachelor's degree recipients who participated in an ethnic or cultural club or organization placed a significantly higher level of importance toward conducting research that will have a meaningful impact on underserved communities, while participation in an academic club or professional association did not have a significant relationship with the dependent variable. Participation in a structured undergraduate research program had a significant positive association with STEM bachelor's degree recipients' value toward conducting meaningful research, providing support for research that suggests that these experiences may not only help students develop their academic aspirations and research skills, but also their critical-thinking skills and individual agency (e.g., Laursen et al., 2006). Finally, STEM degree recipients who felt that their undergraduate institution better prepared them to understand the role of science and technology in society placed a significantly higher level of importance toward conducting meaningful research seven years after college entry.

Post-undergraduate experiences. Among the two post-undergraduate experiences examined in this study, only one had a significant effect on STEM bachelor's degree recipients' value toward conducting meaningful research. STEM bachelor's degree recipients who completed or were enrolled in a STEM graduate or professional program placed greater value on conducting meaningful research compared to those who were in a non-STEM pathway. It is important to note that since information on post-undergraduate trajectories were collected at the same time point as the dependent variables, it is impossible to observe causal effects of post-undergraduate experiences. It may be that those STEM bachelor's degree recipients who have higher values toward conducting meaningful research were more likely to purse a graduate program in STEM. Alternatively, it may also suggest that STEM graduate programs help develop students' values toward conducting meaningful research better than non-STEM pathways. An important caveat to also consider with this result is that STEM bachelor's degree recipients who enrolled in or completed a STEM graduate program may have selected higher values on this item because of the "research" aspect of this item and not necessarily care about utilizing their research to have a meaningful impact on underserved communities. Thus, the significant positive relationship between having enrolled in or completed a STEM graduate program and values toward conducting research that will have a meaningful impact on underserved communities may be more related to STEM graduate students' interests in "conducting research" rather than their interest in having a "meaningful impact on underserved communities." Finally, STEM bachelor's degree recipients who entered the STEM workforce and had yet to enroll in a graduate or professional program did not have significantly different values on conducting meaningful research when compared to those in a non-STEM post-undergraduate pathway.

Institutional Factors. Two institutional level variables had a significant positive relationship with STEM bachelor's degree recipients' value toward conducting meaningful research seven years after college entry, including one structural characteristic and one student peer context. STEM degree recipients who attended a research university had significantly higher values toward conducting meaningful research compared to their counterparts who attended master's comprehensive and other baccalaureate institutions. Attending a research university may expose students to more research opportunities and resources that helps better develop their values to promote a democratic society through conducting research.

Additionally, an institution's average entering freshman score on social agency was a significant positive predictor of STEM bachelor's degree recipients' value toward conducting meaningful research seven years after college entry. In other words, attending an institution where entering freshman, on average, had higher social agency was associated with placing a greater level of importance on conducting meaningful research for STEM bachelor's degree recipients. This relationship connects to Weidman's (1989) undergraduate socialization theory that emphasizes the impact peer normative contexts can have on undergraduates' educational outcomes. Interestingly, while STEM bachelor's degree recipients' values toward conducting meaningful research is affected by the normative peer context related to peer social agency, their values toward conducting meaningful research is not affected by normative faculty contexts. Individual-level experiences with faculty seem to have a more important impact on STEM bachelor's degree recipients' values toward conducting meaningful research than normative contexts shaped by STEM faculty.

Model Statistics. The model statistics of each of the four models predicting STEM bachelor's degree recipients' value toward conducting meaningful research seven years after college entry are also shown in Table 4.8. The results show that almost all of the between-institution variance was explained by variables included in the analysis. Model 1 accounted for 75.8% of the between-institution variance. Adding undergraduate experiences to the model accounted for an additional 15.6% of the level-2 variance. An additional 2.1% of the level-2 variance was accounted for after adding post-undergraduate experiences to the model. The final model accounted for 94.9% of the between-institution variance in STEM bachelor's degree recipients' value toward conducting meaningful research seven years after college entry.

Effect Sizes. As with the social agency model, effect sizes for the undergraduate and post-undergraduate experiences and institutional variables were also calculated to help understand the practical significance of the findings (see the social agency subsection for an explanation of issues with effect size calculations and this study's approach to calculating effect sizes). The largest proportion reduction in variance at level 1 was attributed to participation in an academic club or professional association (2.5%) and working with a faculty member on her or his research (2.0%). Perceptions of whether one's undergraduate institution better prepared her or him to understand the role of science and technology in society and majoring in engineering explained 1.7% and 1.4% of the variance at level 1, respectively. Participating in an ethnic club or organization, having enrolled in or completed a graduate or professional STEM program, and receiving mentorship from a faculty member each explained 1.2% of the variance at level 1. Each of the other undergraduate and post-undergraduate experiences reduced the proportion of variance at level-1 by less than 1%. As for the institutional variables, the mean social agency of entering freshman explained 31% of the variance in the level-2 intercept, while research institutions explained 26.8% of the variance in conducting meaningful research attributed to differences across institutions.

Cross-Level Interaction Effects. Several cross-level interaction effects were tested to examine how significant level-1 undergraduate socialization experiences were moderated by level-2 variables. This subsection addresses research question four. As in the social agency model, the cross-level interactions were tested jointly as recommended by Aguinis et al. (2013)

and included only those significant undergraduate socialization experiences (but not individuals' perception of undergraduate preparation) with all level-2 variables. Table 4.9 presents only those cross-level effects that were statistically significant.

Table 4.9
Predictors of Conducting Meaningful Research: Significant Cross-Level Interactions

	Coef.	S.E. (Sig.)
Undergraduate Experiences by Level-2 Variables		
Academic Discipline		
Undergrad Major: Computer Science/Tech (ref. Bio Sci)		
HSI(25% or more of undergraduates are Latino)	0.85	.38*
Average STEM faculty score on student-centered pedagogy factor	0.21	.09*
Undergrad Major: Physical Science (ref. Bio Sci)		
Institutional Type: Research	-0.33	.12**
Institutional Type: Liberal Arts	-0.32	.15*
HSI (25% or more of undergraduates are Latino)	-1.12	.50*
Undergrad Major: Engineer (ref. Bio Sci)		
Proportion of undergrads in STEM majors	0.50	.24*
Undergrad Major: Health Professional Sciences (ref. Bio Sci)		
Control: Private	0.20	.10*
Undergrad Major: Math/Stats (ref. Bio Sci)		
HBCU	-1.08	.49*
HSI (25% or more of undergraduates are Latino)	0.88	.27**
Proportion of undergrads in STEM majors	1.19	.47*
Faculty Socialization		
Work with a faculty member on his/her research		
HSI (25% or more of undergraduates are Latino)	0.33	.16*

Note: Data are weighted. *p<.05, **p<.01, ***p<.001

The results of the cross-level interactions show that several institutional variables moderate the relationships between several academic disciplines and values toward conducting meaningful research suggesting variation in the culture of particular STEM fields across certain structural and normative institutional contexts. For example, the negative relationship between majoring in computer science/technology (compared to biological science) and values toward conducting meaningful research is more strongly related for STEM bachelor's degree recipients who attended predominantly white institutions compared to Hispanic Serving Institutions. Additionally, the negative relationship between majoring in computer science/technology (compared to biological science) and values toward conducting meaningful research is "less negative" for STEM bachelor's degree recipients who attended institutions where STEM faculty, on average, more often used student-centered pedagogy. For STEM bachelor's degree recipients who majored in the physical sciences, the negative relationship between majoring in physical science compared to biological science and values toward conducting meaningful research is stronger for those who attended a research institution or liberal arts institution compared to master's comprehensive and other baccalaureate institutions. In contrast to the computer science results presented above, the negative relationship between majoring in a physical science discipline (compared to those in the biological sciences) and values toward conducting meaningful research is stronger (more negative) for those who attended HSIs, however, the standard error for this coefficient is particularly high (s.e.=.50). Thus, I would caution against this finding.

The negative relationship between majoring in an engineering discipline (compared to biological sciences) and values toward conducting meaningful research is "less strong" for STEM bachelor's degree recipients who attended institutions with a greater proportion of STEM undergraduates. The negative relationship between majoring in a health profession field compared to biological science and values toward conducting meaningful research was moderated by institutional control. The positive cross-level interaction effect indicates that the negative relationship between majoring in a health profession (compared to biological science majors) and values toward conducting meaningful research is "less negative" for those STEM bachelor's degree recipients who attended a private versus a public institution for their undergraduate years. Finally, the negative relationship between majoring in math or statistics (compared to biological science) and values toward conducting meaningful research was “less negative” for those who attended HSIs compared to predominantly white institutions, stronger for those who attended an HBCU compared to a predominantly white institution, and stronger for STEM bachelor’s degree recipients who attended institutions with a greater proportion of STEM undergraduates. The latter two variables had particularly high standard errors (.49 and .47, respectively), so I would caution against these results.

Among the other faculty and peer socialization experiences, the effect of only one faculty/peer socialization variable on STEM bachelor’s degree recipients’ values toward conducting meaningful research significantly varied across institutional variables. The relationship between working with a faculty member on her or his research on values toward conducting meaningful research was stronger for those who attended a Hispanic Serving Institution compared to a predominantly white institution. In other words, for STEM bachelor’s degree recipients who attended a Hispanic Serving Institution (compared to a PWI), the positive effect of working with a faculty member on her or his research on values toward conducting meaningful research was even stronger.

This finding suggests that student-faculty collaboration on research projects within Hispanic Serving Institutions seems to benefit STEM students differently than in PWI contexts. A study by Stanton-Salazar, Macias, Bensimon, & Dowd (2010) found that at many Hispanic serving 4-year colleges, there were many STEM faculty “who possessed a critical consciousness and understanding of sociopolitical inequities affecting Students of Color, particularly the underrepresentation of Latinas and Latinos in STEM fields (as cited in Dowd, Sawatzky, Rall, & Bensimon, p. 157)”. Perhaps, students working with faculty on her or his research at HSIs receive a different type of experience, maybe one that is more focused on underserved populations, that allows them to develop their values toward conducting meaningful research at a higher level. It may also be that students at HSIs initially may have lower concerns for helping underserved populations specifically through research than their counterparts at PWIs, and thus may have more to gain from these research experiences with faculty. Either way, these findings indicate the critical importance of faculty-student interactions at HSIs.

Comparing Results Across Models

The prior two subsections presented the results with respect to each individual dependent variable. In order to allow for easier comparison of the significance and direction of the fixed effects across both models, Table 4.10 presents the results of the final model for both dependent variables. This subsection will first discuss the common predictors of both dependent variables followed by a discussion of the differences between both final models.

Common Predictors of Both Models. In comparing the final models of the predictors of STEM bachelor's degree recipients' social agency and values toward conducting meaningful research, several background characteristics and pre-college experiences, undergraduate socialization experiences, post-undergraduate experiences, and institutional factors significantly affect both democratic outcomes. With respect to background characteristics, STEM bachelor's degree recipients who were Black or African American, Latina/o, and Asian American or Pacific Islander had significantly higher levels of social agency and values toward conducting meaningful research than their white counterparts. The differences between these groups may indicate how lived experiences in the US across racial/ethnic lines may shape individuals' goals and aspirations to want to create positive change in society. People of Color may be more inclined to want to help underserved populations through both sociopolitical involvement and conducting research given that these groups continue to face vast inequities and discrimination in the U.S. STEM degree recipients' pretest measure of social agency and SAT composite score also had a significant association with both democratic outcomes. These latter findings support Hurtado et al.'s (2002) assertion that high SAT scores do not translate into more complex thinking and understanding necessary for participation in a diverse democracy.

Table 4.10
Comparing the Multilevel Model Results Predicting Social Agency and Conducting Meaningful Research (N=6,341 students, 271 institutions)

	Social Agency		Conducting Meaningful Research	
Variables	Coef.	S.E. (Sig.)	Coef.	S.E. (Sig.)
Background Characteristics				
Race: Black/African American	0.27	0.06***	0.28	0.06***
Race: Latina/o	0.12	0.04**	0.17	0.04***
Race: American Indian/Alaska Native	0.04	0.07	0.03	0.09
Race: Asian American/Pacific Islander	0.12	0.03**	0.21	0.04***
Race: Other	0.02	0.08	0.12	0.08
Gender: Female	0.10	0.02***	0.04	0.03
Socioeconomic status	-0.003	0.00	-0.010	0.00**
Either parent's career in STEM	0.04	0.02	0.02	0.03
Pre-college Characteristics and Experiences				
2004 Social Agency	0.29	0.01***	0.18	0.02***
SAT score	-0.001	0.00***	-0.001	0.00***
Average High School GPA	-0.01	0.01	-0.02	0.01
Political Orientation	0.01	0.01	0.02	0.02
Number of HS Science and Math Courses	-0.001	0.01	0.00	0.01
Participated in health science research program sponsored by university	0.05	0.06	0.16	0.06**
Degree Aspirations: Ph.D./Ed.D.	-0.01	0.03	0.05	0.03
STEM Identity	0.01	0.01	0.07	0.02***
Act in the past year: Did community service as part of a class	0.004	0.01	0.003	0.02
Act in the past year: Performed volunteer work	0.05	0.02*	-0.02	0.02
Act in the past year: Socialized with	0.01	0.02	0.02	0.02

someone of another racial/ethnic group				
Racial Discrimination is no longer a problem	-0.02	0.02	-0.04	0.02*
Undergraduate Experiences				
Academic Discipline				
Undergrad Major: Environmental Science (ref. Bio Sci)	-0.18	0.09*	-0.13	0.09
Undergrad Major: Computer Science/Tech (ref. Bio Sci)	-0.37	0.05***	-0.38	0.05***
Undergrad Major: Physical Science (ref. Bio Sci)	-0.17	0.04***	-0.10	0.05*
Undergrad Major: Engineering (ref. Bio Sci)	-0.25	0.03***	-0.32	0.03***
Undergrad Major: Health Prof Sciences (ref. Bio Sci)	-0.10	0.04*	-0.21	0.05***
Undergrad Major: Math/Stats (ref. Bio Sci)	-0.15	0.05**	-0.31	0.06***
Faculty Socialization				
Work with a faculty member on his/her research	0.01	0.02	0.10	0.03**
Receive mentoring from a faculty member	0.04	0.03	0.06	0.03*
Peer Socialization				
Participate in an ethnic or cultural club or organization	0.21	0.02***	0.09	0.03**
Participate in an academic club or professional association	0.06	0.02*	-0.01	0.03
STEM Educational/Career Preparation				
Participate in a structured undergrad research program	0.06	0.03*	0.07	0.03*
Undergrad Perception: Understand the role of science and technology in society	0.08	0.01***	0.09	0.01***
Post-Undergraduate Experiences				
Grad School: STEM (ref: non-STEM post-college pathway)	-0.05	0.02*	0.16	0.03***
Workforce: STEM (ref: non-STEM post-college pathway)	-0.18	0.03***	0.03	0.04
Institutional Level Variables				
Structural characteristics				
Control: Private	0.01	0.03	0.03	0.03
HBCU	0.14	0.10	-0.09	0.10
Institutional Type: Research	0.09	0.03**	0.10	0.03**
Institutional Type: Liberal Arts	0.02	0.04	0.04	0.04

HSI (25% or more of undergraduates are Latino)	0.12	0.09	0.09	0.07
Student Peer Context				
Average entering freshman Social Agency score	0.01	0.01	0.02	0.01*
Proportion of undergrads in STEM majors	0.00	0.11	-0.04	0.11
STEM Faculty Context				
Average of STEM Faculty: Grade on a curve	-0.01	0.04	0.01	0.04
Average STEM Faculty score on civic minded values factor	0.05	0.02**	0.01	0.02
Average STEM faculty score on student-centered pedagogy factor	-0.003	0.02	0.02	0.02
Intercept	-1.23	0.21***	0.53	0.22*
Model Statistics				
Level 2 variance	0.009		0.003	
Explained variance at level 2	0.890		0.949	
Intercept Reliability	0.224		0.085	

Note: Data are weighted. *p<.05, **p<.01, ***p<.001

STEM bachelor's degree recipients whose undergraduate major was biological science have both higher social agency and values toward conducting meaningful research than computer science or technology, physical science, engineering, health professional, and math or statistics majors. These findings show the strong influence of academic majors in the undergraduate socialization process (e.g., Vreeland & Bidwell, 1966; Weidman, 1979). While the findings connect to what previous scholars have identified as a limitation of STEM education with respect to the development of students' social and civic responsibility (e.g., Beckwidth & Huang, 2005; Garibay, under review; Gutstein, 2006; Sax, 2000), they also demonstrate differences between STEM majors in the preparation of undergraduates.

Only one student-level experience with faculty or peer socialization had a significant relationship with STEM bachelor's degree recipients' social agency and value toward conducting meaningful research. STEM bachelor's degree recipients who participated in an ethnic or cultural club or organization had both higher social agency and values toward conducting research that will have a meaningful impact on underserved communities. Many student organizations grounded on students' racial/ethnic identities, including those that are STEM-related, describe in their mission statements goals of developing agents of change. These organizations seem to provide important peer normative environments that may not only facilitate students' academic success, but also help students develop their desire to promote a more democratic society through both sociopolitical involvement and research. STEM students in these organizations may find important support for their altruistic motivations in science, which may often not be the case in many STEM classrooms and departments.

The models also show a consistent and positive association between participation in a structured undergraduate research program and STEM bachelor's degree recipients' democratic outcomes. This is a very interesting finding as these types of research experiences, unlike working with faculty on her or his research, seem to positively impact STEM students' desire to promote a more democratic society in multiple ways (through both conducting research and their sociopolitical involvement). Prior research has shown that undergraduate research programs allow students to ask their own questions and seek creative solutions to problems (Laursen et al., 2006). Thus, these opportunities seem to provide experiences in science that allows students to develop their research skills as well as their individual agency. This, in turn, may drive students who participate in structured undergraduate research programs to not only want to utilize their research skills and STEM knowledge to promote a more democratic society, but also to be engaged in society to promote these goals.

STEM degree recipients who felt that their undergraduate institution better prepared them to understand the role of science and technology in society also tended to have significantly higher levels of social agency and placed a greater level of importance toward conducting meaningful research seven years after college entry. Many institutions are establishing a variety of co-curricular programs and courses in STEM that are geared toward influencing STEM students' democratic outcomes, such as service-learning opportunities and courses focused on integrating STEM and societal issues (e.g. Baillie et al., 2011, Jordan, 2006). Service-learning opportunities and courses connecting STEM and social issues have been shown to be positively associated with a variety of democratic outcomes (Brown et al., 2007; Einfeld & Collins, 2008; Hurtado, 2003; McClure & Lucius, 2010). The positive relationship between this perception and both dependent variables may indicate student participation in these types of experiences.

Interestingly, STEM bachelor's degree recipients' social agency and values toward conducting meaningful research were affected differently by having enrolled in or completed a STEM graduate or professional program relative to pursuing a non-STEM post-undergraduate pathway. When compared to those in a non-STEM post-undergraduate pathway, STEM bachelor's degree recipients who were enrolled in or completed a STEM graduate or professional program had significantly lower levels of social agency, but significantly higher values toward conducting meaningful research seven years after college entry. Though causality cannot be inferred given the timeframe of data collection, the results may suggest that those who have higher social agency tend to pursue non-STEM pathways after their undergraduate years while those who place greater value on conducting meaningful research may tend to pursue STEM graduate pathways to try to fulfill their research interests. Alternatively, it may also be that STEM graduate-level training focuses less on developing students' desire to promote a more democratic society through their socio-political involvement while focusing more on their desire to promote a more democratic society through conducting research. Future research should further examine disciplinary differences at the graduate level and examine the impact of non-STEM graduate programs on STEM bachelor's degree recipients' democratic outcomes.

With regards to institutional contexts, only one structural characteristic significantly influenced both STEM bachelor's degree recipients' social agency and value toward conducting meaningful research. STEM bachelor's degree recipients' who attended a research university relative to a master's comprehensive and other baccalaureate granting institution for their undergraduate education had significantly higher social agency and values toward conducting meaningful research. Research institutions tend to have greater resources, including campus programs and facilities, which may help STEM bachelor's degree recipients' development of democratic outcomes.

Differences between the two models. Additionally, Table 4.10 shows that several background characteristics and pre-college experiences, undergraduate socialization experiences, post-undergraduate experiences, and institutional factors significantly affect either STEM bachelor's degree recipients' social agency or their value toward conducting meaningful research. Women had significantly higher social agency than their male counterparts, but there was no significant difference between men and women in their values toward conducting meaningful research. This finding shows important differences between men and women in how they seek to make a positive impact on society. Women seem to care more about making a positive change in society specifically through their sociopolitical involvement.

Considering STEM bachelor's degree recipients' pre-college experiences, participating in a health science research program sponsored by a university had a positive relationship with conducting meaningful research, but did not predict social agency, while performing volunteer work was significantly related to social agency, but was not related to values toward conducting meaningful research. These findings demonstrate differences in the nature of these pre-college experiences and how they influence different ways STEM bachelor's degree recipients' would like to promote a democratic society. With regards to pre-college characteristics, STEM identity was significantly and positively related to values toward conducting meaningful research, but did not predict social agency. This difference may represent the makeup of STEM identity and suggest that those with higher STEM identity may want to make a difference for underserved populations through their research or intellectual contributions to their field as opposed to being involved at a sociopolitical level. Merging their sociopolitical interests with their STEM identity may be a more complex or difficult process for STEM students perhaps because making a difference through sociopolitical means may not be valued or recognized in the wider STEM community and culture.

STEM bachelor's degree recipients' agreement with the statement "racial discrimination is no longer a problem in the America" during their freshman year significantly predicted their values toward conducting meaningful research, but not their social agency seven years after college entry. Specifically, STEM students who more strongly agreed that racial discrimination was no longer a problem in the U.S. during their freshman year placed less importance on promoting a more equitable society through conducting research seven years after college. Perhaps, STEM students who recognize this issue early on may be more inclined to promote a more democratic society through their research but not their sociopolitical involvement, arguably a more difficult outcome to achieve for STEM bachelor's degree recipients. It may also be that STEM students' understanding of racial discrimination at the end of college, as opposed to the beginning, may predict their social agency seven years after college entry. In other words, how

STEM students' understanding of this critical issue is developed during their undergraduate years may help explain their level of social agency seven years after college entry.

The factors that significantly predicted social agency, but not values toward conducting meaningful research for STEM bachelor's degree recipients include majoring in environmental science; participation in an academic club or professional association; having entered the STEM workforce; and attending an institution where STEM faculty, on average, have a higher score on the civic-minded values factor. The factors that significantly predicted STEM bachelor's degree recipients' values toward conducting meaningful research, but not their social agency, include working with a faculty member on her or his research; receiving mentoring for a faculty member; and attending an institution where entering freshmen, on average, have a higher score on social agency. STEM bachelor's degree recipients who majored in an environmental science discipline had significantly lower levels of social agency than biological science majors, but there were no significant differences in their values toward conducting meaningful research. Thus, it seems as if biological science disciplines tend to better develop students' desire to promote a more democratic society through sociopolitical involvement than environmental science disciplines, but seem to equally develop students' values toward conducting research that will have an important impact on underserved communities.

Furthermore, participation in an academic club or professional association had a significant positive relationship with STEM bachelor's degree recipients' social agency and not with their values toward conducting meaningful research. These findings may suggest that STEM students' experiences with peers in academic clubs may provide important contexts that support the development of social agency as these academic clubs may be more focused on group members' involvement in society. Alternatively, STEM students' social agency may have more to gain from these experiences in academic clubs than their values toward conducting meaningful research.

Working with a faculty member on research and receiving mentoring from a faculty member both had a significant positive relationship with STEM bachelor's degree recipients' values toward conducting meaningful research, but did not significantly relate to social agency. These findings suggest that these two socialization experiences with faculty may be more beneficial toward or focused on STEM degree recipients' research goals as opposed to their social agency. Also, as mentioned in the predictors of social agency subsection, the fact that these faculty socialization measures do not parcel out how many faculty members students had these important experiences with or which disciplines the faculty are associated with may be contributing to the non-significance.

In regards to post-undergraduate experiences, being employed in the STEM workforce was negatively related to social agency, but was not significantly related to STEM bachelor's degree recipients' values toward conducting meaningful research. Again, given that information on post-undergraduate trajectories and the dependent variables were collected at the same time point it is impossible to observe causal effects of post-undergraduate experiences. It may be that STEM bachelor's degree recipients' social agency may be more likely to affect their post-undergraduate pathway than their values toward conducting meaningful research. However, it may also reveal that being employed in the STEM workforce may affect STEM bachelor's degree recipients' social agency, but not affect their values toward conducting meaningful research differently than non-STEM post-undergraduate pathways.

Finally, the findings also indicate that different faculty and peer contextual effects significantly influence either STEM bachelor's degree recipients' social agency or values toward conducting meaningful research. For example, the contextual effect of STEM faculty members' civic-minded values significantly and positively affects social agency, but does not significantly relate to values toward conducting meaningful research. STEM students' values toward conducing meaningful research may be more related to their individual-level socialization experiences with faculty, while the development of their social agency is affected by the normative contexts shaped by STEM faculty. Also, the contextual effect of peer social agency significantly and positively affects STEM bachelor's degree recipients' level of importance placed on conducting meaningful research, but is not significantly related to STEM bachelor's degree recipients' social agency. STEM bachelor's degree recipients' values toward conducting meaningful research seem to benefit from peer normative contexts related to peer social agency, but peer normative contexts do not affect STEM students' social agency. These peer and faculty contextual findings coupled with the finding that suggests attaining higher social agency may be more difficult to achieve for STEM bachelor's degree recipients than attaining higher values toward conducting meaningful research suggests that for STEM bachelor's degree recipients to attain higher social agency outcomes, it is critical for STEM bachelor's degree recipients to have the support of contexts shaped by those with greater authority specifically in STEM departments (i.e., STEM faculty). With respect to peers, STEM bachelor's degree recipients' social agency seems to be more affected by individual-level socialization experiences with peers as opposed to wider peer normative contexts at the institutional level. The next chapter will discuss these findings in greater detail and provide implications for institutional research, policy and practice.

General Summary of Results

This chapter presented the numerous stages of analysis involved in this study examining the student-level and institutional-level influences of STEM bachelor's degree recipients' social agency and values toward conducting meaningful research. The chapter first presented descriptive statistics of the dependent variables and examined the relationship between STEM bachelor's degree recipients' social agency and values toward conducting meaningful research. These results showed that the two dependent variables are unique and that STEM bachelor's degree recipients, overall, seem to care more about contributing to the betterment of society by conducting research, as opposed to socio-political involvement. The chapter then provided a summary of the descriptive statistics for the student and institutional samples. An analysis of the between-institution variances for each of the dependent variables confirmed the nested structure of the data warranting the use of multilevel modeling to examine the predictors of STEM bachelor's degree recipients' social agency and values toward conducting meaningful research.

After demonstrating the need to use multilevel modeling techniques, the results of the multilevel models of both dependent variables are presented. Each multilevel model was constructed in four steps and several background characteristics, pre-college characteristics and experiences, undergraduate socialization experiences, post-undergraduate trajectories, and institutional variables significantly predicted the dependent variables. The results of both final models show that there are some common predictors of both dependent variables as well as some differences, which suggests that STEM bachelor's degree recipients' desire to promote a more democratic society through sociopolitical involvement versus research develops differently between their freshman year and seven years after initial college entry. Furthermore, cross-level interactions are examined between significant undergraduate socialization experiences and institutional variables, and the results show that the effects of several undergraduate experiences significantly varied across particular institutional contexts. In the following chapter I revisit my research questions and discuss the findings from Chapter 4 in greater depth, as well as provide implications for future research, policy, and practice.

CHAPTER 5: DISCUSSION AND IMPLICATIONS

Scientific and technological development has provided countless benefits to society. However, recent figures on the state of poverty within the U.S. (Baker, Schootman, Barnidge, & Kelly, 2006; DeNavas-Walt, Proctor, & Smith, 2012; U.S. News Centre, 2011; Walker, Keane, & Burke, 2010) and throughout the world (Ali Khan, 2010; United Nations, 2011) suggest that while advancements in science and technology have had a profound impact on human capacity, the overall impact of science and technology on creating a more equitable world remains limited. As eventual actors in the creation and implementation of science and technology in helping to solve pressing social issues, many scholars contend that STEM graduates must be better trained to be socially responsible decision-makers if science and technology is to improve its impact on equity and the human good (Lima, 2000; Holdren, 2008; Vaz, 2005). Given the national attention STEM education reform has received in recent years, higher education researchers must provide empirical evidence to help inform institutional policy and practice. Therefore, the key objective of the study was to understand the various factors that may influence the development of STEM bachelor's degree recipients' values toward promoting a more equitable society.

The next section provides a summary of the problem this study addressed and an overview of the study, including the theoretical perspectives, databases, and the methodological approach used to investigate the problem. Next, the chapter discusses the major contributions this study has on the STEM education research literature followed by a discussion of the findings related to each of the research questions presented in Chapter 3. The chapter concludes with a discussion of the study's implications for research, policy and practice.

Overview of the Study

Recent initiatives demonstrate that STEM education reform is critical to the nation's workforce, health, and economy (Obama, 2010; President's Council of Advisors on Science and Technology [PCAST], 2012). Despite the importance of preparing STEM students to address the current state of poverty (Holdren, 2008), most policy reports frame the purpose of STEM education with respect to maintaining U.S. global economic competitiveness (e.g., National Academy of Engineering, 2005; National Academy of Sciences, 2007; National Science Board, 2004; PCAST, 2012). Many of these calls for maintaining U.S. economic competitiveness grossly ignore the current state of poverty both within the U.S. and throughout the world and leave unexamined how STEM education can support hegemonic ideologies of society (Anderson, 1997; Bishop, 1990; Frankenstein, 1983; Gutstein, 2006). Such economic-centered perspectives have largely framed notions of STEM student success to focus on steering more students into the STEM disciplines and solely developing their STEM capacities to specifically fill workforce roles.

Prior literature examining the preparation and training of STEM students reveals that STEM academic departments rarely focus on developing students' democratic educational outcomes (Beckwidth & Huang, 2005; Vaz, 2005) and studies have shown limitations in the development of STEM students' values toward promoting a more equitable society (e.g., Astin, 1993a; Crandall, Davis, Broeseker, & Hildebrandt, 2008; Crandall, Volk, & Cacy, 1997; Crandall, Volk, & Loemker, 1993; Garibay, under review; Nicholls et al., 2007; Sax, 2000). Several scholars have begun to focus on specific practices and programs being implemented in STEM departments to promote students' social and civic responsibility (e.g., Baillie, Pawley, & Riley, 2011; Brown, Heaton, & Wall, 2007; Gadbury-Amyot, Simmer-Beck, McCunniff, &

Williams, 2006; Jordan, 2006; Lima, 2000; Ritter-Smith & Saltmarsh, 1998; Ropers-huilman, Carwile, Lima, 2005; Vaz, 2005), yet have largely focused on one program or course (e.g., service-learning, science and society courses) and their studies tend to be small in scope (i.e., within one or a few institutions). These bodies of literature demonstrate that although there is broad agreement in the need to prepare STEM students who are socially responsible citizens, there is a dearth of literature on the various college experiences and contexts that may develop STEM students' democratic educational outcomes, especially over the long-term. This study sought to address this gap in the literature by examining two democratic educational outcomes: (1) social agency and (2) values toward conducting research that will have a meaningful impact on underserved communities. This inquiry examined student- and institutional-level factors on a national sample of STEM bachelor's degree recipients, with emphasis placed on experiences with socialization during the undergraduate years that influence these outcomes.

This study applied two theoretical frameworks to help understand the various individuals, experiences, and contexts that may influence the development of STEM degree recipients' democratic outcomes. First, this study relied upon Weidman's (1989) theory of undergraduate student socialization. This model emphasizes that a student's background, the normative influences (both formal and informal) of the academic and social contexts of the college, and off-campus individuals (i.e., parents) all play a role in the development of students' values. The framework helps shed light on how students may negotiate their own values with the social and structural contexts they encounter while navigating their particular college environment. Given this study's specific focus on STEM undergraduate student development, this study applied a second theory that focused on undergraduate socialization within academic departments developed by Vreeland and Bidwell (1966) and further developed by Weidman (1979).

Frameworks of undergraduate socialization within academic departments posit that a student's major becomes a significant part of the academic normative context as students take the majority of their college courses within their specific major. Academic departments exert influence on their students as they vary in their goals for undergraduate education and in the means and resources available to achieve those educational goals. Frameworks of undergraduate socialization within academic departments emphasize that faculty and peers within an academic department are the primary agents through which academic departments socialize undergraduates.

Informed by these frameworks, as well as prior research on STEM education, this study utilized merged data from several national databases including longitudinal student data from the 2004 Cooperative Institutional Research Program's (CIRP) Freshman Survey and 2011 Post-Baccalaureate Survey, and institutional data from the Integrated Postsecondary Educational Data System. Aggregate STEM faculty data was also merged from the 2007 and 2010 CIRP Faculty Surveys to provide information about the STEM faculty within students' institutional contexts. These data provided a final longitudinal sample of 6,341 STEM bachelor's degree recipients across 271 institutions.

The study relied upon several analytical techniques to examine STEM bachelor's degree recipients' social agency and values toward conducting research that will have a meaningful impact on underserved communities seven years after college entry. First, the study presented descriptive statistics of the dependent variables and used correlation analysis and cross-tabulations to examine the relationship between the two dependent variables. Second, a series of descriptive statistics were examined to better understand the characteristics of students and institutions in the analytical sample. The primary analytic method used to examine the development of STEM bachelor's degree recipients' social agency and values toward conducting meaningful research was multilevel modeling given the continuous nature of the dependent variables and the clustered, multi-level nature of the data (Raudenbush & Bryk, 2002). Multilevel modeling accounts for the complexity of the sample design and provides more robust estimates for the standard errors of the parameters (Raudenbush & Bryk, 2002). Factor analyses were also used to create several latent variables used as independent variables in the models, including the dependent variable social agency, and multiple imputation was used for handling missing data, which has been recommended to be the first choice method for handling missing data for quantitative research in higher education (see Cox, McIntosh, Reason, & Terenzini, 2014). Effect sizes of the undergraduate, post-undergraduate, and institutional predictors were calculated to examine the proportion reduction in variance at level 1 and proportion reduction in variance in the level-2 intercepts. Cross-level interactions were also explored to examine whether any of the undergraduate socialization effects were moderated by institutional variables. Chapter 4 provides a summary of the findings from these methods. Additionally, the findings related to each research question presented in Chapter 3 are discussed later in the chapter within the context of prior research.

Major Contributions of the Study

This study significantly extends the current research literature on STEM education and democratic educational outcomes in several important ways. First, given the current state of poverty and the persistence of profound inequities faced by People of Color and other marginalized groups both within the U.S. and throughout the world, this study makes a concerted effort to critically examine what current notions of STEM college student success mean for addressing inequities within *and* beyond the walls of higher education. By contextualizing and critiquing the predominant notion that the purpose of STEM education is for the maintenance of U.S. global economic competitiveness, this study moves beyond examining traditional measures of academic success that largely address the needs of the private sector and examines how higher education institutions are preparing STEM bachelor's degree recipients to promote a more equitable society. Placing greater importance on educational outcomes critical to promoting a more equitable society in the STEM education research literature more appropriately centers the realities and needs of People of Color and other marginalized groups.

Second, the study advances previous research in this area by examining a recent national longitudinal sample of 6,341 STEM bachelor's degree recipients beginning their postsecondary education at 271 higher education institutions. This large institutional sample allowed the study to give specific attention to institutional contexts and enabled the use of multilevel modeling techniques to more accurately estimate the effects of these important institutional-level variables. Previous research focused on democratic educational outcomes in STEM has solely examined students within one (i.e., Crandall et al., 1997; Crandall et al., 1993) or few institutions (i.e., Crandall et al., 2008; Wieland et al., 2010). Additionally, prior higher education research studies examining the development of STEM students' democratic outcomes have utilized descriptive and simple inferential statistics (i.e., Brown et al., 2007; Crandall et al., 2008; Crandall et al., 1997; Crandall et al., 1993; Gadbury-Amyot et al., 2006; Lima, 2000), correlations or multivariate analyses (i.e., Astin, 1993; Sax, 2000), or a combination of basic inferential statistics with qualitative analyses (i.e., Rubin, 2004). The use of multilevel modeling allows the study to take into consideration both individual- and institutional-level variables allowing for a more nuanced understanding of the development of STEM bachelor's degree recipients' democratic outcomes.

Third, this study contributes to the higher education literature by examining the development of students' democratic outcomes seven years after college entry, or roughly 2-3 years after students may have completed their undergraduate STEM degree. Prior research on the development of democratic outcomes of college students have primarily focused on the short-term impact of educational experiences and contexts by measuring democratic outcomes immediately after a program of interest, at the end of a course, or during their senior-year of college (i.e., Astin, 1993; Astin, Vogelgesang, Ikeda, & Yee, 2000; Brown et al., 2007; Chang, 2002; Gadbury-Amyot et al., 2006; Gurin et al., 2002; Hurtado, 2003; Lima, 2000; Milem, 1994; Nelson Laird, 2005; Rubin, 2004; Sax, 2000; Tsang, 2000). By examining the development of democratic educational outcomes over the span of seven years, this study provides a better understanding of the long-term impact of undergraduate experiences and contexts on student development.

Finally, this study adds to the existing literature on STEM students' democratic outcomes by applying a comprehensive framework to examine the development of these important outcomes over the college years. Much of the previous literature on STEM students' democratic outcomes has documented the impact of one program or course usually within one school (i.e., Brown et al., 2007; Gadbury-Amyot et al., 2006; Rubin, 2004; Tsang, 2000; Vaz, 2005) often without the use of a theoretical or conceptual framework to help guide the study. The present study utilized theories of undergraduate student socialization (Vreeland & Bidwell, 1966; Weidman, 1989, 1979) to go beyond simply examining the influence of curricular and co-curricular experiences in STEM to examine how experiences with faculty, peers, academic disciplines, and various institutional contexts play a role in the development of STEM bachelor's degree recipients' democratic outcomes. Additionally, these frameworks of undergraduate student socialization provide a comprehensive examination of the college environment and place the focus on how higher education institutions are preparing STEM bachelor's degree recipients to work toward the betterment of society.

Discussion of the Research Questions, Hypotheses, and Findings

Chapter 4 provides the findings from the multilevel models predicting STEM bachelor's degree recipients' social agency and values toward conducting meaningful research seven years after college entry. Multilevel modeling techniques were used to address each of the research questions posed in Chapter 3. The following subsection provides the findings related to each of the research questions and discusses how the findings of this study relate to prior research.

Research Question 1: Variation Between Institutions

The first research question asked, "To what extent do STEM bachelor's degree recipients' social agency and value toward conducting meaningful research vary within and between institutions?" Given the substantial number and diversity of institutions included in the study, it was hypothesized that the average in STEM bachelor's degree recipients' democratic outcomes would significantly differ across institutions. This hypothesis was confirmed as the significance of the randomly distributed error term at the institutional level of both fully unconditional models presented in Chapter 4 demonstrate significant variation between institutions in the average social agency and importance of conducting meaningful research of STEM bachelor's degree recipients (see Table 4.5). The significance of the between-institution variance of both dependent variables confirmed the nested structure of the data and thus the study then proceeded with the inclusion of individual- and institution-level predictors to examine the factors influencing STEM bachelor's degree recipients' social agency and values toward conducting meaningful research.

The intra-class correlation coefficients (ICCs) of each model reveal that 9.3% of the variation in STEM bachelor's degree recipients' social agency lies between institutions while 6.5% of the variation in their value toward conducting meaningful research is due to differences across institutions. These ICC values demonstrate that institutional contexts play a critical role on the development of STEM bachelor's degree recipients' social agency and values toward conducting meaningful research during college. Given that institutional factors may account for nearly ten percent of the variance in STEM bachelor's degree recipients' democratic outcomes, prior research not accounting for institutional variables (see Pascarella & Terenzini, 2005) or not utilizing multilevel modeling techniques to examine democratic educational outcomes (i.e., Dugan & Komives, 2010) may have misestimated or neglected important influences on college students' development of democratic outcomes.

Research Questions 2a and 2b: Undergraduate Socialization

Undergraduate Socialization Experiences. The first part of the second research question posed in Chapter 3 asked: "Controlling for background characteristics and precollege characteristics and experiences, how do undergraduate socialization experiences with academic disciplines, faculty, and peers contribute to the social agency of STEM bachelor's degree recipients seven years after college entry?" Part B of Research Question 2 asked the same question but for the second dependent variable: "Controlling for background characteristics and precollege characteristics and experiences, how do undergraduate socialization experiences with academic disciplines, faculty, and peers contribute to the importance of conducting meaningful research of STEM bachelor's degree recipients seven years after college entry?" Using both Vreeland and Bidwell's (1966) and Weidman's (1989) frameworks of undergraduate socialization as well as prior research, it was hypothesized that college socialization experiences with faculty, peers, and academic disciplines would have significant effects on STEM bachelor's degree recipients' social agency and importance of conducting meaningful research. The results that address Part A and Part B of Research Question 2 can be found in Table 4.6 and Table 4.8, respectively.

The findings related to undergraduate socialization showed that STEM bachelor's degree recipients' undergraduate majors have a strong influence on the long-term development of their social agency and values toward conducting meaningful research. This finding supports theories of undergraduate socialization within academic departments (e.g., Vreeland & Bidwell, 1966; Weidman, 1979), which indicate that a student's academic major plays a significant role in the development of her or his values given that she or he takes more courses in the major than in any other field. The study compared STEM bachelor's degree recipients whose undergraduate majors were in environmental science, computer science or technology, physical science, engineering, health professional, and math or statistics to those whose undergraduate majors were in the biological sciences. STEM bachelor's degree recipients whose undergraduate major was biological science were found to have significantly higher outcomes on both social agency and values toward conducting meaningful research than all other undergraduate major categories, except for environmental science. Significant differences were found between biological science majors and environmental science majors on social agency, but not on their values toward conducting meaningful research. Generally, the significant influence of academic majors underscore prior research that has identified the limitations of STEM education with respect to the development of college students' social and civic responsibility (e.g., Astin, 1993; Beckwidth & Huang, 2005; Garibay, under review; Sax, 2000), and also suggests that some STEM disciplines (i.e., biological sciences, environmental sciences) may better prepare undergraduates to participate in working towards a more equitable society. The effects of several majors were also among the socialization experiences that explained the most within-group variance of the dependent variables. Specifically, majoring in engineering and majoring in computer science were two of the top four undergraduate experiences that explained the most within-group variance in social agency. Majoring in engineering was also one of the top four undergraduate experiences that explained the most within-group variance in conducting meaningful research. Thus, these specific majors explain a substantial portion of how STEM bachelor's degree recipients' democratic outcomes change seven years after college entry.

It is also important to note that while the effects of most academic majors continued to have a significant influence even after controlling for post-undergraduate trajectories, results from Table 4.6 and Table 4.8 show that post-undergraduate trajectories may affect the long-term influence of undergraduate majors on students' social agency and values toward conducting meaningful research. The importance of post-undergraduate trajectories and experiences on the development of STEM bachelor's degree recipients' democratic outcomes has significant implications for STEM graduate programs and furthering students' development that occurred over the undergraduate years. This point is discussed further in the implications for future research and policy and practice sections.

STEM bachelor's degree recipients' participation in an ethnic/cultural club or organization significantly and positively predicted their level of social agency and values toward conducting meaningful research. Interestingly, of the four student-level experiences with faculty or peer socialization included in the model, this was the sole experience that had a significant relationship with both dependent variables. Participation in an ethnic/cultural club or organization also was among the six undergraduate experiences that explained over 1% of the within-group variance in conducting meaningful research, explaining 1.2%. Given that many racial/ethnic student organizations, including those that are STEM-focused (i.e., National Black Society for Engineers, Chicano's for Community Medicine, etc.), contain in their mission statements goals of developing agents of change and empowering their communities (i.e., National Society of Black Physicists, n.d.; Society of Hispanic Professional Engineers, n.d.), these organizations may provide important peer normative environments that help participants develop their desire to promote a more democratic society through both sociopolitical involvement and research. Also, STEM students' involvement in these organizations may provide them with important community service opportunities (Newman, 2011), which have been consistently shown to positively influence student democratic outcomes (Astin et al., 2000; Brown et al., 2007; Einfeld & Collins, 2008; Gadbury-Amyot et al., 2006; Hurtado, 2003).

Additionally, given that these two dependent variables examine two different ways students may want to be involved in promoting positive change in society, it was also hypothesized that some of the undergraduate socialization experiences examined in this study would influence these two different dependent variables uniquely. There is support for this hypothesis as the findings indicate that participation in an academic club or professional association had a significant and positive relationship with STEM bachelor's degree recipients' social agency, but did not have a significant effect on their values toward conducting meaningful research. Prior research has shown positive relationships between involvement in student organizations and developmental gains in various outcomes (Cooper, Healy, & Simpson, 1994; Foubert & Grainger, 2006), including humanitarianism (Kuh, 1995). Such outcomes are often attributed to the types of tasks students participate in within these organizations (i.e., planning, managing, decision-making, and organizing) and students' level of involvement within the student organization (Foubert & Grainger, 2006; Kuh, 1995). Astin (1996, p. 126) notes that a student's peer group is the strongest single source of influence on a student's cognitive and affective development given that peers are capable of involving each other more intensely in experiences. Indeed, participation in an academic club or professional association was the undergraduate experience that explained the most within-group variance in both dependent variables, however, the relationship between participation in an academic club or professional association and conducting meaningful research was non-significant in the final model. The findings of this study may suggest that STEM students' experiences with peers in academic clubs or professional associations provide important normative contexts that support the development of students' interest in making a difference in society through sociopolitical involvement. It may also be that STEM students' social agency as opposed to their values toward conducting meaningful research may have more to gain from these experiences with peers in academic clubs or professional associations.

Also supporting this hypothesis is the fact that both student-level socialization experiences with faculty included in this study had significant associations with STEM bachelor's degree recipients' values toward conducting meaningful research, but did not relate to their social agency seven years after college entry. STEM bachelor's degree recipients who worked with a faculty member on his or her research and received mentoring from a faculty member had significantly higher values toward conducting meaningful research. These two experiences with faculty were also among the six undergraduate experiences that explained over 1% of the within-group variance in conducting meaningful research, where experiences working with a faculty member on her or his research actually explained 2.0% of the within-group variance. It may be assumed that with these types of experiences students have a strong relationship with a faculty member and learn more about the careers of research scientists and academics. Faculty members who provide undergraduates with the opportunity to participate on a research project and serve as mentors to undergraduates may be serving in a capacity that facilitates students' understanding of the positive impact research can have on helping to create a more equitable society and encourage students to consider this type of career pursuit. It may also be that faculty serving in this capacity may provide critical support to students who have already learned about and chosen this career path. These findings may also suggest that through their interactions with student mentees or research assistants, faculty members may be more likely to encourage students who have altruistic motivations for pursuing science to focus on "making a difference" particularly through research studies as opposed to developing students' interest to work towards a more equitable society through sociopolitical involvement, specifically. Either way, such findings indicate the potential influential role that faculty members have on students as indicated by Weidman's (1989) theory of undergraduate student socialization. With regards to the individual-level effects of peer and faculty socialization, STEM bachelor's degree recipients' social agency seems to be influenced by peer socialization rather than faculty socialization, while their values toward conducting meaningful research seem to be affected by both peer and faculty socialization.

Considering the effects of STEM educational and career preparation, the findings show a positive and significant association between participation in a structured undergraduate research program (i.e., MARC, MBRS) and STEM bachelor's degree recipients' desire to promote a more equitable society through both sociopolitical involvement and research. Interestingly, these types of research experiences, and not experiences working with a faculty member on her or his research, positively influence STEM students' desire to promote a more equitable society through both conducting research and their sociopolitical involvement. The findings show that participation in a structured undergraduate research program was among the top five undergraduate experiences that explained the largest proportion in within-group variance on social agency, explaining 0.95%. Prior research on undergraduate research programs has shown that these programs allow students to ask their own questions and seek creative solutions to problems (Laursen et al., 2006), which may provide students the ability to develop their research interests as well as their individual agency. Thus, participants in structured undergraduate research programs may be driven to not only want to utilize their STEM knowledge and research capacities to promote a more equitable society, but also to be engaged in their communities to promote these goals.

Furthermore, STEM degree recipients who felt that their undergraduate institution better prepared them to understand the role of science and technology in society had both higher levels of social agency and values toward conducing meaningful research seven years after college entry. Given that many STEM programs are establishing service-learning opportunities and courses connecting science and social issues (e.g., Baillie et al., 2011; Jordan, 2006), which have been shown to have a positive relationship with a variety of democratic educational outcomes (e.g., Brown et al., 2007; Einfeld & Collins, 2008; Hurtado, 2003; McClure & Lucius, 2010), the positive association between students' perception and both dependent variables may suggest student participation in these types of experiences. This perception was among the top four undergraduate variables that explained the largest proportion of within-group variance in both dependent variables, explaining 1.6% of the within-group variance in social agency and 1.7% of the within-group variance in conducting meaningful research. The important relationship between this perception and both STEM degree recipients' social agency and values toward conducting meaningful research may indicate that learning about science and technology within a societal context allows students to not only develop their understanding of the impact of science on society but also their agency to use their STEM knowledge to make a positive impact on society through both their research and community involvement. Institutions that seek to provide more opportunities for STEM students to learn about social issues are likely to better prepare future STEM leaders to address poverty and inequities after college.

Other Important Student-Level Predictors. Aside from these findings related to undergraduate socialization experiences, other student-level effects also supported the theoretical frameworks and prior research informing this study. Weidman (1979) indicates that background characteristics can have a strong influence on student values. With regards to racial/ethnic identification, STEM bachelor's degree recipients who were Black or African American, Latina/o, and Asian American or Pacific Islander tended to have significantly higher levels of social agency and values toward conducting meaningful research than their white counterparts, which supports previous research that found an association between race/ethnic identification and democratic motivations for pursuing STEM majors (Carlone & Johnson, 2007; Garibay, under review; Johnson, 2007a; Newman, 2011). The differences between these groups may suggest how the lived experiences of People of Color and whites in the U.S. may differentially shape individuals' goals and aspirations to want to create a more equitable society. People of Color may be more inclined to want to help underserved populations and create a more equitable society through both sociopolitical involvement and research given that these groups continue to face vast inequities and discrimination in the U.S.

Other background characteristics also had an important influence on the development of STEM bachelor's degree recipients' democratic outcomes. Women tended to have higher social agency than their male counterparts, which is in line with prior research that has shown that female students are significantly more likely than males to value social action engagement (Hurtado et al., 2002) and report higher levels of social agency (Nelson Laird, 2005). Individuals' socioeconomic status (SES) was significantly and negatively related to the level of importance placed on conducting meaningful research. Similar to the differences across race/ethnic groups, differences found between men and women, and SES groups may suggest how the lived experiences of women and lower SES students may differentially shape their goals and aspirations to want to help underserved populations and create a more equitable society. Taken together, the findings related to background characteristics seem to suggest a negative relationship between relative privileged status (i.e., white, male, higher SES) in the U.S. and a desire to promote a more equitable society– differences that largely remain even after controlling for the blocks of variables comprising the college environment. These findings have important implications for STEM education and are further discussed in the implications for policy and practice section.

STEM bachelor's degree recipients' pretest measure of social agency and SAT composite score also had a significant relationship with both democratic outcomes. STEM bachelor's degree recipients who entered college with higher levels of social agency had significantly higher levels of social agency and values toward conducting meaningful research seven years after college entry, which supports and extends previous research indicating that freshman-year social agency is an important predictor of social agency at the end of college (Astin, 1993; Nelson Laird et al., 2005; Zuñiga et al., 2005). STEM bachelor's degree recipients' SAT composite score had a significant and negative relationship with their social agency and values toward conducting meaningful research seven years after college entry, which supports and extends Hurtado et al.'s (2002) finding that high SAT scores do not necessarily translate into more complex thinking and understanding critical for participation in a diverse democracy.

With respect to precollege experiences, STEM bachelor's degree recipients who participated in a health science research program during high school had significantly higher values toward conducting meaningful research seven years after college entry. This finding lends support to prior research on the impact of summer research programs in science on students' understanding of the nature of science and scientific inquiry (e.g., Bell et al., 2003; Moss, Abrams, & Kull, 1998; Moss, Abrams, & Robb, 2001; Sadler et al., 2010), and demonstrates that these learning experiences may have an important long-term influence on STEM students. STEM bachelor's degree recipients who participated in volunteer work during their senior year of high school had significantly higher social agency seven years after college entry, showing the important influence precollege experiences with community service may have on STEM students over the long term. This finding is consistent with prior research showing a significant positive relationship between participation in community service and democratic outcomes (e.g., Astin, 1993a, Brown et al., 2007; Einfeld & Collins, 2008; Garibay, under review; Hurtado, 2003).

Other precollege variables that influenced STEM bachelor's degree recipients' democratic outcomes included their STEM identity and view towards whether racial discrimination is still a problem in the U.S. STEM bachelor's degree recipients with a higher score on the STEM identity factor had a significantly higher value toward conducting meaningful research seven years after college entry. This finding connects to Carlone and Johnson's study (2007), which found that altruistic motivations are an integral part of many students' science identity. Given that STEM identity initially had a significant positive relationship with social agency, but became non-significant after controlling for STEM bachelor's degree recipients' undergraduate experiences may suggest that making a difference through sociopolitical means may not be valued or recognized in the wider STEM community and culture and thus merging their sociopolitical interests with their STEM identity may be a more complex or difficult process for STEM students. While altruistic motivations may continue to be an integral part of many students' STEM identity, the relationship between STEM identity and social agency may be separated for many students during the undergraduate socialization process in STEM fields. Additionally, it is important to note that these findings may be a result of the four items that make up the STEM identity factor used in this study, which include students' degree of personal importance on obtaining recognition from colleagues for contributions to his or her field, becoming an authority in his or her field, making a theoretical contribution to science, and working to find a cure to a health program. While the items making up the STEM identity factor were selected based on the literature regarding science identity development (see Chang, Eagan, Lin, & Hurtado, 2011), this factor is still limited as these survey items were not created to specifically assess students' STEM identity. Thus, this factor may not necessarily be capturing one's true identity but rather be capturing some other type of proclivity or sensibility toward STEM fields. In particular, the items may be capturing students' objectives in STEM that are more academically or scholarly focused. The implications of these findings are further discussed in the implications for future research section.

STEM degree recipients who more strongly agreed with the statement that racial discrimination is no longer a problem in America placed a lower value on conducting meaningful research that will have a meaningful impact on underserved communities. Given that racial inequality continues to persist in the U.S. (DeNavas-Walt, Proctor, & Smith, 2012), students who agreed with the statement that racial discrimination is no longer a problem in America may lack a deeper understanding of racial inequality in the U.S. Without a deeper understanding of racial inequality, STEM students are less inclined to want to promote a more equitable society through conducting research. STEM disciplinary programs can go a long way in preparing STEM students to work towards a more democratic and equitable society by finding ways to integrate topics and courses focused on racial/ethnic inequality into the curriculum.

Finally, findings show that STEM bachelor's degree recipients' post-undergraduate trajectories also influence their democratic outcomes seven years after college entry. Having enrolled in or completed a STEM graduate program had a significant negative influence on STEM bachelor's degree recipients' social agency, but had a significant positive influence on their values toward conducting meaningful research. While causality cannot be inferred given the timeframe of data collection, the results may suggest that STEM graduate-level training focuses less on developing students' desire to promote a more equitable society through sociopolitical involvement, yet better prepare them to pursue their altruistic motivations in science through research compared to non-STEM post-undergraduate pathways. Alternatively, STEM bachelor's degree recipients who have higher social agency may tend to pursue non-STEM pathways after their undergraduate years while those who place greater value on conducting meaningful research may tend to pursue STEM graduate pathways to try to fulfill their research interests. It is also important to add a caveat that the significant positive relationship between having enrolled in or completed a STEM graduate program and values toward conducting research that will have a meaningful impact on underserved communities may be more related to the "research" aspect of the item rather than one's interest in having a "meaningful impact on underserved communities." In other words, STEM bachelor's degree recipients who enrolled in or completed a STEM graduate program may have selected higher values on this item because of their higher values toward "conducting research" and not necessarily care about utilizing their research to have a meaningful impact on underserved communities.

Additionally, being employed in the STEM workforce was negatively related to social agency, but did not influence STEM bachelor's degree recipients' values toward conducting meaningful research. Again, causal relationships cannot be inferred given that information on post-undergraduate trajectories and social agency were collected at the same time point. While it may be that being employed in the STEM workforce may negatively affect STEM bachelor's degree recipients' social agency, it may also be that those STEM bachelor's degree recipients who have higher social agency are less likely to enter into the STEM workforce compared to non-STEM post-undergraduate pathways. Whether pursuing a STEM post-undergraduate pathway negatively influences STEM bachelor's degree recipients' social agency, or whether having higher social agency influences the pursuit of a non-STEM post-undergraduate pathway, each explanation is problematic for the retention and development of STEM talent with high social agency within STEM pathways after college. All together, these findings demonstrate the need to account for post-undergraduate experiences when investigating the development of student's democratic outcomes over the long term. These findings are further discussed in the implications for research and policy and practice sections.

Research Questions 3a and 3b: Institutional-level Predictors

The first part of the third research question posed in Chapter 3 asked: "Controlling for individual characteristics and experiences, how do institutional factors such as structural characteristics, peer-context, and STEM faculty context contribute to the social agency of STEM bachelor's degree recipients seven years after college entry?" Like with Research Question 2, Part B of Research Question 3 asked the same question but for the second dependent variable:

"Controlling for individual characteristics and experiences, how do institutional factors such as structural characteristics, peer-context, and STEM faculty context contribute to the importance of conducting meaningful research of STEM bachelor's degree recipients seven years after college entry?" The results that address Part A and Part B of Research Question 3 can be found in Table 4.6 and Table 4.8, respectively.

Structural Characteristics. The findings indicate that STEM bachelor's degree recipients who attend research institutions generally have higher social agency and values toward conducting meaningful research than those who attend a master's comprehensive or other baccalaureate institution for their undergraduate education. These significant positive relationships held even after controlling for other institutional contexts as well as the characteristics and experiences of students who attended these institutions. While research institutions have a positive relationship with both dependent variables, the effect size of research institutions was much larger for the model predicting values toward conducting meaningful research. More specifically, research institutions explained 26.8% of the variance in conducting meaningful research that is attributed to differences across institutions, while only explaining 2.0% of the between-group variance in social agency. Research institutions tend to have greater financial resources along with campus programs and facilities, which may facilitate the development of STEM bachelor's degree recipients' democratic outcomes. Also, given the particular mission of research universities, where faculty are expected to produce research and many undergraduate students participate on research projects or conduct their own research, it was not surprising that students who attended these institutions had a higher value toward conducting meaningful research seven years after college entry.

STEM Faculty Context. Normative contextual effects also seem to play a role in the development of STEM bachelor's degree recipients' democratic outcomes. Attending an institution where STEM faculty, on average, have higher civic-minded values significantly increased STEM bachelor's degree recipients' social agency. This institutional context explained the largest proportion of the variance in social agency that is attributed to differences across institutions, explaining 10.1%. This finding supports Vreeland and Bidwell's (1966) framework that indicates that faculty within a department or field of study can serve as important agents of undergraduate socialization given their ability to define the goals of undergraduate education within their department and establishing the means within their department to achieve those goals. The civic-minded values factor is made up of items that measured the extent to which STEM faculty place greater importance on encouraging students to become agents of change and instilling in students a commitment to community service as part of their educational goals for undergraduates, are more likely to believe that colleges should be actively involved in solving social problems and believe that colleges have a responsibility to work with the surrounding communities to address local issues, among several others (see Table 3.2). Thus, STEM faculty who have higher civic-minded values may be more likely to encourage change in the culture of STEM departments by introducing curricular offerings, speaker series, programs, and pedagogy that place specific emphasis on promoting students' civic outcomes.

Higher education institutions with STEM faculty who have higher civic-minded values may have a different STEM culture than one often described in the STEM college education literature (i.e., Beckwidth & Huang, 2005; Pawley, 2009; Seymour & Hewitt, 2005; Vaz, 2005), and this normative context seems to support the development of STEM students' desire to improve society through sociopolitical involvement. Also, while individual-level socialization experiences with faculty play an important role in the development of STEM bachelor's degree recipients' values toward conducting meaningful research, these individual-level experiences do not influence students' social agency. Together, these results related to the influence of faculty seem to suggest that in order to achieve higher social agency among STEM bachelor's degree recipients, which findings presented in Chapter 4 suggest is a more difficult outcome to achieve than achieving higher values toward conducting meaningful research, there needs to be a shift in the culture of STEM departments to one that highly values and promotes students' social and civic responsibility and encourages students to be agents of change. Without authority figures within STEM departments (i.e., faculty) there to support students in their social agency development, higher education institutions are likely to limit STEM student preparation for participation in a diverse democracy and hinder the potential positive impact science and technology can have on creating a more equitable society.

Student Peer Context. Finally, attending an institution where entering freshman, on average, had higher social agency was a significant positive predictor of STEM bachelor's degree recipients' values toward conducting meaningful research, underscoring the important influence peer normative contexts can have on student development (Weidman, 1989). This institutional context explained the largest proportion of variance in conducting meaningful research that is attributed to differences across institutions, explaining 31% of the variance in the level-2 intercept. Higher education institutions where students, on average, have higher social agency may have more student organizations, clubs, events, and functions that reflect those values within the campus environment. This normative peer context may provide STEM students the knowledge and skills necessary for participation in a diverse democracy as it seems to play a supportive role in the development of STEM bachelor's degree recipients' values toward conducting meaningful research.

Research Questions 4a and 4b- Moderation by Institutional Contexts

The first part of the fourth research question asked: "Are any of the effects of undergraduate socialization experiences on STEM bachelor's degree recipients' social agency moderated by institutional factors?" Like with Research Questions 2 and 3, the second part of Research Question 4 asked the same question but for the second dependent variable: "Are any of the effects of undergraduate socialization experiences on STEM bachelor's degree recipients' values toward conducting meaningful research moderated by institutional factors?" The results that address Part A and Part B of Research Question 4 can be found in Table 4.7 and Table 4.9, respectively.

Structural Characteristics. The findings indicated that several of the undergraduate socialization effects of academic disciplines, faculty, and peers are moderated by institutional contexts. Research institutions were found to moderate the effects of majoring in computer science/technology on social agency, participating in an academic club or professional association on social agency, and majoring in physical science on values toward conducting meaningful research. With respect to majoring in computer science/technology, the negative relationship between majoring in computer science/technology (when compared to majoring in biological science) and social agency was smaller (or "less negative") for those STEM bachelor's degree recipients who attended research universities as opposed to master's comprehensive or other baccalaureate institutions. STEM bachelor's degree recipients who attended research universities derived significantly less benefit from participating in an academic club or professional association on their social agency when compared to those who attended master's comprehensive or other baccalaureate institutions. Additionally, for STEM bachelor's degree recipients who majored in the physical sciences, the negative relationship between majoring in physical science (compared to biological science) and values toward conducting meaningful research is stronger for those who attended a research institution compared to those who attended a master's comprehensive or other baccalaureate institution. Liberal arts institutions were found to moderate the effect of one academic major on one dependent variable. Specifically, the negative effect of majoring in physical science (compared to biological science) on STEM bachelor's degree recipients' values toward conducting meaningful research is stronger (or "more negative") for individuals who attended a liberal arts institution compared to a master's comprehensive or other baccalaureate institution.

Private institutions were found to moderate the effects of majoring in physical science on social agency, majoring in engineering on social agency, majoring in the health professional sciences on both social agency and values toward conducting meaningful research, and participating in an academic club or professional association on social agency. For STEM bachelor's degree recipients who attended a private institution versus a public institution, the negative effect of majoring in physical science, engineering, and health professional science on social agency was weaker (or "less negative"). The negative effect of majoring in a health profession (compared to majoring in biological science) on values toward conducting meaningful research is also "less negative" for those STEM bachelor's degree recipients who attended a private versus a public institution for their undergraduate years. Taken together, these results suggest that differences in the development of students' democratic outcomes between many STEM disciplines and biological science are not as problematic than it seems to be at public institutions. With regards to peer socialization, the positive effect of participation in an academic club or professional association on social agency is weaker for students who attended a private versus a public institution. Thus, STEM students who attended a public institution seemed to gain more from their participation in an academic club or professional association than their counterparts at private institutions.

Minority Serving Institutions (MSIs) also moderated the effects of various academic disciplines and one faculty socialization variable. Specifically, Hispanic Serving institutions (HSIs) were found to moderate the effects of majoring in computer science/technology, majoring in physical science, majoring in math/statistics, and working with a faculty member on her/his research on values toward conducting meaningful research. For STEM bachelor's degree recipients who attended an HSI compared to those who attended a Predominantly White Institution (PWI), the negative effect of majoring in computer science/technology and math/statistics on values toward conducting meaningful research was weaker (or "less negative"). Conversely, the negative effect of majoring in physical science on values toward conducting meaningful research was stronger (or "more negative") for STEM bachelor's degree recipients who attended an HSI compared to a PWI. The positive effect of working with a faculty member on her/his research on values toward conducting meaningful research is stronger (or "more positive") for students who attended an HSI compared to a PWI, which suggests that STEM bachelor's degree recipients who attended an HSI seem to gain more from their collaboration on research with a faculty member than their counterparts at PWIs. This finding connects research by Stanton-Salazar, Macias, Bensimon, and Dowd (2012) who found many examples of faculty at HSIs who used their influence and power to expand educational opportunities, including research opportunities, for Latina/o STEM students.

Finally, Historically Black Colleges and Universities (HBCU) were found to moderate the effect of one academic major. For STEM bachelor's degree recipients who attended an HBCU compared to those who attended a PWI, the negative effect of majoring in math/statistics on values toward conducting meaningful research was stronger (or "more negative"). Thus, the difference between STEM bachelor's degree recipients who majored in math/statistics and biological science on their values toward conducting meaningful research is greater for students who attended HBCUs versus PWIs.

STEM Faculty and Peer Normative Contexts. Finally, the effects of several academic disciplines were also moderated by several STEM faculty and peer normative contexts. For STEM bachelor's degree recipients who attended an institution where STEM faculty, on average, score higher on the use of student-centered pedagogy, the negative effect of majoring in computer science/technology on values toward conducting meaningful research was weaker (or "less negative"). The negative effect of majoring in engineering and math/statistics on values toward conducting meaningful research was weaker (or "less negative") for STEM bachelor's degree recipients who attended an institution with a higher proportion of undergraduates in STEM majors. In other words, the difference between STEM bachelor's degree recipients who majored in engineering and math/statistics with those who majored in biological science on their values toward conducting meaningful research is smaller for students who attended institutions with a greater proportion of STEM undergraduates. Additionally, the negative effect of majoring in the health professional sciences on social agency is stronger (or "more negative") for STEM bachelor's degree recipients who attended an institution where STEM faculty, on average, have higher civic-minded values.

Implications for Future Research

The results of this study offer several implications for future higher education research. First, future research should continue to apply critical perspectives in STEM education (i.e., Barton, 2001, 2003; Frankenstein, 1983; Gutstein, 2003, 2006; Martin, 2003; Roth & Barton, 2004; Secada, 1995) that challenge the economic competitiveness rationale regarding the purpose of STEM education. Given that STEM degree recipients will undoubtedly play a critical role in addressing local, national, and global challenges, how we frame the purpose of STEM education will have serious implications for equity in our society (Garibay, 2013). While it is critical to ensure appropriate opportunities to learn for all students and achieve equity within STEM fields, bounding equity within STEM to the maintenance of U.S. economic competitiveness is problematic as it grossly ignores the current state of poverty throughout the world. Additionally, confining equity in a discourse of domination is shortsighted and problematic especially when many Students of Color have themselves experienced oppression, and may actually emerge from, have familial connections in, or identify with the plight of those in marginalized countries.

If we accept an economic competitiveness rationale for equity, corporate interests will still be allowed to dictate the goals of STEM education and the education students receive can easily serve to reproduce the dominant social order. With many corporations looking to maintain economic dominance by expanding into new and untapped global markets, it is important to ask what then becomes the role of Underrepresented Students of Color? Applying these critical frameworks in STEM education allows researchers to redefine the purpose of STEM education from one that attempts to address threats to U.S. economic competitiveness to one that addresses the state of poverty and injustice that continues to affect so many throughout the world. This shift in the discourse will push us forward in STEM education research to truly center the realities and needs of marginalized populations, which will not only move us toward *sustainably* increasing the success rates of Students of Color in STEM but also toward addressing the needs of disenfranchised groups beyond the walls of higher education.

Second, utilizing these critical perspectives in STEM education, future research should examine additional educational outcomes essential to improving the impact of science and technology on equity and the human good. While this study examines two measures that generally assess students' level of importance on promoting a more equitable society through sociopolitical involvement and research, these measures do not capture a complete picture of whether STEM bachelor's degree recipients' are actually involved in helping to promote a more equitable society in these two ways or simply value these goals. Future research on STEM students' democratic educational outcomes should examine more action-oriented measures as well as additional outcomes critical to promoting a more democratic society, including assessing STEM students' knowledge of how modern Western sciences have contributed to the existence of current inequities; examining their ability to use STEM knowledge to understand, deconstruct, and challenge structural inequities; assessing their commitment to social and environmental justice; investigating their understanding of social issues including poverty, racism, sexism, and other forms of oppression; and examining their implicit biases, among many others. It is also unclear how values toward conducting meaningful research relate to specific perspectives about the types of strategies or approach STEM bachelor's degree recipients may take to address inequality. Many individuals who have higher values toward conducting meaningful research, for example, may take the "trickle down" approach to STEM research and believe that simply doing "good science" for all will in turn benefit marginalized and underserved populations.

Others who have higher values toward conducting meaningful research, however, may focus on addressing or changing structures to help create a more equitable society through their research. This important difference with respect to perspectives about specific actions needed to address inequality through research is not accounted for by the dependent variable measuring values toward conducting meaningful research and should be examined in future research. Examination of these important outcomes may provide a more comprehensive understanding of whether STEM students are being prepared to address the challenges of poverty and inequities that continue to affect marginalized populations around the world. These outcomes are important to assess given that many STEM graduates will be called upon in the future to make decisions on critical issues that have large social ramifications.

Third, future research on the development of STEM students' democratic educational outcomes should examine additional college experiences and contexts that may influence student development, including students' experiences with diversity, volunteering, service-learning courses, and courses connecting science and social issues. The current study is limited by the data and the availability of measures and thus was not able to account for these important experiences that have been highlighted in the literature as college experiences that may influence students' democratic outcomes. Given that this research study found differences between STEM disciplines, and that many institutional characteristics moderate these effects, future research should also attempt to disaggregate STEM disciplines and account for additional measures of STEM programs to understand these disciplines in a more nuanced manner. STEM is often considered a monolithic culture in STEM research, but this study suggests that this may not be the case. While one of the strengths of the study is the inclusion of STEM faculty and peer data at the institutional level, ideally one would have faculty and peer data aggregated up to a disciplinary or departmental level given the particular theoretical perspectives used in this study. Yet, this would present many difficulties in data collection as well as other complexities during analysis. Regardless, STEM education research would greatly benefit from further analysis at the disciplinary and department level. Similarly, future research should try to account for individual-level college socialization experiences specifically with faculty and peers within a student's academic major. The socialization variables used in this study do not distinguish whether these experiences occurred with faculty or peers within one's field of study. Given the pertinent theoretical perspectives, future research studies should seek to collect this information as part of a comprehensive research agenda focused on the development of STEM students' democratic outcomes.

Fourth, future research on the relationship between STEM identity and altruistic motivations for science participation should seek to understand how the make-up of students' STEM identity may change as they become socialized in particular STEM contexts. The development of students' science identity is an interactive and dynamic process that is influenced by experiences and contexts (Carlone & Johnson, 2007). This study found that the initial positive relationship between STEM identity and values toward making a difference in society through sociopolitical involvement becomes non-significant after controlling for STEM students' undergraduate experiences. Thus, future research may seek to examine how undergraduate experiences in particular STEM contexts may confine or broaden the makeup of students STEM identity in hopes to inform the STEM socialization process and expand how students may come to see themselves as scientists, engineers, and other STEM professionals.

Fifth, future research on the long-term development of STEM students' democratic education outcomes should also further examine various post-undergraduate pathways and how these experiences may influence STEM bachelor's degree recipients. While this study found differences between general measures of post-undergraduate pathways, future research should disaggregate these post-undergraduate pathways to better understand how specific pathways may influence students' democratic development. Future research studies may examine medical school programs, various engineering programs, among many others, using frameworks of graduate student socialization (i.e., Antony, 2002; Austin, 2002; Clark & Corcoran, 1986; Egan, 1989; Ellis, 2001; Gardner, 2007; Gonzalez, 2006; Weidman, Twale, & Stein, 2001), while also accounting for important institutional contexts.

Finally, while this study took a long-term approach to the examination of the development of STEM bachelor's degree recipients' democratic outcomes, future studies should also take a narrower, short-term, and in-depth approach to understand how particular practices in the classroom, experiences, or events can trigger the development of students' critical consciousness (Freire, 1970/1998). Qualitative research may allow for more in-depth exploration of how students in STEM education develop into agents of change and allow for a deeper understanding of those undergraduate experiences that were found to significantly influence STEM students' social agency and values toward conducting meaningful research. Future qualitative research may examine STEM students' experiences in STEM-related racial/ethnic student organizations and structured undergraduate research programs as well as examine how STEM students organize around social issues, whether it is more difficult for students in certain academic majors to organize around social issues and why, and how STEM departments support or discourage students during this process.

Implications for Policy and Practice

This study can help inform STEM education policy and practice in several ways. First, while democratic educational outcomes are beginning to gain prominence in STEM as demonstrated by several education policy and research reports and national calls for STEM education reform (i.e., Anderson et al., 1999; Castillo-Page, 2012; Committee on Public Understanding of Engineering Messages, 2008; Holdren, 2008; Jordan, 2006; Middlecamp, Jordan, Shachter, Lottridge, & Oates, 2006; Vaz, 2005), this study shows that many STEM programs have a substantial influence on changes in the development of students' democratic outcomes and have much room for improvement related to the development of these outcomes. The findings demonstrate that there are differences between many STEM disciplines in their preparation of students, where some disciplines seem to better develop their students' democratic educational outcomes than others. Also, findings show that a much smaller proportion of STEM bachelor's degree recipients seem interested in making a positive impact on society through community involvement. These findings may signal that while democratic educational outcomes are considered important for some STEM programs or fields, many STEM programs have yet to effectively embrace these outcomes and have yet to change practices and curriculum to be more reflective of these values. STEM educators, practitioners, and policy-makers, especially in those fields whose students have lower democratic outcomes, should further promote these educational goals not only at national levels but also within their institutions to provide more opportunities for STEM students to develop their democratic outcomes and improve the impact of science and technology on the human good.

Second, the study has implications for strategically and effectively utilizing students' strengths and institutional resources to maximize the development of STEM students' democratic outcomes. Given that findings show STEM students' democratic outcomes are influenced by both student- and college-level variables, institutions that take a comprehensive approach (i.e., altering the focus from simply providing experiences at the individual level to one that focuses on both individual-level experiences and contextual factors) to student development are likely to more effectively increase students' democratic outcomes. The study showed that at both the individual- and institutional-level, faculty and peers play an important role in the long-term development of STEM students' democratic outcomes. Encouraging STEM student participation in student organizations can help students develop important networks and support groups that may help promote their academic success as well as their democratic educational outcomes. Also, it is important to provide more support for racial/ethnic student organizations within STEM, and these organizations are more likely to flourish within institutions that have larger proportions of Students of Color (Chang, 2002b), especially within the various STEM disciplines. While many STEM-related racial/ethnic student organizations currently exist within many STEM disciplines, there are still many STEM fields that do not have these organizations, perhaps due to a lack of a critical mass of Students of Color within these fields.

Encouraging and supporting faculty to provide more mentorship and research opportunities for undergraduates may also promote students' long-term values toward conducting research that will positively affect underserved communities. These interactions and experiences with faculty may help students learn about research careers, gain confidence in their ability to conduct research, and develop their understanding of how research in STEM can be used to effectively address the needs of underserved communities. Institutions should seek to provide more structural support for STEM faculty to engage in these interactions with students, as they are often not given sufficient incentives to mentor undergraduates (Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011).

With respect to STEM-related contextual factors, the findings show that STEM bachelor's degree recipients who attended an institution where STEM faculty, on average, have higher civic-minded values tended to have higher social agency, which has important implications for STEM faculty development and the culture of STEM education. This contextual finding suggests that for STEM bachelor's degree recipients' to attain higher levels of social agency, which findings in Chapter 4 suggest are more difficult to achieve than attaining higher values toward conducting meaningful research, it is critical for STEM students to have the support of those with greater authority within STEM fields (i.e., STEM faculty). Considering that STEM faculty often lack concern for the development of STEM students' social responsibility (Beckwidth & Huang, 2005; Johnson, 2007b), institutions seeking to promote STEM students' democratic educational outcomes should seek to recruit STEM faculty who have a demonstrated interest in developing students to become agents of change, and also provide important development opportunities for STEM faculty addressing their civic-minded values. If entering STEM students with higher democratic orientations enter particular STEM environments that place less emphasis or may not provide the means to develop students' democratic outcomes, these students may be obliged to find ways to develop their own democratic dispositions without critical departmental support, be forced to adapt to the norms of their field and reduce their democratic dispositions, or leave the field altogether in order to find an academic department that is more suitable to their democratic orientations. A strong cultural shift in the STEM faculty is critical to help students develop their democratic educational outcomes, may help retain successful students, and may go a long way toward increasing the positive impact of S&T on equity and the human good.

The study's findings also support increasing Title V funding for HSIs as these institutions remain at the bottom with regards to federal funding yet are critical to providing educational opportunities for the nation's Latina/o population (Cuellar, 2012; Flores, 2011). This study found that the positive relationship between working with a faculty member on her or his research and values toward conducting meaningful research was stronger for STEM bachelor's degree recipients who attended a Hispanic Serving Institution compared to a predominantly white institution. Thus, this collaboration with faculty on research within the HSI context seems to benefit STEM students differently than in PWI contexts, as STEM students who attended HSIs seem to gain more from their experiences conducting research with faculty members than their peers with similar experiences at PWIs. This finding speaks to the importance of assessing additional educational outcomes to have a broader understanding of how these institutional contexts affect student success (given that previous studies on the impact of HSIs on Latina/o success has shown mixed, and often negative results) and demonstrate the importance of examining not only direct effects of these institutions, but also how these institutional contexts may moderate the effects of undergraduate experiences to better inform HSI policy and practice.

Further, the findings point to learning opportunities that may promote STEM students' democratic outcomes, which has implications for curriculum and program development in STEM education. On the one hand, the findings indicate that developing STEM students' learning in particular content areas may encourage them to work towards a more equitable society. This study showed that STEM students who felt that their undergraduate institution better prepared them to understand the role of science and technology in society and students who felt that racial discrimination is still a problem in America had higher democratic outcomes. Thus, developing STEM students' understanding of particular issues, including the role of S&T in society and racial discrimination may lead to a variety of desired educational outcomes and prepare STEM graduates to attend to the difficult challenges of combating poverty and inequities in society.

On the other hand, the findings also suggest that particular types of learning opportunities may promote STEM students' democratic outcomes. Findings from the study showed that students who performed volunteer work (in high school) and participated in research (whether that be through a health science research program in high school, with a faculty member on his/her research during college, or in a structured undergraduate research program) have higher democratic outcomes. Given that STEM students' are more interested in having a positive impact on society through conducting research (as opposed to community involvement), which may be argued is a more removed position, effectively integrating learning opportunities in the community may provide important experiences for STEM students to develop their social agency. Also, providing various opportunities for students to conduct research, especially on their own, throughout the educational pipeline is critical to support the development of STEM students' interest in promoting a more equitable society in multiple ways (i.e., sociopolitical involvement and conducting research). Moreover, STEM administrators and policymakers should make a concerted effort to extend these learning opportunities into STEM graduate programs as well given that STEM students' post-undergraduate trajectories also influence their democratic outcomes over the long-term. Extending these learning opportunities into STEM graduate and professional programs may help further student development and represent an extension of the investment in undergraduate education to help prevent a reduction in students' social and civic gains experienced during the undergraduate years.

Finally, the findings revealed long-term differences on both democratic outcomes between Students of Color (specifically African Americans, Asian Americans, and Latinas/os) and white students, where white students tended to care less about working toward a more equitable society. The fact that the blocks of variables comprising the undergraduate environment do not explain away these differences between racial/ethnic groups on both outcomes may suggest that the current educational process for STEM students does not do enough to address these important differences. Such disparities are also found across gender and SES, which, together, may have important implications for racial, gender, and class dynamics and climate in STEM departments. If students from dominant social groups are afforded an educational process within STEM that does not challenge them to learn about structural inequality or develop their understanding of the importance of working for a more equitable society, STEM departments in essence may further marginalize underrepresented groups both within STEM and beyond higher education. An institution's failure to alter its practices from one of passivity or apathy to proactive institutional transformation to address these differences may inhibit its ability to effectively increase the positive impact of S&T on equity and the human good and to foster an educational environment in STEM conducive to the success of all students.

Conclusion

Despite the fact that scientific and technological development has had a tremendous impact on human capacity, we continue to live in a world that is still profoundly affected by poverty and inequality. S&T has often had progressive advancements for society, however, it is important to note that S&T has also been used in socially and environmentally regressive ways, creating and perpetuating many inequalities (Hammonds & Herzig, 2008; Harding, 1993, 2006). Additionally, many communities and populations continue to have limited access to the benefits of science, such as medical care, digital technologies, among many others (Centers for Disease Control and Prevention, 2011; Institute of Medicine, 1999; Pew Research Center, 2011; U.S. Department of Health and Human Services, 2011). Thus, to improve the impact on S&T on equity and the human good, institutions must make a concerted effort to effectively develop the democratic educational outcomes of STEM students, as they will become the leaders in the creation and implementation of science and technology.

In hopes to aid institutions in this process, this study examined the individual-level experiences and institutional contexts that may support the development of STEM students' democratic outcomes over the long-term. This study yielded an important set of findings that may inform various practices institutions may implement to promote STEM students' democratic educational outcomes. Findings show that institutions should take a comprehensive approach to student development by building on students' strengths and limitations as they enter college, implement and engage students in particular learning opportunities, and facilitate more supportive environments among students and STEM faculty related to STEM students' altruistic motivations for pursuing their respective STEM careers. Limiting the focus to simply preparing STEM students to maintain the country's economic competitiveness significant undermines institutional goals in preparing individuals for meaningful participation in a diverse democracy and goals of improving the impact of S&T on equity and the human good. If institutions do not instill these values within STEM, alter current structures and practices, and take a comprehensive approach to developing STEM students' democratic educational outcomes, STEM graduates will have limited preparation to effectively address significant challenges such as poverty and inequality in a socially responsible manner, which will ultimately perpetuate social inequality and limit S&T's potential to advance social equity and the human good.

APPENDICES

Appendix A: List of STEM Majors (Taken from PBS instrument)

BIOLOGICAL SCIENCES
Biology (general)
Biochemistry/Biophysics
Botany
Marine (Life) Science
Microbiology/Bacteriology
Zoology
Other Biological Science

COMPUTER SCIENCE/TECHNOLOGY
Computer Science
Health Technology (medical, dental, laboratory)

ENGINEERING
Aeronautical/Astronautical Engineering
Civil Engineering
Chemical Engineering
Computer Engineering
Electrical or Electric Engineering
Industrial Engineering
Mechanical Engineering
Other Engineering

ENVIRONMENTAL SCIENCES
Environmental Science
Atmospheric Science (incl. Meteorology)
Earth Science
Marine Science (incl. Oceanography)

HEALTH PROFESSIONAL SCIENCES
Medicine/Dentistry/Veterinary Medicine
Nursing
Pharmacy

MATHEMATICS/STATISTICS
Mathematics
Statistics

PHYSICAL SCIENCES
Astronomy
Chemistry
Physics
Other Physical Science

Appendix B: Variables Used in Multiple Imputation Procedure

Variables	Dependent	Predictor
2011 Social Agency	No	Yes
Conducting Meaningful Research	No	Yes
Race: Black/African American	No	Yes
Race: Latina/o	No	Yes
Race: American Indian/Alaska Native	No	Yes
Race: Asian American/Pacific Islander	No	Yes
Race: Other	No	Yes
Gender: Female	No	Yes
Socioeconomic status	Yes	Yes
Either parent's career in STEM	Yes	Yes
2004 Social Agency	Yes	Yes
SAT score	Yes	Yes
Average High School GPA	Yes	Yes
Political Orientation	Yes	Yes
Number of HS Science and Math Courses	Yes	Yes
Participated in health science research program sponsored by university	Yes	Yes
Degree Aspirations: Ph.D./Ed.D.	Yes	Yes
STEM Identity	Yes	Yes
Act in the past year: Did community service as part of a class	Yes	Yes
Act in the past year: Performed volunteer work	Yes	Yes
Act in the past year: Socialized with someone of another racial/ethnic group	Yes	Yes
Racial Discrimination is no longer a problem	Yes	Yes
Undergrad Major: Environmental Science	No	Yes
Undergrad Major: Computer Science/Tech	No	Yes
Undergrad Major: Physical Science	No	Yes
Undergrad Major: Engineer	No	Yes
Undergrad Major: Health Professional Sciences	No	Yes
Undergrad Major: Math/Stats	No	Yes
Work with a faculty member on his/her research	Yes	Yes
Receive mentoring from a faculty member	Yes	Yes
Participate in a structured undergrad research program	Yes	Yes
Participate in an ethnic or cultural club or organization	Yes	Yes
Participate in an academic club or professional association	Yes	Yes
Undergrad Perception: Understand the role of science and technology in society	Yes	Yes
Grad School: STEM	Yes	Yes
Workforce: STEM	Yes	Yes

Control: Private	No	Yes
HBCU	No	Yes
Institutional Type: Four-Year College (Ref: University)	No	Yes
Institutional Type: Research	No	Yes
Institutional Type: Liberal Arts	No	Yes
Institutional Type: Masters College or University	No	Yes
HSI(25% or more of undergraduates are Latino)	No	Yes
Emerging HS*I*	No	Yes
Average entering freshman Social Agency score	No	Yes
Proportion of undergrads in STEM majors	No	Yes
Proportion of Underrepresented Students of Color	No	Yes
Percentage of STEM Faculty who grade on a curve	No	Yes
Average STEM Faculty score on civic-minded values factor	No	Yes
Average STEM faculty score on student-centered pedagogy factor	No	Yes

Appendix C: 2004 CIRP Freshman Survey

PLEASE PRINT NAME AND PERMANENT/HOME ADDRESS (one letter or number per box) 000001

NAME: FIRST / MI / LAST

ADDRESS:

CITY: STATE: ZIP: PHONE: – –

When were you born? Month (01-12) Day (01-31) Year

2004 STUDENT INFORMATION FORM

MARKING DIRECTIONS

Your responses will be read by an optical mark reader. Please,

- Use a pencil or black or blue pen.
- Fill in the oval completely.
- Erase cleanly any marks you wish to change or "X" out mark if in pen.

CORRECT MARK / INCORRECT MARKS

PLEASE PROVIDE YOUR ID NUMBER (as instructed) | Mark here if directed: GROUP CODE A, GROUP CODE B

0 1 2 3 4 5 6 7 8 9

1. Your sex: Male / Female

2. How old will you be on December 31 of this year? (Mark one)
16 or younger / 17 / 18 / 19 / 20 / 21-24 / 25-29 / 30-39 / 40-54 / 55 or older

3. Is English your native language? Yes / No

4. In what year did you graduate from high school? (Mark one)
2004 / 2003 / 2002 / 2001 or earlier / Did not graduate but passed G.E.D. test / Never completed high school

5. Are you enrolled (or enrolling) as a: (Mark one)
Full-time student? / Part-time student?

6. How many miles is this college from your permanent home? (Mark one)
5 or less / 6-10 / 11-50 / 51-100 / 101-500 / Over 500

7. What was your average grade in high school? (Mark one)
A or A+ / A– / B+ / B / B– / C+ / C / D

8. From what kind of secondary school did you graduate? (Mark one)
- Public school (not charter or magnet)
- Public charter school
- Public magnet school
- Private religious/parochial school
- Private independent college-prep school
- Home school

9. What were your scores on the SAT I and/or ACT?
SAT VERBAL
SAT MATH
ACT Composite

10. Citizenship status:
- U.S. citizen
- Permanent resident (green card)
- Neither

11. Prior to this term, have you ever taken courses for credit at this institution? Yes / No

12. Since leaving high school, have you ever taken courses at any other institution? (Mark all that apply in each column)

	For Credit	Not for Credit
Yes, at a community/junior college	○	○
Yes, at a 4-yr. college or university	○	○
Yes, at some other postsecondary school (For example, technical, vocational, business)	○	○

13. During your last year of high school what proportion of the time did you live with: (Mark one in each row)

	All	Most	Some	None
Mother	A	M	S	N
Father	A	M	S	N
Stepmother	A	M	S	N
Stepfather	A	M	S	N
Grandparent	A	M	S	N
Legal guardian	A	M	S	N
Other adult(s)	A	M	S	N

14. Where do you plan to live during the fall term? (Mark one)
- With my family or other relatives
- Other private home, apartment or room
- College residence hall
- Fraternity or sorority house
- Other campus student housing
- Other

15. Is this college your: (Mark one)
First choice? / Second choice? / Third choice? / Less than third choice?

16. To how many colleges other than this one did you apply for admission this year?
None / 1 / 2 / 3 / 4 / 5 / 6 / 7-10 / 11 or more

17. During high school (grades 9-12) how many years did you study each of the following subjects? (Mark one for each item)

	None	1/2	1	2	3	4	5 or more
English	○	○	○	○	○	○	○
Mathematics	○	○	○	○	○	○	○
Foreign Language	○	○	○	○	○	○	○
Physical Science	○	○	○	○	○	○	○
Biological Science	○	○	○	○	○	○	○
History/Am. Govt.	○	○	○	○	○	○	○
Computer Science	○	○	○	○	○	○	○
Arts and/or Music	○	○	○	○	○	○	○

18. Do you have a disability? (Mark all that apply)
- None
- Hearing
- Speech
- Orthopedic
- Learning disability
- Health-related
- Partially sighted or blind
- Other

19. What is the highest academic degree that you intend to obtain? (Mark one in each column)

	Highest Planned	Highest Planned At This College
None	○	○
Vocational certificate	○	○
Associate (A.A. or equivalent)	○	○
Bachelor's degree (B.A., B.S., etc.)	○	○
Master's degree (M.A., M.S., etc.)	○	○
Ph.D. or Ed.D.	○	○
M.D., D.O., D.D.S., or D.V.M.	○	○
J.D. (Law)	○	○
B.D. or M.DIV. (Divinity)	○	○
Other	○	○

20. Are your parents: (Mark one)
- Both alive and living with each other?
- Both alive, divorced or living apart?
- One or both deceased?

- 1 -

21. How much of your first year's educational expenses (room, board, tuition, and fees) do you expect to cover from each of the sources listed below? (Mark one answer for each possible source)

	None	Less than $1,000	$1,000-2,999	$3,000-5,999	$6,000-9,999	$10,000+
Family resources (parents, relatives, spouse, etc.)	○	○	○	○	○	○
My own resources (savings from work, work-study, other income)	○	○	○	○	○	○
Aid which need not be repaid (grants, scholarships, military funding, etc.)	○	○	○	○	○	○
Aid which must be repaid (loans, etc.)	○	○	○	○	○	○
Other than above	○	○	○	○	○	○

22. What is your best estimate of your parents' total income last year? Consider income from all sources before taxes. (Mark one)

- ○ Less than $10,000
- ○ $10,000-14,999
- ○ $15,000-19,999
- ○ $20,000-24,999
- ○ $25,000-29,999
- ○ $30,000-39,999
- ○ $40,000-49,999
- ○ $50,000-59,999
- ○ $60,000-74,999
- ○ $75,000-99,999
- ○ $100,000-149,999
- ○ $150,000-199,999
- ○ $200,000-249,999
- ○ $250,000 or more

23. Current religious preference: (Mark one in each column)

	Yours	Father's	Mother's
Baptist	Y	F	M
Buddhist	Y	F	M
Church of Christ	Y	F	M
Eastern Orthodox	Y	F	M
Episcopalian	Y	F	M
Hindu	Y	F	M
Islamic	Y	F	M
Jewish	Y	F	M
LDS (Mormon)	Y	F	M
Lutheran	Y	F	M
Methodist	Y	F	M
Presbyterian	Y	F	M
Quaker	Y	F	M
Roman Catholic	Y	F	M
Seventh Day Adventist	Y	F	M
Unitarian/Universalist	Y	F	M
United Church of Christ/Congregational	Y	F	M
Other Christian	Y	F	M
Other Religion	Y	F	M
None	Y	F	M

24. Do you consider yourself a Born-Again Christian?

○ Yes ○ No

25. Please indicate your ethnic background. (Mark all that apply)

- White/Caucasian ○
- African American/Black ○
- American Indian/Alaska Native ○
- Asian American/Asian ○
- Native Hawaiian/Pacific Islander ○
- Mexican American/Chicano ○
- Puerto Rican ○
- Other Latino ○
- Other ○

26. For the activities below, indicate which ones you did during the past year. If you engaged in an activity frequently, mark Ⓕ. If you engaged in an activity one or more times, but not frequently, mark Ⓞ (Occasionally). Mark Ⓝ (Not at all) if you have not performed the activity during the past year. (Mark one for each item)

	Frequently	Occasionally	Not at all
Attended a religious service	F	O	N
Was bored in class	F	O	N
Participated in organized demonstrations	F	O	N
Tutored another student	F	O	N
Studied with other students	F	O	N
Was a guest in a teacher's home	F	O	N
Smoked cigarettes	F	O	N
Drank beer	F	O	N
Drank wine or liquor	F	O	N
Felt overwhelmed by all I had to do	F	O	N
Felt depressed	F	O	N
Performed volunteer work	F	O	N
Played a musical instrument	F	O	N
Asked a teacher for advice after class	F	O	N
Discussed politics	F	O	N
Voted in a student election	F	O	N
Socialized with someone of another racial/ethnic group	F	O	N
Came late to class	F	O	N
Used the Internet for research or homework	F	O	N
Performed community service as part of a class	F	O	N
Used a personal computer	F	O	N
Discussed religion/spirituality: In class	F	O	N
With friends	F	O	N
With family	F	O	N
Worked on a local, state, or national political campaign	F	O	N
Maintained a healthy diet	F	O	N
Stayed up all night	F	O	N
Missed school because of illness	F	O	N

27. For each item, please mark Yes or No:

	Yes	No
Did your high school require community service for graduation?	Y	N
Have you participated in: A summer research program?	Y	N
A health science research program sponsored by a university?	Y	N

28. What is the highest level of formal education obtained by your parents? (Mark one in each column)

	Father	Mother
Grammar school or less	○	○
Some high school	○	○
High school graduate	○	○
Postsecondary school other than college	○	○
Some college	○	○
College degree	○	○
Some graduate school	○	○
Graduate degree	○	○

29. In deciding to go to college, how important to you was each of the following reasons? (Mark one answer for each possible reason)

	Very Important	Somewhat Important	Not Important
My parents wanted me to go	V	S	N
I could not find a job	V	S	N
Wanted to get away from home	V	S	N
To be able to get a better job	V	S	N
To gain a general education and appreciation of ideas	V	S	N
There was nothing better to do	V	S	N
To make me a more cultured person	V	S	N
To be able to make more money	V	S	N
To learn more about things that interest me	V	S	N
To prepare myself for graduate or professional school	V	S	N
To get training for a specific career	V	S	N
To find my purpose in life	V	S	N

30. How would you characterize your political views? (Mark one)

- ○ Far left
- ○ Liberal
- ○ Middle-of-the-road
- ○ Conservative
- ○ Far right

31. Rate yourself on each of the following traits as compared with the average person your age. We want the most accurate estimate of how you see yourself. (Mark one in each row)

	Highest 10%	Above Average	Average	Below Average	Lowest 10%
Academic ability	○	○	○	○	○
Artistic ability	○	○	○	○	○
Compassion	○	○	○	○	○
Computer skills	○	○	○	○	○
Cooperativeness	○	○	○	○	○
Courage	○	○	○	○	○
Creativity	○	○	○	○	○
Drive to achieve	○	○	○	○	○
Emotional health	○	○	○	○	○
Forgiveness	○	○	○	○	○
Generosity	○	○	○	○	○
Kindness	○	○	○	○	○
Leadership ability	○	○	○	○	○
Mathematical ability	○	○	○	○	○
Physical health	○	○	○	○	○
Public speaking ability	○	○	○	○	○
Religiousness	○	○	○	○	○
Self-confidence (intellectual)	○	○	○	○	○
Self-confidence (social)	○	○	○	○	○
Self-understanding	○	○	○	○	○
Spirituality	○	○	○	○	○
Time management	○	○	○	○	○
Understanding of others	○	○	○	○	○
Writing ability	○	○	○	○	○

32. Mark only three responses, one in each column.

	Your probable career occupation (Y)	Your father's occupation (F)	Your mother's occupation (M)
Accountant or actuary	Y	F	M
Actor or entertainer	Y	F	M
Architect or urban planner	Y	F	M
Artist	Y	F	M
Business (clerical)	Y	F	M
Business executive (management, administrator)	Y	F	M
Business owner or proprietor	Y	F	M
Business salesperson or buyer	Y	F	M
Clergy (minister, priest)	Y	F	M
Clergy (other religious)	Y	F	M
Clinical psychologist	Y	F	M
College administrator/staff	Y	F	M
College teacher	Y	F	M
Computer programmer or analyst	Y	F	M
Conservationist or forester	Y	F	M
Dentist (including orthodontist)	Y	F	M
Dietitian or nutritionist	Y	F	M
Engineer	Y	F	M
Farmer or rancher	Y	F	M
Foreign service worker (including diplomat)	Y	F	M
Homemaker (full-time)	Y	F	M
Interior decorator (including designer)	Y	F	M
Lab technician or hygienist	Y	F	M
Law enforcement officer	Y	F	M
Lawyer (attorney) or judge	Y	F	M
Military service (career)	Y	F	M
Musician (performer, composer)	Y	F	M
Nurse	Y	F	M
Optometrist	Y	F	M
Pharmacist	Y	F	M
Physician	Y	F	M
Policymaker/Government	Y	F	M
School counselor	Y	F	M
School principal or superintendent	Y	F	M
Scientific researcher	Y	F	M
Social, welfare or recreation worker	Y	F	M
Therapist (physical, occupational, speech)	Y	F	M
Teacher or administrator (elementary)	Y	F	M
Teacher or administrator (secondary)	Y	F	M
Veterinarian	Y	F	M
Writer or journalist	Y	F	M
Skilled trades	Y	F	M
Laborer (unskilled)	Y	F	M
Semi-skilled worker	Y	F	M
Unemployed	Y	F	M
Other	Y	F	M
Undecided	Y		

NOTE: If your father or mother is deceased, please indicate his or her last occupation.

33. Mark one in each row:

	Agree Strongly	Agree Somewhat	Disagree Somewhat	Disagree Strongly
There is too much concern in the courts for the rights of criminals	4	3	2	1
Abortion should be legal	4	3	2	1
The death penalty should be abolished	4	3	2	1
Marijuana should be legalized	4	3	2	1
It is important to have laws prohibiting homosexual relationships	4	3	2	1
Racial discrimination is no longer a major problem in America	4	3	2	1
Realistically, an individual can do little to bring about changes in our society	4	3	2	1
Wealthy people should pay a larger share of taxes than they do now	4	3	2	1
Colleges should prohibit racist/sexist speech on campus	4	3	2	1
Same-sex couples should have the right to legal marital status	4	3	2	1
Affirmative action in college admissions should be abolished	4	3	2	1
The activities of married women are best confined to the home and family	4	3	2	1
Federal military spending should be increased	4	3	2	1
Colleges have the right to ban extreme speakers	4	3	2	1
If two people really like each other, it's all right for them to have sex even if they've known each other for only a very short time	4	3	2	1
The federal government should do more to control the sale of handguns	4	3	2	1

34. Below is a list of community service/volunteer activities. Indicate which of these you participated in during high school. (Mark all that apply)

- None ○
- Tutoring/teaching ○
- Counseling/mentoring ○
- Environmental activities ○
- Child care ○
- Elder care ○
- Hospital work ○
- Substance abuse education ○
- Other health education ○
- Services to the homeless ○
- Community improvement/construction ○
- Conflict mediation ○
- Service to my religious community ○
- Other community service ○

35. During your last year in high school, how much time did you spend during a typical week doing the following activities?

Hours per week:	None	Less than 1 hour	1-2	3-5	6-10	11-15	16-20	Over 20
Studying/homework	○	○	○	○	○	○	○	○
Socializing with friends	○	○	○	○	○	○	○	○
Talking with teachers outside of class	○	○	○	○	○	○	○	○
Exercise or sports	○	○	○	○	○	○	○	○
Partying	○	○	○	○	○	○	○	○
Working (for pay)	○	○	○	○	○	○	○	○
Volunteer work	○	○	○	○	○	○	○	○
Student clubs/groups	○	○	○	○	○	○	○	○
Watching TV	○	○	○	○	○	○	○	○
Household/childcare duties	○	○	○	○	○	○	○	○
Reading for pleasure	○	○	○	○	○	○	○	○
Playing video/computer games	○	○	○	○	○	○	○	○
Prayer/meditation	○	○	○	○	○	○	○	○

36. Do you have any concern about your ability to finance your college education? (Mark one)

- None (I am confident that I will have sufficient funds) ○
- Some (but I probably will have enough funds) ○
- Major (not sure I will have enough funds to complete college) ○

37. Below are some reasons that might have influenced your decision to attend this particular college. How important was each reason in your decision to come here? (Mark one answer for each possible reason)

	Very Important	Somewhat Important	Not Important
My relatives wanted me to come here	V	S	N
My teacher advised me	V	S	N
This college has a very good academic reputation	V	S	N
This college has a good reputation for its social activities	V	S	N
I was offered financial assistance	V	S	N
The cost of attending this college	V	S	N
High school counselor advised me	V	S	N
Private college counselor advised me	V	S	N
I wanted to live near home	V	S	N
Not offered aid by first choice	V	S	N
This college's graduates gain admission to top graduate/professional schools	V	S	N
This college's graduates get good jobs	V	S	N
I was attracted by the religious affiliation/orientation of the college	V	S	N
I wanted to go to a school about the size of this college	V	S	N
Rankings in national magazines	V	S	N
Information from a website	V	S	N
I was admitted through an Early Action or Early Decision program	V	S	N
A visit to the campus	V	S	N

38. Below is a list of different undergraduate major fields grouped into general categories. Mark only one oval to indicate your probable field of study.

ARTS AND HUMANITIES
- Art, fine and applied 1
- English (language and literature) 2
- History 3
- Journalism 4
- Language and Literature (except English) 5
- Music 6
- Philosophy 7
- Speech 8
- Theater or Drama 9
- Theology or Religion 10
- Other Arts and Humanities .. 11

BIOLOGICAL SCIENCE
- Biology (general) 12
- Biochemistry or Biophysics 13
- Botany 14
- Environmental Science 15
- Marine (Life) Science 16
- Microbiology or Bacteriology 17
- Zoology 18
- Other Biological Science 19

BUSINESS
- Accounting 20
- Business Admin. (general) 21
- Finance 22
- International Business 23
- Marketing 24
- Management 25
- Secretarial Studies 26
- Other Business 27

EDUCATION
- Business Education 28
- Elementary Education 29
- Music or Art Education 30
- Physical Education or Recreation 31
- Secondary Education 32
- Special Education 33
- Other Education 34

ENGINEERING
- Aeronautical or Astronautical Eng. 35
- Civil Engineering 36
- Chemical Engineering 37
- Computer Engineering 38
- Electrical or Electronic Engineering 39
- Industrial Engineering 40
- Mechanical Engineering 41
- Other Engineering 42

PHYSICAL SCIENCE
- Astronomy 43
- Atmospheric Science (incl. Meteorology) 44
- Chemistry 45
- Earth Science 46
- Marine Science (incl. Oceanography) 47
- Mathematics 48
- Physics 49
- Statistics 50
- Other Physical Science 51

PROFESSIONAL
- Architecture or Urban Planning 52
- Home Economics 53
- Health Technology (medical, dental, laboratory) 54
- Library or Archival Science 55
- Medicine, Dentistry, Veterinary Medicine 56
- Nursing 57
- Pharmacy 58
- Therapy (occupational, physical, speech) 59
- Other Professional 60

SOCIAL SCIENCE
- Anthropology 61
- Economics 62
- Ethnic Studies 63
- Geography 64
- Political Science (gov't., international relations) 65
- Psychology 66
- Social Work 67
- Sociology 68
- Women's Studies 69
- Other Social Science 70

TECHNICAL
- Building Trades 71
- Data Processing or Computer Programming 72
- Drafting or Design 73
- Electronics 74
- Mechanics 75
- Other Technical 76

OTHER FIELDS
- Agriculture 77
- Communications 78
- Computer Science 79
- Forestry 80
- Kinesiology 81
- Law Enforcement 82
- Military Science 83
- Other Field 84
- Undecided 85

DO NOT WRITE IN THIS AREA

39. Please indicate the importance to you personally of each of the following:
(Mark one for each item)

N Not Important
S Somewhat Important
V Very Important
E Essential

Becoming accomplished in one of the performing arts (acting, dancing, etc.)	E	V	S	N
Becoming an authority in my field	E	V	S	N
Obtaining recognition from my colleagues for contributions to my special field	E	V	S	N
Influencing the political structure	E	V	S	N
Influencing social values	E	V	S	N
Raising a family	E	V	S	N
Having administrative responsibility for the work of others	E	V	S	N
Being very well off financially	E	V	S	N
Helping others who are in difficulty	E	V	S	N
Making a theoretical contribution to science	E	V	S	N
Writing original works (poems, novels, short stories, etc.)	E	V	S	N
Creating artistic work (painting, sculpture, decorating, etc.)	E	V	S	N
Becoming successful in a business of my own	E	V	S	N
Becoming involved in programs to clean up the environment	E	V	S	N
Developing a meaningful philosophy of life	E	V	S	N
Participating in a community action program	E	V	S	N
Helping to promote racial understanding	E	V	S	N
Keeping up to date with political affairs	E	V	S	N
Becoming a community leader	E	V	S	N
Integrating spirituality into my life	E	V	S	N
Improving my understanding of other countries and cultures	E	V	S	N
Working to find a cure to a health problem	E	V	S	N

40. What is your best guess as to the chances that you will:
(Mark one for each item)

N No Chance
L Very Little Chance
S Some Chance
V Very Good Chance

Change major field?	V	S	L	N
Change career choice?	V	S	L	N
Participate in student government?	V	S	L	N
Get a job to help pay for college expenses?	V	S	L	N
Work full-time while attending college?	V	S	L	N
Join a social fraternity or sorority?	V	S	L	N
Play varsity/intercollegiate athletics?	V	S	L	N
Make at least a "B" average?	V	S	L	N
Participate in student protests or demonstrations?	V	S	L	N
Transfer to another college before graduating?	V	S	L	N
Be satisfied with your college?	V	S	L	N
Participate in volunteer or community service work?	V	S	L	N
Seek personal counseling?	V	S	L	N
Communicate regularly with your professors?	V	S	L	N
Socialize with someone of another racial/ethnic group?	V	S	L	N
Participate in student clubs/groups?	V	S	L	N
Strengthen your religious beliefs/convictions?	V	S	L	N
Participate in a study abroad program?	V	S	L	N

41. Do you give the Higher Education Research Institute (HERI) permission to include your ID number should your college request the data for additional research analyses? ○ Yes ○ No

The remaining ovals are provided for questions specifically designed by your college rather than the Higher Education Research Institute. If your college has chosen to use the ovals, please observe carefully the supplemental directions given to you.

42. A B C D E	49. A B C D E	56. A B C D E
43. A B C D E	50. A B C D E	57. A B C D E
44. A B C D E	51. A B C D E	58. A B C D E
45. A B C D E	52. A B C D E	59. A B C D E
46. A B C D E	53. A B C D E	60. A B C D E
47. A B C D E	54. A B C D E	61. A B C D E
48. A B C D E	55. A B C D E	62. A B C D E

THANK YOU!

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Appendix D: CIRP 2011 Post-Baccalaureate Survey

2011 POST-BACCALAUREATE SURVEY

MARKING INSTRUCTIONS
- Please use blue or black ink
- Fill in or place an X in the square

☐ ■ ☐ ☒ ☐

Please write in your email address:

☐

(Use codes provided on the back of the Participant Information Sheet)

1. Mark your undergraduate major. ☐

2. Please mark your probable career/occupation. ☐

3. What is the highest academic degree that you A) will have earned as of June 2011 and B) intend to obtain? (Mark one in each column)

	June 2011	Intended
None	☐	☐
Certificate or associates	☐	☐
Bachelor's (B.A., B.S.)	☐	☐
Master's (M.A., M.S., M.Div., etc.)	☐	☐
Ph.D.	☐	☐
M.D./D.O./D.D.S./D.V.M.	☐	☐
LL.B. or J.D. (Law)	☐	☐
M.B.A.	☐	☐
Other terminal degree (Dr.P.H., Ed.D., M.F.A.)	☐	☐

4. When you were an undergraduate, did you: (Mark yes or no for each item)

	Yes	No
Work with a faculty member on his or her research	☐	☐
Receive mentoring from a faculty member	☐	☐
Participate in a structured undergraduate research program (e.g., MARC, MBRS)	☐	☐
Participate in an ethnic or cultural club or organization	☐	☐
Participate in an academic club or professional association	☐	☐
Work on campus during the academic year	☐	☐
Work off campus during the academic year	☐	☐

5. Estimate the total amount of money you borrowed to finance your undergraduate education. Enter 0 if you did not borrow money.

$ ☐ **.00**

6. Please rate yourself on each of the following traits as compared with the average person your age. (Mark one in each row)

	Highest 10%	Above Average	Average	Below Average	Lowest 10%
Academic ability	☐	☐	☐	☐	☐
Drive to achieve	☐	☐	☐	☐	☐
Leadership ability	☐	☐	☐	☐	☐
Mathematical ability	☐	☐	☐	☐	☐
Public speaking ability	☐	☐	☐	☐	☐
Self-confidence (intellectual)	☐	☐	☐	☐	☐
Self-confidence (social)	☐	☐	☐	☐	☐
Self-understanding	☐	☐	☐	☐	☐
Understanding of others	☐	☐	☐	☐	☐
Writing ability	☐	☐	☐	☐	☐
Problem-solving skills	☐	☐	☐	☐	☐
Critical thinking skills	☐	☐	☐	☐	☐

7. When thinking about your long-term career choice, how important are the following considerations? (Mark one in each row)

	Essential	Very Important	Somewhat Important	Not Important
Working for social change	☐	☐	☐	☐
High income potential	☐	☐	☐	☐
Social recognition or status	☐	☐	☐	☐
Job security	☐	☐	☐	☐
Potential to be creative	☐	☐	☐	☐
Availability of jobs	☐	☐	☐	☐
Leadership opportunity	☐	☐	☐	☐
Advancement of knowledge	☐	☐	☐	☐
Close alignment between my work and personal values	☐	☐	☐	☐

8. What was your undergraduate: (Mark one in each column)

	Overall GPA	Academic Major GPA
4.0 or higher (A or A+)	☐	☐
3.67-3.99 (A-)	☐	☐
3.33-3.66 (B+)	☐	☐
3.00-3.32 (B)	☐	☐
2.67-2.99 (B-)	☐	☐
2.33-2.66 (C+)	☐	☐
2.00-2.32 (C)	☐	☐
1.67-1.99 (C-)	☐	☐
1.33-1.66 (D)	☐	☐
NA	☐	☐

9. Please indicate the importance to you personally of each of the following: (Mark one in each row)

	Essential	Very Important	Somewhat Important	Not Important
Becoming an authority in my field	☐	☐	☐	☐
Obtaining recognition from my colleagues for contributions to my field	☐	☐	☐	☐
Influencing the political structure	☐	☐	☐	☐
Influencing social values	☐	☐	☐	☐
Helping others who are in difficulty	☐	☐	☐	☐
Making a theoretical contribution to science	☐	☐	☐	☐
Becoming successful in a business of my own	☐	☐	☐	☐
Participating in a community action program	☐	☐	☐	☐
Helping to promote racial understanding	☐	☐	☐	☐
Becoming a community leader	☐	☐	☐	☐
Improving my understanding of other countries and cultures	☐	☐	☐	☐
Improving the health of minority communities	☐	☐	☐	☐
Working to find a cure to a health problem	☐	☐	☐	☐
Contributing to scientific innovations	☐	☐	☐	☐
Conducting research that will impact underserved communities	☐	☐	☐	☐
Raising a family	☐	☐	☐	☐

10. What is your current pre-tax annual income? Provide your best estimate. (Mark one in each column)

	Yours	Your Spouse/Partner
Less than $10,000	☐	☐
$10,000-$19,999	☐	☐
$20,000-$29,999	☐	☐
$30,000-$39,999	☐	☐
$40,000-$49,999	☐	☐
$50,000-$74,999	☐	☐
$75,000-$99,999	☐	☐
$100,000-$149,999	☐	☐
$150,000 or more	☐	☐
N/A		☐

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11. How many of the people in each of the following groups share your race/ethnicity? (Mark one in each row)

	All	Most	About Half	Some	None	NA
Current work associates	☐	☐	☐	☐	☐	☐
Current school associates	☐	☐	☐	☐	☐	☐
Current neighbors	☐	☐	☐	☐	☐	☐
Current friends	☐	☐	☐	☐	☐	☐
College friends	☐	☐	☐	☐	☐	☐
High school friends	☐	☐	☐	☐	☐	☐
Neighbors where you grew up	☐	☐	☐	☐	☐	☐

12. Based on what you know now, how well do you think your undergraduate experience prepared you to:
(Mark one in each row)

	Very Well	More than Adequately	Adequately	Less than Adequately	Very Poorly
Write effectively	☐	☐	☐	☐	☐
Communicate well orally	☐	☐	☐	☐	☐
Think analytically and logically	☐	☐	☐	☐	☐
Work effectively as a member of a team	☐	☐	☐	☐	☐
Understand the role of science and technology in society	☐	☐	☐	☐	☐
Evaluate the quality and reliability of information	☐	☐	☐	☐	☐
Pursue graduate or professional school	☐	☐	☐	☐	☐
Conduct myself responsibly and ethically	☐	☐	☐	☐	☐

13. Please indicate which of the following most closely reflects your current employment status:
(Mark one)

- ☐ Attending graduate school, employed at the institution
- ☐ Employed full-time
- ☐ Employed part-time, looking for full-time work
- ☐ Employed part-time, by choice
- ☐ Not employed, looking for work
- ☐ Not employed, not looking for work

14. Please rate your level of agreement with the following:
(Mark one in each row)

	Agree Strongly	Agree	Disagree	Disagree Strongly
I am satisfied with my current standard of living	☐	☐	☐	☐
The economy has hurt my standard of living	☐	☐	☐	☐
I have had trouble finding a job	☐	☐	☐	☐
The economy has affected decisions about my career path	☐	☐	☐	☐

15. Estimate your scores on the following exams (check N/A next to exams you did not take):

GRE: Verbal	[ ]	☐ N/A
GRE: Quantitative	[ ]	☐ N/A
LSAT	[ ]	☐ N/A
MCAT	[ ]	☐ N/A
GMAT	[ ]	☐ N/A

16. Please indicate whether you are currently enrolled or have enrolled in any of the following since June 2008:
(Mark yes or no for each item)

	Yes	No
Graduate school	☐	☐
Professional school (e.g., law, medicine, nursing, etc.)	☐	☐
Post-baccalaureate research program (e.g., PREP)	☐	☐

If you marked "yes" for <u>graduate</u> or <u>professional school</u> in Question #16, please proceed to Question #17; if you answered "no" to both graduate and professional school, please skip to Question #35.

17. Please print the full name of your most recent graduate or professional institution:

[ ]

18. What year did you start your current or most recent program?

☐ 2007 ☐ 2009 ☐ 2011
☐ 2008 ☐ 2010

19. What graduate/professional degree are you <u>currently seeking</u> or have you <u>most recently earned</u> from the institution named in Question #17?

- ☐ Master's (M.A., M.S., M.Div.)
- ☐ Ph.D.
- ☐ Medical degree (M.D., D.D.O., D.D.S., D.V.I
- ☐ LL.B. or J.D. (Law)
- ☐ Other terminal degree (Dr.P.H., Ed.D., M.F..

20. Estimate the total amount of money you will have borrowed by the time you complete your graduate/professional degree.

$ [ ] .00

NOTE: For the following questions, please refer to your CURRENT or MOST RECENT program of study.

21. Estimate the percentage of tuition, fees, and living expenses that were paid for by: (Mark one in each row)

Family resources (parents, relatives)	[ ] %
Personal savings	[ ] %
Scholarships, grants, or fellowships	[ ] %
Loans	[ ] %
Income from employment outside the institution	[ ] %
Funding from research assistantship(s)	[ ] %
Funding from teaching assistantship(s)	[ ] %
Other than above	[ ] %

22. Since enrolling in your graduate program how successful have you felt at:

	Very Successful	Somewhat Successful	Unsuccessful
Understanding what your professors expect of you academically	☐	☐	☐
Managing your time effectively	☐	☐	☐
Developing research skills	☐	☐	☐
Mastering course content	☐	☐	☐
Collaborating with peers	☐	☐	☐
Pursuing personal intellectual interests related to your discipline	☐	☐	☐
Writing academic papers	☐	☐	☐
Developing contacts in your field of study	☐	☐	☐
Presenting academic material	☐	☐	☐

23. Since enrolling in your graduate program, how often have you: (Mark one in each row)

	Very Often	Often	Occasionally	Rarely	Never
Interacted with faculty outside of class	☐	☐	☐	☐	☐
Interacted with students in your program	☐	☐	☐	☐	☐
Interacted with close friends not at this institution	☐	☐	☐	☐	☐
Felt that your job interfered with your studies	☐	☐	☐	☐	☐
Felt that your family responsibilities interfered with your studies	☐	☐	☐	☐	☐
Felt intimidated by your professors	☐	☐	☐	☐	☐
Discussed course content with students outside of class	☐	☐	☐	☐	☐
Worked on a professor's research project	☐	☐	☐	☐	☐

24. Since entering this program, how often have you: (Mark one in each row)

	Very Often	Often	Occasionally	Rarely	Never
Conducted experiments or collected data	☐	☐	☐	☐	☐
Analyzed data	☐	☐	☐	☐	☐
Searched for literature	☐	☐	☐	☐	☐
Written for publication	☐	☐	☐	☐	☐
Collaborated with graduate students on research	☐	☐	☐	☐	☐
Collaborated with faculty on research	☐	☐	☐	☐	☐
Assisted in writing a grant proposal	☐	☐	☐	☐	☐
Presented research at conferences	☐	☐	☐	☐	☐
Initiated your own research projects	☐	☐	☐	☐	☐
Critiqued others' academic work	☐	☐	☐	☐	☐
Translated scientific terminology into non-scientific language	☐	☐	☐	☐	☐

25. In deciding to enroll in graduate or professional school, how important was each of the following? (Mark one in each row)

	Essential	Very Important	Somewhat Important	Not Important
Inability to find a decent job	☐	☐	☐	☐
Opportunity to get a better job	☐	☐	☐	☐
Opportunity to learn more about things that interest me	☐	☐	☐	☐
Encouragement from a mentor/role model	☐	☐	☐	☐
A program that prepared students for graduate school	☐	☐	☐	☐

26. In choosing the institution named in #17, how important to you was each of the following? (Mark one in each row)

	Essential	Very Important	Somewhat Important	Not Important
Academic reputation of the institution	☐	☐	☐	☐
Academic reputation of the program of study	☐	☐	☐	☐
Opportunity to work with a particular faculty member	☐	☐	☐	☐
Encouragement of a friend or colleague	☐	☐	☐	☐
Recommendation of faculty member	☐	☐	☐	☐
Location	☐	☐	☐	☐
Funding	☐	☐	☐	☐

27. Rate your satisfaction with each of the following in your program: (Mark one in each row)

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Relevance of coursework to career plans	☐	☐	☐	☐	☐
Racial/ethnic diversity of students	☐	☐	☐	☐	☐
The opportunity to interact with faculty	☐	☐	☐	☐	☐
The opportunity for research assistantships	☐	☐	☐	☐	☐
Racial/ethnic diversity of faculty	☐	☐	☐	☐	☐
Representation of women	☐	☐	☐	☐	☐
Quality of graduate-level teaching by faculty	☐	☐	☐	☐	☐

28. Using codes on the back of the Participant Information Sheet, mark your current (or, if already completed, your most recent) graduate or professional discipline.

☐

29. Rate your agreement with the following statements as they relate to your experiences in your current program: (Mark one in each row)

	Agree Strongly	Agree	Disagree	Disagree Strongly
I have been singled out because of my race/ethnicity	☐	☐	☐	☐
I have been singled out because of my gender	☐	☐	☐	☐
I have heard faculty express stereotypes about racial/ethnic groups	☐	☐	☐	☐
I see myself as part of the campus community	☐	☐	☐	☐
There is a lot of racial tension	☐	☐	☐	☐
Graduate students must compete for research opportunities	☐	☐	☐	☐
There are adequate opportunities to gain teaching experience	☐	☐	☐	☐
This program enrolls too many international students	☐	☐	☐	☐
Faculty prefer to hire international students to work on their research	☐	☐	☐	☐
International and domestic students work well together here	☐	☐	☐	☐
I have encountered instances of academic dishonesty	☐	☐	☐	☐
Students are trained to conduct research responsibly and ethically	☐	☐	☐	☐

30. How many journal articles, monographs, or book chapters have you: (Mark one in each row)

	0	1-3	4-6	7 or more
Published as sole author	☐	☐	☐	☐
Published as co-author	☐	☐	☐	☐
Presented at a national conference	☐	☐	☐	☐

Continued on next page...

31. How often do the faculty in your graduate/professional program provide you with: (Mark one in each row)

	Very Often	Often	Occasionally	Rarely	Never
An opportunity to collaborate on research	☐	☐	☐	☐	☐
Advice about your educational program	☐	☐	☐	☐	☐
Feedback on your academic work (outside of grades)	☐	☐	☐	☐	☐
Intellectual challenge and stimulation	☐	☐	☐	☐	☐
An opportunity to discuss coursework outside of class	☐	☐	☐	☐	☐
Help in accessing professional networks	☐	☐	☐	☐	☐
Letters of recommendation	☐	☐	☐	☐	☐

32. What are your: (Mark one in each column)

	Ultimate Career Goals	Immediate Employment Expectations
Professional position for which my program prepared me (attorney, physician, nurse)	☐	☐
Tenure-track faculty position	☐	☐
Non-tenure track faculty position	☐	☐
Non-postsecondary teacher	☐	☐
Postdoctoral researcher	☐	☐
Researcher, academic setting	☐	☐
Researcher, non-academic setting (e.g., national lab, industry, medical center)	☐	☐
Other position in industry (engineer, technician, manager)	☐	☐
Other non-academic position	☐	☐

If you have been or are currently enrolled in an academic graduate program (i.e., M.A., M.S., Ph.D.), please answer the following questions. Otherwise, please skip to Question #35.

33. How many academic terms have you worked as a teaching assistant?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6+

34. Rate your agreement with the following statements related to your discipline: (Mark one in each row)

	Agree Strongly	Agree	Disagree	Disagree Strongly
It is difficult to find tenure-track faculty positions	☐	☐	☐	☐
It is expected that graduates will take multiple post-doc positions	☐	☐	☐	☐
Too few full-time faculty positions exist for the number of students obtaining doctorates	☐	☐	☐	☐
Academic faculty do not have a good work/life balance	☐	☐	☐	☐
It is easier to find jobs outside of academia	☐	☐	☐	☐

35. Are you currently employed, or have you been employed in the past three years, in a position outside of any connected to a graduate program?

☐ Yes ☐ No

If you answered "YES," please answer questions #36-42. If you answered "NO," please answer #43.

36. Write in the code for your current (or, if unemployed, most recent) primary career:

(Use codes from the back of the Participant Information Sheet)

☐

37. Which of the following best describes your primary career: (Mark only one)

☐ Public sector
☐ Private sector
☐ Nonprofit sector
☐ Self-employed

38. In a typical week, how many hours do you or did you spend working for pay?

☐ hrs

39. What was the year you began working in your current position?

☐

40. To what extent is your current (or most recent) position related to the discipline of your highest degree?

☐ Not Related
☐ Somewhat Related
☐ Closely Related

41. If you chose "not related" in #40, to what extent did the following factors affect your decision to pursue a position disconnected from the field of your highest degree? (Mark one in each row)

	To a Great Extent	To Some Extent	Not at all
Desire to start a family	☐	☐	☐
Pay or promotion opportunities	☐	☐	☐
Working conditions	☐	☐	☐
Job location	☐	☐	☐
Change in career or professional interests	☐	☐	☐
Job in highest degree field not available	☐	☐	☐
Family responsibilities	☐	☐	☐

42. Rate your agreement with each of the following statements: (Mark one in each row)

	Agree Strongly	Agree	Disagree	Disagree Strongly
My education prepared me well for my current position	☐	☐	☐	☐
I see myself working in this field for the long term	☐	☐	☐	☐
I am satisfied with my compensation package from my employer	☐	☐	☐	☐
I feel secure in my current position	☐	☐	☐	☐
I do not feel challenged by my work	☐	☐	☐	☐
I need to earn a graduate degree to advance in my field	☐	☐	☐	☐
I expect to change careers in the next five years	☐	☐	☐	☐

43. If you are not currently working and have not worked in the past three years, what were your reasons for not working? (Mark one in each row)

	Yes	No
Difficulty finding work	☐	☐
I am/was a student	☐	☐
Laid off	☐	☐
Family responsibilities	☐	☐
Medical problems	☐	☐
No suitable jobs available	☐	☐
Did not need to work	☐	☐
Did not want to work	☐	☐

Thank you for your participation. Please place the completed survey in the pre-paid envelope. After we process the survey, we will send you a $10 Amazon.com gift card.

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