

## ABSTRACT

Title of Dissertation:

EXPLORING AN INTEGRATIVE  
GRADUATE EDUCATION RESEARCH  
TRAINEESHIP (IGERT): USING  
ORGANIZATIONAL CULTURE TO  
UNDERSTAND HOW PROGRAMS WORK

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Legislators & policy makers recognize the significance of STEM graduate education to issues of national security, innovation and economic competitiveness amongst global peers (Gonzalez & Kuenzi, 2012; Kuenzi, 2008). Federal policy allocates funding to faculty and institutions and establishes programs that ensure equitable opportunity for training, education and employment in the STEM fields. Many of these efforts aim to address existing race/gender-based disparities in doctoral degree attainment amongst women and certain populations of color (Carney, Chawla, Wiley, & Young, 2006; Nerad & Cerny, 2000). There is minimal critique of existing programs in extant literature. Studies focus mainly on understanding program outputs and outcomes with no investigation of program culture or program processes or functions.

A nested conceptual model was created that employs the theoretical tools of Tierney's Organizational Culture theory and Gopaul's conceptualizations of existing graduate student socialization theory to guide a single site case study of an Integrative Graduate Education Research Traineeship (IGERT) Project. Data was collected through analyses of existing program documents, a survey of current and former IGERT student participants and 60-90 minute interviews with IGERT faculty, administration and current & former students. Through data analysis the organizational structure and culture of the case site IGERT program was defined. Data also revealed the specialized training IGERT students received and the specific ways that the program influenced their socialization and professional development. Program experiences of students of URM populations were also described and discussed in relation to how the program promoted and sustained racial/ethnic diversity and intentionally supported URM students. Findings contribute to the complexity of understanding a STEM education program and how it functions within its surrounding environment. Existing limitations and organizational challenges of the program were also illuminated and explored. This research supplements and enhances existing scholarship on the IGERT and other programs designed to train doctoral students of and beyond populations underrepresented in STEM fields. This work will also be useful for developing new and sustaining existing programs that are designed to support STEM doctoral students to eradicate the problem of a lack of diversity in STEM graduate education & labor markets.

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(IGERT): USING ORGANIZATIONAL CULTURE TO UNDERSTAND HOW  
PROGRAMS WORK

by

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## Dedication

This dissertation is dedicated to my mother, Rhonda Y. Robinson and my brother, Brian M. Robinson. To Mommy. Thank you for your selflessness and for all of the sacrifices that you have made for me and Brian throughout our lives. We love you very much. To Brian, I'm so proud to be your sister and I'm so proud of the great man and great educator God called you to be. Thank you for completing your assignment so well. I promise to continue to do our work, please promise me that you'll always have my back. You have never let me down. I won't let you down. I love you forever and miss you always.

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## Chapter 1: Introduction

### Background

Education, and more specifically education in science and math, has been identified as a critical resource for ensuring the nation's position as a global leader in developing innovation and technology (Gonzalez & Kuenzi, 2012; Kuenzi, 2008). In 1989, the American Association for The Advancement of Science argued that "To neglect the science education of any is to deprive them of basic education, handicap them for life and deprive the nation of talented workers and informed citizens- a loss the nation can ill afford" (p. 214). Recently, President Barack Obama acknowledged STEM education as a national tool in his Educate to Innovate Campaign in 2009.

The key to meeting challenges—to improving our health and well-being, to harnessing clean energy, to protecting our security and succeeding in the global economy—will be reaffirming and strengthening America's role as the world's engine of scientific discovery and technological innovation. And that leadership tomorrow depends on how we educate our students today, especially in those fields that hold promise of producing future innovations and innovators. And that's why education in math and science is so important (The White House, 2009 p.1).

**The significance of diversity in STEM graduate education and STEM academic and labor workforces.** In 2003, The National Science Board (NSB) published a report entitled *The Science and Engineering Workforce: Realizing America's Potential*. The NSB is a policy-making entity of the National Science Foundation that advises congress and the President of the United States on policy and

legislation concerning national issues of science and engineering. According to the report “The United States is in a long distance race to retain its essential global advantage in science and engineering human resources and to sustain our world leadership in science and technology” (p. 41). There is a growing body of literature that argues that a diverse workforce in the fields of science, technology, engineering and math (STEM) is critical to sustaining the United States’ academic and economic infrastructure and competitive edge amongst global counterparts (Austin, 2010; COSEPUP, 1995; Expanding Underrepresented, 2011). Throughout world history the United States has strived to maintain a leading/competitive presence in both technological innovation and the global economy. The nation’s scientific academic workforce has sustained that presence by conducting the research in science, engineering, math and technology that continually develops and cultivates the discovery and new innovation in our ever-evolving societies. As our nation continues to diversify, a diverse labor force is critical to sustaining the nation’s growth and development. Diversifying the nation’s talent pool, within STEM fields, and beyond, increases the productivity and innovation of the countries labor force (Burke & Mattis, 2007; Malcolm, Chubin & Jesse, 2004). A diverse STEM workforce is critical in addressing the needs of communities that are rapidly expanding with persons of all races, ethnicities and genders (Expanding Underrepresented, 2011).

Scholars argue that a diverse STEM academic workforce facilitates the development of complex thought in students in classrooms and encourages them to consider scientific problems in novel and unprecedented ways (Chubin & Malcolm, 2008). A study of 357 college students revealed a correlation between more complex

thought processes and exposure to racial diversity in academic settings (Antonio, Chang, Hakuta, Kenny, Levin, & Milem, 2004). In 2003, Massachusetts Institute of Technology, Stanford University, DuPont corporation, IBM, the National Academy of Sciences, the National Academy of Engineering and the National Action Council for Minorities in Engineering wrote a friend of the court brief in response to the Supreme Court cases of affirmative action at the University of Michigan. The brief emphatically argued the importance of diversity in science and engineering (Chubin & Malcolm 2008).

A diverse academic community stimulates critical, reflective and complex thinking, enhancing students' problem-solving abilities.

Moreover, racial and ethnic diversity in higher education significantly contributes to students' ability to live and work together, and to communicate across racial boundaries –skills of great importance in our increasingly heterogeneous world (Grutter v. Bollinger and Gratz v. Bollinger, 2003 p. 13).

Increased racial/ethnic diversity of faculty improves and diversifies colleges and universities and increases the number of faculty mentors for future generations of students of traditionally underrepresented populations within and beyond the STEM fields (Chubin, May & Babco, 2005). Faculty mentoring has been identified as a critical contributor to the academic, professional and social integration of all students especially students of color and students from underrepresented populations.

Mentoring is critical to the development of graduate students as it affords them with knowledge and experiences that are necessary/useful in navigating the pipeline from

graduate study to their chosen careers in their respective fields of study. Several studies note the significance of mentoring for students at various points of the academic pipeline with a subset of that research focusing specifically on the experiences of graduate students of color (Ellis, 2001; Sligh Dewalt, 2004; Willie et al, 1991).

Researchers have argued that adequate faculty mentoring also contributes significantly to the success and retention of graduate students of color (Blackwell, 1989; Sligh Dewalt, 1999; 2004). A number of studies have found that graduate students of color consider their relationships with faculty mentors to be the most substantial factor in their satisfaction with their programs and in their motivation towards degree completion (Hartnett, 1976; Blackwell, 1987; Arce & Manning, 1984; Ellis, 2001). One woman of color expressed the necessity of identifying a mentor during her doctoral program as follows “I found that having a mentor during my program was very important to my psychosocial development. Without this support, I would have left the university at a much earlier time, possibly dropping out of my degree program (Sligh Dewalt, 2004 p. 45). The literature has shown that faculty mentors assist students of color in identifying and securing opportunities for research and publication (Ellis, 2001; Gay, 2004, Sligh Dewalt, 2004; Solorzano, 1993; Willie et al, 1991). Mentors also contribute to the sponsorship and advocacy of minority students to ensure that the professional and financial support that they receive is equitable to that received by their white counterparts (Sligh Dewalt, 2004). Students of color expressed that their faculty mentors (of color) were essential to their

academic and social integration within their graduate programs and may be the most important factor in their lives as students (Ellis, 2001; Solorzano, 1993;).

Graduate students of color report several challenges in connecting with faculty. Many of the faculty in sciences are White faculty and students of color reported having difficulty finding White faculty members who were willing to work with them as advisors and mentors. In previous studies, graduate students of color reported feeling that White faculty did not make it a priority to interacting/meeting with them. They also complained that the White faculty advisors that they were assigned were distracted with other responsibilities and/or disinterested in establishing/maintaining relationships with them (Duncan, 1976; Ellis, 2001; Gay, 2004; Woods, 2001). Other reasons for unsuccessful mentoring relationships between White faculty and graduate students of color identified throughout the literature include inconsistent communications, lack of common research interest and lack of cultural awareness amongst White professors (Ellis, 2001). Many students of color described their White advisors as racists or sexists and reported being discriminated against by faculty (Ellis, 2001; Solorzano, 1993). A more recent study of 33 African American students in STEM PhD programs also reported that participants had similar challenges in their graduate programs. The study found that while most participants reported feeling adequately and appropriately trained in their programs many still reported a lack of mentoring, a lack of career training and an overall absence of diversity and a diversified faculty in their graduate programs (MacLachlan, 2006). These challenges point to the need to educate White faculty on



successful practices to mentor and support minority students and the need to diversity the STEM faculty.

The need for a diverse STEM workforce and professoriate is evident given the demographic shifts in the nation. An academic community and labor force that reflects the racial and ethnic diversity of our nation is necessary in securing the country's position as leader in technological innovation and economic competitiveness in global markets. This diversity also ensures that citizens of this country are adequately and effectively educated and prepared to contribute to the nation's labor force in meeting the needs of society. Securing a diverse academic community begins with ensuring that students of color are recruited and retained throughout the educational pipelines from secondary school to higher education. Efforts must also include post degree attainment to ensure that they are being employed in key leadership and research positions. This is especially critical in the disciplines of science, technology, engineering and math.

This dissertation explored an existing program and diversity effort that is designed to address the needs and challenges of the STEM graduate education. Scholarship on existing programs is scant and bereft of research that explores and understands training and support programs in terms of how they function in providing training and support for student participants. Previous studies focus on describing program components and understanding program outcomes with no investigation of the processes or means by which program outcomes are realized. This single site case study utilized a nested conceptual model to define the organizational structure and culture of an existing doctoral training program known as the Integrative Graduate

Education Research Traineeship. Through defining the organizational culture of the program, the study examined and investigated the ways that an IGERT program influences the socialization and professional training of program student participants, more specifically, students of underrepresented groups. This work extends our understanding of existing programs and diversity efforts in STEM doctoral education and highlights the unique and specialized ways that programs enhance the training of the STEM doctoral students and promote racial and ethnic diversity in the STEM academic and industrial workforce. The following section will briefly describe the IGERT, the doctoral training program and diversity effort that served as the case for this case study. Subsequent sections will detail the purpose of this study and the problem that this study aimed to inform/address and the resulting challenge of diversifying the academic and industrial workforce of this country.

#### **Integrative graduate education research traineeship (IGERT) initiative.**

The Integrative Graduate Education Research Traineeship (IGERT) Initiative was established in 1998 as a federal reform effort to improve the overall quality of graduate education in the sciences, technology, engineering and math (STEM) (Austin, 2010). IGERT has been identified in the literature as the flagship doctoral interdisciplinary training program in the United States (Austin, 2010; Gamse, Espinos & Roy, 2013). The program aims to prepare doctoral students to work collaboratively across academic disciplines to develop and implement innovative solutions that address large and complex research problems throughout national and global domains (IGERT, 2011). Another strategic goal of the IGERT program is to address the lack of racial/ethnic diversity in STEM graduate education and the STEM academic and

labor workforces. The program has funded over 6,700 doctoral students between the year of inception 1998 and 2011 (Gamse et. al., 2013).

### **Purpose of the Study**

This study examined, the Integrative Graduate Education Research Traineeship (IGERT) program, which is sponsored by The National Science Foundation. The study investigated the ways that participating in an IGERT program influences the socialization and professional training of program participants, and more specifically program participants of the groups that are historically underrepresented in the STEM fields. Promoting diversity among IGERT participants and the professional workforce in science and engineering workforce is one of the strategic goals that the IGERT Program has focused on since its inception.

Understanding the experience of IGERT program participants that are Black, Hispanic and American Indian/Alaskan Native (and/or) women was another specific focus of this study. As a flagship research traineeship program in the United States, focusing on the experiences of the program participants from underrepresented populations will illuminate the experiences of these students and identify and highlight the specific ways that the IGERT is supporting this populations and best practices and/or challenges/limitations of fulfilling this strategic goal.

The study is designed to address the following research questions:

1. What is the organizational structure and organizational culture of the IGERT program and in what ways does that culture shape the socialization and training of participants?

2. In what ways does IGERT shape the socialization and training of participants of populations presently underrepresented in STEM graduate education and the STEM workforce?

This dissertation consists of (6) six chapters. The first chapter is an introduction. A chapter that reviews relevant existing literature and the theory used to frame the design of this research will follow. The third chapter that describes the specific methodology of this study and the fourth chapter is a description of the IGERT program that served as the case for this case study. The fifth chapter presents the findings of the research and the dissertation concludes with a sixth chapter that discusses the findings as well as implications and general conclusions of this study.

Chapter one contains the information to establish context that informs this dissertation research. Research and policy that identifies STEM Education as a national priority is presented first, followed by a discussion of the significance of a diverse labor workforce and a diverse academic workforce to meeting the various needs of the nation and the global peers and partners. A formal and comprehensive statement of the problem that this study aims to address and the policy and programmatic initiative designed to address the problem will follow. An overview of the proposed methodology for the research is presented along with a brief synopsis of the conceptual framework that guided the research design, data collection, data analysis and the interpretation of findings. Finally, the chapter concludes with a discussion of the significance of this research and the definition of key terms.

## **Statement of the Problem**

Historically, African Americans, Hispanic/Latino(a)s, American Indian/Alaskan Native populations and women have lagged behind Asian American/Pacific Islander and White male counterparts in earning undergraduate and graduate degrees in the sciences, technology engineering and math. Their representation decreases at every level from undergraduate to advanced graduate and terminal degrees (Expanding Underrepresented, 2011). The National Academies, advisers to the United States on Science, Engineering and Medicine (2011) reported that, in 2007 38.8 percent of enrollment at public K-12 schools and institutions were underrepresented minorities. Similarly, underrepresented minorities comprised 33.2 percent of the population of US College age students and 26.2 percent of all enrolled undergraduates. Underrepresented minorities earned 17.7 percent of bachelor's degrees in science and engineering. The National Academies also reported that, in 2007, underrepresented minorities represented 17.7 of the overall graduate school enrollment. However, minorities earned 14.6 percent of the master's degrees in science and engineering and "a miniscule 5.4 percent of science & engineering doctorates" (p. 3).

According to the National Science Board (2012) underrepresented minority students accounted for 12 % of students enrolled in all graduate science and engineering programs in 2009. Similarly, Blacks, Hispanics and American Indian/Alaskan Native students combined earned 7% of all doctoral degrees in science and engineering (National Science Board, 2012).

Reviewing the statistics on the number of women earning doctoral degrees in the STEM fields reveals substantial gains in recent years. Although percentages of the women earning doctoral degrees in engineering and the physical sciences are low, percentages have increased considerably over the years. Similarly, the number of the STEM doctoral degrees earned by women grew faster than the number of STEM doctoral degrees earned by men as reported by the National Science Foundation in *Science and Engineering Indicators 2014*. Women earned more than half of all doctorates conferred in the social sciences in 2009 however, fewer women earned doctoral degrees in STEM fields such as engineering, the physical sciences and math and computer sciences. For example, women earned only 26% of the PhDs in computer science, 33% in the physical sciences and 25% of engineering doctorates in 2009.

The dearth of women and minorities in STEM doctoral education and more specifically doctoral education is but one of the challenges of STEM graduate education highlighted in the literature (Austin, 2002a, 2002b, 2010; COSEPUP, 1995; Expanding Underrepresented, 2011). Existing research on STEM doctoral training identifies various challenges and limitations including attrition (Lovitts, 2001), low degree completion rates (Walker, et al., 2008), insufficient and/or ineffective training and professional development and inadequate exposure to and training for the academic career (Austin, 2002a, 2002b, 2010; Austin & McDaniels, 2006; Wulff et al., 2004). Existing racial/ethnic disparities in enrollment, achievement and degree attainment in STEM graduate education and specifically doctoral education are discussed throughout previous research and policy reports as major challenges and

concerns amongst researchers, legislators, policy makers, industrial leaders and colleges and universities (Council of Graduate Schools, 2007; Golde & Dore, 2001; Nerad & Cerny, 2004, 2000; National Science Board, 1997; COSEPUP,1995).

### **Programs: Addressing diversity issues and other challenges of STEM**

**doctoral education.** Improving, expanding and sustaining the success and effectiveness of STEM Education has been a mainstay on policy agendas in the United States for the past several decades (Gonzalez & Kuenzi, 2012; Kuenzi, 2008). The federal government has maintained an “active and enduring” interest in STEM education. Legislators and policy makers recognize and cite the significance and contribution of STEM Education to issues of national security, innovation and economic competitiveness amongst global peers and counterparts (Gonzalez & Kuenzi, 2012; Kuenzi, 2008). Efforts vary in scope and focus from preschool to the post doctorate (Gonzalez & Kuenzi, 2012).

The Engineering Act of 1980 is a federal policy established to encourage men and women of all races, ethnicities, and socioeconomic statuses and backgrounds to acquire, cultivate and utilize skills in science, engineering and math. The act authorizes the National Science foundation to fiscally support programs and initiatives that are designed to increase the participation of underrepresented minorities and women science and technology and initiate research and research opportunities on and for women, minorities and minority institutions. (SEEOA Summary, 1980). The policy allocates funding and other resources to faculty and institutions and authorizes the National Science Foundation to establish programs and initiatives that also ensure equitable opportunity for training, education and

employment in the STEM fields. These increases promote literacy in these fields and the “full use of the nation’s human resources in science and engineering” (Women, minorities, 1996 no p). For example, the act facilitates the establishment National Research Opportunity Grants, which are monies specifically designated for women scientists to conduct research in their individual fields of study. Additionally, the act requires the Director of NSF to work collaboratively with the Committee on Equal Opportunities in Science and Technology to prepare and submit a proposal for a comprehensive program that promotes the participation of minority students in STEM fields. The policy also requires the federal government, by way of the President of the United States, the Director of NSF, the Director of the Office of Science and Technology and the office of congress to maintain comprehensive policy and programming that promotes the equal opportunity for minorities and women in science and engineering.

More recently a report published in 2012 noted that annual federal appropriations for STEM Education Programs range from \$2.8 to \$3.4 million dollars with the majority of those funds being allocated to toward postsecondary students and institutions (Gonzalez & Kuenzi, 2012). These funds are distributed by 13 to 15 government agencies with Department of Education, The National Science Foundation and the Department of Health and Human Services sponsoring the majority of resources to students, faculty, colleges & universities (Gonzalez & Kuenzi, 2012).

Several programs and initiatives have been established to address the challenges and limitations of STEM Doctoral Educations specifically. Many of these



programmatic efforts aim to increase the number of the STEM PhDs in the United States and address existing race and gender based disparities in achievement and doctoral degree attainment amongst women and certain populations of color (Carney, Chawla, Wiley, & Young, 2006; Nerad & Cerny, 2000). Programs have been developed by the federal government agencies, state policy, as well as at the institutional level by colleges and universities. Additionally, educational think tanks, research groups, policy organizations have also developed programs (Austin, 2010). The focus of programming is varied as some initiatives are structured to support doctoral students in transitioning to academic/faculty positions. Other programs afford participants with training in conducting forms/types of research once considered unconventional in the STEM disciplines (Austin, 2010).

#### **Limitations in extant research on existing STEM education programs.**

Although the majority of the STEM Education funding is allocated to postsecondary efforts and programs that support graduate students, the literature on STEM education program is largely focused on K-12 and K-16 initiatives. The existing body of literature on STEM education programs is very limited in exploring STEM education programs that serve students on the graduate level. Studies that investigate STEM education programs at the graduate level are scant (Gonzalez & Kuenzi, 2012).

Extant research on graduate STEM education programs varies so much in nature. Research exists in the form of research studies, literature reviews, program assessments, evaluations, etc. The research focuses mainly on program outputs and assessing the broader impacts of program services on program participants. This work explores the career choices of program participants and compares the academic

and professional trajectories of the program participants to a control group of doctoral students. This research is useful for understanding program outcomes but is limited in understanding program processes and the nature of the services and activities that program participants receive. Similarly, there is a small body of work that use graduate education programs as tools for understanding other concepts. For example, scholars have used programs as a site for investigating interdisciplinary research in STEM fields and ways that faculty and students navigate graduate education programs to conduct interdisciplinary research. This work certainly identifies the program as a site for unique training in graduate school but it does not illuminate all aspects of program services, describe the various contexts that exist within a program or broaden our understanding of each component of a program's structure, culture or practices.

Similarly, extant reviews of scholarship that have attempted to assess the efforts of federal STEM Education programs are largely descriptive and are not framed in extant theory or previous research. There is minimal critique or analysis of the existing programs and the description and discussion of the programs focuses mainly on program outputs and outcomes. There is no investigation of exploration of the functions, culture and processes of STEM Education Programs. These reviews present general information on a larger number of programs and the programs reviewed vary greatly in terms of scope, scale of services provided, level of students served, funding agencies etc. Consequently, given the variation in programs between there is no basis for drawing conclusions and comparisons between programs (Gonzalez & Kuenzi, 2012; Kuenzi 2008). A simple factor like the, the definition of

a STEM Education program varies considerably from study to study. Some researchers have identified 105 existing STEM Education programs in the US while others report 252 programs. This is but one example of the kinds of differences in perspectives represented previous reviews of literature.

Consequently, the story of these programs is incomplete, inconsistent, complicated and sometimes skewed. To date there is a limited amount of data and information on STEM Education programs for graduate/doctoral students and the services that these programs provide. However, the National Science Foundation has made a considerable investment toward STEM Education programs and specifically services for doctoral students in STEM Fields. The annual budget of the National Science Foundation for fiscal year 2014 was \$7.172 Billion. The NSF is comprised of six directorates that are each responsible for fulfilling the various goals and objectives of federal agency. STEM Education programs are housed under the Education and Human Resources (EHR) Directorate. The EHR Budget for the 2014 fiscal year was \$846.5 Million. Programs like the IGERT, which are designed to support graduate students, are administered through the Department of Graduate Education (DGE) within the EHR. In 2014, the DGE annual budget was \$259 Million. The IGERT program, and its sister and successor program the National Research Traineeship (NRT), operated at a combined annual budget of \$26.33 million dollars during the 2014 fiscal year, with the IGERT being allocated \$14.22 million and the NRT receiving \$12.11 million respectively. Additionally, as reported in the annual budget requests and budget appropriation bills for the National Science Foundation, the

agency has invested a total of \$133.63 million into to the IGERT program between 2010 and 2015. See Table 1.1

*Table 1.1 Annual Fiscal Appropriations for IGERT from 2010-2015*

<b>Year</b>	<b>Fiscal Appropriation/ IGERT Commitment</b>
2010	30.11 Million Dollars
2011	29.6 Million Dollars
2012	31.01 Million Dollars
2013	24.14 Million Dollars
2014	14.22 Million Dollars
2015	4.55 Million Dollars
<b>Total</b>	<b>133.63 Million Dollars</b>

Given the NSF's investment in STEM education and research development over the years, it is critical that these programs are fully explored in order to illuminate and understand their structure and design as well as the services, activities, knowledge, training and socialization that they afford student participants. Research that focuses on the IGERT program affords the opportunity to understand a government funded education program strictly within the context of US graduate education and more specifically STEM doctoral education. This is significant given the challenges of STEM doctoral education outlined in previous literature and the influence of these challenges in the design and development of government funded education programs for graduate students like the IGERT. Similarly, NSF (2014) reported that in 2009, 61% of all graduate students in science and engineering were supported and funded through federal government traineeships. An in depth exploration of an IGERT project will serve as a basis for future research that will extend the field's understanding of STEM education programs for graduate students beyond exploring inputs and impacts to truly understanding program culture,

activities, processes, etc. and the ways in which those factors influence the socialization and training of program participants.

### **Theoretical Framework**

This study employed concepts from two existing theories, Organizational Culture Theory (Tierney, 1988) and Bryan Gopaul's (2011) conceptualization of graduate student socializations. A brief review of each of these theories will follow and a more extensive review of the theoretical framework will be provided in Chapter II. These theoretical concepts were used as a lens for exploring and understanding an IGERT project and the specific ways that participating in an IGERT project influences/shapes the socialization and training of doctoral student program participants. Theory was useful in defining and understanding an IGERT as an organization and frame an examination of how the IGERT is situated and structured within various departmental, institutional, and disciplinary contexts. Similarly, organizational cultural theory framed an exploration of the culture of the IGERT project and contribute to the description and understanding of the processes, functions and activities informed by that culture. Finally, graduate student socialization theory, most specifically Bryan Gopaul's (2011) conceptualizations of the process of graduate student socialization was used to investigate how IGERT student participants navigate their graduate training and socialization both within and beyond their participation of the IGERT program. Socialization theory framed the exploration of whether or not the IGERT program interacts with and/or influences the graduate training and socialization of program participants and most specifically participants that are of groups historically underrepresented in STEM fields.

## **Description of Methodology**

A single site exploratory case study (Stake, 2005) was the methodology employed to examine an existing IGERT project, which will serve as the unit of analysis in this work. The methods of case study as defined by Yin (2003) and Creswell (2007) informed this work. According to Yin (2003) case study is an exploration of a defined case within a specific “real life” setting or context. The case was an existing IGERT program/project site, which is, bound the context of the doctoral education and training experiences of the program participants (Creswell, 2007; Stake, 2005; Yin, 1984). Case study was the most appropriate methodology for addressing the research questions for this study as it focuses first on describing the case as well as presenting and/or demonstrating a thorough understanding of the case (Creswell, 2007; Yin, 2003). To date existing scholarship on IGERT programs has assessed program outcomes and the role of the IGERT in training students to conduct interdisciplinary research.

Existing scholarship on the IGERT program or any other STEM education initiative is bereft of a study that affords an in depth comprehensive description of program process, practices and program culture. The primary aim of this research was to gain a better understanding of all aspects of an IGERT project including program design, program structure, program practices, program culture, components, curricula as well as the various dimensions, contexts norms and values of the program. The study also explored how those things interface and interact with the socialization and training of doctoral student program participants, particularly those of populations presently underrepresented in the STEM fields. Through this study, I sought to gain a

better understanding of the ways in which an IGERT project prepares participants, and specifically participants of color to understand and work within STEM fields both within their graduate programs and beyond.

In case study, the researcher collects a wide range of data and information through various methods and multiple sources to conduct an in depth exploration of a case or multiple cases over an extended period of time (Creswell, 2007). Several methods of data collection were employed to examine various program components of an IGERT as perceived, experienced and/or understood by program participants, program faculty, program administrators and other program stakeholders. Existing program information and program data was reviewed and examined. Additionally, current and former student program participants and well as program faculty and staff were interviewed and a small survey was distributed to explore communication and information exchange within program contexts. Examples of the program components that were investigated include: program goals, program design, program activities and services, program culture, relationships and interactions within program context, the existence of a sense of community within the program and the roles and responsibilities of faculty and program administration.

### **Significance**

Austin (2010) argues that existing programs were designed and structured in response to policy and research reports that identify and highlight the limitations of the STEM doctoral education. Exploring and understanding an IGERT program contributes to the broader literature STEM doctoral education and the policy and programmatic initiatives that have been designed to reform STEM graduate

education. Through this study the specific ways that participating in and IGERT program contributes to/supplements the training and socialization of program participants are illuminated. This work builds upon a growing body of literature on the experiences of the doctoral students of color within their graduate program and within the context of a research traineeship within the fields of science, technology, engineering and math. Armed with this information faculty, graduate programs, and colleges/universities can work to increase the number of the underrepresented persons who persist in graduate school and earn doctoral degrees.

An exploration of an IGERT project, an initiative designed to address and improve the quality of STEM education and address diversity issues within STEM education programs, is significant for several reasons. First, this research contributes to a broader body of knowledge on the various ways that students and students of underrepresented populations are trained and socialized to work in science, technology, engineering and math. Exploring these response initiatives is also useful in ensuring that these efforts are effectively and efficiently meeting established goals and objectives and serving and supporting all student participants equitably.

Similarly, an investigation of these efforts also illuminates existing challenges and limitations of extant policies and programs, graduate departments, institutions and disciplines in the training of students of and beyond populations underrepresented in STEM. For example, existing evaluation studies and research on the IGERT do not explicitly define or establish criteria for assessing the “success” of an IGERT program. How does an IGERT project define success? What elements of a program contribute to its success/effectiveness in meeting established goals and objectives?



The National Science Foundation and a host of other scholars have studied program outcomes and identified key competencies that IGERT student participants acquire through their participation in an IGERT however, the field is bereft of any formal evidence of the actual indicators or characteristics of a successful IGERT program. This study is useful as it describes and affords demonstrations of the specific program components that contribute to the effectiveness of an IGERT project from the perspectives of student participants, program alum, principal investigators, IGERT faculty, etc. in the context of practice. This information is also useful in developing new mechanisms of training & socialization within and amongst traineeships like the IGERT (and its successor program the NRT) as well as programs in STEM graduate education. This information will empower colleges/universities, legislators, etc. to sustain other existing efforts and initiatives designed to adequately and effectively support all students through their STEM graduate programs, especially those students who are of populations traditionally underrepresented in STEM fields. This work also contributes to the eradication of the problem of an overall lack of diversity in graduate education in science, technology, engineering and math and subsequently STEM academic and industrial labor forces.

Understanding these programs through the relevant research and the theoretical lenses of Organizational Culture Theory (Tierney, 1988) and Gopaul's (2011) conceptualization of graduate student socialization inform and empower future research and scholar practitioners to better understand, revise and construct effective and supportive training spaces and environments for all doctoral students both within and beyond the bounds of the classroom, the research lab and the

faculty/student relationship. Finally, implementing and sustaining doctoral training/reform programs can be quite costly. An in-depth analysis of a research traineeship like the IGERT will support sponsoring agencies and institutions in ensuring that resources are being used effectively and programs are efficiently meeting program goals and objectives.

### **Definition of Key Terms**

- **STEM Fields-** Broadly STEM fields are those designated as subject areas that fall within the broader classification boundaries of the disciplines of the science, technology engineering and math. According to the National Center for Education Statistics (2009) most state and federal legislators, policy makers and educational researchers define STEM and STEM education as those efforts committed to improving education within the natural sciences (including physical sciences & biological/agricultural sciences), mathematics, engineering (engineering technologies) and technology (computer and information sciences. (Kuenzi, Matthews & Mangan, 2006, National Governors Association, 2007, Chen, 2009). Some federal agencies include social and behavioral sciences such as economic, sociology, and political science in definitions of STEM (Green, 2007).
- **Underrepresented Populations -** According to Federal Government Agencies such as the Department of Education, the National Science Foundation and the National Institute of Health, persons presently labeled or identified as underrepresented in the disciplines of science, engineering and math are those who identify as African Americans, Hispanics and American Indian/Alaskan

Natives, Native Hawaiian and persons with disabilities (Broadening Participation, 2008). It is important to consider that the identification as underrepresented minority is may vary according to discipline across the wider range of the fields that fall under the umbrella of the science technology engineering and math. For example, women are considered underrepresented in some fields and they are not underrepresented in others (Broadening Participation, 2008).

## **Chapter 2: Literature Review**

This literature review will begin with historical information that will serve as context for understanding doctoral education support programs and their function within the broader contexts of higher education and STEM academic and industrial workforces. A brief review of the history and overall goals of US graduate education and the origin of doctoral education in global and domestic contexts is presented first, followed by an overview of the rise of STEM research as federal priority in the United States and the implications for the on graduate education, specifically STEM doctoral education in this country. An overview of the literature on STEM doctoral education will follow and will focus on the research that highlights the limitations, challenges and critiques of STEM doctoral education. Research on the responses to these challenges and critiques will then be presented. A review of the extant scholarship on the program at the focus of this study, the Integrative Graduate Education Research Traineeship as designed by the National Science Foundation will follow.

### **U.S. Doctoral Education as a Context for STEM Education**

Prior to the development of the “research university”, higher education in the United States focused on training ministers and religious leaders (Gardner & Mendoza, 2010; Geiger, 2005). As the nation evolved through periods of war, civil/political unrests and industrial revolution, higher education continued to adapt to meet the ever-changing needs of American society. American colleges began to offer training for persons interested in fields of study or trades other than religion. Throughout US history, the goals and nature of graduate education have continuously

evolved to meet the emergent needs of society (Gardner & Mendoza, 2010). The first doctoral degree was awarded in 1861 at Yale University. Early doctoral study was modeled after European educational systems, specifically the British and German models that emphasized active training and involvement in research and rigorous scientific inquiry (Gardner & Mendoza, 2010; Walker, Golde, Jones, Bueschel, & Hutchings, 2008). Considered a prestigious rites-of-passage, reserved only for those with advanced intellectual capacity, doctoral study consisted of rigorous graduate seminars and one-on-one training with faculty. Students were trained to be polymaths, or persons of wide-ranging knowledge and learning (Walker, et. al., 2008). After completing requisite comprehensive exams and submitting and defending their research (i.e., the doctoral thesis), those who earned a PhD apprenticed with faculty until they received faculty status of their own.

The American model of doctoral education coalesced with the opening of Johns Hopkins University in 1876. This model of doctoral education is especially unique as it was patterned after the German concepts/models of graduate education (Altbach, Berdahl & Gumport, 2005). Johns Hopkins provided financial support to doctoral students in the form of fellowship. The emergence of research universities such as Hopkins led to the definition and formation of academic disciplines, fields and departments which led to the establishment of specialized research and research oriented doctoral training in the arts and sciences (Rudolph, 1962; Walker, et. al., 2008). Doctoral education shifted from grooming free ranging polymathic scholars to training specialists with expertise in specific academic disciplines and fields of the study. This shift in doctoral training contributed to the decentralized structure of

graduate education and scholarship that was unique to American higher education (Altbach et al., 2005; Rudolf, 1962; Walker et al., 2008). Academic disciplines matured and expanded beyond academic departments on university campuses to learned societies, national associations, disciplinary organizations and scholarly journals (Walker et al., 2008). Standards of scholarship, best practices and methods of doctoral training were established and enforced through these organizations, which facilitated the rapid production of research and PhD programs (Gardner & Mendoza, 2010). By the 1930s, there were approximately 100 U.S. doctoral-granting institutions in the United States.

### **STEM Research as a Federal Priority**

Throughout educational literature, the time period between the 1940s and the 1960s has been characterized as The Golden Age of Higher Education in the United States (Altbach, Berdahl & Gumpert, 2005; Gardner & Mendoza, 2008). This characterization is largely due to the increase in federal appropriations for higher education and the nation's acknowledgment/recognition of the role that university research played in the industrial revolution, World Wars I and II and the global race for innovation and technology (Altbach et al., 2005; Gardner & Mendoza, 2008). Similarly, within the Golden Age of Higher Education the cultivation of an academic workforce became a national priority (Gardner & Mendoza, 2008). This shift had significant implications for various academic programs within the STEM disciplines especially as related to doctoral education (Walker et al., 2008).

The National Research Council was established at the end of World War I to organize efforts of the scientific organizations that developed during the war (Gardner

& Mendoza, 2008). Similarly, the federal government's investment in graduate education increased substantially thus beginning an era of federal funding for university research and doctoral training (Walker et al., 2008). The National Science Foundation (NSF) and the National Institutes of Health (NIH) were established during this time as well. These federal agencies were designed to provide faculty with financial support for research, which subsequently contributed to the support of graduate/doctoral students (Austin et al., 2009; Gardner & Mendoza, 2008; Walker et al., 2008). Federal monies were used to build and expand university infrastructure, equipment and facilities for the purposes of ensuring the nation's sustained presence in creating new science and innovation and in the global marketplace (Walker et al., 2008). According to Geiger (2005),

This bounteous support was accompanied by assistance for universities to support graduate students, build laboratories and develop new science programs. Sputnik also provoked Washington to support higher education directly, first through the National Defense Education Act and later through direct aid for buildings and students. The federal largess, superimposed on mushrooming enrollments and state support, produced an ephemeral golden age in American higher education. (p. 62-63)

As society evolved and national priorities shifted in the late 1960's and 1970's the Golden Age of Higher Education began to phase out. While the end of the Cold War impacted the federal government's investment in higher education, the nation's emphasis on research and development in the STEM fields remained (Austin, 2010). Funding that was once allocated for "basic" research began to be funneled into

applied research with implications for the environment, the economy and education (Carney, Chawla, Wiley, & Young, 2006).

According to Austin (2010), approximately 40,000 to 50,000 doctoral degrees are awarded annually in the United States. As reported by the Survey of Earned Doctorates (2013), 49,562 doctorates were awarded in 2009; a large proportion - 33,470 or nearly 68% - of those degrees were in science and engineering. With the majority of doctoral degrees awarded in the STEM fields, educational researchers, policymakers and leaders in industry slowly have come to recognize the doctoral program as a critical component of the pipeline to the STEM academic and industrial workforce (Austin, 2010; Council of Graduate Schools, 2007; National Science Board, 1997)

### **STEM Doctoral Education**

The body of literature on doctoral training experience has grown considerably over the last twenty years, particularly within the disciplines of science, technology, engineering and math. This work proliferated in the mid to late 1990s and early 2000s and has remained an educational priority amongst scholars, professional organizations, leaders in industry and policy makers due to the serious implications of STEM doctoral education on a variety of academic, social, economic and political interests (COSEPUP, 1995). This section will review the literature that identified many of the challenges and limitations of the STEM doctoral education

**The challenges of STEM doctoral education.** A subset of the literature on the STEM doctoral experience specifically focuses on challenges and limitations of the culture, structure, goals and values of graduate education within the field.



Examples of these challenges and limitations include causes of increased attrition rates in STEM graduate programs (Lovitts, 2001), race and gender based disparities in STEM doctoral degree attainment (National Science Board, 2012), insufficient and/or ineffective training and professional development and inadequate exposure to and training for the academic career (Austin, 2002a, 2002b, 2010; Austin & McDaniels, 2006; Wulff et al., 2004). Similarly, a review of extant literature on the experiences of women and graduate students of color reveals challenges and limitations of the STEM doctoral training specific to underrepresented populations. Students report experiences of physical, cultural, social and professional isolation, strained relationships with white faculty and a dearth of faculty of color to serve as mentors (Duncan, 1976; Gay, 2004; Nettles & Millet, 2006).

The main critiques of STEM doctoral education relate to the lack of student diversity in STEM doctoral degree programs and the quality of academic/professional training that students receive (COSEPUP, 1995 Council of Graduate Schools, 2007; Nerad & Cerny, 2008). Historically, African Americans, Hispanic/Latino(a)s, American Indian/Alaskan Native populations and women have lagged behind their Asian American/Pacific Islander and White male counterparts in earning doctoral degrees (National Science Board, 2012; COSEPUP, 1995; Council of Graduate Schools, 2007). As noted earlier in the proposal current statistics reveal the persistence of achievement gaps and disparities between underrepresented populations and their White male counterparts. The National Science Board (2012) reported that in 2009 women earned more than half of all doctorates conferred in the social sciences. However, in that same year women earned only 26% of the PhDs in

computer science, 33% in the physical sciences and 25% of engineering doctorates. Similarly, underrepresented minority students accounted for just 12% of students enrolled in all graduate science and engineering programs in 2009 (National Science Board, 2012). When compared to their respective proportions in the US college-age population, White and Asian/Pacific Islander college-age students remain overrepresented among science and engineering PhDs, representing over 65% of the total population of doctoral degrees awarded (National Science Board, 2014). Similarly, Blacks, Hispanics and American Indian/Alaskan Native students earned only 7% of all doctoral degrees in science and engineering with 1451 doctorates awarded to Black students, 1335 awarded to Hispanic/Latino and 154 to American Indians and Alaskan Natives (National Science Board, 2012).

In addition to concerns over the lack of diversity in STEM doctoral programs in the United States, several scholars have critiqued the effectiveness of the traditional structure and culture of STEM doctoral education in preparing students for diverse career options in academic and non-academic sectors (Austin, 2010; Golde & Dore, 2001; National Science Board, 2003; Nyquist, Austin, Sprague & Wulff, 2001). Students report that existing opportunities for professional training are inadequate and fail to meet their needs and/or expectations (Golde & Dore, 2001). Studies have found that students often lack awareness and understanding of the roles and responsibilities of faculty work and are not adequately introduced to or prepared for the academic career (Austin, 2002a,2002b; Carney et al.,2006; Golde & Dore, 2001). Similarly, training opportunities for careers in applied research, industry and policy are not supported and/or are nonexistent within graduate programs (Austin, 2010;

Golde & Dore, 2001). STEM doctoral students are trained to design and conduct research but studies argue that many graduate bereft of the competencies, skills and structures necessary to sustain a successful non-academic career (Austin, 2010; COSEPUP, 1995).

**Responding to critiques of STEM doctoral education.** Given the nation's investment in STEM funding and research development over the years, STEM doctoral education has remained a constant focus for research and reform amongst educational researchers, program developers, private sector leaders and policymakers (Austin, 2010). Several government and nongovernment organizations have developed initiatives and organized committees to assess the quality of graduate education and whether or not doctoral programs are effectively preparing graduates to address the diverse needs of an ever-evolving society. In 1995, The Committee of National Academies organized The Committee on Science, Engineering and Public Policy. That committee released a popular report entitled *Reshaping Graduate Education of Scientists and Engineers* (Committee on Science, Engineering and Public, 1995). Similarly, the Association of American Universities and National Science Board also published similar reports that urged graduate degree programs to revise and reform their curricula to cultivate a wider range of academic and professional skills in students and increase the recruitment of women and minority students (Austin, 2010; Nerad, 2008). A host of scholars and educational researchers also published extensive longitudinal studies exploring doctoral education in the STEM fields and beyond. Examples include *Paths to the Professoriate* by Wulff and Austin (2004) and *PhDs: Ten Years Later Study* by Nerad and Cerny (1999). This

body of literature provided a host of implications for future research and practice as well as recommendations for maximizing the graduate experience for those who study science, technology, engineering and math. In her chapter on strengthening the preparation for scholarly careers in STEM doctoral education, Austin (2010) summarized specific recommendations for STEM graduate education reform. She argues that reform in STEM graduate education should be focused on preparing students to work within and beyond disciplines across a range of career paths in academe and industry. Nerad and Cerny (2000) published five recommendations for the *Ph.Ds. 10 Years Later Study*. The first recommendation focused on increasing and expanding existing career planning strategies in graduate programs to consider professional careers outside of the professoriate. The second recommendation encouraged the continued support of students toward completing their degrees. The authors emphasized the importance of effective mentoring within and across departments, especially for minority students. The third recommendation focused on reforming the postdoctoral experience to ensure that postdocs were adequately trained, supported and compensated. Adequate assessment of doctoral programs is the fourth recommendation offered by Nerad and Cerny, (2000). They argue that doctoral students be surveyed at regular intervals throughout their doctoral program to assess their satisfaction with their graduate program, their training and their universities. The final recommendation focused on supporting spouses and career couples within academe with special emphasis on providing support to women who study science and engineering.

Other studies also offer similar recommendations for STEM education reform. Some scholars argue for an increase in the production of research and scholarship that explores the impact of existing forms of support available to graduate students including traineeship programs, fellowships and research (Austin, 2010; COSEPUP, 1995). Studies that examine aspects of STEM doctoral education such as a lack of student diversity, attrition and time-to degree, as well the federal government's role in supporting STEM graduate and postdoctoral education were cited as strategies for improving STEM doctoral education (Austin, 2010; COSEPUP, 1995; Nerad & Cerny, 2000). In, 2003 the National Science Board published a report entitled "The Science and Engineering Workforce: Realizing America's Potential." The report was written in response to the analysis of two major trends in STEM education with potential to affect the nation's capacity for the preparing a talented workforce in science and engineering. It also provided several recommendations for reforming STEM graduate education and stressed the importance of revising procedures for applying for grants and research funding as well as faculty reward systems to encourage and enable faculty to devote more time to mentoring graduate students (Austin 2009a; 2009b; Austin, 2010; Nerad & Cerny, 2000). Previous procedures for applying for research funding and grants did not emphasize the nation's developing priority for increasing the number of the US born students interested in pursuing careers in STEM fields. The report also highlighted the necessity of the recruiting and retaining students from underrepresented populations to effectively meet that goal. Austin (2010) reported

In arguing for plans to attract more US born individuals to study science and engineering at advanced levels, the report noted that the need for talented individuals in these areas cannot be met without finding ways to ensure that people from underrepresented groups succeed in their studies. (p. 95)

Recommendations in a number of reports stressed the importance of promoting racial/ethnic diversity in STEM graduate education programs and the STEM workforce and increasing access for students of identity groups that are currently underrepresented in the STEM field (Austin, 2010; COSEPUP 1995)

**Programmatic responses to challenges and critiques of STEM doctoral education.** Colleges and universities, national organizations, professional associations and governmental agencies have developed reform programs to address the challenges of graduate education in the STEM fields (Austin et al., 2009; Council of Graduate Schools, 2007; National Science Board, 2003; Walker et al., 2008). These efforts vary in scope, size and services/ supports for student participants. They provide additional programming that affords student participants with professional development and training, funding and experience in teaching and research (Austin, 2010). Many of these programmatic efforts are specifically designed to increase the number of STEM PhDs in the United States. Several of these efforts were also established to address existing race and gender based disparities in achievement and doctoral degree attainment (Carney et. al., 2006; Nerad & Cerny, 2000). An example of an existing reform effort is the Carnegie Initiative of the Doctorate. This reform effort began as a five-year initiative as a means of generating meaningful dialogue about the challenges providing of doctoral education faced by graduate departments

at colleges and universities. Through this initiative, program efforts are fully funded by the Carnegie Foundation for the Advancement of Teaching and are designed to support faculty in developing and instituting discipline specific plans for addressing the issues within doctoral programs and strengthening & enhancing doctoral training (Austin, 2010). Institutions of higher education and more specifically graduate departments, have also taken steps in developing programming that support doctoral education. Coppola (2009), a professor of Chemistry at the University of Michigan, designed a model of reform that focuses on cultivating research teams as a tool in preparing doctoral students for careers as teachers and professors. These research teams were established through a program called Preparing Future Faculty (PFF). The program was developed in response to existing research and reports (Golde & Dore, 2004) calling for reform in STEM doctoral education concerning the training and professional readiness of recent STEM PhD completers (Coppola, 2009). This program, and initiatives like it, afford students and faculty the opportunity to co-construct structured opportunities for professional development and to cultivate skills for professorial teaching while balancing substantive and significant research agendas.

The National Science Foundation's response to the call for STEM graduate education reform has been most notable. The policy writing body of the NSF, also known as the National Science Board, published a report emphasizing the necessity of making a united and organized effort to ensure doctoral students are effectively trained in their graduate programs. The report stressed the necessity of a "well-educated workforce with high level training to meet the needs of the country and the

broader society for innovation and discovery in science and engineering” (Austin, 2010, p. 95). NSF has organized countless efforts aimed at supporting STEM doctoral education and underrepresented doctoral students. One example of NSF’s commitment is the Alliances for Graduate Education and the Professoriate (AGEP), which was established in 1998, formerly known as NSF’s Minority Graduate Education Program. The goal of AGEP is to support the training of underrepresented minorities for professorial careers and to increase the overall number of persons of color (African American, Hispanic/Latino, Alaskan Native and Native Hawaiians or Pacific Islanders) who obtain graduate degrees in the STEM fields (Austin 2010; NSF-AGEP, n.d.). An additional NSF funded STEM graduate education reform effort is the Center for the Integration of the Research, Teaching and Learning (CIRTL). CIRTL focuses on preparing students to become dynamic professors who approach their teaching with the same analytical and technical skills that they use in conducting their research. CIRTL brings STEM doctoral education reform to the institutional level by establishing a network of professionals that continuously share ideas about improving the condition of graduate education (Austin, 2010).

### **Integrative Graduate Education Research Traineeship**

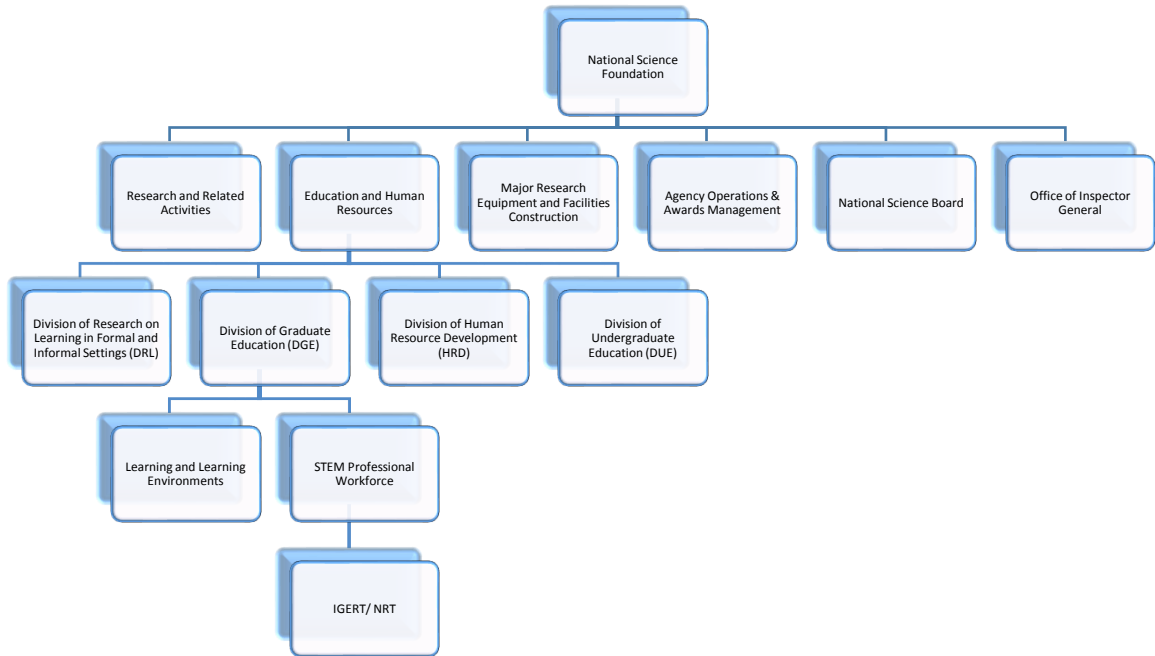
A further programmatic response to STEM education is the Integrative Graduate Education Research Traineeships (IGERT) Initiative which was established as a reform effort to improve the overall quality of graduate education in the sciences, technology, engineering and math (Austin, 2010). The IGERT is a federal reform initiative that has been identified in the literature as the flagship interdisciplinary training program in the United States (Austin, 2010). Given that the IGERT program



is the central focus of this study, this section of the literature review will provide a more detailed overview of the program. This overview includes a review of the history and evolution of the IGERT since its inception, the program's purpose and the existing structure of the program at national and local levels.

The IGERT program was established in 1998 and aims to prepare doctoral students to work collaboratively across academic disciplines to develop and implement innovative solutions that address large and complex research problems throughout national and global domains (IGERT, 2011). The program has funded over 6,700 doctoral students between the year of inception (1998) and 2011 (Gamse, Espinos & Roy, 2013). The Department of Graduate Education (DGE) within the Education and Human Resources (EHR) Directorate of the National Science Foundation (NSF) facilitates the IGERT (Gamse et al., 2013). A full organization chart of the IGERT is provided in Figure 2.1.

Figure 2.1 Organizational Chart of the National Science Foundation



Through the IGERT, NSF holds partner colleges, universities and faculty responsible for creating training environments for graduate students that are consistent with the IGERT program's broader reform goals. The program has concentrated its efforts on three strategic goals.

1. To educate PhD level scientists with the depth and breadth of knowledge and skills to become leaders in their fields.
2. To catalyze changes in graduate education by established models for collaborative research across disciplinary boundaries; and
3. To promote diversity among participating students and the professional science and engineering workforce (Gamse et al., 2013 p. 5).

The IGERT program seeks to partner with colleges and universities to achieve its goals of supporting doctoral students. IGERT requires that doctoral students be US Citizens or permanent residents with interest in interdisciplinary research (Gamse et al., 2013). Typically, IGERT programs are initiated by faculty who apply for funding. Faculty design and develop IGERT projects that support the needs of doctoral students. Once the faculty member initiates the process to apply for support to develop a project they are considered the principle investigator (PI). If they are funded by NSF to develop an IGERT program they may work within a single discipline and collaborate with Co-PIs from other departments, colleges or universities that may be located locally or across state, national and international boundaries (Gamse et. al., 2013). The PI and Co-PI's design curricula, programming and other training materials and activities for IGERT student participants, commonly referred to as IGERT Trainees. These programs components range in scope, context and purpose. Examples include interdisciplinary seminars, professional development workshops, courses that are co-taught by IGERT faculty, off campus internships/co-ops and cross-department laboratory experiences (Gamse et al., 2013). The following table (Figure 2.2) provides examples of program components from existing IGERT Projects. This information was gathered through a review of IGERT Program Websites accessed through the national IGERT project network website

[www.IGERT.org](http://www.IGERT.org).

*Figure 2.2. Sample Program Components of Existing IGERT Projects*

Program Component	Host Project/Source	Example
Interdisciplinary Seminars	Optics & Quantum Electronics IGERT/ Fu Foundation School of Engineering and	Teaching Seminar Series: The IGERT Seminar series features monthly seminars from leaders in academic and industry in Optics and Quantum Electronics

	Applied Science Columbia University	<i>Graphene electronics, Optoelectronics and Plasmonics</i> Dr. Tony Low, IBM TJ Watson, Nanoscale Science and Technology Group  <i>Exponential Asymptotics for Line Solutions in Two Dimensional Periodic Potentials</i> Jianke Yang, University of Vermont
Professional Development Workshops	Solving Urbanization Challenges By Design IGERT/ Fu Foundation School of Engineering and Applied Science Columbia University	Brown Bag Lunch Seminar Series: All trainees are required to attend an hour-long lunch seminar held on alternating Thursdays. Seminars cover a variety of topics including workshops centered on topics that will contribute to the academic and professional development of trainees  <i>Why do you need an Individual Development Plan?</i> Lily Secora, Director of Columbia Office of Postdoctoral Affairs  <i>On developing research skills</i> Dianne Mizzy, Columbia University Library
Interdisciplinary Coursework taught by IGERT Faculty	IGERT Sustainable Energy Solar Hydrogen/University of Delaware	Interdisciplinary Courses Designed and Instructed by IGERT Faculty:  “Solar Hydrogen Systems in Renewable Energy Systems” (2 credits)  “Solar Energy System (3 credits)  “Introduction to Fuel Cells (3 credits)  “Energy and Sustainability (3 credits)
Off Campus Internships & Co-ops	Renewable and Sustainable Fuel Solutions for the 21 <sup>st</sup> Century: A NSF	Trainees have opportunities to gain first-hand exposure to careers in industry and in government with choices for short term focused projects and/or full summer

	IGERT Project at Rutgers University	internships with the IGERT projects external partners <ul style="list-style-type: none"> <li>• Carbozyme Incorporated</li> <li>• McGuire Air Force Base</li> <li>• New Jersey Department of Environmental Protection</li> </ul>
Cross Departmental Laboratory Experiences	IGERT Water Across Boundaries- Integration of Science, Engineering and Diplomacy/Tufts University.	Research Opportunities/Fieldwork- 2 <sup>nd</sup> year IGERT trainees refine and develop research interest and are supported for up to one semester conducting research anywhere in the world in the program global network of water patterns.  Recent research projects have explored water issues in Switzerland, Peru, Laos and New Zealand.

IGERT Projects usually fund IGERT doctoral student trainees for a period of two years. Total program grant awards have increased in recent years and are, on average, approximately \$3.0-\$3.2 million. Funding is distributed over a five-year period with the majority of monies used to fund IGERT doctoral student trainee stipends, which are \$30,000 per year (Gamse, et al., 2013). Depending upon funding availability and other institutional factors, each IGERT project typically funds from 30-35 doctoral student trainees throughout the life of the grant cycle. Trainees are enrolled as graduate students within a single discipline and are required to follow and fulfill established curricula for the IGERT project as well as the single discipline PhD program in which they are enrolled.

IGERT project goals are consistently revised through annual and semi-annual program solicitations and programs standards that are published, issued and distributed by the NSF. These solicitations are designed to incite a fundamental and institutional change or improvement in STEM doctoral education on a national level (Austin, 2010). These fundamental changes infuse STEM innovation education and

training into existing models of student education/training that aim to develop skills in interdisciplinary research, professional development and collaborative partnership (IGERT, 2011).

As stated in the 2011 IGERT Program Solicitation, IGERT students are expected to develop a foundation of experience and expertise that enables them to participate in the processes leading from discoveries in their research, to identification of relevant societal needs for which they may develop creative solutions based on their ideas and discoveries and learn the processes for successful implementation of such idea and solutions as appropriate to the interdisciplinary topic (IGERT, 2011, n.p.).

By providing this training to STEM doctoral students, programs aim to contribute to building and sustaining a broadly inclusive science and engineering workforce of world class, globally engaged scholars. IGERT participants are not only trained through conducting their research, they are also equipped to practically extend their innovation and discovery to address existing societal and economic needs.

### **IGERT Program Research**

This section will synthesize the research on the IGERT Program and identify and summarize limitations and opportunities for further research and exploration. A critical analysis of existing scholarship on the IGERT programs will serve as a basis for understanding the importance of this current research and future research that will extend the field's understanding of STEM education programs for graduate students beyond exploring inputs and impacts to truly understanding program culture, activities and processes. Moreover, this body of scholarship will illustrate the ways in

which the IGERT program culture and activities influence the socialization and training of program participants.

**Descriptive studies.** Existing research on IGERT focuses largely on descriptive studies and program assessments (Carney, et. al., 2006; Cowan & Gogotsi, 2004; Carney, Martinez, Dreier, Nieshi and Parsad, 2011). These studies have been designed to measure broader program impact, the practical effectiveness of program components and the success as monitored through the study program outputs and outcomes. The nature of existing descriptive studies varies but, most studies focused on describing and outlining existing IGERT projects and providing examples of the successful program components, plans and activities as employed by current IGERT principal investigators and faculty. For example, Cowan and Gogotsi (2004) present a model of an IGERT program focused on nanotechnology designed by faculty at two Pennsylvania schools, Drexel University and the University of Pennsylvania. The authors present this program as a means of expanding the field of nanotechnology through multidisciplinary research. As stated in the conclusion of the article,

This is a crucial time for nanotechnology research. ... Many of today's graduate students are eager to participate in this cutting edge field. The non-linear way in which nanotechnology is evolving requires a unique style of graduate education that crosses the boundaries of disciplines, universities and nations. The Drexel/UPenn IGERT with its multidisciplinary, one-campus, two university approach and its emphasis on collaboration and international exchange, is working to do just that (Cowan & Gogotsi, 2004 p. 152).

Cowan and Gogotsi (2004) outline and describe the origin, significant contribution, structure and administration/implementation of the Drexel/UPenn IGERT program with specific attention given to explaining the program's purpose, curricula, research focus, resources and international partnerships. They offer pragmatic solutions to questions that may arise in the process of designing an IGERT and use the Drexel/UPenn IGERT to demonstrate the various processes of developing a program. The authors provide a general overview of program components, program structure and the various historical and contextual events that contributed to the development of the Drexel/UPenn IGERT project. A description of the subfields of research on nanotechnology that IGERT faculty and fellows of the Drexel/UPenn IGERT project study is provided as well. IGERT Activities are listed and described in terms of the challenges that faculty faced in developing interdisciplinary activities that adequately met the diverse range of needs of IGERT fellows and faculty. Activities were not described in detail or in relation to the goals and objectives of the Drexel/UPenn IGERT or the overall training and socialization of doctoral student participants. Cowan and Gogotsi (2004) provide a roadmap for nanotechnology faculty with aspirations to develop a program to the Drexel/UPenn IGERT. This article offers a snapshot of an existing program that has successfully produced interdisciplinary scholarship. While this study contributes to the body of research on IGERT programs, it minimally contributes to the field's understanding of IGERT programs. The structure and components of the program are described but superficially. The underlying elements that combine to form the structure and components of the program are not explored or presented.



The practical value of this study cannot be ignored given the limited body of research on the IGERT. This descriptive study is the only example of scholarship of its kind and although it is published in a scholarly journal, this article does not possess the typical components expected of rigorous scholarship/inquiry. The authors do not identify themselves or state their affiliation to the IGERT project and they never detail their methodology for collecting data and information presented in the article. Essentially the research process is not documented or described. In rigorous research one would expect a review of existing research on the IGERT and similar initiatives in STEM graduate education however these references are not cited in the article.

**Program assessments and evaluative reports.** Program assessment studies began in the form of the evaluative reports sponsored by the National Science Foundation as the official funding agency for the IGERT. This body of research is limited to four studies, the first being published in 2006. Data collection for assessment research is typically quantitative and/or mixed methods approaches that rely heavily on survey data.

The first program evaluation of the IGERT was conducted by an agency of external evaluation consultants, Abt Associates Inc. The evaluation was designed to explore the impact of the IGERT program on student participants, faculty, institutions and recruitment into the STEM disciplines (Carney et. al, 2006). The evaluation report sought to answer twelve research questions. The study aimed to assess added value of the IGERT program to students as well as the impact of how a graduate education supplemented by involvement in an IGERT differs from the graduate

education received in a traditional single disciplinary program. Similarly, researchers sought to understand the differences in IGERT faculty in terms of their teaching, mentoring/advising research, productivity and networking (Carney, et.al, 2006). Thirdly, evaluators explored the ways that IGERT projects influence and impact institutional culture, policies, procedures and structures as well as the ways IGERT projects shaped whether or not, and/or the degree to which, institutions support interdisciplinary graduate education. Finally, the recruitment value of IGERT projects was examined to assess if and to what extent the IGERT projects influenced graduate student recruitment within their host institution. Recruitment was assessed in terms of the quality of students recruited and the diversity of students recruited a well. Researchers surveyed IGERT participants and a comparison group of non-participant students (Carney, et al., 2006). Project directors/principal investigators, department chairs and faculty were surveyed and university administrators were interviewed in order to collect data on the institutional context of IGERT institutions and non-IGERT institutions. Finally, the curriculum vitae (CV) of all IGERT faculty were collected and analyzed (Carney, et al., 2006).

The study concluded that the IGERT program had an observable impact on graduate education by influencing the experiences of student participants (Carney, et al., 2006). IGERT participants reported that their educational experiences were more interdisciplinary and substantially broader than non-IGERT students. IGERT programs have been successful in designing education experiences that afford students with increased opportunities for training in collaborative work,

communication, research ethics and presenting their research. This finding is significant as one of the program goals of the IGERT is,

Educating U.S. Ph.D. scientists and engineers who will pursue careers in research and education with the interdisciplinary backgrounds, deep knowledge in chosen disciplines and technical, professional and personal skills to become in their own careers, leaders and creative agents for change. (Carney et al., 2006 pg. 71)

Similarly, program components have positioned participants for increased career exposure and to develop broader professional and personal skills in a manner that is measurably different than doctoral students who were not enrolled in IGERT projects (Carney, et al., 2006). The IGERT was also found to support faculty engagement in conducting interdisciplinary teaching and research as well as catalyze a shift in the institutional culture of host institutions to acknowledge and advance interdisciplinary graduate education (Carney, et al., 2006). Researchers noted that the institutional impact varied across projects and may be considered small in light of the broad scope and range of the IGERT programs and the colleges and universities that participated in this study (Carney, et al., 2006). However, they argue that these findings are “an indication that IGERT is catalyzing change in graduate education via a funding mechanism that primarily supports graduate students (Carney et al., 2006 p. ix). Finally, the report cited the IGERT capacity to facilitate diversity in STEM graduate education as a continued challenge of IGERT projects (Carney, et al., 2006). Despite the program’s goal of being a leader in increasing diversity in STEM graduate education, data suggests that IGERT programs in this study recruited

persons of populations presently underrepresented in the STEM fields at rates that were comparable or equal to national averages (Carney, et al., 2006).

Carney et. al. (2006) utilized survey data to assess impacts of the IGERT Program. This approach is useful in gauging whether or not participants feel that their graduate experience has been impacted by their participation in the IGERT. However, this approach is limited in really understanding the nature or degree of the impact of these programs. This approach also fails in capturing the specific aspects and components of the IGERT program that impact the graduate education experience of the program participants. Another major limitation of this study is that no demographic data of the larger sample is provided. The researchers do not provide any descriptive information or acknowledge individual differences amongst student participants, IGERT faculty, or any other persons surveyed or interviewed. This suggests perspectives shared in this study are universally held among IGERT participants and/or that all IGERT participants experience the IGERT program activities in similar ways regardless of age, gender, racial/ethnic background etc. Similarly, the study does not cite or reference existing scholarship on STEM graduate education. The research questions, the established research design and the process of data collection and analysis were not framed through a theoretical framework. Additionally, various elements of data collection procedures were not adequately described, the survey instruments were not identified and psychometric data of instruments were omitted. The processes of analysis of the interview data and the CV's collected in the study were not explained. Failure to include this information threatens the credibility of findings and broader conclusions reached.

A follow up evaluation study of the IGERT was published in 2011. The purposes of this evaluation were two fold. The study aimed to describe the short-term outcomes and career trajectories of recent graduates of the IGERT. The research also sought to understand the ways that participating in an IGERT prepared participants for the professional responsibilities of their chosen career paths (Carney, Martinez, Dreier, Nieshi & Parsad, 2011). Additionally, the study compared the outcomes and short-term career trajectories of IGERT graduates with a comparison group of recently graduated STEM PhDs who had not participated in an IGERT project during their doctoral programs. IGERT recent graduates were also compared to national data on STEM graduate students collected through the Survey of Earned Doctorates, the Survey of Doctoral Recipients and the PhD Completion Project (Carney et al., 2011).

The study was conducted in two phases and each phase of data collection was guided by four questions respectively. Questions were designed to assess the demographic characteristics, motivations and career interests of IGERT graduates as well as their early career outcomes and respective job responsibilities (Carney et al., 2011). Participants were also asked questions to determine the effect that participating in an IGERT had on various aspects of their doctoral study and their level of readiness/preparedness for the career of their choosing. Questions also ascertained how IGERT Graduates compared to their non-IGERT affiliated peers in terms of motivations for graduate school, degree completion rates, rates of hire, range of careers entered, the diversity of job responsibilities assumes and the perceived effects of IGERT training on preparation to join the STEM workforce upon earning

their PhD. Data was collected from various sources for this study. Data from the IGERT Program Distance Monitoring System was analyzed in order to ascertain the demographic and descriptive data and degree completion rates.

Major findings reveal that over 800 students successfully completed their IGERT programs, earned their PhDs and entered the workforce during the first nine years of the IGERT program (Carney et al., 2011). Of this population 81% of graduates conducted interdisciplinary research for their dissertations and 96% reported that participating in the IGERT project successfully contributed to the completion of the degree programs citing financial support as the most valuable contribution. Other factors of the IGERT projects acknowledged as significant/critical contributions to graduates' abilities to complete their PhDs include the interdisciplinary focus of the IGERT, access to equipment, technology and resources and the freedom that IGERT trainees have pursue their own research interests (Carney et al., 2011). All IGERT graduates expressed that, upon graduation, they felt prepared to conduct research in a variety of sectors including academia, industry and federal and state government. At the time of data collection, graduates were working a variety of positions with the majority working in academic settings working in research and teaching. Most graduates reported feeling that the training and preparation that they received in their graduate programs gave them leverage and a competitive edge when applying for positions and that their experience in their IGERT assisted them in securing their jobs (Carney et al., 2011).

When compared to the control group of non-IGERT affiliated students, researchers found a significant difference in terms of how well their graduate

experiences prepared them for their research faculty positions and/or professional jobs and assisted them in their entry into the workforce (Carney et al., 2011). Those students felt significantly less prepared than IGERT graduates. Similarly, IGERT students earn their degrees slightly sooner than non-IGERT students and were significantly more likely than non-IGERT students to pursue STEM careers to create new knowledge and for the sake of the intellectual challenge (Carney et al., 2011). Researchers cite the potential for selection bias in the comparison group as the greatest limitation of the study as they were unable to determine conclusively whether or not participation in the IGERT led to the observed outcomes and differences between experimental and control groups (Carney et al., 2011). Consequently, the researchers urge readers to consider the findings presented in this report to exploratory versus confirmatory.

#### **The IGERT program as a lens for exploring interdisciplinary research.**

Remaining scholarship on the IGERT program largely focuses on understanding interdisciplinary research. Studies utilize the IGERT as a conceptual lens for exploring how faculty conceptualize and students experience interdisciplinary education and interdisciplinary research training in STEM graduate education. Gamse, Espinosa and Roy (2013), for Abt Associates, recently published an exploratory investigation on how IGERT principal investigators conceptualize interdisciplinary and how IGERT trainees value and experience interdisciplinary education. The study was developed with the objective of informing NSF, IGERT PI's, program officers and STEM graduate education departments of the core competencies of interdisciplinary education and how competencies contribute to

training and education of IGERT student participants. According to Lattuca and Knight (2010) competence is the ability to understand and make use of information and research methods common to fields of study that are different than one's own. In understanding interdisciplinary training in graduate education, researchers reviewed existing research on STEM education/graduate education, higher education and interdisciplinary studies in the social sciences and humanities in order to attempt to identify and categorize the skills and capacities that contribute to the development of interdisciplinary competence.

Similarly, Borrego and Cutler (2010) conducted a content analysis of program proposals for 130 IGERT projects for the purpose of understanding how faculty in engineering and science conceptualized interdisciplinary education. The study is rooted in an instructional design framework and aimed to illuminate common practices and critique them for purposes of improvement. Researchers identified desired outcomes that were most commonly assigned to or associated with interdisciplinary learning as well as the evidence used amongst IGERT PIs in order to determine whether or not interdisciplinary learning had taken place. Results indicated that outcomes commonly associated with interdisciplinary learning included the development of specific technical skills germane to the project's subject area focus and interdisciplinary domain. Examples of technical skills may include mastery and application of specific disciplinary concepts and tools or a familiarity with a specific technique or piece of the equipment (Borrego & Cutler, 2010). Another outcome commonly associated with interdisciplinary was teamwork and collaboration. Forty-one percent of the proposals reviewed clearly articulated learning outcomes related to



fostering teamwork and collaboration amongst IGERT participants as a desired outcome used to determine whether or not interdisciplinary learning had taken place. Examples of teamwork outcomes include “work efficiently in multidisciplinary teams” and “enable them to collaborate successfully and productively across traditional disciplinary boundaries” (Borrego & Cutler, 2010 p. 360).

Finally, the learning experiences that PI’s designed for purposes of the interdisciplinary learning within their IGERT projects and surrounding graduate programs in science and engineering were also identified. Findings of this study indicated that most of the IGERT proposals reviewed did not demonstrate strong connections to outcomes associated with successful learning experiences and evidence of interdisciplinary learning. This suggests that IGERT PIs may still be challenged in conceptualizing interdisciplinary education and designing a learning experience that will achieve desired learning outcomes. This study afforded the opportunity to explore elements of program design and program evaluation that contribute to a broader understanding of the IGERT as a STEM Education program and a mechanism for facilitating student graduate training. It also illuminates how programs ensure that participants are trained in interdisciplinary education and research. However, the program relies on the program proposals, which limits the study in fully capturing various dynamics of the program. For example, as acknowledged by the authors, “as in any educational program, best practices evolve over time and therefore are not necessarily reflected in initial program proposals” (Borrego & Cutler, 2010 p. 358). Having served as formal evaluators of the IGERT,

Borrego and Cutler (2010) verify that aspects of curricula and programming have changed drastically throughout the evolution of a program.

The IGERT program has also been used as a tool for understanding interdisciplinary training from the student perspective. In an article published by Graybill, Dooling, Shandas, Withey, Greve and Simon (2006) a group of doctoral student IGERT trainees described their experience with IGERT specifically as it relates to their training as interdisciplinary researchers. They offer their perspectives and recommendation as feedback to faculty and administrators and highlight components of the IGERT that they found most beneficial. They also discuss aspects of the program that could be improved and provide six recommendations for creating and revising useful program components (Graybill et al., 2006).

The recommendations are provided to enhance the overall effectiveness and success of IGERT students and faculty (Graybill et al., 2006). The authors provide the recommendations as tools to cultivate the professional and personal skills of the IGERT participants navigating program contexts and their doctoral programs respectively. As students that have experienced the IGERT they offer their perspectives to augment both philosophical and pragmatic aspects of the IGERT programming and services. Each recommendation will be listed and briefly described.

*Core Recommendation One* encourages faculty and program administration to “attend to the process” or acknowledge that it takes mental agility, dexterity and effort to explore and pursue interdisciplinary research while navigating the various interpersonal dynamics of disciplinary groups (Graybill et al., 2006). The authors

suggest consulting and utilizing a professional who is adept at facilitating group processes, implementing creative problem solving skills and employing interpersonal communication strategies in the development and administration of IGERT program services and activities. *Core Recommendation Two* focuses on ensuring that students develop a sense of ownership and agency of all the elements of the program. This sense of ownership of the program is developed by making sure that students are included in the development and administration of aspects of program curricula and activities. For example, students are required to exercise their agency in the program when they are held responsible for coordinating and facilitating seminar series or professional development activities (Graybill et al., 2006). *Core Recommendation Three* addresses the importance of securing the support of college and universities for the IGERT program and IGERT student participants. The authors stress that institutional support must exist in the forms of intellectual support and financial support. Intellectual support is reflected in graduate programs that cultivate strong professional networks within and across disciplinary boundaries. These networks foster a culture that promotes and supports interdisciplinary research and encourages and accommodates the individual development of interdisciplinary scholars (Graybill et al., 2006). Financial support from institutions is necessary in making sure that IGERT students have funding throughout the length of their doctoral study. Limited funding threatens students' ability to successfully progress through their program to degree completion.

*Core Recommendation Four* encourages programs to ensure that participants develop detailed plans for successfully completing an interdisciplinary doctoral program. According to authors

Students need to a) clarify the accountability of all team research participants (students, team members and faculty), b) align requirements for progress in the home department and the IGERT program, c) recognize and accommodate the amount of time needed to conduct team research and complete all other requirements and d) address individual funding needs before the termination of IGERT funding (Graybill et al., 2006 p. 762).

*Core Recommendation Five* emphasizes the importance of IGERT programs maintaining a sense of flexibility and adaptability to the ever-changing needs of student participants, fluctuating research trends and hot topics, varying schedules and countless challenges that arise as a program evolves in response to its environment. Graybill et al. (2006) urge faculty and administration to implement adaptive models of management that encourage and utilize the feedback of program participants and stakeholders in the constant revision and application of program services. Finally, *Core Recommendation Six* offered by the authors, for augmenting the overall success and effectiveness of the IGERT program for doctoral student participants, is fostering a commitment to curiosity and appreciative inquiry that acknowledges the contributions of different disciplines to conducting good interdisciplinary research (Graybill et al., 2006). This inquiry challenges the prevailing notion that research is confined to the biases and barriers of individual fields of study and creates a culture that is patient and diligent in appreciating the contributions of all disciplines,

intellectual traditions and methodologies. This appreciative stance is most conducive for creating scholarship that effectively meets the various and multidimensional needs of the society (Graybill et al., 2006).

The authors of this study provide a sound introduction that really highlights the specific need for the contribution of this work. However, a limitation of this research is that it cites and references a body of literature of interdisciplinary research training initiatives but fails to reference research on graduate education, graduate training or graduate student socialization. This is a limitation as this work on the interdisciplinary training that graduate students receive within their graduation programs is a subset of existing research on STEM graduate education and graduate student socialization. Additionally, the discussion of existing literature on interdisciplinary education nor the recommendations that the authors present are grounded in a theoretical or conceptual framework.

A significant contribution of this work is a three-stage developmental practice model that IGERT students created and presented as a means of describing their individual journeys to becoming interdisciplinary and disciplinary scholars within the context of their IGERT Program. The model is presented as a conceptual tool to aid in understanding their graduate training experiences as IGERT students.

The first stage is referred to as the period of *Naissance* and is characterized by processes that students navigate as they try to find their place as persons with interests in more than one discipline or field of study (Graybill et al., 2006). The second state of *Navigation* is when students acclimatize themselves in their home disciplines and their interdisciplinary program. Students must begin to balance

multiple responsibilities and fulfill requirements of their IGERT as well as the disciplinary doctoral programs that they are enrolled in (Graybill et al., 2006). They must learn to manage multiple tasks and loyalties that may often conflict. The third and final stage of *Maturation*, typically occurs later in a trainee's graduate program after they have completed curricular requirements of the IGERT and mostly completed course requirements of their degree program (Graybill et al., 2006). During this phase IGERT Trainees acknowledge their unique identities and interdisciplinary researchers and work strategically to build a platform for their future work (Graybill et al., 2006).

A study by Boden, Borrego and Newswander (2011) extended this work by using socialization theory to explore the ways that IGERT students learn the values, norms and cultural practices of graduate programs in traditional disciplines as well as in conducting interdisciplinary or integrated research. Data for this study was collected as a part of a larger study and focused specifically on examining the socialization of IGERT trainees at four different IGERT programs at two different research universities in the United States. Researchers conducted 43 interviews with students, faculty, support staff and administrators of four programs at both institutions. The theoretical framework employs concepts of socialization theory and theory on organizational culture to scrutinize the “culture of disciplinarity that dominates most of higher education institutions and stands as a barrier to the coexistence of a fully legitimate culture of interdisciplinarity” (Boden et al., 2011 p. 742). The researchers approach this work in an effort to illuminate barriers to

interdisciplinary education that are sustained by the organizational structure and culture of traditional discipline specific graduate study (Boden et. al., 2011).

Findings from the study highlight various aspects of the IGERT that have contributed to the socialization of student participants including improved relationships with faculty advisors, opportunities for networking facilitated through faculty relationships and an overall sense of community supplemented with communal physical space available to IGERT student participants (Boden et al., 2011). These findings are also useful in extending the field's understanding of graduate student socialization and existing organizational structures of graduate degree programs that facilitate the transmission of existing cultural norms and values. Boden et al.'s (2011) findings are consistent with previous research on graduate student socialization and STEM graduate education and a demonstration that concepts of socialization theory can be used to explore interdisciplinary graduate programs. This work is valuable as it highlights existing structures and policies embedded within the organizational culture of the STEM graduate education that are barriers to the interdisciplinary training of graduate students. The research is limited as it fails to acknowledge and explore the organizational culture of interdisciplinary graduate education programs themselves. Similarly, it does not examine the ways that organizational culture influences the socialization and training of program participants.

### **Broader Limitations**

Limitations of the scholarship explored for this literature review have been provided throughout the previous section of this paper. Reviewing existing literature

on STEM education programs and specifically the Integrative Graduate Education Research Traineeship also reveals limitations of existing scholarship and opportunities for additional research and further exploration. For example, all of the studies fail to acknowledge existing diversity within IGERT programs, amongst trainees, faculty and other program stakeholders. This reflects an overall assumption that all persons who participate in an IGERT experience or are influenced by the program in similar ways. As expressed in the IGERT program evaluation published in 2006, the IGERT aims to be a leader in increasing the diversity of the STEM workforce (Carney et al., 2006). Similarly, previous research outlines the various challenges that women and students of color face in graduate education and more specifically STEM doctoral programs. This is further confirmed by the underrepresentation of persons of color and women in populations of persons who pursue and earn doctoral degrees in STEM fields. Future research must acknowledge these differences with respect to research design and the varying perspectives and experiences to be explored.

Interdisciplinary research is the major goal of the IGERT and the IGERT is recognized as the hallmark STEM Education Program for interdisciplinary research and training in the United States (Austin, 2010; IGERT, 2005). It is also important to note that the IGERT program has two other major goals as programmatic efforts designed to reform graduate educations. Future research must acknowledge these goals and design rigorous scholarship that will explore the ways that programs are working to address them.



Finally, outcomes have been the focus of previous literature on the IGERT and other STEM graduate education programs. The literature is limited in exploring the processes by which these outcomes are reached. Previous studies have described program components, services and activities and have even identified exemplary programs and best practices.

Since its inception in 1998, the IGERT programming is designed to address three strategic goals.

- To educate PhD level scientists with the depth and breadth of knowledge and skills to become leaders in their fields.
- To catalyze changes in graduate education by established models for collaborative research across disciplinary boundaries; and
- To promote diversity among participating students and the professional science and engineering workforce (Gamse et al., 2013 p. 5).

The Gamse et. al (2013) work highlights essential competencies for interdisciplinary graduate education in IGERT program. Other IGERT program research has identified successful program outcomes of the IGERT however, the broader body of scholarship on these programs is still limited in identifying the specific behaviors, attitudes, values etc. that participants of “successful” IGERT programs must have/demonstrate.

Unfortunately, the majority of this work is evaluative in nature and lacks the rigor afforded by sound methodology and a strong basis in extant literature and theory. With the exception of the research that used graduate student socialization theory and organizational culture theory as theoretical lenses, no other research

presented in this literature review has employed theoretical/conceptual frameworks to guide investigations of graduate degree programs or graduate traineeship programs as organizations. Similarly, previous research has not aimed to describe or understand the various behaviors, characteristics, cultures, norms, values etc. that comprise graduate traineeship programs. Exploring the various activities, services, networks, information, knowledge and even capital that exists within programs through the lens of the relevant theory will broaden the field's understanding of these efforts and their significance to student participants, graduate education and the broader social society at large.

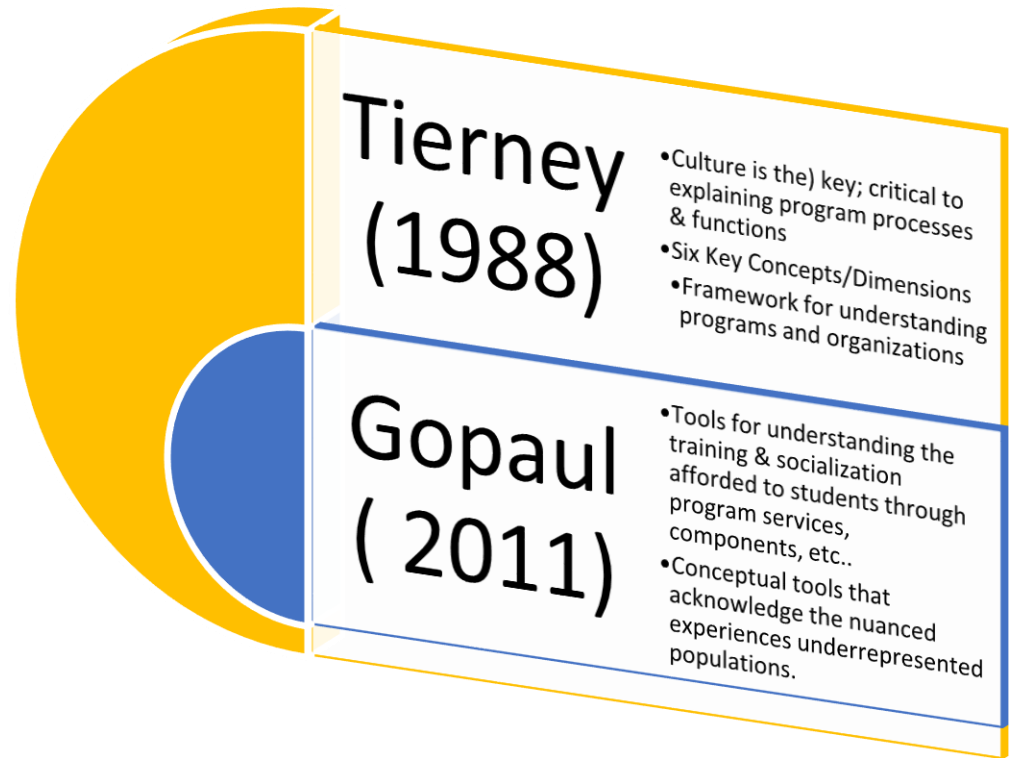
This study builds upon the small body of extant research on graduate traineeships and graduate education programs by incorporating socialization theory as cited in previous research on the IGERT program, into a broader nested conceptual model. This nested model uses the theoretical concepts from three existing models to 1) formally define the IGERT as an academic program/academic organization, 2) provides a basis for identifying and describing the organizational culture and organizational structure of an IGERT program and 3) guide an investigation as to how this organizational culture shapes and influences the socialization and training of doctoral student participants and more specifically doctoral student participants of populations underrepresented in STEM fields.- Theoretical concepts have been identified to position this research to define and examine the various activities, persons, values, norms, behaviors, etc. that coexist to comprise the IGERT experience. The model will acknowledge the unique culture of an IGERT and the influence of that culture on student program participants that navigate this space.

It is also critical to acknowledge students enter graduate programs with a host of different backgrounds, experiences, levels of access, etc. Theory must also recognize these varying identities and their potential to influence how students experience their training and education while in graduate school. The nested conceptual model designed to guide this research was developed to consider the nuanced goals of this work and the research questions at the center of this dissertation. I aim to illuminate strengths and weaknesses of the structure, components, culture, processes and the work of an IGERT project in a manner that will arm faculty, colleges and universities, funding agencies, policy makers, etc. with the knowledge necessary in shaping STEM graduate education in this country. An exploration of traineeships of this kind is requisite in determining whether or not programs are effectively serving and supporting all program participants and meeting prescribed goals.

### **Theoretical Framework**

A nested theoretical framework has been designed for this study. This section in Chapter II will provide an overview of each of the theories that will be used as lenses for exploring an existing IGERT program. The two theories used to develop the nested theoretical framework are: William Tierney's (1988) Theory of Organizational Culture and Bryan Gopaul's (2011) conceptualization of how graduate students are socialized and trained within their graduate programs (See Figure 2.3)

Figure 2.3. Nested Theoretical Framework



The theories contribute to the process of defining and understanding the program's organizational culture and the various ways that organizational culture interacts with or influences the socialization of program participants, most specifically participants of populations presently underrepresented in the STEM fields. The theoretical concepts provide a roadmap for defining and examining and describing and IGERT project as an organization as well as the functions, processes and organizational culture of the IGERT project. The theory also frames an

exploration and investigation of the specific ways that an IGERT program shapes, interacts with and/or influences the training and socialization of IGERT program participants, specifically IGERT program participants from underrepresented populations.

**The role of organizational culture.** William Tierney (1988) proposes that understanding the culture of a program/organization is critical to explaining essentially every event, function or process of that organization. Culture is a dynamic rooted in a program's history; it finds its form in the goals, values and shared assumptions held by persons closely connected and involved within the program's functions and processes (Tierney, 1988). These shared values and assumptions are unearthed through an exploration of the norms, institutional ideologies, attitudes and stories of program participants. Tierney (1988) encourages an anthropological approach to understanding organizational culture within colleges and universities. An in depth analysis that aims to define/describe the culture of an organization serves to illuminate what is done within that organization. It also explains how the workings of that program are done and it clarifies the roles at work within and beyond the permeable boundaries of that program (Tierney, 1988).

Tierney (1988) advances six key concepts/dimensions for exploring organizational culture within colleges and universities. These key concepts provide a framework for uncovering the operative elements and dimensions of an organization that contribute to the development and sustenance of that organization's culture. The six concepts of the Framework of Organizational Culture are 1) environment, 2) mission, 3) socialization, 4) information, 5) strategy and 6) leadership. Conceptual

tools from this theory provided a basis for exploring and understanding the culture of the IGERT program and how program culture informs the program's activities, functions, processes, actors, actions, etc. A brief description of each concept will be presented here followed by a description of the goals of understanding the concepts of organizational culture as they relate to the exploration the IGERT program at the focus of this research.

Understanding the *environment* of a program requires an investigation of how program participants and stakeholders define their surrounding environment as well as the attitudes that those within the program have toward or about their environment (Tierney, 1988). The *mission* of the organization is understood in terms of how participants define and articulate the overall goals and objectives of the program. This concept also monitors whether or not there is agreement among constituents in terms of how the mission of an organization is defined and used (Tierney, 1988). For example, do faculty, program administrators and students have similar ideas concerning the mission and purposes of the IGERT program? Or do faculty see the program as a means for generating research funding while student participants consider the IGERT program as a vehicle for recruiting and supporting students of color to the institution? Similarly, the concept of *socialization* frames an investigation of what participants need to know in order to survive and succeed within the program context. This requires an exploration of how survival and success are articulated and communicated to new participants as they enter programs and throughout the duration of their involvement in program activities (Tierney, 1988).

An analysis of *information* and the manner in which it is defined and disseminated within a program is critical to understanding the culture of that program. This analysis must determine what constitutes information, who has it and the manner with which it is communicated among all program constituents (Tierney, 1988). Understanding the *strategy* of a program requires the study of decision-making processes employed in program contexts. This calls for the identification of persons responsible for making decisions and who have an understanding of rewards and penalties of making good and bad decisions respectively. Finally, the concept of *leadership* guided an investigation of the leaders of a program, the processes by which leaders are selected and what program participants expect of leadership employed (Tierney, 1988).

These concepts provide a conceptual map that was useful in understanding the IGERT program and the organizational culture that informs the program processes, functions and activities as understood by program constituents. This framework aligns with the overall purpose of the study to explore the various contexts, dimensions and organizational culture of a research traineeship program to and understand the nature and function of the work of program components and program personnel in training program participants. The operative key concept of socialization was especially useful in addressing the research questions of the study, specifically the first question that explored if research traineeships shape the socialization and training participants. The concept also provided a conceptual road map for understanding the specific ways that an IGERT program shapes/influence the

socialization and training of doctoral students from populations that are underrepresented in the STEM disciplines?

**Graduate student socialization.** Socialization theory provides the conceptual tools necessary for examining how IGERT student participants navigate the various contexts of their graduate experience within and beyond the IGERT and learn how to survive and succeed in STEM disciplines. The theory presented in this section also frames the investigation of how the IGERT program interacts with and/or influences the socialization of program participants and most specifically participants that are members of groups historically underrepresented in STEM fields.

Socialization theory is often employed as a theoretical framework in research that explores the training of doctoral students (Gopaul, 2011). Sweitzer (2009) argues that socialization frameworks are the most frequently used theoretical models in guiding our understanding of various aspects of doctoral education. She does not offer a rationale for the frequency of its use but maintains that most research on the training and orientation of doctoral students employs a socialization framework (Gopaul, 2011; Sweitzer, 2009). Several studies emphasize that the successful navigation of the doctoral process and the maximization of opportunities within doctoral study relies heavily on the development and sustenance of various relationships in graduate school (Gardner, 2008; Golde, 2005; Sweitzer, 2009). The faculty-student relationship is recognized as a critical site and source for doctoral student training and has been the subject of much research that explores doctoral study/ doctoral education (Hartnett & Katz, 1977; Lovitts, 2001; Nettles and Miller, 2006). Relationships between peer doctoral students, relationships that doctoral



students have both within and beyond their academic departments and non-academic relationships have not been studied as heavily. Yet scholars acknowledge that these relationships influence the graduate school experience and training of doctoral students (Gardner & Barnes, 2007; Golde 2005 Sweitzer, 2009).

The definition of socialization as presented by Merton, Reader and Kendall (1957) (as cited in Gopaul,2011) interprets socialization as, “the processes through which [a person] develops [a sense of his/her] professional self, with its characteristic values, attitudes, knowledge and skills... which govern [his or her] behavior in a wide variety of professional situations” (p. 287). With respect to this definition, one’s behavior (which includes knowledge, values and attitudes) is important in establishing membership within specific professional groups (Gopaul, 2011). Several scholars have studied, critiqued and extended this definition as it relates to STEM doctoral education (Gardner, 2008; Gopaul, 2011; Thornton & Nardi, 1975, Weidman, Twale & Stein, 2001;).

Thornton and Nardi (1975) proposed four stages of socialization that novices proceed through to achieve or acquire professional roles. The stages are 1) anticipatory, 2) formal, 3) informal and 4) personal. Weidman, Twale and Stein (2001) extended this work by a developing a model of socialization that is celebrated and widely cited in graduate education research and scholarship that focuses on doctoral student training. Their theory posits that the process of graduate student socialization is non-linear, dynamic and interactive as students acquire professional skills and subject matter knowledge through academic learning and direct interaction/engagement with peers and faculty (Gopaul, 2011; Weidman et al., 2001).

A student's graduate degree program, in terms of the structure, design, culture, values, expectations, contexts, boundaries, etc. of a masters or doctoral program, is the site and source for socialization according to extant socialization theory (Weidmann et. al., 2001). Within a graduate degree program students navigate and interact with (1) broader institutional cultures/contexts, (2) learning/integration/interaction with coursework and subject matter, (3) interactions with faculty and peers and (4) the core elements of the socialization; knowledge acquisition, investment and involvement. The process is explained further

Graduate students acquire new knowledge, become involved in the life of their academic programs and career fields, experience the peer climate and invest in developing the capacities necessary to become professional practitioners in their chosen areas. They also adapt to the institutional culture as it impinges on the passage to their degrees in both academic and social spheres. (Weidmann et.al, 2001 pg. 38)

This process of socialization takes place within various surrounding contexts and external communities including (1) personal communities-friends, families and employers (2) other novice professional practitioners, (3) prospective students – students' backgrounds and dispositions and (4) professional communities consisting of professional associations and practitioners (Weidman et. al., 2001). All of these contexts/communities, and the components therein, interface with each aspect of the socialization process as a student progresses through his/her graduate program (Weidman et. al., 2001). The relationship between and amongst each of these surrounding contexts and communities is fluid, nonlinear and interactive (Weidman

et. al., 2001). All four surrounding contexts/communities have permeable and moveable boundaries; they do not exist independently rather they depend on one another. Many of them exist outside of the academic setting yet they influence graduate degree programs and the students enrolled in them in various ways (Weidman et. al, 2001).

Weidman et. al.'s (2001) contemporary model of graduate student socialization is built upon previous iterations of socialization theory. It has been adapted to meet the ever changing faces and the ever-evolving needs of graduate students. Unlike the linear approach of fundamental socialization theory, this model suggests that the processes associated with each "stage" of socialization may be present at any point throughout a student's graduate study (Weidman et. al, 2001). Professional identity and commitment are not outcomes of the socialization process rather they are in a constant state of gradual development and that development is different for each individual student (Weidman et. al, 2001). Graduate student socialization is ongoing. It does not end when a graduate student completes his/her degree program, rather the process of professional identity development and commitment continues to evolve (Weidman et. al, 2001).

Bryan Gopaul's work (2011) argues that incorporating Bourdieuan tools and concepts such as habitus, social and cultural capital, practice and field extends our understanding of graduate student socialization and its surrounding contexts. This Bourdieuan analysis is an extension of Weidman et al.'s (2001) framework, that recognizes the individual traits that students bring with them to graduate school and also acknowledges the ways in which nested social contexts of social interaction

facilitate graduate student socialization and model/teach individuals what it means to be an academic.

According to Gopaul (2011) the Bourdieuan concept of habitus represents the worldview and/or personal standpoint that a graduate student brings with him/her into their graduate study/ graduate training experience. Acknowledging a student's habitus acknowledges that graduate students bring with them their own values, beliefs, cultural practices and experience to graduate school. Habitus also recognizes that these things shape and influence the ways that a student experiences graduate school. Habitus frames an exploration into the lived experiences of the IGERT student participants and positions the study to attempt to understand students' perceptions of graduate school. This is useful in examining how IGERT student participants view and understand themselves as students within the IGERT and in relation to their overall graduate training.

Similarly, social and cultural capital are Bourdieuan concepts that Gopaul (2011) suggests represent the norms, values, standards, knowledge and information exchanged in graduate student socialization and training. Social capital is the knowledge accessed specifically through a graduate student's ability and capacity to develop relationships with faculty, peer students and other professional colleagues. Through these relationships and the development of a social academic/professional network a graduate student learns what knowledge and information is necessary and useful for successfully navigating graduate school. Similarly, cultural capital represents the cultural professional norms, socially accepted behaviors, etiquette, protocol and language that students must master in order to successfully navigate

their graduate degree program and academic/professional careers. These concepts guide this study in identifying and investigating what information is valued in an IGERT program and how that information is communicated and exchanged by program stakeholders within program contexts. It also provides a conceptual road map for identifying and understanding the cultural norms of the IGERT program and why that information is valued. Finally, defining and exploring social and cultural capital and how it is exchanged in IGERT program context, the study investigates the socializing experiences of the IGERT student participants and if access to these socializing experiences are equitable for all student participants particular those that are of populations presently underrepresented in the STEM fields.

According to Gopaul (2011) Bourdieu's concept of field represents the actual training experiences and various spaces and contexts where students are socialized and trained. This Bourdieuan tool will be useful in identifying describing and exploring the various program contexts of the IGERT program and the structured and unstructured ways that IGERT student participants are trained within these program. Similarly, the concept of the practice as interpreted by Gopaul (2011) represents the actual choices that IGERT student participants make within the field of the IGERT program, their graduate departments, sponsoring institutions, academic disciplines, etc. Exploring practice provides a useful framework for describing the interplay or interaction between the other Bourdieuan concepts of graduate student socialization namely students' habitus and existing forms of social and cultural capital within the field (Gopaul, 2011)

Gopaul (2011) uses Bourdieuan concepts as tools to illuminate the unique nuanced ways that students, especially students of color and/or other marginalized identities are positioned within the socialization process. Gopaul (2011) also challenges extant theory and scholarship on graduate school socialization theory that presupposes that all graduate students have similar experiences of graduate school or experience graduate education/graduate training in the same way. It also argues against the assumption that graduate school is a level playing field where all students have access to the same tools, experiences and resources as they navigate their graduate training.

Socialization theory as framed by Weidman et. al. (2001) and critiqued by Gopaul (2011) is useful in framing an investigation of an IGERT program that trains, supports and retains students throughout their doctoral education. These concepts frame the exploration and analysis of the traditional mechanisms of student socialization and position this research to investigate the similar and unique ways that the organizational structure and culture of an IGERT program interacts with, supplements, contributes to or even counteracts with existing practices and policies in STEM doctoral programs.

### **Chapter 3: Methodology**

This chapter provides a detailed overview of the research design of this study beginning with a discussion of the purpose and research questions. It outlined and described the various procedural steps and research strategies that were employed to address the research questions. First, a rationale for utilizing a qualitative research methodology and case study design is provided. I then turned to a description of solicitation and sampling procedures that were used in this study. An overview of available data sources and data analysis procedures were utilized to interpret research findings will follow. Next I present an overview of the conceptual model that details the ways that theory informed data collection and the analysis of the data. Finally, the chapter concludes with a statement of my epistemological framework and positionality as researcher. These statements provide an account of the assumptions and personal experiences that guided the design of this study and shaped the interpretation and discussion of findings.

#### **Purpose of the study**

The purpose of this dissertation was to explore an Integrative Graduate Education Research Traineeship program/project (IGERT) site to better understand the program's organizational culture including program components, curricula and personnel; and to understand students' experiences as participants in an IGERT program. The study investigated the ways that participating in an IGERT program influences the socialization and professional training of program participants and more specifically program participants of the groups that are historically underrepresented in the STEM fields.

The research questions guiding this study were:

1. What is the organizational structure and organizational culture of the IGERT program and in what ways does that culture IGERT shape the socialization and training of participants?
2. In what ways does IGERT shape the socialization and training of participants of populations presently underrepresented in STEM graduate education and the STEM workforce?

### **Appropriateness of Qualitative Research**

Creswell (2007) argues that broader and general definitions of qualitative methods are limited. He also purports that these general definitions are not useful and in some ways obsolete due to the complexity and variety of qualitative approaches and research techniques. Based on an analysis of the literature on qualitative research, Creswell (2007) presents a list of common characteristics of qualitative research that can be used to understand what qualitative research is. Examples of these common characteristics will be presented to substantiate the appropriateness of employing qualitative research methods to address the specific research questions of this study.

A study that broadly explores the various dynamics and dimensions of doctoral student training and support programs will require a researcher to enter and engage with program context and environments. One of the purposes of qualitative research is to illuminate phenomena and gain a complex and detailed understanding of concepts, issues, experiences, individuals or groups (Creswell, 2007). A key characteristic of qualitative research is that it is conducted within participants' natural



environments. Qualitative methods enabled me, as the researcher, to study an IGERT program as is, within its natural settings.

Qualitative research does not seek to explain causal relationships or predict behavior. The focus is on identifying, observing, describing, understanding and reporting the range of factors, experiences and perspectives that exist within a concept, issue, group or phenomena (Creswell, 2007). Employing the techniques of the qualitative approach is specifically useful as it allowed me to investigate an IGERT program/project as whole phenomena. Instead of focusing on one aspect of an IGERT program, my study examined various components of the IGERT program, explored interactions within and amongst program components, and examined and illuminated the program from multiple perspectives (i.e., the perspectives of program participants, program faculty and program personnel). A comprehensive approach was applied to identify and understand IGERT program culture and the ways that the culture of the program continues to shape the program's history, development, services/activities, norms, values and expectations. The study focused specifically on investigating and understanding whether or not the IGERT program culture influenced the training of program participants most particularly participant of populations underrepresented within the STEM fields.

According to Merriam (1989), meaning, or the manner in which individuals interpret their lived experiences, is socially constructed. Qualitative research acknowledges the nuances and differences of how individuals make meaning or define and interpret phenomena (Merriam, 1989). Participants are encouraged and empowered to tell their stories free from the biases and expectations of the researcher

and/or the common themes and patterns of previously published research (Creswell, 2007). As a researcher I encouraged all program participants, stakeholders and constituents to share their experiences within and amongst program contexts freely. Presenting a full range of multiple and diverse perspectives, and even divergent, viewpoints was critical in gaining a full and comprehensive understanding of the IGERT research traineeship, its function and its potential impact on the socialization of student participants.

### **Rationale for Case Study Approach**

Yin (2003) defines the case study as the exploration of a defined case within a specific “real life” setting or context. A case is a specific or current entity, system and/or phenomena that is bound by time, place or context (Creswell, 2007; Stake, 2004; Yin, 1984). In case study, the researcher collects a wide range of data and information through various means and multiple sources to conduct an in depth exploration of a case or multiple cases over an extended period of time (Creswell, 2007). Case study is the most appropriate method for addressing the research goals/research questions for this study as it focuses first on describing the case and then positions the researcher to present and/or demonstrate a thorough understanding of the case. The primary aim of this research was to explore and examine an IGERT research traineeship. Exploring the IGERT contributes to an existing body of the research on STEM graduate education student by extending the field’s understanding of the culture, components, curricula and personnel of an existing STEM education program. The study also investigated the perspectives of various program constituents and assessed whether or not the program influences the socialization of doctoral

students, and more specifically doctoral student participants of populations that are historically underrepresented in the STEM fields.

In case study research it is important that the study is informed by rich details and “thick” descriptions. Ponterotto (2006) acknowledged the variation in definition of the qualitative concept of the “thick” description and reviewed relevant research and theory to identify commonalities and common themes. Several scholars agree that thick description requires more than providing extensive and comprehensive detail rather, it acknowledges context, meaning and the intention of participants (in terms of behavior and action) as interpreted by the researcher (Ponterotto, 2006). Scholars also recognized the importance of acknowledging the culture of participants. According to Holloway (1997)

It [thick description] must be theoretical and analytical in that researchers concern themselves with the abstract and general patterns and traits of social life in a culture. This type of description aims to give readers a sense of the emotions, thought and perceptions that research participant’s experience. It deals not only with the meaning and interpretations of people in a culture but also with their intentions. Thick description builds up a clear picture of the individuals and groups in the context of their culture and the setting in which they live.... (Holloway, 1997, p. 154).

Quantitative methods would not be appropriate for purposes of this research as it would not afford a rich thick detailed description of the IGERT program nor the perspectives of program participants. Case study facilitated the description of the

culture of the IGERT project and how participants exist, behave and learn within the various contexts of the program's components and activities. It was also useful in understanding the implications of the program culture on the intentions and behaviors of all program participants. This extends our understanding of IGERT beyond how programs are conceptualized and understood by principal investigators in theory; it reveals the perspective of graduate students as to how they experience the program

Additionally, case study methodology recognizes the varied perspectives and meaning making processes of the program participants and aims to include the full range of the experiences in the data analysis. This is distinctly different from quantitative methods where surveys and other quantitative data collection tools define terms and experiences in general, uniform and categorical ways. Similarly, the study did not seek to understand causal relationships between variables, predict outcomes, or yield information that is generalizable to large populations. Consequently, utilizing quantitative measure is unfavorable for meeting research goals of this investigation

### **Solicitation and Sampling Procedures**

I studied an established IGERT program and I was very purposeful in using my academic and professional networks and resources to identify the right IGERT program to serve as the case site for my study. Purposeful sampling (Jones, Torres, & Arminio, 2014; Patton, 1990) allows the researcher to take specific and intentional steps to identify an optimum site for comprehensive study to understand a phenomenon. This is not for the purposes of the generalizing findings to broader populations but rather to ensure that the most useful and most appropriate information/data is acquired for the research and/or that information/data of high

quality is identified and examined to understand a phenomenon (Jones, Torres, & Arminio, 2014; Patton, 1990). Patton (1990) characterizes this approach as the sampling of “information-rich cases.” These cases “are those from which one can learn a great deal about issues of central importance to the purpose of the research, thus the term purposeful sampling” (Patton, 1990, p. 46). Sampling procedures for this study were guided by and uniquely customized to the goals of this study and the specific research questions stated in the beginning of this chapter (Jones et al., 2014).

Processes of purposeful sampling began with the collection of key information about the phenomena. For example, a researcher may refer to themes in extant research to identify descriptive information about the population from which the sample will be drawn (McMillan & Schumacher, 2001). According to Denzin and Lincoln (2011), specific sites, groups, contexts and environments that house the phenomena and the processes that were studied must be identified and intentionally pursued by the researcher. This was useful in establishing and refining the sample selection criteria (Denzin & Lincoln, 2011; Jones et al., 2014).

Sample selection for this study was purposeful in that only IGERT programs that met the established criteria were selected as potential case sites. I have worked with high-level administrators and personnel at the IGERT Program Project office at the National Science Foundation. I had an opportunity to present a general overview of my research study to the IGERT project directors via email and solicited their assistance in identifying existing IGERT programs that could potential serve as the case site for this investigation. As a result of this email correspondence, I met with select scholars and professionals at the National Science Foundation who have and/or

have had extensive experiencing managing, administering, and/or evaluating existing IGERT programs. I was also able to tap the expertise of the Acting Deputy Division Director of the Division of Graduate Education & Program Director for IGERT and National Research Traineeship (NRT) Grants, and other past and present IGERT program officers to discuss the research questions and overall goals and objectives of this investigation. During this meeting I discussed various aspects of research design including procedures of project solicitation, sampling and selection as well as other logistical aspects of proposed methods of data collection and analysis. The group discussed existing IGERT program structure, policies and existing formative and summative evaluation of the IGERT Program. This information was used to establish and refine the purposeful sampling criteria that was used to identify the IGERT project for this study.

Based on the feedback from these key individuals and factors identified in the literature, the IGERT Program selected for this study met the following criteria. The program:

- Was fully funded by the National Science Foundation and be active within the broader IGERT community
- Was in compliance with all broader IGERT goals and initiatives as well as the conditions of the grant contracts and proposal (interdisciplinary course content and research training, fulfillment of international global perspectives directives, diverse program recruitment and enrollment and opportunities for professional development) Project directors/program administrators of potential programs will complete demographic questionnaires that will assess

and determine compliance. If possible, project proposal will be collected and reviewed to assist in this process.

- Had at least a three-year history. This will ensure that programs have an established program culture, norms and values and to assess perspectives of the program services from student participants at various stages of their doctoral study. Additionally, IGERT participants are typically funded by the IGERT project for a maximum of two years. Graduate departments usually fund students for the remainder of their graduate study. Criteria was established as programs that are at least three years into their funding cycle are also much more likely to have alum and I wish to include the perspectives of IGERT program alum in the data collection procedures.
- Graduated a cohort of students and have program alumni
- Had an active cohort of current doctoral students
- Had students of underrepresented populations in STEM actively enrolled as IGERT Trainees.

A preliminary list of 3-5 potential programs was identified. Once potential programs were identified, the contact information of the principal investigator of each IGERT was obtained through [www.IGERT.org](http://www.IGERT.org), a public networking database and electronic resource system. IGERT.org was developed as mechanism of networking and information exchange amongst IGERT faculty, personnel and study participants. The website also contained a database of active IGERT programs that contained a brief description of the interdisciplinary research focus of each IGERT and the

contact information of the project director and/or project administration for purposes of recruitment.

I contacted each of the principal investigators (PIs) and/or primary contacts for each potential IGERT program via email. In the email correspondence I detailed the purpose of the study and provided an overview of the study with specific emphasis on the proposed research design and intended procedures for the data collection and data analysis. A sample of email is included in the appendices (See Appendix A). In the email, I requested to schedule a follow up phone call to discuss the study in greater detail and to answer any questions that they may have had. Through these individual conversations and interactions with the PIs that programs that were willing to be considered for the study were identified. A demographic questionnaire, used to acquire further information about their IGERT project, was sent to each potential program. This information was used to help me understand the components of each project and determine the extent to which a program met the study's selection criteria. After the program was identified, all programs/project that expressed interest or agreed to participate but was not selected received a personal note thanking them for their willingness to participate. I also agreed to share my final dissertation with them as it will hopefully help to inform their own program development in future years.

### **Data Sources**

A key element characteristic of the methodological approach of the case study is the use of multiple sources of data (Creswell, 2007). The section will provide an



overview and description of each data source and method of data collection employed during this case study.

**Document review/document analysis.** A range of IGERT program documents were collected including the program grant proposal, contracts with National Science Foundation, letters of support, memorandums of agreement, job descriptions of program personnel, curriculum vitae and resumes of the IGERT faculty and staff, organizational charts, previous internal program assessment tools and reports, meeting minutes, program recruitment/marketing materials IGERT program curricula, all IGERT course materials including course reading, assignment descriptions, grading rubric, programming calendars and financial reports. This information was gathered and organized. A text analysis of each document was conducted to gain an understanding of the history and evolution of research traineeship program and identify and describe existing program structure as it relates to the design and administration of the IGERT project. Text analysis consisted of reading the document multiple times, assessing the author and source of the document and identifying the purpose for its development or creation. The intended audience of the document was also identified and recorded. This information served as the basis for a comprehensive case description. Creswell (2007) argues that a thorough description of the case is fundamental to good case study research. Case description served as the basis for data analysis as it provides useful for context for the uncovering of new and unexpected findings through the data collection and the analysis and interpretation of findings (Creswell, 2007). Document review also aided

in the identification of additional sources and sites to collect data that may not have been previously identified or outlined in the proposal of this research.

**Survey.** Anderson and Swazey (1998) argue that surveys afford researchers the unique opportunity to collect information and identify and explore patterns within and across that information. They also propose that surveys are useful in examining the incidence and prevalence of certain behaviors within a group of people. A brief survey was also an element of the data collection process for this case study. The purpose of the survey was to understand patterns of information transfer and exchange within IGERT program contexts as perceived by student participants. The survey instrument was designed to assess the frequency of conversations and exchanges between and amongst students, faculty and program administration and gauge/identify the nature and quality of information exchanged as perceived by student program participants. The survey aimed to identify and explore a) the various formats of communication transfer (conversation, training lecture, interactive activities), b) the means by which communication and information transfer exists within the IGERT program (face to face conversation, telephone, email, etc.), c) the frequency of communication between program stakeholders in program contexts and d) the perceived quality of the information that students receive from program faculty, program administration and fellow program participants. A sample of the survey is included (See Appendix B). This information contributed to building a case description for the study and also guided the other forms of data collection and analysis. As the researcher, I designed this survey using items/questions from existing survey instruments used to assess various elements of the experiences of

doctoral students. Items/questions were adapted to meet the specified goals and objectives of this study. All current student participants of the IGERT project for this case study will be asked to complete the survey. A group of former IGERT students identified by the IGERT program director were also asked to complete the survey.

**Semi Structured Interviews.** Semi structured interviews was also a tool of data collection in this case study. Semi structured interviews are characterized by free flowing conversation. According to Morse and Richards (2002) within the semi structured interview researchers design unstructured interview protocol to be used to interview participants. These protocols may consist of open-ended questions and probes, which used for the purposes of the clarifying interview questions (Morse & Richards, 2002). Interviewers do not follow the protocol in a strict and structured manner rather they seek to generate a conversation with the interviewee and include them in the processes of knowledge constructing and meaning making (Jones et al., 2014). The semi-structured approach was most appropriate for this case study versus other approaches of interviewing as it afforded participants the freedom and space to describe their experiences and ideas in their own way (Jones et al., 2014). The goal of this study was to explore research traineeships as experienced by student participants, recent alumni, program faculty, program administration and other program constituents. The semi-structured approach ensured that all persons interviewed are encouraged to freely share their thoughts & experiences and tell their stories.

The IGERT program administrator sent all current and former students an email to introduce me to the students. The email contained an overview of my study an invitation to participate in the study by completing a survey and/or participating in

a semi structured interview. A separate and similar email was sent to IGERT program faculty by the IGERT project director. Participants who were willing to be interviewed contacted me via email and interviews were scheduled. Each participant engaged in one semi-structured, face-to-face interviews with me, as the researcher. Participants were permitted to choose between an in person interview or an electronic interview via Skype as to be sure that all interviews were conducted at a time that was most convenient and most comfortable for participants. All Interviews were conducted in a neutral and secure place to ensure that participants felt free to speak honestly and openly. Each interview began with an explanation of the purpose of the study and the terms of consent for participating in the study. Upon providing consent participants were asked a series of demographic questions. Interviews ranged from 30 to 90 minutes in duration. The semi-structured interview protocol used to frame the discussion during the interview was designed to examine the ways that student, faculty and staff participants of the IGERT perceived their experience of the IGERT program (See Appendix C). Specific attention was given to understanding participants' perceptions of how the program interfaces with and influences the doctoral training and socialization to work within STEM disciplines. Each interview was audio recorded and transcribed verbatim.

### **Data Analysis**

According to Huberman and Miles (1994) data analysis processes are not one size fits all rather they must be tailored to meet the unique needs and nuances of a study. This section will provide an overview of the data analysis processes that were employed during this study.

In analyzing the data collected through the review of program documents I first developed a formal system of summarizing and organizing the data based on data type. For example, in terms of document review, a synopsis or summary of each document was created that described its overall purpose, the manner in which it was used, whether or not it was disseminated to other program participants & constituents and, if so how, the target population/audience the document was developed before, etc. I then created a database to monitor and track documents and guide the overall construction and development of the comprehensive description of the case site IGERT project. Similarly, interview data was analyzed first through the review of the memos and field notes of the researcher. Codes were developed to contribute to grouping the data for processing. This contributed to revealing consistencies and nuances in program documents. The codes were developed using the research questions and tools from the nested conceptual model of this study. As data was coded and analyzed, codes were constantly reviewed and refined. An overall final group of codes and emergent themes was formulated to contribute to triangulation and broadly discussing findings in terms of the addressing the research questions (Jones, et. al., 2014; Luker, 2008)

Triangulation is the process of data collection and data analysis whereby findings are confirmed through various methods of data collection (Creswell, 2013; Denzin & Lincoln, 2011). It is the means by which findings from one data source, as interpreted by the researcher, are substantiated and authenticated through another data source. For example, if thorough document review of course evaluations reveals that student participants have a negative experience of a programs activity, quotes from

observation notes or quotes from interview transcripts will be identified to confirm and lend credence to a theme concerning the experience of the program activity. While the utility and necessity of triangulation is debated throughout qualitative data, Jones et al. (2014) argue its importance for case studies. Triangulation was used in the development and revision of themes for this study. It was useful in analyzing the wide range of various data within this study, as well as digesting the data to address research questions.

All current students were asked to complete a 40-item electronic survey via an email sent by the current coordinator and project director of the case site IGERT project. The Project Director preferred that she send the students the email as she felt that doing so would give the email request credibility and established the email as something that students should take seriously. She felt that this would discourage students from disregarding the email and encouraged them to participate in the study. An access link was sent to students. After providing consent, each participant completed the survey via the online survey platform Qualtrics. The Qualtrics survey platform also collected and organized survey data for the purpose of analysis. The survey was open for a period of 30 days. Upon closing the survey, responses were organized/explored and descriptive statistics were conducted to assess patterns of communication and information exchange amongst groups of IGERT participants.

Each semi-structured interview was transcribed and cleaned for accuracy by checking the recordings with the actual transcript. Cleaned transcripts were shared with those interviewed as well. Each interviewee was asked to review the transcript

to ensure that it was accurate and properly reflected what they wanted to convey. This was done to ensure the accuracy of the interpretation of the findings. No recommended changes were offered by the participants. After these member-checking (Jones et. al, 2014) processes were completed I read and reviewed each transcript a number of times to immerse myself in the interview data. This process is recommended through existing qualitative research literature. According to Agar (1980), this process is useful in becoming sensitive to the details of the data and understanding “the interview as whole before breaking it to parts” (p. 103). Two phases of analysis were employed for coding and interpreting interview transcripts 1) open coding, and 2) axial coding (Merriam, 2009). First data was reviewed to identify emergent themes. During open coding of the data, I (the researcher) read each transcript and note specific words and phrases connected to the research questions and conceptual frameworks. These codes were then reviewed and grouped in tentative categories using a technique referred to as axial coding (Merriam, 2009). These categories were reviewed and refined as I continued to review transcript data and digest and interpreted research findings. Interview protocols, field notes and personal memos were then read thoroughly and coded in the organizational database that I developed in this study. In this way, the organizational database was the first steps taken toward identifying themes both within and across the sources of data for this study. Additionally, it contributed to identifying unique findings that emerged during the first phases of data analysis as well. Codes were developed from this organizational database, interview protocols and themes and concepts from the theories that serve as the nested conceptual model for this study.

Data collected via the various data sources of this study were coded using Dedoose, an online qualitative and quantitative analysis software. Once the data was coded it was assessed noting the unique, iterative, interrelated and continuous nature of data analysis processes is integral (Creswell, 2007; Huberman & Miles, 1994). Data collection and data analysis processes are often conducted concurrently (Creswell, 2007; Merriam, 1998). As the process of developing interview protocols and reviewing program documents commenced I consistently refined and revised strategies to ensure the overall accuracy of data collection, the interpretation of findings and tracking/monitoring of emergent themes across findings.

### **Theoretical Concepts and Corresponding Methodological Choices & Considerations**

In this section I detail the specific ways that concepts of the theoretical framework were employed in this research and how they informed the methodological choices made in the design of this research. The IGERT program as a whole/phenomena was the unit of analysis in this study. The objective was to examine multiple aspects of the program (e.g. key stakeholders, students, program curriculum) and to illuminate and understand all the components, dimensions, and contexts of an IGERT project and how all program stakeholders engage and interact with one another. These data points were used to address the research questions that guide this study. Due to the multidimensional scope of this work, a multifaceted conceptual framework was necessary to adequately guide this research. As described earlier in the dissertation, I have designed a nested framework to examine IGERT.



These frameworks draw from two key theories: William Tierney's (1997) Theory of Organizational Culture and Bryan Gopaul's (2011) conceptualization of how graduate students are socialized and trained within their graduate programs.

A detailed review of the concepts within each theory was provided in the previous chapter. In this chapter, I provide a methods matrix to demonstrate how the components of the theory were operationalized in my study. The matrix explains what was used in this research and describes the ways that that theory was applied to inform the elements/phases of the data collection and analysis. Each theory within the theoretical framework was useful in defining and understanding the organizational, structural and administrative components of colleges and universities and the socialization and training of graduate students. The various theoretical concepts provide a roadmap for defining and describing the culture, functions and processes of an IGERT project. Similarly, the theory frames an investigation of the specific ways that an IGERT program interacts with, influences and/or shapes the training and socialization of program participants specifically program participants from underrepresented populations.

Tierney (1997) argues that an organization's culture is what connects these organizational entities together and informs the way that an organization functions and evolves. The six conceptual elements of organizational that he provides guided the research design of this study and informed specific methodological choices made in order to glean information that accurately and thoroughly identified and described the program components, activities, norms, practices that contribute to the culture of the IGERT project that serves as the case site for this case study.

In order to understand the socialization and training of all graduate students, a theory that recognizes the various phases of the graduate student socialization and acknowledges that every graduate student navigates each of these phases in a variety of ways is requisite. Gopaul's (2011) conceptualization of graduate student socialization extend existing graduate student socialization to consider the identities of students and the ways that social positionality can shape one's progression through graduate education. His approach critiques previous theory that often assumes that graduate school is experienced in the same way by all students regardless of their gender, race/ethnicity, social class and other elements of identity. Gopaul's (2011) application of Bourdieuan concepts like habitus, social and cultural capital, practice and the field positioned this study to explore and better understand the socialization of all IGERT program participants and assess and examine the ways that the IGERT program supports students for populations traditionally underrepresented in the STEM fields.

The following matrix (Figure 3.1) provides an outline of the ways that the theoretical concepts outlined in the nested conceptual framework inform the processes of data collection and analysis for the proposed study. A written overview of each potential data source and method of data analysis will follow.

Figure 3. 1. Theoretical Concepts /Methods Matrix

Theory	Theoretical Concept	Corresponding Data Source/Methodological Choices]
<b>Understanding the IGERT through the Lens of Organizational Culture : How Does Culture Inform Program Processes &amp; Functions</b>		
Tierney (1997)	Environment: exploring how program participants and stakeholders define their surrounding environment.	Understanding how environment is defined and understood; assessing if and how program participants define their surrounding environments and if those definitions are consistent with stated program objectives and goals (as defined by program stakeholders, the funding agency, the institution, etc.) a) Semi Structured Interviews b) Document Review – NSF Program Solicitations/Extant Evaluations; Grant Proposals/Mid-Year and Final Reports
Tierney (1997)	Mission: how participants define and articulate the overall mission of the program: specifically noting whether or not participants agree in terms of the mission of the program?	What is the Mission of the IGERT? a) Document Review: Identifying Stated mission statements, goals and objectives as determined by IGERT program, department, funding agency, etc.; Existing project evaluation materials b) Semi Structured Interviews: IGERT Project Directors/Project Administrators, IGERT Faculty, Current student participants (General pop & Underrepresented), Formers student participants (General pop & Underrepresented)  Do participants agree in terms of the mission of the program? a) Semi Structured Interviews: IGERT Project Directors/Project Administrators, IGERT Faculty, Current student participants (General pop & Underrepresented), Formers student participants (General pop & Underrepresented)
Tierney (1997)	Socialization: What do participants need to know in order to survive and succeed in program contexts	Defining Success and Survival: How does the IGERT define Success? a) Document Review: Identifying Stated goals, standards, objectives as determined by program, department, funding agency, etc.; Existing project evaluation materials b) Semi Structured Interviews: IGERT Project Directors/Project Administrators, IGERT Faculty, Current student participants (General

		<p>pop &amp; Underrepresented), Formers student participants (General pop &amp; Underrepresented)</p> <p>How is survival and success defined to new participants as they enter the program and throughout the length of their participation?</p> <p>a) Semi Structured Interviews: IGERT Project Director/Program Administration, Current student participants (General pop &amp; Underrepresented), Formers student participants (General pop &amp; Underrepresented)</p>
Tierney (1997)	Information: How is information defined and disseminated within a program.	<p>What constitutes information? Who has it? How is it communicated?</p> <p>a) Survey Assessing Nature &amp; Frequency of Communication and Information Exchange within Program Context</p> <p>b) Semi Structured Interviews: Students (Current &amp; Past) and Faculty</p> <p>c) Document Review: Identifying Stated goals, standards, objectives as determined by program, department, funding agency, etc.; Existing project evaluation materials</p>
Tierney (1997)	Strategy: Studying Decision making processes	<p>Defining Decision Making Processes: Who is responsible for making decisions? What are the rewards of good decisions? What are the consequences of bad decisions?</p> <p>a) Document Review: Aiming to understand infrastructure and division of labor; organizational charts; departmental structure; understanding authority (assessing institutional involvement/ assessing the involvement of funding agency, assessing the involvement or external partners/stakeholders), reviewing curriculum &amp; course materials</p> <p>b) Semi Structured Interviews: IGERT Project Director/Program Administration (What were the critical incidents during the proposal writing process? During course &amp; program development) Your interviewees would be able to tell you about the consequences of bad or good decisions as well.</p>

Tierney (1997)	Leadership: Who are leaders? How is leadership defined? What are the processes by which leaders are selected? What do program participants expect of the leaders?	<p>Defining Program Leadership: Who are leaders? How is leadership defined? What are the processes by which leaders are selected?</p> <p>a) Document Review: Aiming to understand infrastructure and division of labor; organizational charts; departmental structure; understanding authority (assessing institutional involvement/ assessing the involvement of funding agency, assessing the involvement or external partners/stakeholders), Curriculum</p> <p>What do program participants expect of the leaders?</p> <p>b) Semi Structured Interviews: IGERT Project Director/Program Administration, Current student participants (General pop &amp; Underrepresented), Formers student participants (General pop &amp; Underrepresented)</p>
<b>Graduate Student Socialization: Acknowledging the Experiences and Needs of Graduate Students of Color</b>		
Gopaul (2011)	Habitus: One's View of the world and his/her place in it? How does this view shape choices and behavior?	<p>Learning about student participants (Who are students as they enter the IGERT); Understanding student perceptions of graduate school/graduate education. Exploring how students see and understand themselves within the graduate programs, graduate training, participation in the IGERT.</p> <p>Does this facilitate of limit graduate students of color in terms of their academic tools, social schema needed to successful navigate the IGERT program and their graduate program?</p> <p>a) Semi Structured Interviews: Current student participants (General pop &amp; Underrepresented), Formers student participants (General pop &amp; Underrepresented)</p>
Gopaul (2011)	Social Capital: Values, knowledge, and information accessed through a	Determining Value, Knowledge and Useful Information; Exploring faculty mentoring relationships, peer relationships, etc. If/how students acquire

	student's capacity to sustain and develop relationships and social networks	<p>content knowledge and are taught to navigate academic and professional environments.</p> <p>a) Semi-Structure Interviews: Students (Current &amp; Past) and Faculty  b) Survey: Assessing Nature &amp; Frequency of Communication and Information Exchange with Program Contexts</p>
Gopaul (2011)	Cultural Capital: Language skills, professional etiquette protocol, professional norms and values	<p>Defining Cultural Capital What are norms of the program? What information is valued?</p> <p>a) Document Review  b) Semi Structured Interviews: IGERT Director, IGERT Administrators, Program Faculty</p> <p>How is this information communicated and transferred within program contexts? Is it communicated and transferred equitably.</p> <p>Access to socializing experiences, training and exposure. Is this access equitable? Is additional support available to underrepresented populations?</p> <p>d) Survey Assessing Nature &amp; Frequency of Communication and Information Exchange within Program Context  e) Semi Structured Interviews: Students (Current &amp; Past) and Faculty</p>
Gopaul (2011)	Field: Various program spaces and contexts. Actual training experiences that are useful in exploring how students' backgrounds and positionality interact with forms of capital.	<p>Identifying, describing, exploring various program contexts. What are the structured ways that IGERT participants are trained within program contexts? Where does student training exist within and beyond the bounds of IGERT programs. What forms of capital are valuable? Are they valuable in similar ways for all program participants? Which forms are valued and why?</p> <p>a) Document Review: NSF Program Solicitations, Program Proposals, Curriculum Information (Are there stated learning outcomes, goals and objectives)</p>

Gopaul (2011)	Practice: The actual choices that participants/students making within the rules, norms, and culture of the IGERT, their graduate programs, their careers?	<p>Describing the interplay or interaction between students' habitus, capital and field.</p> <ul style="list-style-type: none"> <li>a) Document Review</li> <li>b) Semi Structured Interviews: IGERT Director, IGERT Administrators, Program Faculty</li> <li>c) Survey: Assessing Nature &amp; Frequency of Communication and Information Exchange with Program Contexts</li> </ul>
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## **Epistemological Framework**

Due to the qualitative nature of this research study, I must acknowledge that my interpretation of the problem, the corresponding review of relevant literature and the methodology of this proposed study have all been shaped by my own personal epistemology, worldview and standpoint. The following section will briefly describe the epistemological framework employed in conducting this research. A statement of my positionality, as it relates to this research and why it is so important and valuable to me, will follow.

The design of this study is consistent with the social constructivist epistemology that assumes that the meanings that we ascribe to our lived experiences exists in response to and as a direct result of the various contexts that these lived experiences occur within (Merriam, 2009; Creswell, 2007). Acknowledging the historical, social, and cultural contexts where experiences occur is critical to gaining an understanding of the varied and complex ways that persons make meaning of their experiences and the places and spaces in which they exist. Broido and Manning (2002) present four themes of the constructivist paradigm. These themes are offered to demonstrate the applicability of the social constructivist framework to the goals of this study of understanding the IGERT program and the ways in which the culture of the program influences the training and socialization of student participants (Jones et. al. 2014). The themes are as follows (1) the relationship between researcher and participant is interactive and subjective; (2) realities (lived experiences) are complex and multiple; (3) the values of the participants, environment, theory and the research are all aspects of the research process; and (4) the interpretations of the research are



context specific (Broido and Manning, 2002). These themes guided all of the methodological choices made during each phase of the research process including research topic selection, data collection, data analysis and the presentation of findings

Denzin (1985) argues, the biography and self of the researcher is where “interpretive research begins and ends (p. 12). The following positionality statement is provided to share my experiences with and personal connections to this study. I also state the values that inform my interest in this research. I understand that it is necessary for me to be aware of myself and my position prior to conducting this research in order to acknowledge and attend to my own personal biases and ensure that this work does not conform to my own beliefs and assumptions of myself and others. Similarly, Jones et al, (2014) suggest that understanding a researcher’s positionality within his/her research study is necessary in understanding how a research collects and interprets his or her data.

### **Positionality Statement**

In November of 2009 I started a new position as a program administrator at an engineering school of a private university. As a woman of color with an expressed interest in recruiting and supporting underrepresented populations in the sciences, technology, engineering and math (STEM fields) I was not surprised when I was approached by the Dean of Diversity and Faculty Development about joining the Committee for Diversity. My first assignment was to assist in a review of hiring practices within the college. I was asked to compile and analyze applicant data for open faculty positions. My charge was to track the number of persons of color that made the short list for consideration, those that were interviewed and those hired as

tenure track faculty over a ten-year period. In reviewing the data, I quickly noticed a pattern. In 10 years, there were six or seven searches for faculty positions. Each position announcement yielded approximately 400-600 applicants. Of the combined applicant pool for all of the faculty positions roughly 25% of applicants were women and 15-17% were persons of color. For the hiring processes, for all but one of the faculty searches only ten women applicants were added to the short list of consideration for interview and no person of color were considered for interview.

I went back to the dean and reluctantly gave him a report of my findings. He could tell that I was bothered by what I had found and asked me to expound on my reaction.

I bombarded him with questions seeking to understand what could be contributing to this problem. Why were women and people of color so underrepresented in the applicant pool? Were they disinterested in faculty work and if so why or why not? Was it a matter of their preparedness or training? Who was responsible for overseeing hiring practices to ensure that they were equitable? Were current faculty aware of the existing race and gender based disparities in the professoriate and the implications of an exclusively White Male faculty? The Dean remained calm as I rambled. I noticed a smile surface on his face. He allowed me to finish, then quietly stated. "I knew that this would happen. You have great questions, Tykeia, and I believe that a doctoral program would be a great place to begin to explore them further." At that time, I was finishing my Ed.M. in Higher and Postsecondary Education. I used my comprehensive seminar paper as the opportunity to explore doctoral education as experienced by underrepresented populations with a

specific focus on the challenges faced by students of color in doctoral programs. The more I explored the literature the more questions about graduate education developed. I stored these questions on a word document saved on my desktop. As I combed the literature I noted all of the recommendations offered to remedy and address the challenges of the STEM doctoral education. I realized that program that I worked for was lauded in the field as a “successful initiative” but I found no literature on how success was defined or the specific unique processes, services, components that made our program successful. It troubled me that research on an around these STEM reform programs was so limited, especially in light of the millions of governmental and institutional monies that are spent to fund them.

The research questions that guided this study were largely shaped by the experience described above and my own experiences with academic support programs as a student informed the design of the study. I can personally attest to the work programs and reform efforts that aim to address an overall lack of diversity in educational contexts and support and retain students of populations that have been marginalized to the academic enterprise throughout history.

My mother is the eldest of five children; all born and raised in Nashville, Tennessee my grandmother often recalls the frustration that she felt when it was time for my mom to go to college. My grandparents were overwhelmed, undereducated and confused. They had never applied to college and were completely unaware of how to navigate the processes of applying for college or financial aid. My mother applied to a local historically Black college. She was accepted but she did not receive any financial aid. My grandmother still recalls the fear and uncertainty that she felt

when she and my grandfather left the financial aid office. “How did they expect us to pay for college with four children?” My grandmother was a licensed cosmetologist and a factory worker. My grandfather worked at a publishing house and pastored a small Baptist church in Donelson, Tennessee. My mother enrolled in college “by faith.” She acknowledged that she did not know how she was going to pay for school and that there was a potential that she would not graduate.

After a year, my grandfather was called to pastor a church in New York. My mother left college in Tennessee and moved to a small but growing suburban city just 20 miles north of New York City with her parents. There she enrolled in small business college/trade school. She graduated 18 months later with an Associate degree and began working. She obtained a “good” job at a local office at one of the nation’s most popular business firms. My mother had a very successful career and was able to provide her children with a very comfortable life. She never attempted to transfer her credits from Tennessee State University and she never pursued a Bachelor degree. She was never advised to do so. She regretted that she did not have the information, know-how, or resources to navigate her academic planning and college choice process. She committed herself to ensuring that her children knew their options and made sound choices regarding their education. As a result of her diligence I was able to benefit from the Science & Technology Entry Program (STEP).

STEP is a pre-college initiative funded by a grant from the New York State Education Division’s Office of K-16 Initiatives and Programs. The purpose of the STEP program is “to prepare minorities historically underrepresented or

economically disadvantaged secondary school students for entry into postsecondary degree program in scientific, technical, health-related fields, and the licensed professions” (New York State Education Dept., n.d.). STEP was the resource that my mother used to make sure that I was equipped with the tools and skills that she felt that she did not have in high school. Based at a local college, our program consisted of supplemental math and science classes, research opportunities, SAT prep, college counseling, and cultural awareness. I joined the program in the 7<sup>th</sup> grade and remained a member until I graduated from high school.

As a college student, I participated in another state funded initiative that provided support to minority and underrepresented students. The Collegiate Science & Technology Entry Program (CSTEP) is the sister program to STEP. CSTEP students benefited from academic advising, financial support, research opportunities and internships, conferences and assistance with applying to graduate school. Through this program I traveled to present at statewide research conferences, and held internships with prestigious companies. I received professional etiquette training and was supported throughout every challenge and triumph of my undergraduate study. Despite the success of these programs, as evidenced in my life and the lives of my peers in the program, the state government consistently cut program budgets. CSTEP program directors from across the state organized “Lobby Day” trips to the state capital where students would meet with legislators and ask for their support in ensuring the funding that would sustain program efforts. We were encouraged to share our stories. What did CSTEP mean to us? What had we gained from our experience as CSTEP students? I struggled to understand the necessity of lobby day.

Why did the legislators not know of these programs? Why did they not understand the work of STEP/CSTEP? Why did not they know that these programs were working?

After graduate school I started my first “real” job. I served as the Assistant Director of CSTEP at a small liberal arts college in New York that was not much unlike the small liberal arts college I graduated from six years prior. As a young administrator, I learned the nuances of program development within the context of institutional policy and competing institutional priorities very quickly. I was exposed to the dynamic world of student affairs and worked to situate myself, and my program, within the culture of the campus community and the policies and processes of the institution. Quickly, I learned that while enhancing the experiences of my students and supporting students of color through my program service was my personal priority, it was not a priority shared by many of my colleagues or institutional policy. I realized that very few people acknowledged, understood, or appreciated the unique work of academic support/ research programs like STEP/CSTEP and other initiatives. It seemed as if the only people who really recognized this work were the program administrators responsible for managing program services and the students and families that the programs served.

My experiences with programs are layered and multifaceted. They have developed a personal desire to interrogate the various levels of program functioning as well as the interaction between and amongst the administrators, faculty and students that learn and operate within them. I can attest to the contribution of programs in navigating my own academic trajectory, however my advocacy does not suggest that I regard these programs as a great panacea in supporting all

underrepresented populations of students in college and graduate school. My experiences have positioned me to witness these programs from a variety of angles. I have observed and experienced the nuances, issues, challenges, limitations and idiosyncrasies of these programs and the various ways that they work. This research does not argue whether or not programs work or compare the work of these programs to other initiatives and policies. Challenging the monolithic portrayal of these programs and the populations that they serve is an overarching goal that frames my research. In this study and throughout my career, I aim to understand the organizational culture, goals and function of these programs and engage with the administrators, faculty, and students that exist and interact within these programs. I also seek to understand how they construct and co-construct knowledge that expands our understanding of the role of programs and program administrators within the context of the ways that students are socialized.

## Chapter 4: Comprehensive Case Description

This chapter provides descriptive information of the Urban Renewal IGERT program, which serves as the case site for this case study. This program was formerly known as the *Addressing and Eradicating Problems Associated with Urban Renewal Integrative Graduate Education Research Traineeship (Urban Renewal IGERT)*. This case description is based upon information that was gathered through an analysis of existing program information, including the program proposal, program marketing materials, and institutional data. The environmental setting of the program will be described followed by an overview of the goals and objectives of the program. A brief review of the historical context of the Urban Renewal IGERT will be presented along with a description of program participants, program components (including program curricula and activities), and formal program policies and procedures. The chapter will conclude with the review of the sources of data used in this study, and the demographics of various data collected for this study.

### Program Setting

The *Addressing and Eradicating Problems Associated with Urban Renewal Program* is an interdisciplinary training program for doctoral students at Hillman University, a large and urban private research university in the mid-Atlantic Region of the United States. The program is funded by an Integrative Graduate Education Research Traineeship (IGERT) training grant sponsored by the National Science Foundation. Members of the faculty of Garret A. Morgan School of Engineering and the Norma Merrick Sklarek School of Architectural Design and Urban Development collaborated to write the grant and design the program curricula, activities, and



services. Morgan and Sklarek are two of the eleven graduate and professional schools of Hillman University, which enrolled a total of approximately 7,000 graduate students during the 2014-2015 academic year. There are three undergraduate colleges that enrolled close to 9,000 students.

### **IGERT Program Goals and Objectives**

Five Hillman University faculty are responsible for designing and developing the Urban Renewal IGERT program. Faculty established this program to develop a new paradigm of doctoral training, which “combines and extends current research, pedagogy, and practice in architecture and engineering to enable holistic consideration of new urban requirements for the adaptability, ecological performances, and resilience of urban areas” (IGERT Program Proposal, pp.2).

According to the initial grant proposal, “The vision of this IGERT is to bring architectural and engineering PhD education back together in a new, interdisciplinary program that will fundamentally transform design education and approaches to contemporary urban expansion” (IGERT Program Proposal, n.d., p. 2) The primary goal of the IGERT program is to establish an interdisciplinary PhD program between the School of Architectural Design and Urban Development and the School of Engineering. This interdisciplinary doctoral program features new training that integrates engineering and architectural methods. The second goal of the IGERT is to acknowledge and integrate the needs of urban stakeholders or those communities who are potential beneficiaries of research from the beginning of the program. Trainees will design and conduct research that has real-time practical application, and that is socially relevant with a significant potential for impact both within and beyond

academia. The third goal of the program is to create and sustain collaborative relationships between IGERT trainees and participants and global partners. The combination of these form a novel and nuanced approach to doctoral training and ensure that participating student are equipped with the content knowledge and skills that are necessary for addressing existing challenges that relate to the renewal and redevelopment of urban environments both locally and in national and global contexts as well” (IGERT Program Proposal, n.d., p. 4).

### **Historical Context**

The National Science Foundation (NSF) IGERT grant for the Addressing and Eradicating Problems Associated with Urban Renewal program was originally awarded to Hillman University in the Fall of 2009. At that time, an Executive Committee was officially formed, and included the Program Director and the four faculty Co-Principal Investigators identified on the program proposal contract with NSF. The executive committee of the IGERT met several times throughout the Fall to hire IGERT Program Staff, develop the IGERT curriculum and other program policies, and recruit and facilitate the admissions process for the first cohort of IGERT Trainees. The first year of the IGERT program began at the start of the Fall semester of the 2010-2011 academic year. A cohort of trainees was recruited each following year until the 2013-2014 academic year. The IGERT applied for a one year, no-cost extension with NSF during the 5<sup>th</sup> year of the IGERT program (2014-2015). That extension was granted and the IGERT is currently in its last year of operation.

## **Program Participants**

**IGERT faculty.** The core executive committee is comprised of five faculty who worked collaboratively to design and administer IGERT curricula and program services. Committee members include the project director/principal investigator of the IGERT and four co-principal investigators. This committee managed the IGERT program staff, and ensured that all program components were adequately assessed and evaluated. The committee also made sure that program courses and activities were in alignment with the project goals and objectives as well as the broader goals of the IGERT program as established by the National Science Foundation. Brief biographical summaries of the project director/principal investigator and other members of the Core Executive Committee are provided below, along with a brief overview of each member's role and significant contributions to the program.

According to the Proposal and Award Policies and Procedures Guide published by the National Science Foundation, the project director/principal investigator is the person appointed and designated by the organization or entity that receives a grant to oversee and be responsible for the direction of the project ([http://www.nsf.gov/pubs/policydocs/pappguide/nsf08\\_1/index.jsp](http://www.nsf.gov/pubs/policydocs/pappguide/nsf08_1/index.jsp)). This person is also responsible for the submission of reports to NSF. NSF uses the terms “project director” and “principal investigator” interchangeably. They will be used as such in this case description. Co- Principal Investigators (Co-PIs), are individuals who share in the responsibility of the overall management and progression of the program. It should be noted that all faculty members of the core executive committee racially identify as persons who are White (Non-Hispanic).

Professor Dorothy Davenport, PhD is the Project Director of the Urban Renewal IGERT. Dr. Davenport is a tenured full-time faculty member in the Department of the Engineering Mechanics at Hillman University. She entered the professoriate over 25 years ago, and has held a number of administrative positions in the School of Engineering. Professor Davenport has an extensive record of publication which includes 3 books, 4 book chapters, and well over 50 refereed articles and other major reports and publications. Additionally, while serving as the Principal Investigator for Urban Renewal IGERT, Professor Davenport has also served as the Director for Hillman University's Center for Research on Civil Engineering and Sustainability, and the Chair of Committee for Faculty Diversity and Development in the School of Engineering. She has held several appointments on various advisory boards and councils at a number of local and national research organizations and businesses devoted to addressing challenges of urban renewal. She has advised countless graduate students at the masters and doctoral level, and teaches and co-teaches several courses both within her department and with colleagues from other schools and departments at Hillman. The Addressing and Eradicating Problems Associated with Urban Renewal IGERT is the first IGERT program for which Professor Davenport has served as the Project Director/Principal Investigator.

Co-PI Professor Taylor Bradford, PhD is a tenured faculty member in the Department of Urban Design with thirty plus years' experience in the professoriate. He presently serves as Director of Graduate Studies within his department, and oversees several aspects of the admissions process of graduate students within the School of Architecture and Urban Design. He developed and teaches one of the

required courses of the core curriculum for the Urban Renewal IGERT. He has published extensively and serves, or has served, on the editorial board for several major professional journals within the field of the Urban Design. Co- PI Professor Banks is a tenured faculty member in the Department of Structural Engineering. He is widely published and recognized by colleagues in the academy and industry for his work as it relates to urban renewal and the influence of natural disasters on urbanization. He has advised a number graduate students and post-doctoral fellows during his tenure at Hillman University and at several other colleges and universities.

Co-PI Professor Vernon Gaines, PhD serves on the faculty within the Department of Architecture and contributes a substantial amount of industry experience to the Urban Renewal IGERT. Professor Gaines is the Director of the Center for Architectural Design, and also developed and instructs one of the required courses for the Urban Renewal IGERT. He has extensive experience as a consultant for a number of organizations, and(?) maintains a number of partnerships with various firms and policy organizations addressing issues of housing and urban planning in urban areas throughout the country. Finally, Co-PI Professor Grayson co-instructs a required course for the Urban Renewal IGERT, and has extensive experience in managing logistics for large scale research and construction projects. He teaches several courses throughout the School of Engineering at Hillman University.

Approximately 22 other members of the faculty from the Chemical, Civil, Mechanical, Earth and Environmental, and Industrial Engineering departments in the School of Engineering and the Urban Planning, Urban Design, and Architecture

departments in School of Architecture and Urban Design have contributed to the development and facilitation of research and education training within the Urban Renewal IGERT throughout the duration of the program grant. They have served as teachers and instructors of IGERT coursework and electives, guest speakers at IGERT lectures, seminars and workshops, advisors to IGERT trainees, and affiliates and contributors to IGERT symposia and other research events.

**IGERT administrators.** The IGERT Coordinator is responsible for managing the day to day administration of program services. He/she plans and facilitates all IGERT professional development programming as well as the IGERT Brown Bag Lunch Seminar Series. Additionally, the coordinator is responsible for ensuring all trainees receive their funding stipends and benefits, and assisting and advising IGERT trainees in navigating administrative policies and protocol. The coordinator must create and maintain all program enrollment, processing, registration, and reporting databases, and assist the project director in meeting program reporting requirements as outlined by the National Science Foundation. Similarly, the coordinator handles all purchasing, and assists the project director in managing the program budget. The coordinator also assists the Executive Committee as necessary as it relates to maintaining program records and revising program policies and practices. The coordinator also works to ensure program services are in compliance with goals and objectives. He/she works collaboratively with other departments in the School of Engineering to contribute to program recruitment; specifically, the recruitment and retention of students from populations presently underrepresented in the STEM fields.

To date, the Urban Renewal IGERT has had three individuals to serve as IGERT coordinator. The first coordinator was an African-American woman with a BA in Psychology and a MA in Higher Education. She joined the administrative team of the Urban Renewal IGERT with professional experience in university program administration. She served as program coordinator from Fall of 2009 until the Spring/Summer of 2012. The second program coordinator was an Asian woman with a BA in Philosophy. She completed her MA in Higher Education during her tenure as program coordinator. She also served the program for 3 years, from the Fall of 2012 until Spring/Summer of 2015. It should be noted that in 2012 the IGERT coordinator position expanded with the inception of another IGERT program in the School of Engineering at Hillman. The IGERT coordinator became responsible for the administration of the Urban Renewal IGERT as well as the Computer Networking IGERT. These programs functioned as two separate entities' with two different sets of goals, objectives, administrative staff, etc.

The current IGERT coordinator is a male of Hispanic/Latino descent. His previous work experience was in undergraduate admissions. He earned a BA in East Asian Studies and was also in the process of earning his BA in Higher Education at Hillman while serving as the IGERT program coordinator. At the time of data collection, he had been in his position for about 4 months.

A number of Hillman University administrators from within and beyond the School of Engineering have also contributed to the Urban Renewal IGERT since 2009. These persons have contributed to program recruitment, program evaluation, student advising and support, and curriculum development.

**IGERT trainees/IGERT affiliates.** IGERT student trainees are students who were accepted into the IGERT program and funded by program monies. Trainees receive the IGERT fellowship for the first two years of their doctoral program. Students are still considered IGERT trainees after their funding expires, and are required to attend IGERT events. IGERT affiliates are doctoral students who are not formally enrolled in or funded through the IGERT program, but apply and are selected to participate in IGERT coursework and seminars. Affiliates can be students who may not have met admissions criteria for the program but have an expressed interest in interdisciplinary training, or their research topics and projects directly align with the research focus of the IGERT. By participating in IGERT coursework, seminars, and activities, IGERT affiliates are considered members of IGERT cohorts with trainees. This IGERT program has served a total of 23 trainees and 5 affiliates during all years of funded program services. An overview of the group of doctoral students that the Urban Renewal IGERT has served is provided. The table (Table 4.1) below identifies the number of students served each year and their home departments.

*Table 4.1 Total Number of IGERT Students Served*

School/Department	Number of Students				
	Cohort 1	Cohort 2	Cohort 3	Cohort 4	Total
Architecture & Urban Design	2	2	2 + (1 Affil.)	1	7 + 1
Civil Engineering	3 + (1 Affil.)	3	1 + (1 Affil.)	1 + (1 Affil.)	8 + 3
Mechanical Engineering	1	1	0	1	3
Earth & Environmental Engineering	0	1 + (1 Affil.)	2	2	5 + 1



Total	6 Trainees (1 Affil.)	7 Trainees (1 Affil.)	5 Trainees (2 Affil.)	5 Trainees (1 Affil.)	23 + 5
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**External partners/external support.** The Urban Renewal IGERT also received various forms of support from a number of external partners from within and beyond the affiliated schools and colleges at Hillman University. External support varies in nature from financial to curricular/programmatic. Additionally, several organizations partnered with the IGERT for purposes of assisting students with securing internships and co-ops, and affording IGERT trainees with opportunities to develop interdisciplinary research projects that address existing problems related to urban renewal. Each external partner outlines the specific support that committed to giving the Urban Renewal IGERT throughout the life of the grant in the form of a letter that was included with IGERT program proposal submitted to the IGERT grant. The table below (Table 4.2) lists the program's external partner and provides a summary of the ways in which they have agreed to support the IGERT program.

Table 4.2 Letters of Support Table

Institution	Form of Support	Description
Hillman University Executive Vice President of Research	Financial	Tuition fellowships to supplement the difference between budgeted costs of attendance/education. This represents an estimated total level of support of the up \$1.55 million  Supplemental university support of up to \$54,000 a year over the duration of grant. These monies will be spent in the form A total contribution of \$270,000
Hillman University School of Engineering and Applied Science	Financial	Tuition fellowships to supplement the difference between budgeted costs of attendance/education. This represents an estimated total level of support of the up \$1.55 million  Supplemental university support of up to \$54,000 a year over the duration of grant. These monies will be spent in the form A total contribution of \$270,000
Hillman University School of Architecture and Urban Design (Dean)	Administrative/Curricular  Research Training and Development	“I have established a series of “think and action tanks”, a set of research units which collaborate to provide the highest possible levels of data collection, analysis, and application”  Partnerships facilitated through existing studios and labs  “I will be a participant to the project in an advisory, pedagogical and facilitating role.”
Hillman University School of Engineering (Asst. Dean of Faculty Diversity & Director of Post-Doctoral Affairs)	Student Support  Recruitment	The office will work with the PI to establish and sustain relationships with HBCUs and Hispanic Serving Institutions  “These offices will provide professional development opportunities for the IGERT students and post-doctoral fellows and provide a comprehensive program to support the success of these students.”

		The office claims to make “significant gains in the number under-represented minorities and women into Engineering and Architecture”
Hillman University Urban Development Group	Research Seminars Industry Partnership	“ We will welcome the collection of available research data by the PhD students and will participate in seminars in which IGERT PhD students, faculty and practitioners on the Hanks Project discuss meeting the challenges of urbanism by design”
12 <sup>th</sup> Street Business Improvement District	Research Consulting External Advisory Board	The 12 <sup>th</sup> Street BID is happy to consult with Hillman University on the design research projects that the IGERT fellows will undertake.
Hillman University The Earth Institute	Internship Research Facilities	<ul style="list-style-type: none"> <li>- assisting IGERT trainees in obtaining internship experiences on involving a meaningful project related to sustainable urban development that will include a global partner</li> <li>- access to state of the art cyber enabled audio and video collaboration facilities</li> </ul>

Hillman University International Development and Globalization IGERT	Internal Board of Advisors  Research  International Partnerships	<ul style="list-style-type: none"> <li>- IGERT program manager will sit on the Internal Advisory Board and will share best practices and lessons learned through developing and managing the IGERT program</li> <li>- The program will arrange an annual research symposium and an annual joint inter-IGERT symposium</li> <li>- Will assist and enable IGERT students to secure international partnerships</li> </ul>
Sapienza Universita Di Roma	Research Partnerships	<ul style="list-style-type: none"> <li>- Facilitate research visits for IGERT students to explore new research and global collaborations</li> </ul>
Oluf Granlund	Research Collaboration	<ul style="list-style-type: none"> <li>- Building upon existing collaborations with Professor Grayson</li> <li>- Agrees to host faculty and IGERT PhD Students on visits to explore new research and global collaboration directed at the use of design in solving urbanization challenges</li> </ul>
Indian Institute of Technology Madras	Research Collaborations	<ul style="list-style-type: none"> <li>- Building upon existing collaborations with Professor Grayson</li> <li>- Agrees to host faculty and IGERT PhD Students on visits to explore new research and global collaboration directed at the use of design in solving urbanization challenges</li> </ul>

Global Center of Excellence Program, Entitled by Urban Sustainability	Research Collaborations	<ul style="list-style-type: none"><li>- Building upon existing collaborations with Professor Gaines</li><li>- Agrees to host faculty and IGERT PhD Students on visits to explore new research and global collaboration directed at the use of design in solving urbanization challenges</li></ul>
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## **IGERT Program Components**

**IGERT program curricula.** The following section will provide an overview of IGERT Program curricula including IGERT coursework, program activities and program policies and procedures.

*Coursework (core curriculum).* All IGERT trainees progress through a core curriculum of two or three integrated courses, an integrated studio experience, annual research symposia, and a professional development workshop/seminar series. Student trainees also meet with advisors to identify other applicable course electives that constitute each trainee's overall plan of study. Integrated courses and the urban ecology studio are taken during the first two years of doctoral study. Electives were taken as students progressed through their degree programs.

*Urban ecology studio.* IGERT Trainees are required to take the integrated Urban Ecology Studio. This is a four credit course where students work on collaborative learning teams to develop integrative design projects. The studio focuses on an existing challenge of urbanization as experienced by an actual urban stakeholder who will serve as client for the Studio course. The studio method/course design is a pedagogical tool that is central to graduate study in applied fields, like architecture. In studio courses, students are challenged to build and apply their knowledge and work under the supervision and instruction of faculty toward resolving existing problems. The problems addressed in the studio are divergent and multidimensional in nature. Consequently, the information that is collected, the manner in which that information is processed, and students' analysis applied to the design problem will all lead to the development of a range design solutions. These

solutions will vary in terms of effectiveness and efficiency, and each will be applicable to the design problem to some degree. The design studio fosters an environment where students and faculty of different disciplinary backgrounds who share common interests can work together to engage with explicit problems and complex phenomena. Within the studio, faculty and students work together to cultivate the acquisition of new knowledge, concepts, investigative tools, and research techniques for student participants.

*City as assemblage.* This core course examines the development and constant evolution of cities. It is designed to afford students with a holistic and historic understanding of cities, with an emphasis on the prevalence and precedence of networks and assemblages of human and non-human things. The course utilizes perspectives from actor-network theory, research, and scholarship on “vibrant matter”, cyborg urbanism, development and infrastructure, urban assemblages and ecology, and the city. Course content will focus specifically on “natural” forms such as wetlands and rivers, plant and animal life, people, infrastructures, the materiality of buildings, and specific structures such as billboards.

*Sustainable urban infrastructure systems.* This core course is based on the perspective that cities, and the infrastructures that support cities, are all interconnected and interdependent components of complex systems. In order to understand and function within these complex systems, constructive dialogue that considers societal, environmental, and physical perspectives is requisite. Sustainable Urban Infrastructure Systems is designed to afford students with an interdisciplinary framework that integrates the perspectives of the engineering, architecture and urban

planning. This framework positions students to conduct practical research that focuses on ecological, resilient, and adaptive urban design and urban planning. Course discussions cover a variety of topics including the intersections between ecosystem function and urban environments, short-term and long term natural and man-made threats to urban areas and policy, governance, and cultural factors that can shape urbanization.

*Strategic management in global design construction/ IGERT globalization and virtual teams seminar.* The content of this course was developed to introduce students to the strategic issues that are related to virtual working environments and managing projects in the ever-expanding industries of construction and global design. A number of construction companies and design firms are expanding their business models to incorporate virtual working environments. These virtual environments position and empower industry professionals to develop global teams that conduct iterative and synchronous research. The nature of this work is dynamic and uncertain and a significant level of coordination and communication is required to ensure the work is productive, especially with project teams that are globally distributed. This course investigates the issues and strategies that are employed to manage projects in global design and construction. Specific emphasis is placed on understanding how the virtualization of the workforce is influencing and being impacted by industry globalization. Students virtually contribute to a global collaboration team project that involves other graduate students from institutions in several different countries. Together the team uses organizational simulation tools and modeling tools to conduct an urban construction project and present their findings. Additionally, students are



exposed to issues of both theory and practice through virtual discussion with other students on the global collaboration team.

*IGERT program activities.* The following section describes specialized IGERT program activities designed as afford supplemental training opportunities for student program participants. The section concludes with an overview of the pathway and trajectory of program curricula and program activities that IGERT student participants were required to complete in order fulfill program requirements.

*Professional seminar series: “Brown bag seminars.”* The professional development workshop/seminar series is offered on a bi-weekly basis. Workshops/seminars are an hour long, and all trainees are required to attend during their first two years of the IGERT program. Participation is not mandatory but strongly encouraged for students in their third of year of doctoral study and beyond. Workshops feature a variety of invited guest lecturers & speakers and the workshop content covers a wide range of subject matter.

The seminar series is designed to:

“(1) examine interdependencies that must be addressed to holistically meet the challenges of urbanization, (2) provide interactions with designers to create a meaningful exchange about design and approaches including ethical approaches, to the global challenge of urbanization, (3) allow a forum for the more senior IGERT trainees to present their research and work to newer trainees, and (4) provided professional development opportunities for Trainees” (Program Proposal, n.d., p. 17).

The seminar space serves as an environment where program participants and partners discuss and engage around existing scholarship, new research, and practical and professional strategies and information. Former and current IGERT students and IGERT faculty refer to the seminar series as the “brown bags” or the “brown bag seminars.” IGERT participants and partners also use the space to discuss the potential for future collaboration and opportunities for employment. Similarly, students also have the opportunity to learn and engage with campus departments and support services and resources during the seminar. These professionals will provide IGERT trainees with a variety of professional development tools and information that can be used to assist them as they navigate their doctoral programs and survive and succeed in graduate school. Examples of training and professional development topics covered during seminar series include: proposal and paper writing, effective mentoring, strategic planning and career success, negotiation skills, public speaking, research presentation and effective communication to various audiences, ethics and responsible conduct, leadership, resume writing, applying for jobs, and interviewing.

Faculty and professionals from local and national colleges and universities, research organizations, government agencies and think tanks have served as guest speakers for the seminar series. Additionally, doctoral students and faculty from within and beyond the IGERT program have also served as speakers and facilitators for seminars. A small number of seminars are devoted to social interaction and cohort building. These events give IGERT trainees the opportunity to socialize and strengthen relationships with their peers and colleagues.

*Research symposium.* The IGERT also sponsored several research symposia throughout the life of the IGERT grant. These symposia convened faculty, researchers, and design practitioners to present and discuss research and design solutions that emerged through research projects. IGERT student trainees from all cohort years were asked to present their research and participate at the symposium. The symposium participation exposed IGERT student trainees to presentation opportunities at national professional conferences and spaces. International program partners, global collaborators and students and faculty from other IGERT projects were also invited to participate in the research symposia. The goal of the research symposium as articulated in the program proposal was “to ensure that that IGERT participants at Hillman University are up-to-date with ongoing, complimentary work, and to generate potential collaborations between other IGERTs that have parallel themes.”. Similarly, the symposium was instrumental in facilitating discussions among IGERT faculty, students, and administrators about current pedagogies, and the educational and training needs of the community of IGERT trainees.

*Opportunities for international study & international partnerships.* Trainees have the opportunity to work with international partners (think tanks, NGOs and government organizations) and spend time in urban areas in other global markets. In 2012, the IGERT trainees and faculty from the Urban Ecology Studio were sponsored by a nonprofit organization to conduct research that focused on specific issues of sustainability in the Puerto Plata region of the Dominican Republic. In 2013, The Urban Ecology Studio traveled to East Aalborg, Denmark for ten days to work with another group of students in the Erasmus Mundus Scholars program. The Erasmus

Mundus focuses on interdisciplinary research that addresses challenges associated with urbanization. Students worked collaboratively on design projects that focused on reimagining the role of suburban areas in future cities.

In addition to group research trips, travel stipends were offered as a benefit of the IGERT fellowship. Trainees with opportunities to conduct and/or present literature in other countries and regions of the world were encouraged to apply for IGERT travel monies. These one-time awards were established to help Trainees defray costs associated with studying and working abroad.

All trainees have the opportunity to intern with the University's Earth Institute Millennium Cities Initiative. As an intern, students are based locally at the university but work on projects that focuses on urban renewal in developing countries.

*The pathway to program completion.* All IGERT students were admitted simultaneously into the IGERT program and their graduate/doctoral programs in their home departments. Students were admitted as a members of a cohort and were expected to complete IGERT coursework as a cohort. Each IGERT student trainee is supported by IGERT funds for a minimum of two years. Students were responsible for working with advisors to secure funding for the third and all subsequent years of their doctoral training.

Each IGERT student/ IGERT affiliate was required to complete two or three integrated courses, and attend and participate in a biweekly seminar series. IGERT courses were to be completed during the students' first and second year of doctoral study. Students were expected to participate in the bi-weekly seminars and the annual research symposia after they completed their IGERT coursework, and until they

completed their doctoral study. IGERT students/affiliates are expected to complete IGERT courses, seminars and activities, while fulfilling the curricular requirements of their respective home departments. Additionally, students were expected to work with IGERT faculty advisors to co-construct a plan of study and research experience that would facilitate the development and completion of an interdisciplinary dissertation project. It should also be noted that IGERT courses were not exclusive to IGERT students. Other students enrolled in various undergraduate and graduate degree programs in various disciplines were enrolled in IGERT courses as well.

Trainees may participate in their study abroad/international project at any point during their doctoral study. While not required, all students are strongly encouraged to participate in one international project during their graduate study. Consistent with the second stated goal of the IGERT program, each trainee is afforded the opportunity to visit another city at a collaborating institution in another city. Additionally, IGERT Trainees have the opportunity to participate in teaching training experiences or outreach activities. Students with expressed interest in applying for faculty positions upon graduation are also able to gain additional teaching training by serving as a teaching fellow in the IGERT Studios. IGERT students with expressed interest in securing positions in industry, government organizations, and/or NGO's will have the opportunity to work alongside urban stakeholders to publish and publicize IGERT research.

***IGERT program policies and procedures.*** This section is comprised of a description of policies and procedures of the Urban Renewal IGERT program. Policies and procedures on program recruitment, student advising, retention are

provided followed by a comprehensive overview of program evaluation and assessment procedures.

*Program recruitment.* The IGERT program developed a program website and a range of print marketing materials in order to provide program recruitment information to prospective students. Program information is featured in online and print marketing for the School of Engineering and the School for Design and Hillman University as well. Similarly, IGERT faculty and administration have participated in national conferences and research symposia for student and professional organizations for underrepresented populations. Additionally, the IGERT has sent representation to a number of graduate school fair and colleges and universities across the nation in effort to recruit graduate students into the IGERT program.

According to the program proposal, members of administration and leadership of the IGERT program are committed to addressing issues of racial diversity in STEM graduate education by increasing the number of the persons from underrepresented populations represented in the faculty and student population in the IGERT program and STEM graduate programs/schools at large. Program funds have been specifically earmarked/allocated for IGERT faculty to travel to minority serving institutions in order to develop and sustain strong partnerships that will facilitate the recruitment, mentoring, and support of minority students into the IGERT program. The program proposed to work in the collaboration of the Office Faculty Development and Diversity to cultivate faculty exchanges between IGERT faculty and faculty at historically black colleges and universities and universities of systems known throughout the world for graduating large numbers of Hispanic students.

Similarly, existing relationships between the Office of Faculty Development and Diversity and organizations and program specifically designed to support underrepresented students in STEM graduate education will be leveraged to “aggressively” recruit underrepresent minority students and women into the IGERT program. The sponsoring institution was cited in a recent report as graduate program that has the highest number of African American alumni who are licensed professionals in the field of architecture. Additionally, the School of Design has organized/assembled a board of advisors that can guide and assist the school and the IGERT program in attracting and recruiting faculty and students of color. Existing program and organizations at Hillman and its affiliated or sister colleges and universities will be leveraged to help recruit IGERT trainees and IGERT trainees of underrepresented populations into the program.

The Executive Committee of the program argues that the thematic basis/subject area/interdisciplinary focus of this IGERT program will be attractive to underrepresented populations. As cited in the program proposal (n.d.), “There is growing evidence that women and under-represented minorities in STEM disciplines are attracted to programs that are interdisciplinary in nature, involve contextual problem solving and have potential for societal impact” (Beraud, 2003; Fromm, 2002, p. 5).

*Student advising.* Every IGERT trainee was assigned an advisor from his/her department. Trainees were asked to submit a written outline/summary of their research interests at the end of the fall semester of the first year of doctoral study. That outline was reviewed/assessed by IGERT program administration and/or

members of the Core Executive Committee. Following that meeting, a joint advisory committee consisting of faculty from a range of disciplines and programs was assembled for each trainee. The joint advisory committee is tasked with ensuring the “ (i) the trainee’s education and research experiences are interdisciplinary and well suited to the trainee’s skill set and interests, (ii) the trainee engages in a suitable research/internship activity during the summer semesters, (iii) the trainee gains global education and research experience; (iv) the trainee obtains an appropriate teaching or outreach experience, and (iv) overall, the Trainee experience in the IGERT program is positive.” (IGERT Program Proposal, n.d., p. 25). The composition of the committee will be revisited and reassessed and the end of year one and year two. No changes will be made to the committee following year three.

*Retention services.* As per the program proposal, “Hillman has an excellent record for retention in the PhD degree across all the departments and programs involved in the IGERT.” (IGERT Program Proposal, n.d., p. 25). The program aims to the maintain that record especially for students presently underrepresented in STEM PhD programs, namely women students and students who are African American, Hispanic/Latino, and American Indian/Alaskan Native. The IGERT program has organized a very diverse group of participants and contributors who are instrumental in administering program services and support. All IGERT trainees received intensive mentoring and careful monitoring by IGERT program staff and administration. Each IGERT trainee meets with two administrators, identified as senior program personnel, at the end of every semester. The purpose of these meetings are to assess and understand student perceptions of the advising/mentoring



that they receive through the IGERT program. Any student who may have appeared to be at risk of academic dismissal or withdrawing was asked to meet with a me a team of advisors and IGERT senior program personnel to develop an individualized feasible retention plan for the at-risk student.

With regard to retaining IGERT Trainees of URM populations, over thirty-five percent of the persons identified in the IGERT program proposal/contract as core participants of this IGERT are women and/or underrepresented minorities. These persons worked collaboratively with IGERT Faculty and staff and served as role models and mentors that contribute to the success and retention of the URM IGERT trainees.

*Program evaluation and assessment.* A comprehensive plan for program evaluation has been established to assess formal IGERT program objectives. An assessment team consisting of an external evaluator, an external advisory board and an internal advisory board facilitate the ongoing evaluation and revision of IGERT program services. The assessment team functions under the direction of Associate Dean of the School of Engineering. The Associate Dean has extensive experience and expertise in outcome assessment methods for student learning, and the design and application of tools for curriculum assessment in higher education. The external evaluator for the program is the Director of Research and Evaluation at the Institute for Learning Assessment. The Director has substantial experience in designing and administering the evaluation of educational projects that employ innovative pedagogical strategies in secondary and higher education. Examples of organizations and agencies that have been evaluated by the Director include the US Department of

Education, the National Science Foundation, various state and local government offices, and a host of private foundations. The Director has also served as the external evaluators for two other IGERT projects within Hillman University. Formative external evaluations have been conducted at the end of each programming year. A summative evaluation will be done at the end of the fifth and final year of the IGERT project funding grant.

As cited in the IGERT Program proposal, “the evaluation will look at the success of the project in reaching its overall goal of developing a new PhD program between Architecture and Engineering that graduates a cohort of diverse design students uniquely qualified to work on contemporary urbanization challenges.” (Section 6 p. 22). The evaluation population consists of IGERT faculty, IGERT students, and external partners & program stakeholders. A control group of non-IGERT students is also included in evaluation activities to assess any differences in the graduate school experiences by IGERT Trainees and non-IGERT participant counterparts. Similarly, a host of program data in the form of surveys, focus groups, network analysis, and structured interviews is collected to monitor the success of program interdisciplinary activities including, “the mentoring/advising structures, the newly created (IGERT) courses, the Studio experience, the weekly seminar series, and the annual research symposium.” (IGERT Program Proposal, n.d., p. 22). The progress of all IGERT Trainees is monitored throughout their entire graduate careers. An annual report is made available to both IGERT faculty and IGERT Trainees as developed and submitted by the external evaluator through the IGERT Executive

Committee. These reports provide program feedback that is used to revise, refine, and improve IGERT program services and practices.

A number of educators and professionals were asked to serve as advisors to the IGERT program. The Internal Advisory board consisted of faculty and administrators at Hillman University as well as local industry leaders and professionals. The External Advisory Board was comprised of faculty, principal investigators of other IGERTS and graduate training programs at other universities, and professionals and leaders of industry and STEM professional organizations from around the nation. Each member was selected for his/her expertise and professional or research experience in a number of fields and areas associated with the IGERT including, graduate education in the STEM fields, interdisciplinary research, recruitment, retention, & support of underrepresented students, globalization, urban renewal, brokering partnerships, architecture, etc. These persons convened to provide guidance and feedback on seven outlined metrics that served as the basis for the plan of assessment designed to ensure that IGERT program services aligned with the established goals and objectives of the IGERT program. The seven metrics are as follows: “1) importance and intellectual merit of IGERT research, 2) importance and intellectual merit of IGERT core curriculum, 3) capacity of IGERT research to concurrently address urban adaptivity, resilience and ecology, 4) diversity of IGERT trainees, 5) differences between IGERT trainees’ research and educational experiences and the research and education experiences of PhD students in traditional engineering, architectural and urban design programs, 6) importance of IGERT

products to urban stakeholders, and 7) importance of IGERT products to Hillman University” (IGERT Program Proposal, n.d., p.23-24).

The advisory boards met and communicated regularly to monitor the progress of the IGERT program. Each board worked collaboratively amongst themselves with the Dean of the School of Engineering to provide written feedback to the Executive Committee. Examples of the IGERT program areas addressed, and sometimes modified, by advisory boards include: the content of IGERT core coursework, and the nature and sustainability of relationships between IGERT trainees and external industry partners & program stakeholders.

### **Overview of Data Sources and Data Collection Procedures**

Data collected to answer the research questions of this study was gathered from a number of sources including: document review/analysis, surveys, and semi-structured interviews. A number of existing program documents from the Urban Renewal IGERT were collected in order to define and describe the organizational structure and culture of the IGERT program. Program documents reviewed for this study included, the Urban Renewal IGERT Program Proposal (including attachments and appendices), the informational and recruitment website, print recruitment materials, existing annual evaluation reports (2009-2014), transcripts of student focus groups, job descriptions of program staff, and the resumes and curriculum vitae of program faculty. These documents were reviewed, coded, and analyzed through the lens of the applicable theory as described in previous chapters.

A sample of current and former IGERT trainees and affiliates completed an online survey designed to assess student perceptions of the communication and

information transfer within program contexts. The survey sought to identify the most prevalent means of communication between IGERT student participants and their peers, advisors, other IGERT faculty and IGERT staff, as well as illuminate the the nature and frequency of communication between and amongst groups of IGERT program participants. The survey consisted of approximately 40 items. A total of 18 students completed the survey, and 3 students chose not to complete demographic questions of the survey. 44.4% (8) of the respondents identified as male students, 38.8% (7) respondents identified as female students, 16.6% of respondents did not respond to this question. Additional demographic data is provided in Table 4.3.

*Table 4.3 Demographic Data Survey Respondents*

<u>Ethnicity</u>	<u>Number</u>	<u>Percentage</u>
Asian	1	.05%
Black, African American	2	11.1%
Hispanic/Latino	3	16.6%
White	9	47.3%
Did Not Identify (Left Blank)	3	16.6%

<u>Doctoral Program/Home Department</u>	<u>Number</u>	<u>Percentage</u>
Civil Engineering	6	33.3%
Environmental Engineering	2	11.1%
Mechanical Engineering	1	.05%
Engineering ( Did Not Specify)	2	11.1%
Total Engineering	11	61.1%
Urban Planning	5	27.7%
Did Not Identify (Left Blank)	3	16.6%

The final data source of this study was a semi-structured interview. Thirteen IGERT program participants agreed to be interviewed in this study, including three IGERT faculty members (including the Project Director) and two IGERT Coordinators (one former coordinator and the coordinator that is presently serving the program). Five IGERT student participants were interviewed and three former IGERT students, program alumni completed interviews. Students were considered program alumni if they had completed their doctoral studies and were no longer enrolled as students at Hillman University. Pseudonyms were created for persons interviewed for this study, and they will be referred to as such in the presentation and discussion of findings.

Given the size of the program and the personal and sensitive nature of experiences and perceptions shared by participants, certain measures have been taken to protect their anonymity and the anonymity of the program. To the extent possible, I will indicate as much information as I can about each participant to properly contextualize the presentation and analysis of findings. This may include a participant's gender, program affiliation, or their race/ethnicity. However, any information that may compromise the confidentiality of the participant's responses has been excluded.

## Chapter 5: Analysis of Findings

### Introduction & Chapter Overview

The purpose of this chapter is to review the findings of the study. The study findings are informed by several data points including an analysis of program documents, a survey and semi structured interviews. The findings are reported in alignment with key elements in William Tierney's Theory of Organizational Culture. Conceptual tools from Gopaul's (2011) conceptualizations of graduate student socialization will be used to investigate and understand the training experiences of IGERT student participants.

Tierney's concepts will be used to define the cultural components of the Urban Renewal IGERT and demonstrate the specific ways this program's culture influences how student participants are socialized and trained as they navigate their doctoral study. A final summary of the organizational culture of the Urban Renewal IGERT will be presented next, followed by an overview of the organization's challenges and limitations that emerged while defining and describing the program's culture through data analysis. Finally, a presentation of emergent themes on the specialized training afforded to IGERT participants and the experiences of underrepresented students within the IGERT will follow. This section will also highlight how the IGERT has impacted and shaped the doctoral training of URM students through the lens of Gopaul's (2011) conceptualizations of graduate student socialization theory.

## **The Organizational Structure of the IGERT**

The organizational structure of the Urban Renewal IGERT program is loosely bound and loosely connected. Data shows that IGERT program courses were not directly connected to one another or specifically connected to student's overall doctoral training. Throughout the program data IGERT students expressed a desire for more connection between the training that they received through various program components and with required courses in the home doctoral degree programs.

In each year of evaluation data students expressed feeling that the IGERT program did not provide enough structured opportunities for interaction and engagement across program components. Data shows that the IGERT program could have facilitated interaction with people from different disciplines across IGERT courses and IGERT activities to a greater extent. According to transcripts of a focus group, IGERT students conducted through the program's internal evaluation efforts, one student participant argued that IGERT students needed to proactively make connections with other students, faculty, departments, research training opportunities, etc., instead of relying on the program to do it. In the evaluation report for year three of the IGERT, another student described the program as a collection of "discrete experiences, like the Brown Bag, lectures, Studio, etc." rather than a cohesive and coherent program. Kimberly, an Urban Planning student in the inaugural cohort of the IGERT, described how student interaction typically decreased after coursework. Her comments reflect the minimal connections between IGERT courses and other IGERT activities.



Now, I mean, after your coursework you really had no . . . no need to interact beyond the fact. It kind of became a burden because there was also no incentive to interact. If a relationship or bond across disciplines hadn't already occurred, I think that, you know, wanting to encourage interdisciplinary is great; but the practice of actually doing that takes more work than just putting two people/two groups of people together in a room, shaking them together and hoping something sticks.

Students also expressed that certain IGERT courses were interesting and worthwhile but did not particularly connect with their research interests or the required coursework in their home departments. Data from year one and year four annual evaluation reports revealed that several Engineering and Urban Planning students who participated in the IGERT considered the Strategic Management in Global Design, Construction/Globalization and Virtual Teams course content useful but not related to their research interests or their academic or research goals. An alum of the program, Ron, identified the required IGERT courses as the least useful component of the program. According to Ron, these courses did not connect to his research interest or contribute to preparing him for qualifying exams or other necessary benchmarks of progress in his home department of Civil Engineering. A required IGERT course kept him from taking a course that was germane to his dissertation research. He missed his only opportunity to take this course as it was only offered once every several years. His annoyance with the lack of “relevance” of IGERT programming is exhibited in the following comment.

It's kind of a double-edged sword, right? But I think the most frustrating part was the curriculum. Because in the PhD program, . . . You have very limited time to take classes. And you need those classes to really work towards your dissertation and your qualifying exams. And if I'm spending one or two classes a semester on these topics that have virtually nothing to do with my research, it's pretty frustrating. So like, for an example, there was this one class that was offered once every other year which . . . at best, once every other year. It ended up only being taught once during my entire career at Columbia. And I couldn't take it because it conflicted with... It's just frustrating that you have to sacrifice your discipline to a degree to be able to maintain the requirements of the IGERT.

The loose connection between IGERT courses and other courses was challenging for students to navigate and greatly influenced how students navigated the IGERT program and their doctoral training.

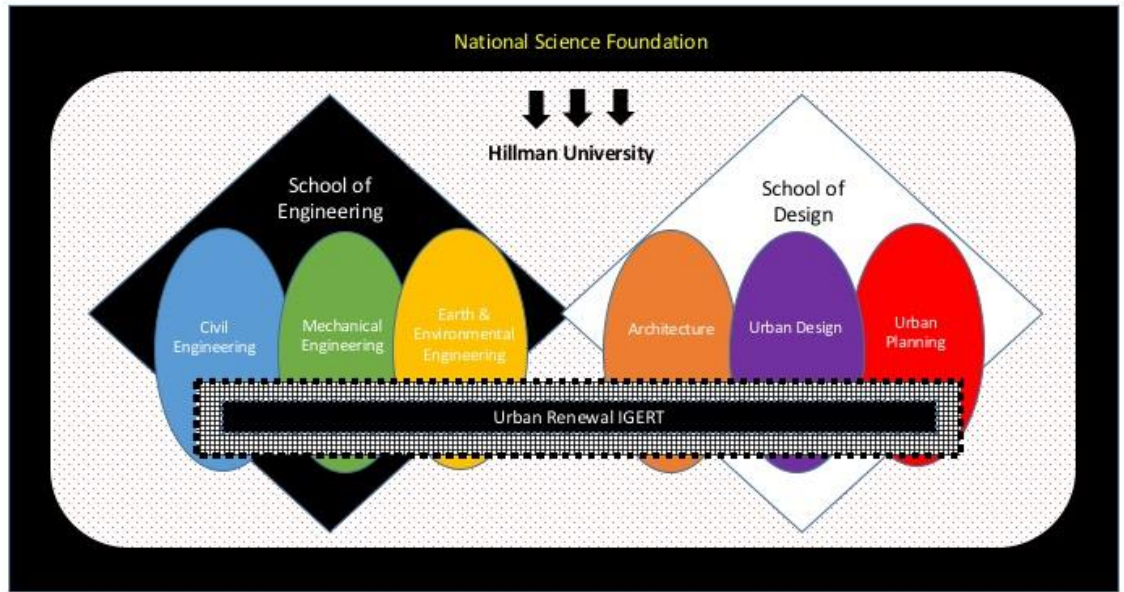
### **Organizational Culture of the IGERT**

The organizational culture of the Urban Renewal IGERT program is multi-dimensional and dynamic. The program culture is characterized by constant change and activity due to loosely connected organizational structure of the IGERT and the flexibility that students exercise while managing the responsibilities of the IGERT within the demands of multiple surrounding contexts. Concepts of William Tierney's Theory of Organizational Culture were used to identify and illuminate the organizational culture of the Urban Renewal IGERT. Four of the six concepts were most appropriate in meeting the goals of this study. Those concepts are environment,

mission, socialization and information. Each concept will be defined and employed in the analysis of the data in the sections that follow.

**Organizational culture theory concept: Environment.** According to Tierney (1997) program environments are defined and understood by exploring how participants describe the various contexts and entities that surround them. Illuminating a program's surrounding environment informs the analysis and interpretation of the program by providing the context necessary to understand that program as it is experienced by all participants. The Urban Renewal IGERT program is deeply embedded. All IGERT courses and related activities exist within six different graduate degree programs within both the School of Engineering and the School of Design at Hillman University. The program is also obligated to comply with guidelines established by the funding agency, the National Science Foundation (NSF). As illustrated in Figure 5.1, the Urban Renewal IGERT functions within the contexts of surrounding graduate departments, the Schools of Engineering and Design, Hillman University and NSF. The environmental contexts that surround the Urban Renewal IGERT influence the IGERT program participants and participants are expected to successfully navigate and negotiate each of these contexts. Each of these environments have their own priorities, values and standards of behavior that occupants are expected to comply with in order to succeed.

*Figure 5.1. Urban Renewal IGERT and Surrounding Environments*



The data reveal that environmental contexts that surround the IGERT influence the IGERT program participants in three specific ways. Environmental contexts surrounding the Urban Renewal were found to be 1) unfamiliar with or resistant to the Urban Renewal IGERT 2) in conflict or competition with the IGERT and 3) intrusive upon IGERT student and faculty participants. What follows is a discussion of the ways that contexts and environments that surround the Urban Renewal IGERT program influence the program and the training of student participants.

*Surrounding environments unfamiliar with and/or resistant to the Urban Renewal IGERT.* Participants perceived that faculty and administration at the departmental level within the School of Design did not acknowledge the IGERT program as a useful training program for their students. Faculty reported that senior leadership in the School of Design vocally expressed their disdain or lack of approval

of the IGERT program. During his interview Professor Vernon Gaines of the School of Urban Design attested to the lack of support from the administration in the school, specifically from the Dean.

Institutionally, it was not a very positive situation. It was not reinforcing that grant. Starting with the School of Design, the Dean did not like this idea for very crazy reasons. He obstructed it. He agreed to apply for the grant and then when it came around to how the money would work he was opposed to it for reasons that none of us could ever understand.

The administration's resistance to the IGERT program had adverse effects on the faculty's perceptions and willingness to commit to engage with and support the program or student participants of the program. Similarly, findings from the annual evaluation report of year three of the IGERT, conducted by the IGERT program's external evaluator, show that IGERT faculty expressed concern for how the IGERT would impact student training as well as their future career. Faculty were surveyed as a part of the assessment and results reveal that a number of the faculty members affiliated with the IGERT program worried that the interdisciplinary focus of the program could limit students in terms of future professional options and may hurt students by making them less marketable for faculty positions. This demonstrates the faculty's unfamiliarity with and/or resistance to the IGERT program and their failure to recognize the program's contribution to the training and socialization of student participants.

***Surrounding environments in conflict or competition with the Urban***

***Renewal IGERT.*** The environments that surround the Urban Renewal IGERT were

in conflict or competition as a result of differences in disciplinary and departmental values, interests and priorities. Traditionally, graduate education is discipline specific and graduate training is very focused (Walker et. al., 2008); students are typically immersed in their graduate departments and trained to know, hold and solely practice the values, perspectives, methodologies, norms and professional standards of their field of study. The nature of the IGERT is based on cross disciplinary collaboration which is counterintuitive to conventional graduate training in the STEM fields. IGERT participants reported several instances of culture clashes and conflicts where the disciplinary and departmental values, norms/methods, interests and priorities differ amongst students and faculty from different fields resulted in tension, disagreement and anxiety. Navigating these conflicts and clashes in departmental and disciplinary culture was a challenge for both IGERT students and faculty which impacted the training of student participants.

During a focus group workshop, one female IGERT student reported that she was cautioned against the IGERT by her advisor in her home department. Although her advisor acknowledged that the IGERT was a good opportunity, he was fearful that it would distract her from the research that she was engaged in as a member of his research team. The warning that she received from her advisor led her to expect discord and tension between her responsibilities to the IGERT and her responsibilities to her advisor.

And I have to say that my own trepidation came from my advisor being a little... like, 'Well, maybe this will be a good opportunity for you, but don't let it take away from your research.' And the fact that he would say that to me

is like, “oh...” This is the type of thing that might be really fun, but now there’s this disconnect between this IGERT. I want to start looking into other things, but my advisor wants me to still focus on my own research. So there is definitely this sort of expectation of there being a possible tension between what’s going on in the IGERT and what my advisor wants from me.

Similarly, another student described the tension he experienced between the competing responsibilities of the IGERT and his home department. His department required students to complete a research thesis during their first year which conflicted with the IGERT requirement that students take and complete two IGERT courses during year one, namely the Urban Ecology Studio, where students work collaboratively to complete a very large project. He felt that the IGERT could have or should have done more to make sure that there was more coordination between IGERT program requirements and home departments so that students would not feel so distracted or that their efforts in one area would not compromise their ability to perform in another area.

From my own department, it was a very big distraction to have to do sort of two seemingly unrelated projects then try and, you know, take as much as I could from the IGERT one and apply it to the MS.... Because you know in the interest of time, all this stuff. I wish that it could have been like, you know, a lot more energy invested into something that could have been much better instead of like distracting or diverting my attention. .... So perhaps

coordinating is a big deal, you know? I think for the departmental requirements, it's really hard.

Students were not the only stakeholders who experienced the conflicting interests. All of the faculty interviewed for this study mentioned and/or described conflicting interests a well. Each provided an example of how conflicting/competitive interests influenced the program and the training of program participants. A faculty member from Urban Planning, Professor Taylor Bradford, perceived a clash in disciplinary culture between the fields of Urban Planning, Architecture and Civil Engineering. He highlighted differences in the ways that each discipline structured doctoral training for students and differences in the way that each field approached and conducted research. He noted that Engineering students typically navigate a path toward their dissertation that is a bit more defined and clearly outlined whereas students in Urban Planning have to identify faculty on their own who will help them design their research path. Similarly, he found that Architecture and Engineering students were more familiar with design approaches and were much more comfortable in the Urban Ecology Studio IGERT course. Urban Planning students were not at all familiar with design approaches and typically struggled with the Urban Ecology Studio.

Civil Engineering is very much based upon research culture, where lots of grant money is being brought in and people are working directly with the faculty on research projects. That's different from the culture here, we don't have faculty bringing in a lot of money, students are not attached to individual faculty, and their path in the program is not as clear. My students were not used to doing studios, we don't give PhD students planning studios, they don't



take them, but Vernon Gaines was running his program that way around studios, so that was a kind of culture clash around the program

Both interview and survey data with IGERT students confirm that the aforementioned culture clash between programs influenced the ways that students were trained. Urban Planning students struggled in the Urban Ecology Studio course. Their overall experience of the IGERT program typically differed from Engineering students. Course evaluations of the Urban Ecology students from Urban Planning reflect that some Urban Planning students felt that planning perspectives were not represented or considered in the course and that the course was geared toward Architecture students. Kimberly, an Urban Planning student, highlighted the Urban Ecology Studio as the least useful component of the IGERT program. She described how challenging and uncomfortable the course was for her.

The studios that included the architecture master students. I felt like it was a weird, like, architects plus engineers plus planners, and the intentions were different. The master students – the architects – they were trying to, I don't know, do a major project. And we were coming in with these, like, solutions; I felt like we were bothering them. ... And not that we were working collectively to push out a mutual goal. I felt like there was some sort of convenience in putting these three groups of people together, whether it was funding, or logistics, or it was . . . It worked for the professors. I didn't feel like there had been a concerted effort to create a curriculum that blended the needs of each professional population together very well in the syllabus.

Professor Gaines in Urban Design described these conflicts as disciplinary divides. He noted how these discrepancies at the disciplinary, institutional and departmental level impacted the Urban Renewal IGERT in several ways specifically in terms of faculty engagement/involvement in the program.

...there was almost no participation of the whole cohort of [Urban Design/ Urban Planning] faculty, very little. In one or two cases, there was behind the scenes negativity about it because of the disciplinary divides. Basic problem was Urban Planning. Urban Planning, especially at Columbia, has wandered very far away from design. It's more social science orientation by their proclamation. This is not just an IGERT problem. It's a problem with school because you base it on the design school, which planning component. It's not openly hostile, at least not sympathetic. That got reflected in the IGERT and its reflected even in the dynamic between faculty in the school. The IGERT gets mixed up in this problem. There was no one here who was available at the time to put together who was really going to bridge that problem on the planning side.

His comments demonstrate the historical conflicts between the disciplines in the IGERT and how that contributes to the dissension between departments and departmental faculty. His comments also confirm the Urban Design School's resistance to and unfamiliarity with the IGERT as reflected in their lack of involvement in the program.

***Surrounding environments intrusive to the Urban Renewal IGERT.*** The surrounding environments were also intrusive as student's experiences were shaped

and influenced by outsiders or persons who were not members of the IGERT. The boundaries of the Urban Renewal program overlapped with the boundaries of doctoral programs and departments that surround the program. These boundaries were also flexible and permeable. Individuals who were not Urban Renewal IGERT students and faculty crossed program boundaries and shared and participated in IGERT courses and activities. Non-IGERT students from any number of undergraduate and graduate programs of study and any range of disciplines were permitted to enroll and participate in IGERT courses alongside IGERT students. These non-IGERT students typically had goals, motives and values that were different than those of IGERT student participants. This often resulted in tension that impacted the training experiences of IGERT students.

A review and analysis of annual reports prepared by the external evaluator of the Urban Design IGERT revealed student frustration concerning the Urban Ecology Studio course. Students were asked to report the experiences of the course, challenges that they faced as students as well as suggestions to improve or enhance the course to make it more useful in terms of meeting the stated goals and objectives of the IGERT. Student were also asked to identify specific things about the Urban Ecology Studio that could be changed to further refine and facilitate the interdisciplinary training offered through the course. Four annual evaluation reports were analyzed. In each report students provided examples of how having to take the course with students of different disciplines and/or students enrolled in the course for different purposes limited or impeded their ability to fully engage with and benefit

from the interdisciplinary training or overall satisfaction with the Urban Ecology Studio.

An Engineering student who took the Urban Ecology Studio during year one of the IGERT wrote:

There seems to be a large difference between the expectations of the senior undergraduate students, masters and PhD students. For seniors and some masters, they seem to work better when given certain projects to work on. As for PhD students, they like to be a part of the decision making process to help create ideas.

The difference in background and experience among students in the Urban Ecology Studio influenced the power dynamics of the collaborative teams. The structure of the course was critiqued as students felt it failed to consider differences among students. Students also reported that the course failed to ensure that all students were treated fairly and had an equitable experience. Architecture students enrolled in the Masters of Science Architecture program took the course as an applied experience and earned up to nine credits in the course. Doctoral students studying Urban Planning and Engineering earned only four credits but were still expected to complete the same amount/level of work as architecture students. One Engineering student expressed frustration in one of the evaluation reports.

... it was frustrating that architects and PhD's were expected to produce equal amounts of work, and yet architects were taking the course for 9 credits and the PhD's we taking it for only 4 credits.

Similarly, it appeared that students in the Urban Ecology Studio had various objectives and enrolled in the course for a number of different reasons. Students also reported feeling that students studying areas/disciplines that were more familiar with aspects of design (i.e. architecture and urban design students) took on more leadership roles than students with less familiarity or experience with this kind of work (engineers and urban planners). This caused students with less experience to feel excluded and feel that their ideas and contributions to the project were not valued or welcomed. The evaluation report from year three of the IGERT summarized the experiences of the IGERT students in the Urban Ecology Studio class as follows.

Students spent the majority of the [evaluation] focus group talking about their Studio experience. As was the case in previous years, they described how the Studio projects were often “driven by architects’ need for a physical design and their professional orientation, while the engineers wanted to “identify problems” and find solutions.

As demonstrated by the data presented in this section, the environmental contexts that surround the Urban Renewal were found to influence the IGERT program participants in a number of ways. The findings reveal that these surrounding environmental contexts were intrusive, conflicted/competitive and unfamiliar with or resistant to the IGERT and influence all IGERT program participants. Consequently, students had to manage feelings of dissonance and anxiety while working to meet and fulfill the course requirements of the Urban Renewal IGERT and their respective home departments.

**Organizational culture theory concept: Mission.** Tierney (1997) argues that a mission of an organization is understood in terms of how the members of that organization define and articulate the goals and objectives of the organization, or in this case the Urban Renewal IGERT program. The presence of agreement amongst program participants is another means of exploring how the mission of an organization is defined, understood and expressed. The data reveal that program participants share two common understandings of the goals and objectives of the Urban Renewal IGERT Program. The two common understandings are (1) the IGERT program is a space where students are afforded structured and unstructured opportunities for collaboration and interaction and (2) the premise and focus of the work done in and through the IGERT is interdisciplinary and utilizes the disciplinary perspectives, values, methodologies and approaches of more than one discipline. Evidence of each of these shared understandings as reported in the data are presented below.

*Opportunities for shared space and collaboration.* When asked to describe their perception and understandings of the mission of the Urban Renewal IGERT, several students and faculty reported that the program was designed to bring students from Engineering, Urban Design and Urban Planning together to discuss and develop innovative research ideas and research projects. Students seemed to recognize the siloed disciplinary culture of traditional graduate education and acknowledge the IGERT program as an effort established to encourage students to interact and work collaboratively. Ron, a former Civil Engineering student and IGERT student at Hillman articulated the mission in the following manner:

I think the ... (IGERT) from an academic standpoint, it was meant to foster some sort of collaboration between the school from the program and have the student not be in their little silos that they'll usually be in.

Similarly, another alum of the program Dwayne, also from the department of Civil Engineering, agreed that the IGERT aimed to bring students beyond the boundaries of their home departments and outside of the buildings where they usually met and worked into spaces where they could engage and work with students from other fields.

I would say the objective of the IGERT... well maybe it has/was really to spark dialogue between disciplines around one specific sort of problem or concentration area... I don't think I would've interacted with any students from Urban Design. Maybe I interacted ... would've interacted with Whitley but she was a floor down, but some of the other students I would have [had] zero interaction with because they were in a whole completely different school, and even geographically in a different building.

IGERT faculty, Professor Taylor from the School of Design, shared the sentiments of Ron and Dwayne. He stated "the program was meant to coordinate between PhD programs." Findings show that both students and faculty considered the Urban Renewal IGERT a mechanism for facilitating collaboration and coordination between graduate programs and departments.

It is also important to note that program participants recognized that these opportunities for shared space, interaction and collaboration were sometimes

structured and other times they were ill-defined and unstructured in nature.

Additionally, participants noted that these collaborations were not limited to student-student or faculty-student interactions, but also included a range of external partners and program supporters. Maggie, another Civil Engineering student in the IGERT program reported,

I think just getting to know the IGERT's. Being put in the same place as the other students was probably the most beneficial. That was... Our IGERT, like gave us some structure, but really a lot of it... well some of it was really up to us. I mean there wasn't really a formal like, 'oh, you guys should do... you guys should work together on this thing.' Like it was some students were more interested in working with different disciplines than others. And those that made more of an effort, I think just probably got more out of it.

IGERT students expressed an appreciation for opportunities for unstructured interaction with other members of the IGERT community. Students and faculty participants used a number of words to describe Brown Bag programming. It was highlighted as one of the most useful, most beneficial and most enjoyable aspects of the IGERT training. Participants expressed a desire to supplement more structured IGERT programming (typically featured during the seminars) with more opportunities for unstructured interaction and interaction with IGERT students and faculty. One student made a request of IGERT faculty and administration during an IGERT workshop to consider amending IGERT programming to offer more open forums and discussion sessions. She offered suggestions for programmatic changes she would have liked to see more of during her IGERT experience.



...[more] opportunities to talk to other students... facilitating more small group discussions instead of giant big meetings where there are a whole lot of people. ... just creating smaller spaces and smaller groups and encouraging them to meet. So just more facilitation and communication among students would help.

Data reveals that IGERT participants recognized and appreciated that goals and objectives of the program. They understood that the program worked to foster interaction and collaboration between and amongst students, faculty and other external partners. These collaborations extended beyond academia as students recognized the utility and application of interdisciplinary research in applied fields. An alum of the program, Byron, shared how his IGERT experience prepared him for his post-doc experience with a government agency after earning his PhD in Civil Engineering.

I don't know if that was explicitly mentioned, but in our program, the idea was to bring architects and planners and engineers and various disciplines together in academia, government, local government, industry, etc. And, I think that's kind of letting me ... continue to keep in that direction

***Training students to conduct interdisciplinary work.*** The project director and lead principal investigator of the grant, Dorothy Davenport PhD, shared that the IGERT program was birthed through her experience co-instructing a studio-style course designed as an alternative to traditional classroom teaching. As a Professor of Civil Engineering, she co-taught the course with Professor Gaines in the Department of Urban Design at Hillman University. The course was designed to encourage

students to be much more proactive in their learning experience. That course brought Engineering and Architecture students together to work collaboratively to address a specific issue of urban design. After teaching the course for several semesters, the instructors felt that the designs that students created during the semester-long course could easily develop into new ideas, questions, research designs, research projects and ultimately dissertation topics that were innovative, interdisciplinary and have real practical impact. Professor Davenport, shared the following as she recalled previous Urban Ecology Studios,

The mission of the IGERT has been to try and bring two major design disciplines that exist on campus that are both looking at issues related to urbanization challenges to bring them together, and to create an environment where . . . where the . . . the product of each discipline, the philosophy of each discipline, and the approach of each discipline are actually somehow synthesized. And with that . . . synthesis, create new knowledge of the interface of those two design disciplines. And the design disciplines we focused on were engineering and architecture/urban design.

As evidenced throughout the data, student and faculty participants of the IGERT agreed that interdisciplinary research was a common goal amongst all members of the IGERT program. Participants recognized that their common interest in urban renewal and the issues and challenges that surround the phenomena required a nuanced approach. Students and faculty acknowledged similarities in their areas of study and the overlap that existed amongst the disciplines. They also saw the potential impact of

taking an interdisciplinary approach on their ability to create research solutions to existing problems. Professor Taylor from the Urban Design School noted,

I thought it was a good idea to do this sort of cross disciplinary work, particularly between Civil Engineering and Planning. There are some interesting overlaps around infrastructure, particularly transportation constructed more generally, and even the built environment. I thought, intellectually, there was something to be done here.

A number of students shared this sentiment and saw the value in acquiring training that would ultimately inform their perspectives and diversify their approach to their research. One student reported:

.... I had thought that the purpose was to do that through the interdisciplinary nature of the program, or encouraging planners and engineers to come to an overlap or better understanding what they do to present better solutions to urban issues.

Maggie offered her understanding of the mission of the IGERT as a national program. She recognized that interdisciplinary work was not or has not been largely supported or funded within traditional disciplinary spaces, such as research journals, grant funding solicitations and even graduate degree programs. In her interview, she shared that she felt that the IGERT program was a means of giving interdisciplinary work a platform. She credited the IGERT as a program that gave students the resources to try new and unconventional research that extends beyond the boundaries of their discipline.

It's trying to create an environment where people that are interested in doing interdisciplinary research can actually, like, do it in a more structured way. And it's very challenging to do that. And we search . . . As much as there is interest in doing interdisciplinary research, it's very challenging to do that because there were a number of things. One is probably funding. Unless there is funding to do research across disciplines, it's very hard to justify that; I mean, you know, like just taking the initiative to do it yourself. So I think providing students with funding for a program like this gives them a chance to actually, like, justify doing research outside of their discipline.

Terrance, an IGERT student, studying Earth and Environmental Engineering shared his conceptualization of the Urban Renewal IGERT. He considered the program a mechanism for pushing past disciplinary limitations & boundaries and disrupting conventional ways of conducting research. Terrance felt that traditional graduate training was not adequate to solve present challenges and the interdisciplinary training received through the IGERT was a way of ensuring that research maintained its relevance. He argued that, through the IGERT, students are exposed to different perspectives and new approaches. This exposure ensures that students do not become too entrenched in their own disciplines, as doing so, stifles innovation and flexibility in the research process. According to Terrance, flexibility is critical in conducting research that is relevant in a changing world. He commented,

For me, it was to continue to try to make your research relevant to the changing world. You know it's sort of an, I think, understanding now that if you are going to be an engineer or a planner, your traditional training is sort of

deficient in many ways; and that you have to think about disruptive, you know, ways of attacking problems. You know, you have to think inter-disciplinarily; ... I think this is coming from a perceived need in engineering that, you know, the traditional ways of educating are going to be less relevant in the future.... It might not be the case right now, but this is something that I think . . . I'm starting to see as I apply for things. You know, for instance, I could be a power engineer, right, for 10 or 15 years of experience; and then you could have something like a micro-grid development that completely supplants that and makes it obsolete . . . And I think the training is supposed to keep you flexible; and how you think about addressing problems so that you don't get too caught up. Yeah, because engineers can do that.

Being consumed with one discipline, one approach, one methodology or way of thinking results in researchers that lose their flexibility in approaching, understanding and solving problems. Terrance credits the IGERT for giving him this perspective and affording him the opportunity to exercise that flexibility to think within and across disciplinary boundaries.

The data presented in this section indicates that program participants share a common understanding of the mission, goals and objectives of the Urban Renewal IGERT. Students and faculty agree that the IGERT is designed to train students to learn how to conduct and practice interdisciplinary research as well as afford participants with shared spaces and platforms for collaboration.

**Organizational culture theory concept: Socialization.** Socialization as presented by Tierney (1997) frames an exploration of what organizational participants

believe they need to know in order to survive and succeed within their organization. The data presented in the following section will frame our understanding of participants' perceptions of what students need to survive and succeed in the Urban Renewal IGERT. During semi-structured interview IGERT faculty and program administration stress the need for students to be open to the unstructured and unconventional training strategies and practices employed through IGERT courses and planned activities. Faculty emphasized that students needed to have genuine interest in the IGERT program and be fully committed to actively participating and engaging the program's in interdisciplinary training and research activities. In order to succeed in the IGERT program students must 1) have a sense of purpose and a plan of action in navigating their interdisciplinary doctoral training, 2) be proactive and take initiative to pursue experiences that will enhance their interdisciplinary training, and 3) acquire the ability to manage IGERT program requirements with the responsibilities that students have to their home departments. An overview of data supporting faculty perceptions of socialization strategies will be presented in this section followed by data that substantiates student participants' perception of the requirements for realizing program success.

***Reports from IGERT faculty and program administration.*** Faculty expressed that an open mind was critical to successfully navigating the IGERT program. They argued that students needed a certain flexibility to learn a range of disciplinary perspectives and theoretical and methodological approaches. Students also needed to be open and willing to see the ways that these various perspectives connected, intersected and converged around existing problems. One of the IGERT

program administrators, Walter, shared a very similar belief to the IGERT faculty who were interviewed. He reported that he cautioned students against prematurely judging unfamiliar perspectives and thinking that there are “right” and “wrong” ways to approaching problems and addressing research questions. He believed that students who fell into that skewed way of thinking stifled the program’s capacity to broaden and expand their perspectives and their skill sets. Talking about these differences in perspective he noted,

to be challenged by this really different way of thinking through a problem I think just really pays off in this big way. But if you go into a class and instead . . . and you lean into the idea of, “Oh, there are really big holes in this,” you really believe it and you never change your perspective, then you’re not getting anything out of it. All you’re doing is finding a way to be more divisive and critical of other disciplines. And so challenging yourself to open up and really challenge your own perceptions on things and be willing to be vulnerable and uncomfortable with the fact that you don’t know everything, and you don’t have the answer I think is incredibly important and something unique to an interdisciplinary PhD versus departmental PhD where you’re kind of in an echo chamber all the time.

Similarly, faculty felt that students needed to be genuinely interested in doing interdisciplinary research versus being involved in the program solely for purposes of securing funding or because they otherwise would not have been admitted to Hillman University. Faculty members recalled previous experiences with students that came into to the IGERT with preconceived notions or a lack of commitment to the process

of learning through prescribed coursework and IGERT programming. These students were hard to engage and really interrupted the atmosphere of interactive and collaborative learning that were central components of the IGERT courses, especially the Urban Ecology Studio. Professor Gaines, co-instructor of the Urban Ecology Study with Professor Davenport, taught every cohort of IGERT students. He offered his perspective on the characteristics of students who had unsuccessful Studio experiences in previous years.

They came too predetermined in their own minds... They weren't open to the whole premise of participating in the IGERT program. They might as well have just done a regular program. They didn't do the regular program because either they wouldn't get into that program or they wanted the financial support I think, but my view was very peripheral.

Dr. Gaines admitted feeling that his perspective of the program was peripheral when compared to other IGERT faculty who may have been more involved in the curriculum development and administration of the IGERT program, yet his comments reflect the sentiment that those IGERT students who did not demonstrate a willingness to be there were a source of frustration for IGERT faculty.

***Reports from IGERT student participants.*** Faculty perceptions of success and survival in the IGERT dealt mostly with the attitudes and the state of mind that a student must have to navigate the program. Student perceptions of success and survival in the IGERT focused more on the behaviors that students must exhibit and the strategies that they must employ to have a meaningful IGERT experience that enhanced and contributed to their doctoral training. The data suggests that successful



IGERT trainees must 1) have a sense of purpose and a plan of action in navigating their interdisciplinary doctoral training, 2) be proactive and take initiative to pursue experiences that will enhance their interdisciplinary training and 3) acquire the ability to manage IGERT program responsibilities with the responsibilities that students have to their home departments.

A number of student participants felt that students should possess some sense of purpose and have a general sense of direction or plan of action while navigating their IGERT training. Students were consistently exposed to existing problems, as well as, interesting and compelling potential research topics through IGERT courses and activities. They were presented with any number of opportunities to travel or collaborate on research projects with their peers. The active, dynamic and collaborative nature of IGERT program environment made it easy for some students to be distracted. Interview data showed that some students were so consumed with the work that they were exposed to through IGERT classes and program activities that they were unable to focus and manage their own individual research responsibilities. Current Urban Renewal IGERT students stated that they would encourage new IGERT students to have a prescribed plan of action when pursuing their research interests. A plan of action will help students stay on track given the fluid/complex nature of the IGERT program. Bryon shared his experience in the IGERT. He entered the program right after completing his undergraduate degree and admitted that he thought he would just stumble upon a research topic that he could pursue at the doctoral level. His lack of direction at the start of his IGERT experience delayed him in choosing a specific research question for his dissertation. He

ultimately regretted wasting that time and cautioned future students against making the same mistake.

So I think having some idea of what they want to do with their research project. For me, I kind of misinterpreted going into it that something was just kind of come up and I would take hold of it; or I would get led more in a direction. You know eventually I was, but I think that going in there with some idea of what you want to do and the impact . . . that theoretical thing. It's hard for someone fresh out of undergrad to do that. Now it's, like, much easier for me.

Bryon's comments reflect the need for a sense of direction when navigating IGERT program components. Students needed to have a clear vision about their research interests and goals and work diligently to remain focused on meeting those goals even amidst competing priorities and distractions that surround them. Maggie a doctoral student in Civil Engineering, agreed that students must approach their IGERT experiences with a sense of direction and purpose. During her interview Maggie shared advice that she would give a new IGERT students about how to navigate the program successfully. She urged students to develop a plan for the interdisciplinary research and communicate that plan with faculty in the different departments that students may be affiliated with or working within

I would say that they really need to, from the beginning, communicate. First of all, plan out how they're going to do this interdisciplinary research in terms of working with different departments and different professors; and to communicate that with whoever their advisor is.

The second major proponent of IGERT's success is proactivity and an overall sense of initiative. Students recognized the IGERT as an unconventional training program and admonished new students to be intentional and proactive in navigating their IGERT program training. The IGERT program curricula and activity was designed to ensure that students received some level of structured training on how to conduct interdisciplinary research however, the program was not designed in such a way that students would know exactly what steps to take in order to have successful outcomes. Students needed to be active participants in the IGERT program. They needed to take initiative, engage in every aspect of IGERT programming and work with faculty and their peers to co-construct opportunities for their training and development as interdisciplinary researchers. If they needed assistance and help they had to actively pursue it. Dwayne shared his beliefs of what was required to realize success in the IGERT program:

I would tell them that, you know, you have to be able to work independently. And you can't expect that the collaboration is going to happen from the faculty members and the professors. They're way too busy. If you want to move something in this direction, the onus is on you. To schedule a meeting with faculty, everybody is more than happy to contribute, but it's going to be on you to sort of get things organized and get things moving. Both . . . And so . . . Maybe that's a little advice for anybody going into a PhD, but I would say be ready to work independently and then go after resources and people that you need help from without sort of, you know . . . in organization to necessarily help you.

Students and faculty agreed that proactivity should also be accompanied by a healthy dose of tenacity. Several current and former IGERT students attested to the fact that the IGERT experience is not typically free of obstacles or challenges. This is especially true in light of the fact that interdisciplinary research or the IGERT program is not widely supported by faculty, department chairs/ administrators and even program directors and deans at Hillman University. Students must have a plan, effectively communicate their needs and ambitions to their advisors and lab supervisors and seek out information and resources to help them successfully complete the IGERT program as well as their doctoral coursework at Hillman University.

Similarly, the third and final component of program success revealed in analyzing interview data with current and former participants is the capacity to manage IGERT program responsibilities with the responsibilities that students have to their home departments. Students stressed that the IGERT program is important but success in your home department is priority. The IGERT program requires students to complete courses, commit to research and to attending seminars and programs. As students come to manage the freedom of pursuing interdisciplinary research through the IGERT they must be careful not to lose site of the responsibilities that they have to their advisors and/or lab supervisors or to the course and research requirements of the doctoral programs that admitted them. Whitley, an IGERT student studying Mechanical Engineering offered her perspective.

Your primary advisors are still going to be your primary advisor, and so don't expect too much autonomy. Like even though the name . . . Even though, in

theory, there should be freedom to explore these other aspects, it might be difficult to do that. And the classes that you're going to have to take are interesting, but they may not contribute towards your requirements or your PhD. So it might be a bit more work.

**Organizational culture theory concept: Information.** Tierney's (1997) concept of information is used to frame an understanding of how information is defined and disseminated by organizational participants. An analysis of the information of a program or organization must determine (1) what information is, (2) who has that information and (3) the manner in which it is communicated and distributed across organizational contexts and spaces. The findings demonstrating how information is defined in the Urban Renewal IGERT will be presented first, followed by an overview of data describing how information is communicated, transmitted and transferred amongst IGERT program participants.

*Defining information.* In the IGERT program, information is defined as training. As a traineeship, training was not only what students sought when they applied to the IGERT program, it was also what the IGERT program promised to deliver. The IGERT program marketed itself as source of training for students. Recruitment materials claimed that the program would empower students "to conduct research at the emergent boundaries" of the disciplines of Urban Design, Urban Planning and Engineering. Students would also benefit from courses that would train them to work collaboratively, develop design projects and learn strategies to manage projects in industry, government and academe at local state, federal and global levels (Program Website, n.d.). Additionally, according to the program website IGERT

students worked alongside their team of faculty advisors to design a plan of study that was customized to ensure they acquired a strong foundational understanding of (a) urban cities and the processes of urban renewal and (b) their individual research interest.

Students participated in the program because they were drawn to the opportunity to learn. Students sought training that would broaden and diversify their knowledge base through taking courses and engaging with faculty and students in other departments and schools. They applied to and participated in the IGERT in order to build their skills and enhance their professional development. Students wanted to deepen their interest in the subject area of Urban Renewal and enrolled in the IGERT program because they recognized the program as an opportunity for training in interdisciplinary research design, collaboration and project management.

Engineering students shared their reasons for pursuing the IGERT program in annual evaluation reports conducted by the program's external evaluator. One student from Civil Engineering stated

I hoped to use this program to develop a better knowledge of the city and its environment/resource management problems in a general sense (engineering and planning issues). From here I wanted to develop my specific research and solutions.

Similarly, another student from Mechanical Engineering reported

I found it perfectly in line in that I did not want a degree strictly in engineering and the IGERT has allowed me to branch out and take classes in planning and policy.

Similarly, Maggie expressed that she was drawn to the IGERT because she was interested in learning how to do interdisciplinary work and she knew that the program would position her to do so. She knew that she did not want a traditional experience limited only to the field of civil engineering but she wanted to be exposed to and learn how to employ other perspectives and paradigms in her own research.

I had just finished my Masters, and I really believed in the mission of the program. I think one of the things that actually guided my decision to pursue a PhD in the field that I did was knowing that there could be an opportunity like the IGERT where I could reach out to other departments. And my goals . . . my research goals were much more . . . much broader than the discipline that I studied in, so I wasn't interested in just staying within the Civil Engineering field. I wanted to expand that to include other fields and other methods from different departments. So I was really excited by the prospect of what a program like this could bring both to my work and for my future.

Freddie, a current trainee studying Urban Planning, reported that she pursued the IGERT program because she wanted a promotion in her professional career. She saw the IGERT as a means of acquiring the skills necessary to become a leader in her field.

I was working at a university research center/transportation center that was a consortium of, I think, 16 colleges in New York and New Jersey; universities; and [IGERT faculty was on the Board, and he was also my professor when I was a Masters student a long time ago. So I had been wanting to pursue my research degree. And if I was going to stay in academic research, I needed to

have the PhD in order to be a principal investigator, and you know, apply for grants and proposals and that kind of thing. So we'd been talking casually about that. So then he was the one who told me about the new program.

***How is information(training)transmitted?*** Eighteen current and former IGERT students completed a survey designed to assess students' perception of information transfer within the various, spaces and contexts of the IGERT program. The survey aimed to assess the frequency of conversations and exchanges between and amongst IGERT students, IGERT faculty and IGERT program administration. The survey was also designed to identify the nature of relationships and measure student perceptions of the quality of the information exchanged between and among IGERT program faculty, students and program administrators.

Survey results reveal that IGERT students communicate with a range of people within and beyond the IGERT program. Respondents reported that they received advice and information from their primary and formal advisors, faculty affiliated with the IGERT program, other IGERT students (within their cohorts and from previous or subsequent cohorts), the IGERT program administrator(s), post-doctoral fellows, external partners & collaborators, spouses/partners, family members, friends and therapists. The following sections will outline the nature of the communication between students and primary advisors, students and IGERT program faculty. An overview of communication amongst students follows. The overview discusses the nature and frequency of students' communication with peers in their home departments and the nature and frequency of students' communication with



peers in the IGERT program. The section will end with an overview of IGERT programming that facilitated student interaction and engagements.

*Transmission/communication between students and primary advisors.* All surveyed students reported that they maintained consistent contact with their primary advisors. Ninety-four percent of surveyed students reported that their primary advisors were affiliated with the IGERT. Survey responses indicate that students communicated with primary advisors for several reasons. Advisors provided students with guidance in pursuing research goals and professional goals. According to one respondent, she communicated and interacted with her advisor because the advisor was the person who was most familiar with their research goals. Another student agreed that his advisor “guided my research projects and helped me understand how to pursue research goals and communicate results.” One student indicated that communication with her advisor “mostly revolves around my faculty/academic job search.” Another student credited his primary advisor with helping him finish his PhD research and plan for his future career.

Advisors also assisted students in navigating and completing their doctoral training. One student shared that she maintained communication with her advisor “in the interest of me completing my dissertation with the 5-year time frame.” Another student agreed that consistent communication with his advisor was necessary in order to complete the PhD, so he met with his advisor on a weekly basis to discuss progress towards degree completion. Several students reported that they collaborated with their advisors on research projects and maintained communication with them in order to complete those projects. Data suggests that students whose IGERT advisors were

faculty members in their home departments were more active in the program. These students had even more engagement with faculty, as there was overlap between their responsibilities to the IGERT program and what they were required to do in completing their doctoral programs.

Survey data also showed that the means of communication most frequently used between student and their primary advisors was in person with 59% of the respondents noting this and 41% indicating email correspondence.

*Transmission/communication between students and IGERT program faculty.*

Seventy-one percent of survey respondents reported that they made a concerted effort to establish and maintain consistent communication with IGERT program faculty throughout their IGERT experience. These are program faculty who were not the primary advisors to IGERT students. Students provided reasons why they maintained communication with IGERT faculty. Several students noted that they received great advice and mentoring from IGERT faculty about their research. They were also given assistance and support while navigating their graduate training experiences and preparing for their professional careers. One Engineering student expressed that IGERT faculty served “as mentors who guided their [students’] research during the program and afterwards”. Another Engineering student stated that she maintained communication with IGERT faculty in order to help herself “grow as a researcher and to broaden my [her] research and its applicability to broader topics and audiences”. Twenty-nine percent of survey respondents reported that they did not try to maintain contact with IGERT faculty while participating in the

IGERT program. Those students did not list or provide specific reasons why they did not engage in consistent communication with IGERT faculty.

The table (Table 5.1) below reports the frequency that IGERT students had specific forms of interaction with IGERT faculty. Results show that for each form of support indicated, the majority of IGERT surveyed students received academic/professional/emotional support and encouragement from IGERT faculty at least two times per semester. For example, 94% of students reported receiving advice about their educational program, 88% of students believed that faculty helped them in achieving their professional goals, 64% students had an opportunity to work on a research project and 52% of students reported receiving some form of emotional support and encouragement from IGERT faculty.

*Table 5.1 Frequency of Interaction Between IGERT Students and IGERT Faculty*

Question	Percentage of Participating Respondents
An opportunity to work on a research project	64%
Advice and guidance about your educational program	94%
Emotional support and encouragement	52%
A letter of recommendation	64%
Honest feedback about your skills and abilities	76%
Feedback on your academic work (outside of grades)	76%
Intellectual challenge and stimulation	88%
An opportunity to discuss coursework outside of class	58%
Help in achieving your professional goals	88%

Survey data also showed that the means of communication most frequently used between students and IGERT faculty was email correspondence (65%), in-person, person-to-person conversation (29% of sample) and conversation and interaction at IGERT program activity (41%).

*Communication amongst students.* The survey also assessed the frequency and nature of communication between IGERT students and doctoral students in their

home departments and communication between IGERT students and other IGERT students.

*Departmental engagement.* Eighty-eight percent of students surveyed strongly agreed or agreed that consistent interaction and communication between doctoral students is a critical element to the socialization process of doctoral students. Less than half of survey respondents (43%) felt that their home departments supported/promoted consistent interaction and communication between doctoral students in the department.

Sixty-nine percent of the IGERT students reported that they chose to be active participants in the community of peers in their home departments. This communication and interaction was not usually consistent throughout the length of doctoral study. Most students reported that they were more interactive in the community of their departmental peers during the coursework phase of doctoral program. The level of interaction usually diminished after students finished taking their courses and focused more intently on developing and completing their dissertation work. One Urban Planning student in the latter stages of her doctoral study was quoted as follows, “When I was in classes I was more active. The more years in ABD status, the less interest in simple socializing I am.” Similarly, another student also studying in the School of Design shared that they were more engaged with the community of departmental peers during their first four years of doctoral study but were less active during their fifth year. “Other students waited until the latter years of their doctoral study to become involved.” Similarly, one Engineering student acknowledged that having access to a network of departmental peers was a

benefit but chose not to integrate that network until the very last year of her PhD. These findings demonstrate that engagement and communication in departments varied from to student to student.

Regardless of the duration of interaction, students elected to engage with departmental peers for a number of reasons. An Urban Planning student stated “I think it is important to build support and friendships with other PhD students for both moral and intellectual support.” Another Mechanical Engineering student identified her peers as a “good sounding board for ideas as well as perspectives about different ways the PhD can be structured.” Students also had social relationships with other doctoral students in their departments. Some emphasized social relationships over peer interactions that were more intellectual/academic in nature. One Civil Engineering student reported being friends with a few people in their department but he noted that this friendship was sustained despite the fact that their work focused on different things.

The nature of student-to-student interaction within departments was also quite varied for survey respondents. Examples of the activities that student participated in included orientations for new students, participating in graduate school admissions, mentoring graduate/undergraduate students in the department, study groups and/or providing feedback to fellow students on ideas or works in progress.

The following table (Table 5.2) provides examples of the activities that IGERT students participated in with other students in their home departments. The percentage of survey respondents who indicated that they participated in these activities is provided as well.

*Table 5.2 IGERT Student Engagement with Community of Peers in their Home Departments*

Answer	%
I played a formal role in graduate student admissions ( e.g. served on an admissions committee, hosted potential students during campus visits)	31%
I participated in graduate student events (e.g. social events, orientation for new students, study groups).	81%
I organized graduate student events	50%
I mentored other graduate students	69%
I mentored undergraduate students	50%
I gave or received feedback on ideas or work in progress to/from a fellow student	88%
I am part of an intellectual network that goes beyond my immediate classmates and includes colleagues senior or junior to myself	81%
I know a significant proportion of people in my department ( faculty and students) outside of my subfield	63%

Thirty-one percent of survey respondents chose not to be active participants in the community of peers in their home departments. Most of these students did not provide specific reasons why they chose not to participate. However, one student did state why she was not active with other students in her home department. This student was studying Urban Design. She shares her experience as follows, “I find it difficult to be an active participant as of late since there seems to be a lack of an actual community. Instead, my peers seem to prefer isolation, which deters me.”

*IGERT program engagement.* Sixty-three percent of survey respondents reported that they chose to be an active member of the community of peers within the IGERT program. Eighty-four percent of students strongly agreed or agreed that the IGERT program supports and promotes consistent interaction and communication between all IGERT program participants. This is almost an 100% increase when compared to student perception of the interaction and communication in their home departments. Eighty-two percent of survey respondents reported feeling that their

experience, opinions, beliefs and ideas were acknowledged and respected by their peers in the IGERT program.

Data shows that students maintain regular communication with IGERT peers. Of the eighteen current and former IGERT students who completed the survey 25% of students surveyed maintain regular communication with one other IGERT peer, 25% of students surveyed maintain regular communication with two IGERT peers, 25% of students surveyed maintain regular communication with three IGERT peers, and 19% maintain regular communication with four or more IGERT peers. One student reported that he does not maintain regular communication with any IGERT peers.

Reports of level of activity and engagement on the survey ranged from very active to not at all active. A number of students expressed that they were more active in the IGERT during their first two years in the program. This is the period when IGERT students are funded by the IGERT monies and are required to participate in IGERT activities. Their participation tapered off during subsequent years of their doctoral training. Several students were committed to actively engaging with the IGERT throughout their doctoral programs as they acknowledged that student engagement was necessary to the IGERT experience and facilitated their interdisciplinary training.

According to survey data, the means of communication most frequently used between students within the IGERT program are in-person conversation and email correspondence. Sixty-nine percent of the survey respondents stated that in-person conversation was the most common means that they employed to engage with other

IGERT students. Twenty-five percent of students reported that they usually communicated with their peers via email.

***Where is information transmitted: Brown bag seminars.*** A review of the annual reports conducted by the IGERT program external evaluator revealed that the IGERT Brown Bags were well attended by current and former IGERT trainees throughout all four years of program activity. Students were reportedly less enthusiastic about the professional development workshops, rather they really appreciated and enjoyed the Brown Bag seminars that gave them the opportunity to discuss their research with other IGERT students. They also enjoyed research presentations given by their fellow IGERT students and found the feedback and discussion that student research presentations facilitated helpful. Students considered Brown Bag Seminars as spaces for community and engagement. These seminars were one of the only program spaces that was mainly exclusive to IGERT participants, where IGERT students and faculty were able to handle, question and conduct true interdisciplinary research instead of just reading and writing about it, as they did in IGERT courses.

Data also reveals student perceptions of the Brown Bag Seminar, their interaction within the seminar and the specific ways that participating in the Brown Bag program influenced their learning and training in the IGERT program. One student expressed that IGERT programming, specifically the Brown Bag seminars, afforded him the opportunity to learn things outside what he learned at the seminars in his own department. Students also acknowledged that the program had some structured opportunities for student engagement but that students needed to take the



initiative to sustain interaction and communication with one another. One student stated his rationale for actively engaging with IGERT peers as follows, “I joined the IGERT because I believed in the mission of conducting interdisciplinary PhD research. I found that while the program itself provided some tools to help foster collaboration, it was up to the students to make and sustain the relationships that would truly make collaboration happen.” Another student noted that the program provided opportunities for students to interact and give each other feedback even after they completed IGERT coursework. “Besides a number of IGERT students being directly involved in my lab group, other (IGERT) students shared similar research goals, but through different projects. This provided an opportunity to share ideas and improve each other’s projects. Additionally, the IGERT curriculum kept us in contact for the first year and then less frequently through brown bags.”

A number of IGERT students and faculty cited their participation in the Brown Bag seminars as the means by which they maintained interaction with other students and program participants throughout their doctoral training. The seminar gave students the space and opportunity to have meaningful cross disciplinary dialogue, exchange resources information and ideas about the work they were doing and/or aspired to do. Whitley, a Mechanical Engineering IGERT student, credited the Brown Bag seminars as the space where she learned how to extract and apply ideas from other disciplines to her own work. She acknowledged that that skill is something she will take with her throughout her career.

The Brown Bag Seminar also became a place where students were able to interact and discuss their experiences as doctoral students and burgeoning

professionals. The Brown Bag seminars were a unique space within the program that cultivated the sense of community within and amongst IGERT cohorts. Students perceived this space and the information exchanged within the space as critical elements of their training as interdisciplinary researchers. A number of students highlighted the brown bag as the most useful component of the program for this reason. Ron offered the following rationale for why he considered the Brown Bag seminar an essential element of the program.

Yeah. That was one of the best parts about the IGERT. It was just being forced to interact with these people from wildly different backgrounds. And so you don't . . . You're not just interacting with the people from your lab who are working on the same problems with the same tools. And so you get to talk with people . . . I mean I'm pretty much just limiting it to the Engineering side at this point; but, like, you could talk to the different engineers; learn about the problems they're solving and how they're solving it; and usually there's things you could take away to bring to your own problems, which was the . . . That was probably the best part.

The IGERT sponsored focus groups that were conducted to illuminate student experiences also reveal students' perceptions of the utility Brown Bag seminars offered as spaces for students to engage, discuss and cultivate their research ideas in a group or communal setting. This facilitates exposure to different perspectives that challenge students to think beyond disciplinary boundaries. One IGERT trainee in the focus group discussed the value of work shopping research ideas with student peers.

.... It would be beneficial to discuss research and see how it balances with people in other fields. And just get other people's opinions on things that you're thinking about, because it's too easy to sort of get lost in your own little bubble.... And I think those connections would be made stronger if we actually talked amongst each other about that sort of thing. Our advisors may have their own agendas, but that could be separate from what we as trainees want to achieve

Students learned from one another and were able to benefit from the specialized skills of other members of their cohort. Dwayne shared how the Brown Bags, which he referred to as "lunch and learns," facilitated this kind of skill building interaction and collaboration between him and other members of his IGERT cohort. Through the Brown Bags he was able to share resources with other students that he thought would help them. Additionally, since he was somewhat familiar with the research projects of his peers, he was able to seek specific assistance about unfamiliar topics and glean from the experiences of his peers who were doing things that he had not yet learned how to do.

"Yeah. So we would often meet at these lunch and learns.... So I would say this: It's that in terms of learning, some of it was just, like, oh, I knew specifically Whitley was working in this space. Here's a cool paper I read on a new method that may be of interest to her. Same thing [with] Ron in that he was really good at implementation and computing resources in Matlab. And so a couple times when I got stuck, I went to him for some help on how I could parallelize my code and simulation."

These examples demonstrate how information was transmitted amongst students within the program. Faculty agreed that that Brown Bag Seminars were useful in cultivating student interaction. Dr. Davenport, the project director reported that the Brown Bags were specifically designed to help students maintain the relationships that they established through their coursework. She was very pleased with the fact the most IGERT students remained engaged with the Brown Bag seminars after they were no longer required to attend them. It should also be noted that former students who participated in the surveys and interviews reported that they still maintained communication with IGERT peers after graduation. All reported that they maintained friendly social interactions with IGERT peers and more importantly, many still worked collaboratively on research projects, networked, gave each other advice & feedback and shared information about postdoc and professional opportunities.

*Challenges of transmission in program spaces.* While some IGERT students were fully engaged within the Brown Bag Seminars, others had very rich experiences. The student-to-student interactions of other IGERT students in other IGERT program spaces were not as robust as some of their peers. Additionally, as the brown bag seminar series changed and evolved over the years the structure of the program changed which altered the level to which students were able to engage within the Brown Bag spaces. These data points are presented below.

Throughout the data, students report that their experience of engaging with other IGERT students was limited and in some cases, nonexistent. Some students did not engage with other members of the IGERT and/or did not establish or sustain a

substantive or significant connection with other students on an academic, professional or a social level. For example, a student survey respondent studying Environmental Engineering stated:

I have been an active participant [in my departmental community of peers] on occasion, but the same applies to my IGERT peers. None of use are really close and we typically only come together for brown bag sessions. Other than that, we all have a rather superficial relationship with one another.

This student did not provide any information as to what caused or contributed to this lack of engagement but the data shows that his/her experiences are not isolated.

Annual evaluation reports indicate that IGERT students entered and operated the IGERT program with different expectation of how interdisciplinary training would be administered. Some students were not as active in the program because they felt their disciplines were not represented, considered or integrated into the structure of curriculum and course design. These students were primarily based in the School of Design and expressed the IGERT program courses and activities were heavily skewed toward the perspectives of the engineers. Kimberly, an IGERT student from the School of Design responded similarly. She felt that the perspectives of Urban Planning and Urban Design were not represented in IGERT curricula and activity and attributed that to the lack of IGERT program engagement amongst IGERT faculty from Urban Planning and Urban design departments.

...because IGERT was administratively housed in the Engineering school, I felt like that influenced the curriculum design and that helped influence the engagement of the faculty. I felt like when I went to an IGERT event, I was

more likely to see engineering folks, than not. And I think, you know, to have that interdisciplinary . . . I felt like I understood. . . I learned about engineering culture and expectations . . . professional culture and expectations, but I don't feel like the engineers understood us. I think they were, like, annoyed by having to read more; or having to write longer papers; or, you know, "Why are you guys talking about these soft people stuff?" And I felt like if they had actually had a more authentic engagement with the faculty or with supposed planning teachers, they would have a better understanding of the field.

Kimberly's comments reflect the lack of engagement and activity of IGERT program faculty from the School of Design which resulted in a lack of representation of planning perspective in IGERT programming and activity. This limited student participants' exposure to planning perspectives which had implications for how students discussed and conducted interdisciplinary research both within and beyond IGERT spaces. Kimberly argues that students' engagement with Urban Planning faculty was inauthentic and infrequent which limited their understanding of the field and consequently their engagement with interdisciplinary research. Similarly, if Engineering students did not understand Urban Planning students as Kimberly suggests than interaction and engagement between Urban Planning /Urban Design students and Engineering students would be limited as well.

The data also shows the changes to the brown bag seminar series over the course of time also contributed to a decrease in interaction and engagement amongst IGERT student participants. During the third and fourth year of the IGERT, select groups of non-IGERT students were invited to participate in IGERT activities,

namely the Brown Bag Seminar Series. The nature of the Brown Bag changed to accommodate the addition of these students and the focus shifted more toward professional development workshops and lectures from guest speakers. Students felt that the inclusion of non-IGERT students limited their opportunities to communicate and engage with other IGERT students.

Maggie stated that the integration of other groups of students into the brown bag seminars actually led to less interaction amongst IGERT students which ultimately made her less inclined to participate.

And the brown bags were . . . There was not that much interaction, actually.... It was more like we were just listening to somebody speak and maybe asking questions, but there wasn't really . . . I never felt it was really discussion between the IGERTs. And also a few . . . My third or my second year – I don't know, one of the years – we had additional people come join the brown bags that were not IGERT students. So I think that actually made the interaction . . . There was less interaction after that, because it was a larger group and we didn't really know each other.

Another student from the School of Engineering agreed that the addition of non-IGERT students limited the IGERT discussion and engagement in the Brown Bag Seminars. This student's comments highlighted the ways that the addition of non-IGERT students in the Brown Bag changed the nature and structure of the programming which limited students' capacity to have actual discussion and conversation with each other. As demonstrated through the data presented above this discussion is where students actually engaged with peers and faculty to develop their

interdisciplinary research skills, share their ideas, develop and sustain relationships that led to collaborative research projects.

***Summary of the organization culture of the Urban Renewal IGERT.***

Analyzing the data through the theoretical lens of Tierney's Theory of Organizational Culture was used to define the organizational culture of the Urban Renewal IGERT Program. A summary of that organizational culture is presented below.

The organizational culture of the Urban Renewal IGERT program is multi-dimensional and dynamic. The loosely connected nature of the organizational structure of the IGERT and the flexibility that students exercised while managing the responsibilities of the IGERT within the demands of multiple surrounding contexts resulted in a program culture that is characterized by constant change and activity. The environmental contexts that surround the IGERT are 1) intrusive, 2) in a state of conflict and/or competition and 3) were unfamiliar with or resistant to the IGERT program and all IGERT program participants. The boundaries of the program are loose, overlapping and permeable. Students and faculty participants must navigate their responsibilities to the IGERT and their responsibilities to their graduate departments/ programs within and outside of IGERT program contexts simultaneously. This negotiation exists on a number of levels throughout the duration of participants' affiliation with the IGERT and can produce feelings of tension, anxiety and confusion for student participants.

Data reveals that all participants interpret the mission and goals of the program similarly. The overall goal of the Urban Renewal IGERT is to introduce students to research that is interdisciplinary in nature and to train them to design and



develop interdisciplinary research projects of their own. Secondly, The IGERT is designed to provide students with opportunities for interaction and collaboration. Some IGERT faculty and student participants were not satisfied with the nature and structure of training strategies and some student participants felt that certain elements and aspects of program culture, coursework and activities rendered the program less effective or ineffective in facilitating interdisciplinary training.

Information was defined in program context amongst participants as the various resources that facilitate interdisciplinary training. These resources existed in the form of content knowledge from affiliated fields and disciplines and, discussions and synthesis of previous, conducting and presenting new scholarship and innovation, networking & professional development and strategies for accessing various institutional, academic, administrative services and supports. This information was exchanged within and amongst all groups of participants but mainly between faculty advisors and students as well as amongst student cohorts of IGERT student participants. Information was typically exchanged via in-person conversation, discussion or conversation at IGERT program activity and email correspondence. Most student participants communicated with advisors at least once weekly. Student interaction was more frequent within student cohorts and less frequent across student cohorts. Communication with IGERT program administrators centered around addressing administrative concerns and the facilitation of schedule IGERT program activities. Communication between IGERT faculty members was far less frequent as the majority of IGERT faculty were less engaged with the program from year-to-year of program operation.

Successful student participants were adaptable and proactive co-constructors of their graduate training experiences who identified necessary resources and pursued them with intention. Survival of the IGERT program was based on a student participant's capacity to manage and fulfill the overlapping and, at times, competing requirements of the IGERT program and the degree requirements of their home graduate departments.

Exploring the Urban Renewal IGERT through the lens of organizational cultural theory illuminates the program's limitations and challenges. The following sections will present an analysis of data related to program's organizational challenges.

### **An Overview of Organizational Challenges.**

An analysis of the organizational structure and culture of the Urban Renew IGERT Program also illuminates challenges and/or limitations of program components as perceived by all program participants. The significant challenges that emerged through the data are (1) inconsistencies in defining and understanding interdisciplinary research, (2) inconsistencies in understanding diversity as a program priority and (3) IGERT program leadership expressing that support and feedback from National Science Foundation was minimal and not useful. Each of these challenges are described below along with data that support and substantiate their incidence.

**Lack of consistency in defining interdisciplinary research & interdisciplinary training.** While participants agree that the mission of the IGERT program is to train student participants to conduct research on emergent disciplinary

boundaries, the data reveal that that IGERT program faculty and students do not share a common understanding of 1) what interdisciplinary research is, 2) the place and utility of interdisciplinary research in academic spaces, or 3) how students should be trained to conduct interdisciplinary research. Ultimately, this significantly influenced the training experiences of program stakeholders and participants.

Data from evaluation reports and IGERT student focus groups reveal that students of the Urban Renewal IGERT interpret the concept of interdisciplinarity differently. Student conceptualizations of what interdisciplinary research is and how it is done typically fell into one of two broader categories. Some students considered interdisciplinary research an approach that acknowledges and applies previous scholarship, theories, methodologies and values from a number of disciplines to a specific research area or project. These students perceived the IGERT program as means by which they are trained to navigate and integrate other disciplinary perspectives into their own research. Other students conceptualized interdisciplinary research as a collective and collaborative endeavor in which persons from various disciplines come together and contribute their varied expertise to explore and understand broader issues and concerns and address existing problems. A participant in the one of focus groups facilitated by IGERT program administration noted this difference. In her comment she compared her understanding of interdisciplinary research to one her IGERT peers who was from a different discipline.

What it meant to me was mostly to be exposed to ideas from other fields. To go to talks that were not my own field. And for the people in urban planning, it was about interacting more directly and working with people that were

architects, engineers and urban planners and not just one type of person like I do.

The variation in how participants interpreted interdisciplinary research had great influence on how students navigated courses and training experiences within the IGERT. For example, students who subscribed to the conceptualization of interdisciplinary research that emphasizes applying various disciplinary perspectives to one's own research typically did not feel that the Urban Ecology Studio course was useful or effective in facilitating interdisciplinary training. For example, an Urban Planning student offered a recommendation for how to improve the Urban Ecology Studio in the annual evaluation report published after year three of the program. She thought that the studio placed too much emphasis on the perspectives of one field and failed to adequately facilitate interdisciplinary work or the explicit discussion of the interdisciplinary research.

The first-year Studio, however, needs to be geared less towards architects and more towards real interdisciplinary participation and the concept of interdisciplinary research itself needs to be discussed and debated more directly and more often.

In the evaluation report from year four, another student from urban planning expected that the studio course would inform her interests in urban renewal policy and connect to her research as an Urban Planning student. She felt the course did not meet those needs and failed to encourage interdisciplinary research amongst student participants in courses such as the studio and in other IGERT program activities as well.

I didn't feel like it was the most relevant thing for me... the non-design elements were deemphasized. It did not feel important to the evaluators. It was odd for it to be dominated by design when it feels like the purpose of the class was to generate interdisciplinary research. I feel like the studio course should have been based on our actual research rather than having to come up with a design for [name of external client]

These students subscribed to the first interpretations of interdisciplinary research and their expectations and experiences of the Urban Ecology studio reflect that interpretation as they found the course less effective in terms of facilitating interdisciplinary research training.

Conversely, students who conceptualized interdisciplinary research as a collaborative effort recognized the Urban Ecology Studio as a valuable and unique training opportunity in applied research. Students reported that through the studio, they were positioned to work with other IGERT trainees and external partners and clients and learn and grow together as a group of students. Freddie, from Urban Planning, highlighted the training that she received through the studio as follows,

Well, I think that the courses we take together are important, and the studio project in particular was a way to train students to work together; and to think about the future; and what . . . the languages of the different disciplines; and what the focus is; and what the outcome is per discipline; and just try, you know, merge and learn from each other.

**Lack of consistency in defining racial/ethnic diversity as a program priority.** Data reveals that there are differences in the ways that program participants

discuss, define, and understand diversity. Similarly, program participant's perceptions of the program's capacity and commitment to recruiting, supporting, and retaining students from diverse and/or underrepresented minority (URM) populations were varied as well. The National Science Foundation (NSF) highlights diversity as the third strategic reform goal of the IGERT. NSF holds partner colleges/universities responsible for (1) designing and sustaining training environments that educate PhD level scientists, (2) catalyzing change in graduate education by creating models for encouraging collaborative cross disciplinary research, and (3) promoting diversity among student participants and the professional workforce of science and engineering (Gamse et al., 2013).

The proposal for the Urban Renewal IGERT also expressed a specific commitment to increasing the diversity of the faculty and the student body at the School of Design and the School of Engineering at Hillman University. The Urban Renewal IGERT program proposal stated that all IGERT participants would complete diversity training that would equip them to recognize unconscious bias and the impact of that bias on the processes of graduate student recruitment, advising, mentoring, and support. The program also pledged to work with administrators at Hillman University to design and implement strategies to aggressively recruit underrepresented minorities and women students.

However, the data reveal that actual IGERT program practices were not consistent with the program's intention to promote diversity as expressed in the program proposal. Participants offered a range of responses to interview questions on whether or not they considered the Urban Renewal IGERT program an effort that

promoted diversity or intentionally supported underrepresented students. Responses suggest that promoting diversity was valued amongst IGERT participants. However, although the majority of students and faculty agreed that diversity was important, it appears that the program made minimal effort, if at all, to discuss diversity or unconscious bias and its implication for program practices and the training and training experiences of student participants. Program administration briefly described strategies that the program has employed to recruit underrepresented students to apply to the IGERT and to graduate programs at Hillman respectively. However, the interview data also show that most students and faculty were unaware of or not directly involved with any existing recruitment efforts implemented by the IGERT or Hillman University, especially those established to recruit and support underrepresented students. Additionally, it appears that the majority of IGERT participants were not aware that promoting racial/ethnic diversity was goal of the IGERT program nationally or an expressed commitment of the Urban Renewal IGERT as noted in the initial program proposal.

A number of student participants acknowledged that their cohort and collective community of students in the Urban Renewal IGERT were diverse groups. These students reported that despite the racial/ethnic diversity of their group they did not believe that the IGERT was an effort that promotes diversity or took intentional steps to achieve and sustain the ethnic diversity of the group. Ron, a former Civil Engineering student shared,

I don't know that I would call it a diversity effort . . . because I don't know how much of the actual purpose or scope of it . . . But that said, I think it

succeeded – whether intentionally or not – in diversifying the . . . the experience of getting a PhD – especially in engineering. Because let’s face it: It’s a pretty monotonic crowd usually. But the IGERT was especially diverse. I don’t think there were many people the same race, gender, background, country of or . . . Well, I guess everyone had to be American, so I take that back. But it was an extremely diverse cohort, I thought.

Some IGERT participants felt that the program emphasized disciplinary diversity or a diversity of perspectives, experiences and character traits over other forms of diversity. Former civil engineering student Byron agreed, “I wouldn’t consider it a diversity effort, but I thought that it was a diverse group of people.” When asked whether or not the IGERT program promoted diversity, Professor Gaines stated, “If you apply through the IGERT, in theory you are interested in something different. Therefore, there’s some kind of diversity connection.” These comments reflect the participants were not aware that promoting ethnic diversity was a stated goal of the Urban Renewal IGERT.

Other participants agreed that program faculty focused and perhaps prioritized cultivating a diversity of other traits and qualities in recruiting and selecting students versus considering and prioritizing the racial/ethnic diversity of the program. Students felt that faculty employed broader definitions of diversity, as there was no sense or common understanding that race-based diversity was an intention of the program. Maggie, an Urban Planning student, highlighted the gender diversity of the program and the noted the faculty’s attention to developing a diversity of other student characteristics as demonstrated by her comments by herself.



I think the diversity in terms of, like, different topics of research – I think there's been a bit of that; although there were probably, like, a chunk of us that had very overlapping research topics within the same department. So besides that, yeah, I mean, the diversity in other ways . . . I think there's a pretty good ratio of boys and girls; male and female. I think that there's probably also a diversity of characters; like characteristics that people have. So I'm not sure what the selection process was for selecting the IGERT students, but seems like they paid attention to some things like that.

Additionally, Dwayne's comments demonstrate the notion that students were not aware that diversity was a goal of the program at the national level or locally within the Urban Renewal IGERT. He noted that his cohort was diverse and that the IGERT could be a tool of recruiting minority students. He also stated that diversity is one the things that attracted him to the IGERT even though he was not aware that the mission of the program was to encourage diversity.

I guess in some ways there was maybe more encouragement . . . Or definitely the demographic of my cohort was different than I think that would've naturally happened in the IGERT; but I don't know after post mission if there was really any specific effort. Or I wasn't aware of it for encouraging diversity. I think it was a really great recruiting tool and mechanism. But after the fact, I don't think there was any programmatic elements. Or at least I wasn't. I didn't interact with those.

The IGERT Project Director and the IGERT coordinators shared similar understandings of the concept of diversity. The interview data show that there is

consistency and overlap in their responses to questions pertaining to the program practices concerning diversity and the recruitment and retention of students from underrepresented backgrounds. The Project Director and IGERT coordinators interviewed perceived the IGERT as a unique opportunity to increase diversity, however they were hesitant to call the program “a diversity effort.” Their comments describe how they conceptualize and prioritize diversity as they designed and administered program services. Responses also detail the steps that the program has taken over the years to attract underrepresented students to the program. Jaleesa, one of the IGERT coordinators who participated in this study, reported that the program attended undergraduate diversity conferences and other events to recruit minority students and women. The other IGERT coordinator interviewed in this study, Walter, also agreed that the IGERT was a diversity effort even though he was not certain about whether or not existing strategies for increasing diversity were a result of NSF’s commitment to diversity or the project director’s personal commitment to diversity. He appreciated the project director’s commitment to diversity and credited her for the existing diversity within current and previous cohorts of IGERT students. Additionally, he highlighted the program’s capacity and potential to be a source of support for all students especially for students of underrepresented backgrounds. However, he also noted that actual existing program services that promote diversity and support underrepresented students were limited. More specifically, Walter felt that the program could do a lot more to better support URM students and address some of the challenges that URM students face in graduate school.

And I think that for people of color who are first generation in particular and don't have a lot of people even in their family that can provide them with a community that understands what it's like to be a PhD student, having a built-in community of sort of like-minded students does a lot to make someone feel more integrated within experience. And so I think in terms of programming, we can do a lot more to address that. In terms of admitting students into the program that are diverse, I know ... both my principal investigators – are phenomenal at being very conscious of who we want to bring in; and, you know, what they're going to be able to provide to the larger Hillman community, which I think is great. So yeah . . . So I think yeah, it is; but mostly because of them. Not because of NSF.

The comments of Dr. Davenport, the project director, align with the sentiments expressed by Jaleesa and Walter. She agreed that the IGERT was more of an opportunity to diversify a community of admitted students than a diversity effort. She argued that all the students admitted were students who met existing university criteria and the program's effort contributed to diversity of the body of applicants.

And so at that point, we considered all of the students equivalent in terms of strength of application holistically; like, over all strengths of application. Some had better GPA's. Some had better GREs; but they all looked like they would thrive on the university program. And then we . . . we actually . . . They added diversity to the STEM pipeline. So in our case we were lucky enough to get through the applications that when we started to think of other things that the students could contribute overall to the PhD cohort across

Columbia. We were able to consider whether they would diversify in the different disciplines.

Dr. Davenport acknowledged that it was challenging to pinpoint which program components were responsible for the diversity in group of applicants from which program participants were selected. Students were not admitted because they were diverse, which is why she was hesitant to call the program a diversity effort. She preferred to identify the program as an interdisciplinary training program with a component that aims to promote and increase racial/ethnic diversity in STEM graduate education and subsequently, the STEM academic and industrial workforces. Students were admitted to the IGERT program because faculty thought that they would enhance the overall culture in the program, their graduate departments and more broadly, the Hillman University campus community. Students' racial/ethnic identities contributed to the decisions to offer program admission. However, Dr. Davenport stressed that students' racial ethnic/identities were not the basis of any decisions to offer program admission.

Dr. Davenport also reported that the program efforts mostly focused on recruitment of URM students rather than retention of students after they had been admitted. Consequently, the program lost three students throughout the course of its existence. She highlighted the program's capacity to recruit a Native American student as Native Americans are largely underrepresented in STEM fields. She went on to disclose that the program was unable to retain this student and two other IGERT students throughout the course of the program from 2009 until the present. As project director of the IGERT, Professor Davenport attributed the attrition of these students

to an overall misalignment between students' individual research focus and interests and the information and knowledge that they were being evaluated on in their qualifying exams.

Comments made during her interview suggest that Dr. Davenport deeply regrets not being more engaged in processes of recruitment and intentionally supporting URM IGERT students. She recalled that the Urban Design and Urban Planning faculty were especially disengaged with program administration and program activity. She was also unaware of any of their efforts to facilitate and sustain racial/ethnic diversity in their applicant pool or amongst students admitted to the IGERT and Urban Planning and Urban Design doctoral programs. Since she was left to manage these program concerns on her own, without the help of the IGERT affiliated faculty, she acknowledged that Urban Renewal IGERT was limited in realizing its full potential to adequately support and retain URM students.

**Lack of partnership from the National Science Foundation.** The data also reveal a lack partnership from NSF in terms of promoting racial/ethnic diversity. Dr. Davenport described her previous experience serving on review panels for other IGERT grants at NSF. She noted that principal investigators (PIs) and project directors were required to comprehensively describe and demonstrate how they planned to train program participants. PIs were also required to outline the specific ways that their program would increase diversity. Although diversity was emphasized as a necessary component for a successful program grant, NSF did not follow through to ensure that programs were fulfilling their commitments to promoting diversity within their programs. In Dr. Davenport's experience as a

program director, her efforts to promote diversity were not acknowledged or monitored and she did not receive any form of substantive feedback or training as to how ensure that diversity goals were being met in her IGERT.

And I honestly thought . . . Because when I got awarded a grant, that he {NSF Program Manager} was going to come and pay attention to it and he was interested . . . And I really thought that NSF was going to be more of a partner. And I feel like they gave me the money, and they gave it to me every year. They didn't give it and take it back, but I seriously thought they would be more involved and provide more support. . . And then they even stopped having the annual meetings.

This lack of structure and support from NSF, combined with the lack of engagement of the majority of affiliated IGERT faculty made Dr. Davenport feel as if she was working to fulfill the goals of this grant alone. She did not have the capacity to provide the support that she felt that students, most specifically URM students, required. Program evaluation reports from year three and year four of the program confirm Dr. Davenport's concern with the lack of NSF involvement and the lack of IGERT program faculty engagement in managing and facilitating the grant. She recognizes the contributions of a very small core group of faculty that have assisted her with various aspects of the grant but maintained that she bore the majority of responsibility of running the IGERT throughout the duration of the program grant.

When asked if given the opportunity, would she write another grant and serve as project director for another IGERT program Dr. Davenport responded that she would not. Her disinterest is not rooted in a negative experience of her IGERT

program as it relates to students or training students. Rather, her disinterest is in response to administrative challenges that she faced while serving as the lead administrator for the program since its inception in 2009. There are many things that must be considered and taken care of in administering a grant like the IGERT including managing student funding, managing program staff, encouraging faculty involvement with the program, overseeing the development of programming and activities, budgeting and finance concerns, and advising students, among other tasks. Given this amount of work, the IGERT program was not structured in a manner that would permit leadership to hire or compensate someone to share in managing the responsibilities of running the program. As a result, the project director was left to take care of things herself.

It's a huge amount of work. And I think what frustrated me about my IGERT – and I know they've changed the rules – is like So after the first year, the P.I.s are the only person that can get salary. And it's like one month . . . two months [of] work. And not actually being able to give any salary to other faculty, they're like, "Okay, well, you're getting salary, you know, so there's that . . . I think that NSF at the time, they set the rules . . . The IGERT I have really didn't appreciate. . . The amount of effort to make these programs successful is significant and provide the P.I.s with the resources that they needed to be successful.

The lack of support for program leadership evidenced in this example is a major challenge of the program. In particular, as the project director was inundated with administrative responsibilities of the IGERT program, there was an increased

likelihood that she would be unable to devote her attention to other program priorities. This limited the program's capacity to fulfill its goals of impacting the quality of training that student participants receive and providing services that promote racial diversity in STEM graduate education and provide support to URM students.

### **Emergent Themes: IGERT Specific Training**

Throughout the data, faculty, staff, and students described the different forms of training that IGERT students were exposed to and/or received through IGERT program services. Examples of the specific ways that the IGERT program shaped and influenced students' research training and professional practice were discussed as well. Descriptions of unique and specialized IGERT training fell into three broader categories 1) facilitating exposure to interdisciplinary research & practice, 2) lessons in cross disciplinary communication and collaboration, 3) synthesizing and presenting interdisciplinary research in a variety of settings. Participants argued that students were afforded unique and specialized training and training experiences through the structured and unstructured methods and practices of IGERT courses and activities. Several students and faculty reported that, if not for the IGERT, student participants would not have obtained these specialized skills as traditional doctoral students matriculating through their discipline specific graduate programs. An overview of data describing each category of specialized IGERT training afforded to students is presented below.

**Facilitating exposure to interdisciplinary research and practice.** IGERT program faculty described the program as a unique opportunity for students to gain



awareness and exposure to the perspectives, priorities, and practices of disciplines other than their own. Both of the faculty members interviewed in this study highlighted the training students received through IGERT courses such as the Urban Ecology studio. Each reported that this training challenged students to consider the limitations of their own disciplines to acknowledge and integrate other methodological approaches to problem solving to their own research projects. Data show that faculty and students agreed that this process was not easy, seamless or comfortable for students. However, they argued that it was beneficial to students in that it broadened their skillsets and afforded them a wider range of professional opportunities both during and after their graduate study.

Professor Taylor, a member of the urban planning faculty, recalled his experience sitting on a dissertation committee of an urban planning IGERT student who was able to integrate civil engineering perspectives into an urban planning dissertation that focused on transportation. He described the contribution of a civil engineering faculty member who sat on the student's dissertation committee. He went on to acknowledge that the exposure to other perspectives was good for his students, although most of them did not like it.

He was helpful in giving her a better understanding of transportation and politics in the city because he is working as a consultant in the city. There was learning there, all of it was transferred from civil engineering into planning. I think for my PhD students being exposed to studios, they may not have liked it but they got exposed to them, that was helpful. They got exposed to a lot of

the civil engineering students, who are a lot more quantitative than the planning students, I think that was helpful too.

Professor Gaines, from the field of Urban Design, spoke directly of the benefits of this specialized training and how it influences how students' approach, how they understand and conduct their research in graduate school, and how this, in turn, shapes their career options after they complete their graduate work. He also indicated that the IGERT was useful to some student participants who were not as involved or satisfied with their IGERT experience, in that the program helped them acknowledge their preference for more conventional approaches to research.

For the ones who really got into it, it changes their career path and promotes an understanding that their traditional limited discipline is too closed and the opportunities are elsewhere. Then, they want to discover what they might be. What they can do or who they should be seeking out to work with or partner with going forward, definitely.... The ones who are not very enthusiastic or openly negative, I think it was also good for them I guess because they realized this wasn't for them. They wanted more traditional ways of doing things.

A number of IGERT students also identified and described the specialized training that they received through the IGERT as an opportunity for exposure to perspectives and practices of disciplines other than their own. Whitley, a Mechanical Engineering student, spoke specifically about how the program positioned her to learn more about urban planning through coursework and Brown Bag seminars. She credited the Urban Ecology Studio as the IGERT course that gave her the opportunity

to work with other engineers, architects, and urban planners and become familiar with the various roles that each discipline plays in addressing and developing solutions for the multidimensional problems associated with processes of urban renewal.

Similarly, Terrence, an IGERT student studying Earth and Environmental Engineering, described how he was able to explore and enhance his research on batteries and battery storage through the IGERT. He provided an example of how the IGERT helped him consider his research through other disciplinary lenses and perspectives. His comments below demonstrate how he was able to see his work on batteries and battery storage in relation to larger engineering challenges and, more specifically, how his work connects to and is influenced by a number of other factors.

My work . . . So batteries . . . In battery storage now, that's environmentally relevant. It's sort of a big problem area that's never really been fully addressed. So it's, you know . . . It's with a cost that's sort of within the IGERT framework. And I was able to interact/introduce, I guess, sort of more of a civil engineering mindset to electrical chemical engineering, which is rare; so ideas of infrastructure and maintenance, etc. and larger scale thinking. So yeah it was, I think, this ability to sort of merge, you know, sort of large scale systems with small scale units; and so that sort of served as the basis for my idea, really, about this technology I've been working on and all that stuff. Thinking about it a little differently. So yeah, I would credit the IGERT with that, because it gets you thinking about infrastructure. It gets you thinking about larger engineering challenges; and then being cross-disciplinary about it. So yeah. Applying a different discipline sort of mentality to another.

This student acknowledged the IGERT as a mechanism for broadening and diversifying his understanding of the challenges of urban renewal. He found this exposure to be quite useful to him and his training as a researcher. Kimberly, an urban planning student, shared this sentiment and acknowledged that cross-disciplinary discussion in IGERT program spaces was enlightening to her as she navigated her graduate study. Her experiences in the IGERT revealed differences in how engineers and planners think about and approach problems.

I think, you know, just the opportunity to be around the engineers and see how they address different problems or challenges in the classroom differently was knowledge in and of itself; to see how they think versus how we think was knowledgeable; the fact that they really don't think about people or they don't interact with people in their work was just mind blowing. I was like, 'How can you design something and not talk to the people who is going to be affected by what you create?' ... So it's just more like seeing how just different disciplines look at the world and interacted with the world was very intriguing for me.

Kimberly was exposed to research and researchers who think about the world differently than she does. She agreed with the other IGERT Students and faculty described in this section that this exposure enhanced her research training. Through the IGERT Kimberly was able to gain experience and practice working in groups of people with various interests, values, goals, and ideals. This helped her to learn how to acknowledge and consider the ideas and perspectives of others and articulate and

advocate for the ideas and perspectives that framed and guided her own research interests.

**Lessons in cross-disciplinary communication and collaboration.** Students and faculty also credit the IGERT program with exposing students to disciplinary language and teaching them how to communicate within and across disciplinary boundaries. These trainings facilitated collaboration and were helpful to students as they developed their own individual and collaborative research projects with faculty and their peers. Dwayne, a former IGERT student who earned his PhD in Civil Engineering, described how his experience with the IGERT helped him in his current professional position. He credited the IGERT for exposing him to Urban Planning perspectives and acknowledged that he would not have received that exposure without his experience as an Urban Renewal IGERT Program student.

I do think that some perspectives from urban planning, I would have not received. And now as I work on urban-type problems, when I interact with urban planners, I can . . . I can speak the same language. So that's probably a skill that I got from being a participant in the IGERT that I wouldn't have received if I was just a typical engineering student.

Maggie, another student in the Civil Engineering department, agreed that the IGERT program was valuable to her as it helped her connect with people and learn and understand how people from other fields communicate. She did not feel that the IGERT directly taught her hard technical skills. Rather, she and her peers learned a lot by being exposed to and observing the practices and behaviors of other IGERT program participants from other fields the IGERT courses like the Urban Ecology

Studio. She also acknowledged that she would not have had access to these training opportunities as a non-IGERT student.

So this design studio was probably the most interesting part that I got the most out of in terms of the structured programs that we had. That was something that I wouldn't have done myself. I mean it's pretty likely that I wouldn't have done it myself. So to be involved with the architecture studio first of all, and then to have that be an interdisciplinary architecture studio was very cool, and I think kind of special. That was a really good way to connect with people and sort of . . . I mean, I guess I didn't learn specific skills; like, we weren't taught specific skills in that studio. It was more, like, observational things. So you noticed how architects work; or how they present their work versus urban planners; and how they choose to communicate, you know, versus the engineers. So all of those things I think were really good. . . opportunities.

Additionally, according to Walter, one of the IGERT program coordinators interviewed, the IGERT program trained students to communicate across disciplines and pitch their interdisciplinary research ideas in a manner that facilitates understanding and support or buy-in from potential faculty and student peer collaborators and supporters. He argues that IGERT students had to adopt a certain level of fluidity and learn to communicate and navigate various disciplinary spaces in order to establish collaborative relationships and garner and sustain support for their dissertation research. His comments on the value of this training are below.

...I think that's an incredibly important skill, too, that you may not necessarily get [through traditional graduate programs]. And just that conscientiousness of how to get everything you know to be understood by another person in the room. Because it's so, so easy when all you do is spend your time in the echo chamber to stay with this highly technical language. That everyone in your field understands, but no one else outside of your field does.

Data show that, through IGERT curricula and programming, students were exposed to other disciplines and were trained to communicate and collaborate across disciplinary boundaries. Students and program administration acknowledged that they would not have acquired these skills and experience if not for their IGERT training and that the skills in cross-disciplinary communication enhanced their graduate training and professional development.

**Synthesizing and presenting interdisciplinary research.** Consistent with the cross-disciplinary communication and collaboration category of specialized IGERT training, program faculty, staff and students also agreed that through Urban Renewal program, students are trained to synthesize and present their research in various settings for a variety of audiences. The research ideas and projects that are conducted through the program do not fit neatly into any one area rather, students must learn to collect a range of information, ideas, perspectives, and methodologies from several different places and integrate and combine this information into one unified and cohesive piece of work. This is a difficult task as there are no models or templates or prescribed instructions as to how to go about doing this. However, in navigating this process students learn how to get it done. Professor Davenport, the

Project Director, described her experience advising her students through this process. She believes that this is useful to students as it builds their confidence as researchers and professionals.

I think they get much better at synthesizing. Because at the end of the day, they have to pull the work they have done into a PhD thesis. And to . . . to somebody sitting on the outside, the work might look a little bit disjointed or desperate, and they are the ones that have to present it as a synthesized piece of work. So they really have to think through about . . . about how to do it...I hope that... that experience gives them a little bit more self-confidence.

The ability to synthesize one's research is critical to communicating with people in other disciplines and fields of work. More specifically, students must be able to explain their research to others in a manner that not only facilitates the understanding of potential research partners and colleagues but of community clients and partners as well. The IGERT program trains students to communicate their research to the communities of people and professional who will be affected and impacted by their work. Students learn how to engage with people and communities. They learn how to understand the problems and challenges as experienced by people and include them in conversations and discussions that lead to the development of solutions of these problems.

The IGERT afforded students with these opportunities through the Urban Ecology Studio. In the Studio, IGERT students develop design projects that address the urban renewal challenges of an actual community client. Freddie, of the Urban Planning department, described her experience in the studio as follows.



. . . Human Ecology class and the studio that we did, I wouldn't have been able to take it. I wouldn't have done something like that without the IGERT program. You know we walked the informal settlement, you know, right next to the port, and meeting with all of the different levels of government and professionals that were sharing their stories with us. I think that was very eye opening, and also like a bright light when you're in your classroom. And for instance, an example, say, "Oh my God? Why aren't they recycling?" or this or that. And then you go to see the community, and you're like, "How can they worry or care about recycling when they're worrying about where they're going to get clean water from, you know what I mean? And so that inter-disciplinari-ness of the program and working on projects, you know, like that, I think helped me; and will continue to help me in my career.

Similarly, Byron, another former IGERT student shared his experience of the program. He spoke specifically about how the program trained him to organize and present his research for different audiences, and not just in academic spaces.

I think it taught me how to kind of see projects through. I mean I'd done this a bit in undergrad; but, you know, whether those projects went through, in the end it taught me how to take them and present them to a non-profit or a local government or something like that. . . . I think through . . . Strategic Management, . . . I feel like that class gave me a lot of anecdotes. Like it was the end result, but they were all very good. Things like if you wanted implemented innovation, an innovation that affects one industry is much easier to implement than one that everyone has to adopt or something like

that. And those kind of things, I think, helped me scope about how I think about projects. Like if I want to ask the government . . . or I propose the government do something, if they need to have other government agencies do it....

Byron's experience in the IGERT course that focused on strategic project management positioned him to learn how other interdisciplinary research teams approached and conducted their interdisciplinary projects. This experience shaped the way he thought about, practiced, and presented his own research throughout his graduate study.

Illuminating the experiences of IGERT students from populations presently underrepresented in the STEM fields was an additional goal of this study. Bryan Gopaul's (2011) conceptualizations of the graduate student socialization provides tools to frame an exploration of how students, particularly URM students, process and navigate their graduate training. His work is also useful for understanding the unique ways that the Urban Renewal IGERT influenced how students/URM students learn to conduct and present interdisciplinary research in the academy and in industrial and practical/applied arenas.

### **Emergent Themes: Experiences of Underrepresented Minority Students**

This section will use Gopaul's (2011) theory to analyze and illuminate the experiences of the URM IGERT students who participated in this work. Examples of poignant student experiences as persons of color in graduate school are presented followed by an overview of the experiences of URM students that describes student

perceptions of the Urban Renewal IGERT program and how participating in the IGERT impacted their graduate training and socialization.

Four of the IGERT student study participants identified themselves as URM students. One male student participant and one female student participant racially identified as Hispanic Latino students and two female student participants racially identified as African American students. All four participants completed the survey and three agreed to be interviewed. The data presented below will focus on interview data. Due to the sensitive nature of the experiences that students shared during their interviews, descriptive information and specific identifiers have been withheld in the interest of confidentiality and to protect the anonymity of URM participants.

**Experiences as graduate students of color.** According to Gopaul (2011), doctoral students enter graduate school with their habitus. Habitus includes a student's set of individual skills, lived experiences, interests, potential, and enthusiasm, among other characteristics. These elements combine to form and determine the way that a doctoral student views the world and his/her place within. A student's habitus shapes his/her perception of access to resources and information in graduate school and thereby influences the choices that he/she makes during their graduate training (Gopaul, 2011). Analysis of interview data yields a number of examples demonstrating how the racial identities of URM students in the Urban Renewal IGERT have influenced their graduate training experiences.

When asked to describe how his racial Hispanic/Latino identity shaped his graduate experience Terrence recalled the discomfort that he felt as a result of not always knowing how to identify himself in graduate school. His comments reveal an

uncertainty about how he was viewed in graduate school and other spaces. His comments also suggest that he has considered the implications of certain identities and the intersection of certain identities in various settings.

Yeah it's . . . you know, it's a narrative. I think that, like, all of us, we have certain groups that, you know, we sort of identify with most, you know? It's sort of like a subtext, I guess; like the idea of being Latino is one that perhaps I sort of felt – and perhaps still feel – that it required of me to work a little harder in terms of, I guess, you know, there weren't many of us. I don't know. I consider myself a person of color sometimes. Not really. It's a confusing identity, first off. Like, what is Hispanic? What is Latinos? Oftentimes, I mean, am I European? Am I . . . The background is so mixed, but finding a place to fit in. Because, you know, I'm not fully White. Right. It's challenging to sort of be off-White, and to think, "Okay, my family had limited resources. I come from a very different group of people." And then, like, I'm sort of like in a school that's largely filled with a White demographic. And how do you deal with that? Yeah, I don't know if that's sort of like one of the main reasons why I got into IGERT. Maybe it's some sort of narrative that's continued throughout my entire life; but it's sort of like it might be that, you know, there's a much larger aspect to this than I'm aware of probably on a conscious level that makes me feel like perhaps I don't fit in in the White standard; but, you know, that sort of makes me try and think differently about, you know, everyone else. You know, I know that I'm not White, tall and beautiful, but maybe some people would argue that I am

Graduate school through the lens of his habitus made Terrence feel like he may have needed to work harder as a result of his racial identity. His comments reveal a struggle with questioning his racial identity and what it means to be Hispanic/Latino especially in spaces where Hispanic/Latino students and faculty are underrepresented. The struggle is reflected in the wording of this quote and the many pauses throughout. These pauses may demonstrate the discomfort that he describes as he shares his experience. Terrence questioned what it meant to be Hispanic/Latino at school like Hillman University that is mostly White and how these identities have made him feel throughout his time at Hillman as a graduate student. His comments suggest that URM students understand that racial identity factors into how they are perceived by their peers and professors especially in spaces that are mostly White. This has directly influenced how he has navigated his graduate training experience both within and beyond courses and activities of the Urban Renewal IGERT.

Kimberly's response to questions of the influence of her racial identity on her graduate training indicated she believed that graduate school and academia can be a hostile and unsupportive place for persons of color. Her habitus, has been shaped by her lived experience and experiences that she has observed from other URM persons, most specifically other URM faculty in her field.

Academia is a cruel place. It's this whole "publish or perish" mentality. It's unhealthy. It's not good for one's mental health. It's not good for my mental health, and I don't want to be . . . I don't want anything to do with the tenure track. So I don't know if you know in my department, but last . . . This academic year, or earlier this academic year, my advisor didn't get tenure.

She's a XXXX woman. She's the third woman of color in my department in succession to not get tenure. Like, nothing about this graduate schooling experience is selling me on academia. It's just showing me how f\*cked up it is, and I don't want to live my . . . you know, what my advisor is living through. I don't. I mean it's just . . . I'm opting out. At this point, I've been in it for so long, I might as well finish my degree. But I'm done with tenure track academia. I mean I might still end up in higher education; but this whole . . . this academic culture is sick.

The challenges that women of color have faced in Kimberly's home department, and her advisor's failure to earn tenure have gravely discouraged Kimberly and severely altered her perception of the academic profession and the culture of progress and promotion in academia. Kimberly was interested in a faculty career prior to coming to Hillman, however these experiences have led her to completely change course. This demonstrates how Kimberly's habitus has shaped her perception of access and potential for success both within and beyond her graduate training. Both Terrence and Kimberly's experience highlight the ways that racial identity influences how underrepresented students understand and navigate their graduate training. They illuminate significant issues faced by students of color as well as the need to ensure that schools, departments, graduate programs, and faculty are attentive to the importance and necessity of not only recruiting students of diverse and underrepresented populations, but programs must also be committed to ensuring that graduate students (and faculty) of color are supported in specialized and specific ways.

### **Students' perceptions of the IGERT's commitment to diversity:**

**Recruitment vs. retention (support).** Interview data show that students recognized the Urban Renewal IGERT as a diverse and safe space that acknowledges the importance of the racial/ethnic diversity. Students highlighted the strengths of the program in recruiting racially/ethnically diverse groups of students. Students' comments also highlight the program's failure to intentionally and adequately support URM students. Gopaul's (2011) concepts of the social and cultural capital will be used to frame an understanding of how the Urban Renewal IGERT supported URM IGERT students.

URM IGERT students recognized and appreciated that IGERT student cohorts and the larger body of IGERT students were racially and/or ethnically heterogeneous. Each year, the cohorts of Urban Renewal IGERT were often more racially/ethnically diverse than student groups in students' home departments. URM students noted that that diversity was reflective of the program's commitment to ensure that the larger community of IGERT student participants consisted of persons with a range of perspectives, ideals, and experiences. URM students acknowledged the program's commitment to creating and sustaining experiential and disciplinary diversity, however they did not feel that the Urban Renewal IGERT was explicitly committed to promoting or sustaining racial or ethnic diversity. This sentiment is reflected in Kimberly's response to the question of whether or not the Urban Renewal IGERT was doing a good job of recruiting and supporting underrepresented students.

Well, since I never felt like I was explicitly being recruited because I was an underrepresented student, then I don't know. Then, I mean, I feel if they

never even tried, then they failed at that goal. But in general I enjoyed my . . . I felt like I was in a safe space racially. It actually ended up being kind of pretty diverse; because there was me, <Whitley, another student – he was half Cuban and half Scott, anyways. Then there was the girl from Iran. I didn't feel like I was in a . . . I didn't feel like I was a complete token, if that makes sense.

Kimberly acknowledges that the racial diversity within the larger group of IGERT students helped her feel safe as a student of color. Similarly, Terrence recognized the Urban Renewal IGERT's commitment to diversity but, like Kimberly, was not aware of whether or not promoting racial diversity was an explicit objective or a priority of the program.

Yeah, I think absolutely. I mean, you know, we all think traditionally: What is diversity, you know? White, Black, Hispanic, etc. in a program. You know, I don't know if that was the primary objective. It might've been in the acceptance or whatever, but that's something that I don't really know much about. But I think as far as diversity goes, I think of it, you know . . . opinion. Diversity of sort of experience and there was a good range of . . . Yeah, a diverse set of experiences and just goals. So yeah, in more senses than just the racial and ethnic background of the people involved, it was an effort at diversity.

So here again, Terrence agrees that the Urban Renewal is a diversity effort, although he was unaware of the program's commitment to racial diversity.



Interview data also reveal that, in recognizing the Urban Renewal IGERT's commitment to diversity, URM students noted that the program focused more on recruiting students versus taking specific measures to support and retain underrepresented students. Whitley, a Mechanical Engineering student, acknowledged that the program was an effort in diversity in that it successfully recruited underrepresented students but the program did not provide URM students with any form of direct and specific support. Whitley reported that she did not know that the IGERT was a diversity effort prior to being accepted and enrolling into the program.

I wasn't expecting it from the program. Like, I know through my experience that it's a diversity effort group, but I wasn't expecting it. So . . . But given that they, that it was a diversity effort, I would expect some type of acknowledgement of that. Or yeah, but there was no direct support.

We see here that support for URM students was not something that Whitley expected, as the program did not claim to be committed to recruiting and supporting URM students. However, upon realizing that the Urban Renewal IGERT was supposed to be a diversity effort Whitley did look for some level of programming or support that targeted URM students in the IGERT. She learned that there was none.

Kimberly had a similar response when questioned about how the IGERT program provided students with space to discuss or process their experiences and the challenges that they faced in graduate school.

I mean, I remember, you know . . . This happens to all kids of color. The first time you go to school somewhere or . . . I mean Whitley and I hooked up

pretty close, like, pretty soon after we met; like maybe a week later. It was like, ‘We’re the only two XXX kids here. We might as well, you know, get to know each other and be friends.’ Like, .... that wasn’t, like, us having an intellectual reconstruction of race relations in the IGERT program. It was just like, “You’re \*URM Identity\*. I’m \*URM Identity\*. Let’s be friends.

Here, Kimberly’s comments indicate that there were no established program services designed to support URM students in this way however, she connected with another student of color and developed a relationship. Through this connection she was able to find community and support in her relationship with Whitley and the commonalities of their experiences as women of color in doctoral programs.

According to Gopaul (2011), students learn how to navigate graduate school through their relationships with faculty, interaction and collaboration with peers, counsel of advisors and mentors. These relationships facilitate the exchange of social capital, or the actual information, knowledge and training that actually teaches and socializes students how to survive and succeed in graduate school. Similarly, Gopaul’s (2011) concept of cultural capital serves as an indicator of student status and professionalism. It includes the language skills, cultural professional norms, protocols, and socially accepted behavior and etiquette that students must master in order to successfully navigate their graduate training. Cultural capital is necessary in managing various professional experiences throughout one’s graduate training. It must accompany and work in concert with aspects of the socialization and training process.

Just as habitus influences how students understand graduate school it also influences the types of social and cultural capital that they will need to succeed in graduate school. The data show that underrepresented students are confronted with challenges that are unique to their experiences as students of color. Programs must ensure that efforts to promote and sustain diversity extend beyond recruiting diverse students to ensuring that they have access to social and cultural capital that will equip them to sustain their success in graduate schools and the careers of their choosing.

**Program influence on URM students.** Interview data reveal that URM students recognize the Urban Renewal IGERT program's potential to provide support and facilitate the exchange of social and cultural capital. Each URM IGERT student participant acknowledged that programs that encourage and sustain the racial diversity of students in graduate school are necessary and valuable components of services available to all graduate students. Whitley and Kimberly recalled previous experiences in their undergraduate and masters programs. Both of them were affiliated with programs designed to support underrepresented minority students and credit those programs with affording them with unique training and experiences that contributed to their academic success.

Additionally, Whitley, Kimberly, and Terrence acknowledged that programs like the IGERT are important not only for the purposes of empowering and supporting students of color at Hillman University for students of underrepresented populations at all colleges and universities. Terrence highlighted the capacity of diversity initiatives to liberate students of color from the boundaries and restrictions that limited access to information and resources can erect. In the comment below, he

described feelings that, he believed, URM students have as result of not being racially and/or economically privileged. He recalled his own experiences and the feelings of restriction that he has felt. He goes on to suggest that graduate students of color often feel compelled to consider or worry about things that their White or privileged counterparts are seemingly not effected by and describes how that can impact one's graduate training.

. . . It's not often that you sort of get a diverse group of people with the ability to think outside of the mold. Because often times they feel more . . . I mean I felt more restricted in terms of what I can and cannot do. . . . So I think that there always should be programs to lessen the stress of, you know, not being privileged in many ways. Either that be racially or economically privileged in terms of the, you know, what you think your experience can be. You know just because I am, say, an attractive White female or whatever doesn't mean I don't have to worry about X, Y and Z; that mentality. You know, having the IGERT students capable of thinking a little bit more like that, I think is important because it relieves them of the one-dimensional aspect of sort of being too focused and fixated on, you know, having a very traditional background out of fear or anxiety that they won't be able to get a job, etc. There has to be programs like this that really enable, you know, underprivileged kids to think outside of their restrictions.

Terrence saw the IGERT as a tool for making unprivileged students aware of their options and helping them to think beyond the limitations that they may perceive that they have as a result of the unprivileged or under privileged identities that they carry.

Despite the absence of structured programming, services, or mechanisms of support for URM students through the Urban Renewal IGERT the program influenced student practice with the field of higher education. URM program students identified, cultivated, and pursued relationships and opportunities to receive and exchange social and cultural capital. URM students interacted with one another and also participated in other working groups and student organizations that were established so that URM students could assist, affirm, and support each other. Kimberly recalled times when she and Whitley would get together and support one another and interact with other minority students. She stated,

... we ended up hanging out with some of the other minority students because the engineering school had some other programming. So then we would hang out with them, too. So, you know, that's it.

Together, Kimberly and Whitley were able to identify programming and other forms of support for minority students at Hillman Engineering.

Additionally, a number of students identified the project director as an advocate and source of support that they relied on throughout their graduate training. URM students acknowledged and appreciated the project director's commitment to diversity and described the ways that she provided them with additional individualized support as they navigated the IGERT and their overall graduate study. Each URM student participated in this study expressed a sincere appreciation for Dr. Davenport's accessibility and her willingness to go above and beyond in to assist them in obtaining the information, resources, and experiences they needed. Students

recalled specific actions and interactions that they had with Dr. Davenport throughout their IGERT experiences.

Gopaul's (2011) concept of practice is characterized as the interplay between the various concepts of the theory, such as habitus and social and cultural capital. A student's practice is the actual choices that he/she makes, through the lens their habitus and with respect to available social/cultural capital, within their graduate experiences. Observing and analyzing practice positions this research to highlight and understand the ways that the Urban Renewal IGERT influenced that choices and practices of the students, specifically URM students. The data that follow are presented to demonstrate the ways that the support of the IGERT Program Director influenced the practice of URM IGERT students.

Whitley identified Dr. Davenport as an additional advisor who would listen to her and provide objective feedback. This relationship with Dr. Davenport helped her to navigate and mediate challenges that she experienced in her relationship with her primary advisor in her home department. She recalled an opportunity that she had to travel with Dr. Davenport to attend an IGERT meeting and research symposia in Washington DC.

And so Dorothy was kind of my sounding board; not sounding board, but she gave me a different perspective. Like when I'm in front of . . . Like, I just had time with her. .... And so we actually went to D.C. that year before they had the online one, and I had time to sit with her for a couple hours and was just asking her questions about research and things; just anything. And so I got to

have . . . I got to have someone that I could ask those questions to that wasn't my advisor, which was nice.

During her interview, Whitley went on to describe the nature of the advice that she received from Dr. Davenport through their conversation in Washington DC and throughout her experience as an IGERT student. Dr. Davenport gave her insight and instruction on how to cultivate research ideas, how to manage relationships with her advisor and lab partners, how best to present her research to a range of audience and how to market herself for postdoctoral positions and jobs. Having Dr. Davenport as a “sounding board” gave her perspective that she would not have had. The capital that she received through her interactions influenced her practice and the choices that she made throughout her graduate training.

Terrence also recalled support he received from Dr. Davenport that helped him manage a difficult time in his graduate training. At one point, Terrence was unsure of where he and his research interests fit within or amongst different departments in the School of Engineering at Hillman. He was dissatisfied with his graduate training experience and considered leaving. Terrence credits the Urban Renewal IGERT, and most specifically his relationship with Dr. Davenport for convincing him to stay and complete his doctoral study.

so Professor Davenport really helped me. I actually . . . So I don't know if you were aware of this: I was actually not very satisfied with my programming in Triple E, and I actually was considering leaving after the MS. And I spoke with Professor Davenport\* about this, and she encouraged me to stay. And it was . . . and, you know, I had this situation where I couldn't work in between

departments, so it was actually very difficult for me to realize what I, kind of, wanted to do, and she, kind of, made that happen. So she . . . She gave me a little bit of money through the XXXX account. It was like a few hundred bucks to buy, like, an electrode. And then it just started from there where I could do my own projects. So yeah, it was enabling, I think. It gave me a little bit more of a network of people that felt enabled, and then I felt more enabled as a by-product of that; and I also decided that, you know, I could take a risk because I had a support. Professor Davenport and I could talk. So yeah, it was enabling, and supportive, and provided for a more risk-prone way of thinking about projects or research and stuff.

As shown above, Terrence outlines several ways that Dr. Davenport supported him through his IGERT experience. Like Whitley, Terrence identified Dr. Davenport as a person that he could talk to and get guidance from as he learned to navigate the various departments with the School of Engineering at Hillman University. Dr. Davenport was also instrumental in helping Terrence find a graduate program that best fit his needs and interests. In addition to providing advice and mentoring, Dr. Davenport also provided financial assistance that facilitated Terrence's research. This consequently expanded the student's network of the peers and faculty who were conducting similar research. Terrence also describes how this relationship empowered and enabled him and expanded the way that he approached and conducted his research. This affords another demonstration of how the support of the Urban Renewal IGERT through Dr. Davenport, influence the practice of this student. In addition to providing advice and counsel, Dr. Davenport gave Terrence resources that



would position him to expand his academic and professional network and benefit from the exchange of social and cultural capital in those spaces.

Dr. Davenport did the same for Kimberly as well. During her interview, Kimberly also cited support she received from Dr. Davenport in the form of financial support to participate in an academic boot camp designed to support underrepresented doctoral students and position them to succeed in academia.

She's been a very good, you know . . . She's (Dr. Davenport) \* been very supportive whenever I asked for extra assistance. One of the things that I asked for and I got was she paid for me . . . I don't know if you've ever heard of the National Center for Faculty Diversity & Development (NCFDD), that org, it's this organization that was started by this Black academic, and they do various different activities to help underrepresented groups succeed in academia. One of the things they do is they have these boot camps, and I asked Dr. Davenport for money, and she gave it to me.

As seen in the previous example with Terrence, Dr. Davenport was able to use resources from the Urban Renewal IGERT to sponsor Kimberly in attending this training boot camp. In attending the boot camp, Kimberly gained access to information and persons that broadened her academic and professional network. Attending the boot camp influenced Kimberly's doctoral training and her practice within the field of her graduate training,

To conclude, the conceptualizations of graduate student socialization presented by Bryan Gopaul (2011) positions this work to better understand the experiences of underrepresented minority students in the Urban Renewal IGERT.

Data collected in this study demonstrate that the racial/ethnic identities of URM students influence how students understand and function within their doctoral training. URM students recognize the Urban Renewal IGERT as a program that acknowledges and appreciates ethnic diversity by recruiting students from diverse racial/ethnic backgrounds. However, findings also show that students perceive that the IGERT's commitment to promoting ethnic diversity is limited to recruitment. Students report that there are no specific and structured program services that are designed to support and retain underrepresented students or to discuss the issues and implications of a lack of diversity in STEM graduate education and the STEM academic workforce. As such, URM Urban Renewal IGERT students developed and sustained supportive relationships with one another and with other minority students and diversity programs at Hillman to get the assistance that they needed. Finally, interview data reveal that despite the lack of structured retention programming or support in the Urban Renewal IGERT, each URM student highlighted the program's project director, Dr. Dorothy Davenport, as a valuable source of support during their graduate training. Dr. Davenport offered URM students advice, financial support and access to information, resources, and training experiences that impacted the training and socialization of these students in substantial and significant ways.

## Chapter 6: Discussion, Implications and Conclusions

A number of programs and initiatives have been established in order to enhance STEM education at all points in the educational pipeline, specifically regarding training at the doctoral level. These programmatic efforts are designed to address a number of challenges and limitations of STEM doctoral education. The purpose of this study was to explore an existing Integrative Graduate Education Research Traineeship (IGERT) program to better understand the program's organizational structure and culture; and to understand the experiences of IGERT students. This study investigated the ways that participating in an IGERT program influenced the socialization and professional training of program participants. Exploring the experiences of program participants from groups that are historically underrepresented in STEM fields was an additional focus of this work. Employing case study methodology, the study sought to answer the following research questions

1. What is the organizational structure and organizational culture of the IGERT program and in what ways does that culture shape the socialization and training of student participants?
2. In what ways does IGERT shape the socialization and training of participants of populations presently underrepresented in STEM graduate education and the STEM workforce?

This chapter will begin with a brief overview of the study context, theoretical framework and, methods. This is followed by a summary of the findings presented in Chapter 5. The primary focus of this chapter is to discuss and present the implications of the findings and to offer observations for theory, policy and practice. The chapter

will conclude with a discussion of the limitations of this study and a statement of final conclusions.

### **Overview of the Study**

Two frameworks were selected to inform the conceptual lens for the study: William Tierney's (1997) Organizational Culture Theory and Bryan Gopaul's (2011) Conceptualizations of Graduate Student Socialization. Each of these theories contributed factors that were useful for understanding Urban Renewal IGERT of Hillman University and how the program shapes the training and socialization of the student participants, especially student participants of color. Briefly, Tierney (1997) affords conceptual tools for defining and describing the elements of an organization that constitute the organization's culture. This culture frames an exploration of the processes, activities, and functions of an organization as experienced by all of its participants. Gopaul (2011)'s theory was employed to examine and understand how student participants navigate their doctoral training both within and beyond the boundaries of the IGERT program. Similarly, the theory frames an exploration of the ways that the IGERT program interacts with and/or influences the socialization and training of student program participants, with specific attention to the program experiences of participants that are of groups historically underrepresented in STEM fields. The study's design was also informed by an extensive review of the literature on doctoral education and STEM doctoral education.

**Overview of methods.** This study employed a qualitative single site case study design to present a comprehensive description of an existing IGERT Program. The case site for this study is the Urban Renewal IGERT program of Hillman

University. The IGERT program is the unit of analysis in this study thus data collection was designed and conducted in a manner that ensured perspectives of all program participants, partners and stakeholders. This was done to make sure that components and activities of the IGERT program were not simply described but presented and understood within the full context of the programs past and current history. According to Creswell (2007) a thorough case description is fundamental to sound case study research. Existing program documents were collected and served as the basis for a comprehensive case description of the Urban Renewal IGERT. This case description (presented in chapter 4) defined and described the origin and evolution of IGERT program and described program components. It also proved a rich context that contributed to understanding the functions and processes of the program.

Data for this study was collected in several ways. First, existing program information and evaluative data was collected and analyzed and current and former student participants of the Urban Renewal IGERT completed an electronic survey designed to assess patterns of communication within program contacts. Secondly, semi-structured interviews were conducted with 13 program participants including the Urban Renewal IGERT project director, two IGERT faculty members, two IGERT coordinators (1 former coordinator and the current coordinator), 3 former IGERT student trainees/graduates and 5 current IGERT student trainees. Interviews were conducted over a period of four weeks and were between 45 and 90 minutes each in duration.

Additionally, a survey was developed in order to understand participants' perceptions of communication and exchange of information within the IGERT program. Current and former IGERT students were contacted through the current coordinator, and asked to complete a 40-item electronic online survey. A total of 18 students completed the survey which was designed to identify and explore the formats of communication, the means by which communication exists, the frequency of communication between program participants and the perceived quality and utility of information that students receive from advisors, departmental and IGERT program faculty and departmental and program peers.

Purposeful sampling methods were employed to identify the Urban Renewal IGERT program as the case site for this case study research (see chapter 3 for more tails about the site). IGERT program students and faculty were sent a formal email from me, the investigator by way of the project director and program coordinator. The letter summarized the study and invited interested faculty and students to participate. The participants, the program and the university were assigned pseudonyms to ensure confidentiality and anonymity.

Data analysis was completed in several stages. The first stage was cleaning and organizing the data. A data management system was created to monitor and track all the various data collected for this study and organize the data for purposes of analysis. All program documents were coded by type/function and nature. Survey data was cleaned and descriptive analysis was run to determine frequency and emergent trends. Audio files of the interviews were transcribed, cleaned and coded by categories that aligned with interview protocols and theories presented in the

conceptual framework. All program documents and interview data were loaded into software that facilitated the organization, coding and retrieval of data for analysis. Dedoose, a web-based mixed methods software package was utilized in this study. The summary of findings will be organized around the two primary research questions.

### **Summary of Key Findings**

#### ***Research Question 1a: What is the organizational structure and organizational culture of the IGERT program?***

The organizational structure of the Urban Renewal IGERT program is loosely bound and loosely connected. The components of the program that comprise the IGERT are new and previously existing courses, professional development activities and training experiences that were organized to train students to conduct and present interdisciplinary research that will address challenges related processes of urban renewal in developed and developing countries. Students reported that IGERT program components (IGERT courses specifically) were not directly connected to one another or specifically connected to their overall doctoral training. Students also expressed that certain IGERT courses were interesting and worthwhile but did not particularly connect with their research interest. Students also felt that IGERT courses were wholly disconnected from required coursework in their home departments.

Additionally, the components of the IGERT program are deeply embedded and situated within six graduate degree programs, within the School of Engineering and the School of Design at Hillman University. The program is also obligated to comply with guidelines established by the funding agency, the National Science

Foundation (NSF). The Urban Renewal IGERT functions within the surrounding contexts of six graduate departments/doctoral program, the Schools of Engineering and Design, Hillman University and NSF as the funding agency. IGERT student and faculty participants must navigate their responsibilities to the IGERT and their responsibilities to their graduate departments/programs within and outside of IGERT program contexts simultaneously. The environmental contexts that surround the Urban Renewal (i.e., graduate departments, institutional environments within the School of Engineering and the School of Design, the National Science Foundation, etc.) were found to influence the IGERT program participants. Data shows that these surrounding environmental contexts were 1) intrusive, 2) in conflict and competition with the IGERT and 3) unfamiliar with or resistant to the IGERT. Data also shows that each of these aspects of the environmental contexts that surround the IGERT had influenced the experiences of IGERT program participants, especially the training experiences of student participants. Students had to manage feelings of dissonance and anxiety while working to meet and fulfill the course requirements of the Urban Renewal IGERT and their respective home departments.

The organizational culture of the Urban Renewal IGERT program is multi-dimensional and dynamic. The loosely connected nature of the organizational structure of the IGERT and the flexibility that students exercised while managing the responsibilities of the IGERT within the demands of multiple surrounding contexts resulted in a program culture that is characterized by a constant change and activity. Applicable concepts from Tierney's Theory Organizational Culture were used to further define the various dimensions of the culture of the Urban Renewal IGERT.



Data reveals that all participants shared a common understanding that the mission of the program is twofold. The mission, or overall goal, of the Urban Renewal IGERT is to introduce students to research that is interdisciplinary in nature and to train them to design and develop interdisciplinary research projects of their own. Secondly, The IGERT is designed to provide students with opportunities for interaction and collaboration.

Program information was defined amongst participants as the various information and access to resources that facilitated interdisciplinary training for students. This information was exchanged constantly and in various forms within and amongst all groups of participants but mainly between faculty advisors and students as well as within and amongst IGERT cohorts. Successful student participants were adaptable and proactive co-constructors of their graduate training experiences who identified necessary resources and pursued them with intention. Survival of the IGERT program was based on a participants' capacity to manage and fulfill the overlapping and, at times, competing requirements of the IGERT program and the degree requirements of their home graduate departments.

***Research Question 1b: in what ways does that culture shape the socialization and training of student participants?***

Participants noted that IGERT students were afforded unique and specialized training and training experiences through the structured and unstructured methods and practices of IGERT courses and activities. Several students and faculty reported that, if not for the IGERT, student participants would not have obtained these specialized skills as traditional doctoral students matriculating through their discipline specific

graduate programs. Descriptions of unique and specialized IGERT training fell into three broad categories: 1) Interdisciplinary Exposure/Awareness and Practice, 2) Cross Disciplinary Communication and Collaboration, and 3) How to Synthesize and Present Interdisciplinary Research in a variety of settings.

***Research Question 2: In what ways does IGERT shape the socialization and training of students of populations presently underrepresented in STEM graduate education and the STEM workforce?***

Racial identity influenced how URM students of the Urban Renewal IGERT understood and navigated their graduate training. Data revealed that underrepresented students in the program were not initially aware that the program was committed to encouraging and sustaining racial diversity amongst student participants. URM students acknowledged that the IGERT successfully recruited students of underrepresented populations however, they reported that specific services and activities designed to support and retain URM students did not exist. URM students developed and sustained supportive relationships with one another and with other minority students. They also participated in other diversity programs at Hillman to get the assistance that they needed. Interview data also revealed that despite the lack of structured retention programming or support in the Urban Renewal IGERT, each URM student highlighted the program's project director, Dr. Dorothy Davenport as a valuable source of support during their graduate training. Dr. Davenport gave URM students advice, financial support and access to information, resources, and training experiences that impacted the training and socialization of these students in substantial and significant ways.

Several other significant findings emerged. First, exploring participant's perceptions of IGERT program services through the lens of Tierney's organizational cultural theory revealed a number of challenges that the Urban Renewal IGERT encountered such as (1) a lack of consistency in defining and understanding interdisciplinary research, (2) a lack of consistency in understanding diversity as a program priority, and (3) limited support from the National Science Foundation. Communication between NSF and program administration was minimal and feedback on annual reports were superficial and focused largely on issues of reporting and not on monitoring and assessing program progress toward the stated program priorities and objectives. Additionally, program leadership reported feeling like NSF did not acknowledge the amount of administrative work required to manage an IGERT program effectively. Data revealed that the project director did not feel supported and bore the administrative responsibility of the program alone. This lack of support from the funding agency had significant implications for program functioning and resulted in limited involvement and engagement of IGERT program affiliated faculty and institutional partners. This influenced student graduate training and socialization as well.

Understanding the IGERT program requires an acknowledgment of the intersectionality of program components and recognition that various dynamics and elements of the program exist and influence one another constantly and simultaneously. It is important to note the interconnectedness of the various components, challenges, issues and themes of the Urban Renewal IGERT programs as revealed through the analysis of data. For example, identifying the structure and

organization of the program and program components highlights the ways that partnerships and relationships among faculty across disciplines influences the socialization and training experiences of the student participants. Similarly, the description of the organizational culture presented in this study argues against the notion that the program is a static and systematic organization where participants behave in structured and predictable ways. Investigating culture requires an acknowledgement of the varied perspectives, priorities, and experiences of program participants. This is especially important for conversations of diversity and the experiences of persons from underrepresented populations. Understanding how students were socialized both within and beyond program contexts illuminated the ways that identity and social positioning influence the graduate school experience. This intertwines with exploring and understanding diversity and how it is defined, conceptualized and understood by program faculty, staff and student participants and the funding agency. Acknowledging intersection like these (and others) is a unique contribution of this study. Examining these intersections further is critical in building upon the broader body of scholarship on the IGERT program and similar initiatives. This work also and ensures that program services are designed and administered to meet program objectives and that all student participants are trained in effective ways and equitable ways.

### **Discussion of Findings**

The findings of the study highlight three major contributions that build upon the body of research on IGERT program, graduate training, and retention programs and STEM doctoral education. The major contributions are presented in this section.

This study contributed to the field by: 1) applying organizational culture as a framework for describing and understanding IGERT program functioning, 2) describing the ways programs are influenced by surrounding environments, and 3) highlighting the necessity of increased communication, feedback and support from the National Science Foundation (funding agency).

### **Culture as a framework for understanding program functioning.**

Researchers in the fields of sociology and business began to study culture in organizations as early as 1982 (Kezar & Eckles, 2002). Early studies investigated the role of culture in organizational life (Morgan, 1982; Schein, 1985; Smirich & Calas, 1982) and how culture influenced organizational effectiveness (Tichy, 1983). Higher education literature has used organizational culture to demonstrate the ways that colleges and universities differ from other types of organizations (Bolman & Deal, 2008; Clark, 1970; Lunsford, 1963; Riesman, Gusfield & Gamson, 1970) and to explore and investigate the nuances of higher education as discipline and field of study since 1970. These works discussed culture as a feature or characteristic of an organization that distinguishes it from other aspects of the organization. Other studies expand the body of literature and use the concept of culture and cultural theory as a means of exploring and understand program function. Studies have explored the impact of culture on college and university governance (Chaffee & Tierney, 1988), planning (Hearn, Clugston & Heydinger, 1993; Leslie & Fretwell, 1996), institutional leadership (Birnbaum, 1988), and institutional change (Kezar & Eckles, 2002).

This study adds to the scholarship on organizational culture by applying organizational culture to an exploration of a training program within a university context. The application of this work adds to our understanding of how the IGERT program operates and is experienced by all program participants. This study focused solely on providing a rich, comprehensive, holistic description of the program. It did not focus on the experiences of one group or program component over another; rather the research was designed to understand the origin, design, development, existence and evolution of the Urban Renewal IGERT. Identifying and defining the culture of the Urban Renewal IGERT is the means by which this research describes and examines the various processes that contribute to the functioning of the program (Tierney, 1997).

Employing organizational culture as a framework in this study revealed the various mechanisms and conditions by which doctoral student program participants were socialized and trained within the contexts of the Urban Renewal IGERT. This represents a new examination of the IGERT from studies conducted in the past. Previous studies on the IGERT program are often descriptive and list and outline the components and activities that constitute an IGERT program as well as shed light on the processes of developing and implementing an IGERT program (Cowan & Gogtsi, 2004). Similarly, larger assessments are useful for understanding how a program impacts various participants (student, faculty, institution), STEM graduate education, labor market/workforces, etc. (Carney, et. al, 2006; Carney et. al, 2011). This dissertation builds upon a body of existing research. The study shifts the focus from evaluating whether or not students learn in an IGERT program to investigating and

understanding how students learn and are trained and socialized within an IGERT program. The work extends beyond descriptions of what students learn in an IGERT to exploring and understanding program components, activities and services in the context of practice. Findings from this study illuminate and provide a deeper understanding of the various processes, mechanisms, and practices that connect program components and facilitate program outcomes. This also shows how the IGERT program interacts with and influences how students learn and are trained to become interdisciplinary researchers and members of the STEM academic and industrial workforce.

Research that acknowledges and understands an organization's culture also recognizes the experiences and perspectives of all program participants and recognizes that those experiences and perspectives are in constant state of change and development (Tierney, 1997). The data presented in this research highlight how the Urban Renewal IGERT has developed, adapted and changed from its inception throughout the duration of grant. An exploration of the culture of the IGERT program illuminated participant's perceptions of program activities and the degree to which participants' understandings of program goals, concepts, standards, etc., were consistent both within and amongst various groups of program participants. This positions this work to examine how all IGERT student participants experience socialization and training and whether or not there were cases where students or groups of students felt that their training failed to meet their individual needs.

An examination of culture also identifies program components that were the most useful and effective and specific program mechanisms that enhanced the

program experience from the experience of student participants. For example, the data revealed that the Brown Bag Seminars contributed significantly to facilitating connection and building community among student participants. Seminars also promoted the interdisciplinary nature of the program and helped students to acquire and cultivate skills and collaborative experience beyond those that they acquired through their discipline specific graduate training programs alone. These seminars gave students space to engage and collaborate amongst themselves and with faculty as well. Findings showed that through the Brown Bags students (1) developed and design research of their own unique interdisciplinary interests and (2) established strong social and personal relationships (both within and across student cohorts) that facilitated their professional development in and beyond their graduate training. Students elected to participate in Brown Bag Seminars long after they were required to do so. Brown Bag Seminars proved to be a significant component of the IGERT program that promoted the goals and objectives of the project. A number of students and faculty highlighted the seminar as a key element of the program. It was an activity that several students really enjoyed as long as (1) the seminar remained closed to IGERT program participants only and (2) the disciplinary perspectives of all faculty and student participants are equitably represented and engaged.

The rich and robust description of an IGERT program that resulted from this study affords detail and context about the program that is currently missing from research on IGERT programs. This information is not only useful for evaluating the effectiveness of the Urban Renewal IGERT, it is also critical context that will facilitate the program's processes of organizational learning and its ability to address



issues and challenges. This also contributes to the understanding the organization's capacity to respond and adapt to external stimuli, to evolve and to change. According to Kezar (2005b), learning organizations are committed to developing and sustaining a community of learners that the learning of all individual participants enriches the organization as a whole.

Employing culture as a framework for understanding program functioning challenges previous research that supports a model of socialization that presupposes that all students experience graduate education in the same way (Gopaul, 2011). This is consistent with William Tierney's (1998) postmodern revisionist approach to defining and understanding organizational culture employed as a conceptual framework in this research. Tierney argues against research that suggests that culture is a set of static concepts that new members must acquire in order to succeed. Rather, organizational culture, and the processes of socialization participants navigate in order to learn and understand success and survival within an organization, must acknowledge both the unique individual characteristics and backgrounds of participants and the various and ever changing contexts that surround the organization (Tierney, 1997). Tierney challenges research to consider the implications of socialization and question whether participants are socialized toward assimilating and "where successful incorporation means all people march to the same institutional drummer?" (Tierney, 1997 pp. 7). In defining and describing the culture of the Urban Renewal IGERT this research recognizes the experiences and perspectives of every program participant. This is especially important for the Urban Renewal IGERT and similar programs and initiatives that are committed to enhancing the training of

students and broadening and increasing the participation and degree attainment of the URM populations.

An understanding of organizational culture is also critical to ensuring organizations are learning and changing to face challenges effectively and meet the ever evolving needs of diverse students (Kezar, 2014; 2005a; 2005b). Organizational culture informs organizational leadership of the various experiences, knowledge, perspectives and intelligence that participants bring with them to an organization (Tierney, 1997). Failing to acknowledge and value diverse perspectives and the contributions of all program participants limits how organizations view and understand its capacity to learn and what and how it learns, grows and evolves in response to its environment and the needs, values and interests of its partners, participants and constituents. This limits the sense of inclusion and equity within a program (Kezar, 2005b). Similarly, conceptualizations of graduate student socialization as presented by Gopaul (2011) were designed to highlight and explore processes of doctoral education to understand if and whether the training and support that students receive in their doctoral program was equitable. Gopaul also identifies and frames an exploration of the ways that the Urban Renewal IGERT program was limited in providing equitable training experiences and support to all student participants. Defining the organizational culture of the Urban Renewal program adds depth to descriptions of program components and allows for a multidimensional exploration and analysis of a program as an active, moving, adaptive and evolving entity that is designed to serve and supports all student participants, especially

students from underrepresented populations in STEM fields (Tierney, 1997; Gopaul, 2011).

**The influence of environments and contexts that surround programs.**

Previous research on the IGERT program and similar training and support initiatives aimed to identify and examine the ways that programs influence students, colleges and universities, and disciplinary fields (Carney et. al, 2011). This scholarship extends beyond investigations of STEM education programs at the graduate level to include STEM undergraduates (Hrabowski & Maton, 2004; Jones, Barlow & Villarejo, 2010), low income/first generation colleges students (McElroy & Armesto, 1998), and students of color or other marginalized groups (Goodman Research Group, 2002; Hughes, 2000; Soldner, Rowan-Kenyon, Inkelas, Garvey & Robbins, 2012). These studies highlight how programs influence the colleges and universities that they exist within in several ways, including: 1) how programs affect institutional retention rates, 2) the impact of programs on the practice of faculty and administrators, and 3) how programs influence institutional and disciplinary cultures, norms and beliefs. This study demonstrates that relationships between programs and surrounding institutional and disciplinary contexts and environments are not unidirectional. Rather, analysis of the data reveals that the cultures and priorities of graduate programs, departments, colleges/universities and disciplines and fields of study influenced the Urban Renewal IGERT program and the training and socialization of student participants in negative ways.

Birnbaum's Systems theory provides a very useful theoretical framework for exploring the bidirectional influence that exists between programs and their

surrounding environments. Birnbaum (1998) defines a system as “an organized whole that has two or more interdependent parts (or subsystems) and is separated from its environment by a boundary” (p. 30). He argues that colleges and universities are hierarchical systems composed of smaller subsystems and are typically part of a larger system themselves. For example, Hillman University as a larger system is comprised of a number of schools and colleges such as the School of Engineering (subsystem) and the School of Urban Design (subsystem) that collectively house the Urban Renewal IGERT. Within those schools exist various graduate departments and programs that Urban Renewal students and faculty were required to simultaneously navigate throughout their participating in the IGERT (subsystem). Systemic theory purports that the complexity of a system is determined by the levels of interactions between system components and the manner in which the system interacts with its environment (Birnbaum, 1998). The levels of interactions between the Urban Renewal IGERT as a subsystem of the various departments of the School of Engineering and the School of Urban Design that the program is embedded in are significant. IGERT students and faculty must interact with other IGERT students, doctoral student peers, faculty, department and university administration in IGERT courses, and program activities. Similarly, IGERT students and faculty were also required to manage multiple departmental responsibilities and IGERT program responsibly simultaneously. Data also showed that these responsibilities were often in conflict or competition with one another. This had implication for students training experiences as students reported feeling dissonance and anxiety while working to

meet and fulfill the course requirements of the Urban Renewal IGERT and their respective home departments.

Additionally, systemic theory asserts that organizations can be open or closed as determined by the nature of their boundaries (Birnbaum, 1988). Closed systems have rigid and impermeable boundaries and interaction within the surrounding environment is limited. This is not the case, with the Urban Renewal IGERT program. Data revealed that environmental contexts that surrounded the program were intrusive and student participants complained that there were little to no spaces that were exclusive to IGERT students and faculty. IGERT participants took classes with non-IGERT participants who often had different values and approaches to research that challenged and sometimes stifled the training of IGERT students. This is contrary to Birnbaum's (1998) concept of the closed systems which are unaffected and not influenced by the external environment. Systems theory affords the theoretical tools and concepts that acknowledge and explore the Urban Renewal IGERT program as the open system that it is. Open systems like the IGERT have penetrable boundaries and system components interact with the environment in a variety of ways. Open systems are dynamic and in a constant state of flux and change. They are constantly interacting with themselves and their surrounding environment and adapting and evolving as time progresses.

Programs do not exist in vacuum, rather they are surrounded by contexts and environments that interact with and greatly influence them in various ways. Previous research (Carney et. al 2006; Carney et. al, 2011) on the IGERT and other academic training and support programs has highlighted ways that existing initiatives have

influenced surrounding environments. This study makes explicit that surrounding environments influence a program and the program's capacity to train and support student participants. Future research and practice must acknowledge that relationship of influence between program and surrounding environments are bidirectional.

**Highlighting the necessity of support and substantive feedback from NSF.**

As discussed in previous chapters, the existing body of literature (Borrego & Cutler, 2010; Carney, Chawla, Wiley & Young, 2006; Carney, Martinez, Dreier, Nieshi & Parsad, 2011; Cowan & Gogotsi, 2004; Graybill, Dooling, Shandas, Withey, Greve & Simon, 2006) on the IGERT program and similar STEM education training and support initiatives is scant. I draw upon and connect the findings from this current study to the larger body of theory and scholarship on colleges and universities as organizations and research that explores how colleges and universities function. This literature highlights what programs within colleges and universities need to function effectively, and serves as a useful frame for the major findings of this dissertation. The structural bureaucratic framework as presented by Bolman and Deal (2003) and Birnbaum (1998) are specifically useful as data from this study demonstrate the tenets of these organizational theories in practice and provides a theoretical basis for future research and applied work on training and support programs for STEM doctoral students and students of all levels and disciplines.

Communication between the Urban Renewal IGERT program and the National Science Foundation was infrequent and lacked substance and specific direction. The program director reported that she did not feel that NSF provided the support that she needed in order develop the administrative infrastructure and staffing

required to run her program effectively. Additionally, she received little to no feedback on annual reports and very little direction for navigating challenges that she encountered as program director. There was also very little opportunity for professional development for IGERT program administrators. According to the structural framework, organizations ensure efficiency and maximize performance through specialization and the appropriate division of labor (Bolman & Deal, 2003). Organizations develop specialized roles to ensure program function and productivity. Within an organization, individuals with specialized roles are given standardized tasks. Each task contributes to the achievement of collective organizational goals (Bolman & Deal, 2003). The Project Director of the Urban Renewal IGERT reported feeling that NSF did not recognize or understand the amount of work that was required to effectively manage her grant. The IGERT coordinator was there to assist with the daily operations of the programs but the director felt that she was left to manage the grant on her own. NSF did not permit her to compensate other faculty members who served key roles in the program. Additionally, program resources could not be spent to hire additional administrative staff or faculty to ensure appropriate division of labor. If NSF supported the need to pay for additional faculty and staff it would eliminate undue stress on the current program director and coordinator of the program. Moreover, the program would have the person power to increase productivity, predictability, reliability, and uniformity of the Urban Renewal IGERT program (Bolman & Deal, 2003). Bolman and Deal (2003) argue that organizations that allocate and share responsibility among members of the organization and establish policies, rules and structure to coordinate the various

activities that constitute the collective efforts of the organization (Bolman & Deal, 2003). This scholarship highlights the importance of funding agencies ensuring that programs are properly and appropriately staffed and managed.

With respect to division of labor it is also important to note that the size and age of an institution has implications for organizational structure as well (Bolman & Deal, 2003). As simple organizations grow and age their structure/ hierarchy must become more formal and more complex (Bolman & Deal,2003). The Urban Renewal IGERT was in the fifth and final year of operation during the time of data collection for the current study. The nature and structure of the management and program administration of the IGERT had not changed since the program's inception in 2009. The program was managed by a project coordinator and project director and each year it enrolled more students and affiliates adding additional workload and demands on the staff. Bolman and Deal (2003) purport that it is important to revise and restructure roles and relationships in organizations as they grow and expand over time. Failing to do so can result in confusion of responsibility, lack of creativity and innovation, and detachment and boredom amongst organizational members (Bolman & Deal, 2003; Birnbaum, 1998). Evidence of this was demonstrated in the study. Members of the Executive Committee and other IGERT affiliated faculty were not active participants in the program on a consistent basis. Faculty were more involved at the start of the program but their participation waned as time progressed. This dwindling of faculty involvement had negative implications for the program capacity to support all students. It also contributed to the project director feeling overwhelmed and solely responsible for running the program. Future research can further explore



the relationships between NSF, or other funding agencies, and the programs that they fund. Findings from this study and the theory presented here show that the hierarchy and division of labor influence a program's capacity to function in adequately and equitably training and supporting students.

Another component of the structural/bureaucratic frame is that these specialized tasks and activities performed by individuals within the organization exist within a hierarchy where supervisors have the authority over subordinates. Supervisors monitor the efficiency and productivity of subordinates and ensure that subordinate activity is consistent with organizational goals and objectives (Bolman & Deal, 2003). Managers solve problem, resolve conflicts, and evaluate performance (Bolman & Deal, 2003). NSF established and enforced policy that governs the behavior of the IGERT projects that they fund and support. NSF served as the manager for project director of the Urban Renewal IGERT and annual reports were established to track and assess the productivity of IGERT projects in meeting organizational goals and objectives. A lack of feedback on annual reports to the National Science Foundation was another challenge experienced by IGERT program leadership. Analysis of findings indicates that the program director never received a substantive response to any annual report from the NSF. The lack of feedback on annual reports was a significant frustration for the program.

According to Birnbaum (1998), organizational feedback informs organizational communication within and amongst the various layers or levels of an organization. This communication takes place within various interaction loops that exist between supervisors and those that work beneath them. A lack of feedback

results in a blockage of the interactive loop that influences organizational performance. In the case of the IGERT program, NSF (the manager) provides the Urban Renewal IGERT (the subordinate) with directives, and specifically a directive to complete and submit an annual report of program activity and information about program participants. The Urban Renewal IGERT complies and generates the report and returns it back to NSF. Unfortunately, this is where the cycle of communication is broken as NSF does not process the report received from the Urban Renewal IGERT and no new directives, policies, instructions are established. Consequently, the concept of the interactive loop presented in the bureaucratic frame is no longer a complete loop; rather communication is one sided. The lack of feedback to annual reports made administrators feel underappreciated and that their work was in vain. The director questioned whether or not the information submitted in annual report was being read by NSF or if they “were sitting in a box on someone’s office.”

According to the bureaucratic frame, feedback should be generated at every point of the interactive relationship between manager and subordinate (Birnbaum, 1998). This feedback serves to inform both parties of the levels of individual and organizational performance. Feedback not only ensures that programs are actually meeting their goals and objectives, it also reinforces the organizational structure and functioning. Organizations need to continually adapt and learn to meet the changing needs of its constituents (Birnbaum, 1998; Bolman & Deal, 2003). Without feedback an organization cannot accurately assess its growth and development (Birnbaum, 1998; Bolman & Deal, 2003; Kezar, 2005; Showing, Yiming & Tseng, 1998). Future research on IGERT programs and similar initiatives should consider and explore

relationships with funding agencies and managing entities and institutions. Findings from this study point to the important ways in which these relationships shape, influence, inhibit and/or enhance how programs function in supporting and training student participants.

### **Study Implications**

The following section provides implications for research, practice, diversity and program funding agencies.

**Implications for research.** In previous research (Chaffee & Tierney, 1988; Hearn, Clugston & Heydinger, 1993; Leslie & Fretwell, 1996) institutional culture has been shown to shape and inform how colleges and universities function, behave and operate. Programs that exist within institutions have cultures and future research should acknowledge culture as a feature and a function of programs and organizations. This study serves as an example of research that employs culture as a mechanism for better understanding how programs work. Future research should continue to explore program culture in this manner. The experiences of URM student were also explored with specific attention to understanding if the program promotes racial/ethnic diversity and the success of the URM students. Given the rich description and analysis of an existing IGERT program future research can investigate specific actions and responsibilities of the program faculty and staff in and around meeting established program objectives. Future studies can explore how programs define and articulate success and how programs (structures, cultures, and administrators) are responsive to students' needs. Similarly, structures and components of surrounding institutional or disciplinary cultures that may facilitate or

mitigate against a programs' ability to be responsive/reflexive to the needs of all students can be investigated as well.

Exploring the organizational culture of the Urban Renewal IGERT revealed challenges that the program encountered in delivering program services to students. One challenge faced by the program was the lack of consistency in defining interdisciplinary research and interdisciplinary training among program participants. The data revealed that student and faculty participants of the IGERT disagreed on 1) the definition of interdisciplinary research 2) the usefulness and utility of interdisciplinary research in academic spaces and 3) the ways that students should be trained to conduct interdisciplinary research. The lack of common or shared interpretation and understanding of interdisciplinary research had great influence on how students navigated courses and training experiences within the IGERT. Lisa Lattuca's (2003) work on interdisciplinarity provides a typology of four grounded definitions of interdisciplinary research and training as understood by a sample of college and university faculty in the liberal arts and sciences. The four types or categories of interdisciplinary work and practice presented were (1) informed disciplinarity, (2) synthetic interdisciplinarity, (3) transdisciplinarity and conceptual disciplinarity. These categories reflect how faculty defined, understood and practiced interdisciplinarity in their scholarship and professional work. Lattuca (2003) also includes examples of course practices and research projects from each category presented in the typology. Future research could employ this typology as a conceptual lens for a more in depth analysis of the how interdisciplinary education is understood and practiced in the Urban Renewal IGERT. This work will extend upon the findings

of this study by (1) identifying and examining the factors that may contribute to these differences (2) and presenting recommendations for addressing and eradicating them.

Existing scholarship affirms the perspectives of IGERT program faculty and IGERT program students in a number of ways. Research has highlighted the broader impact of programs and tracked program outcomes at the national level (Carney, Chawla, Wiley & Young, 2006; Carney & Nieshi, 2011; Cowan & Gogotsi, 2004). Similarly, studies have shown the significant variation in the ways that IGERT participants understand and interpret interdisciplinary education and existing limitations and challenges that programs face in designing programs that effectively train students to do interdisciplinary work (Borrego & Cutler, 2010; Gamse, Espinosa & Roy, 2013). This study illuminates organizational culture in a manner and explores how program components function and work to socialize and train student participants. Findings also highlight how programs are influenced by surrounding context and environment ( Boden, Borrego & Newswander, 2011; Gamse, Espinosa & Roy, 2013; Graybill, Dooling, Shandas, Withey, Greve & Simon, 2006) and existing challenges that programs face that limit the program's capacity to serve students in comprehensive, effective and equitable ways. To date, extant research does not include the perspectives of funding agencies, like the National Science Foundation. Future research should describe and analyze the experiences of program officers and those who manage IGERT projects and programs as sponsors. These studies will position the field to understand how sponsoring agencies define and interpret program activity. Moreover, this work will highlight the ways that agencies communicate with project directors and program administrators and existing trends

and practices of communication are conducive to IGERT goals and objectives at the national level. Understanding the perspectives of sponsoring agencies will also expose the challenges that agencies face. This will provide an opportunity to explore and identify ways to ensure that agencies have what they need to support programs in training and supporting doctoral student participants.

**Implications for practice.** IGERT Project directors, university faculty and university administration must acknowledge that IGERT programs are deeply embedded within a number of contexts. Programs must also recognize that each environmental context impacts program functioning and program training and support as experienced by program participants at every level. In this study faculty and administrators of surrounding graduate departments and administrative leadership at the School of Design did not support the Urban Renewal IGERT program. Several observations were given including they did not understand the program, they were unfamiliar with program goals and/or perceived the program as a distraction to doctoral students and IGERT program faculty. Additionally, longstanding tensions and disagreements at the departmental, institutional and disciplinary level also contributed to the lack of institutional support experienced by the Urban Renewal IGERT. Acknowledging the history and dynamics of relationships between programs, departments and schools is essential. IGERT project directors must also acknowledge existing tensions between disciplines and develop a plan for mediating and working through disagreements and conflicts between faculty and administration in all affiliated graduate departments and schools. IGERT program administration should

take steps to ensure that all perspectives are represented in curriculum, course design, activity development and training.

Project directors should take steps to ensure that the faculty from all surrounding graduate departments affiliated with IGERT are made aware of the goals of the IGERT program and the specific ways that the IGERT program can contribute to and enhance the training of student participants. This will position project directors to demonstrate the value of interdisciplinary research and collaborative interdisciplinary research training. It will also highlight the direct and indirect ways that faculty and administrators within these surrounding contexts can get involved with the IGERT program and support program and training of IGERT students.

Additionally, data revealed splinters and fractures and other challenges in the structuring of IGERT program components. IGERT project directors and administration should consider developing a plan for facilitating open and productive dialog and collaboration between affiliated schools and departments. Findings show that Urban Renewal IGERT students struggled to manage feelings of anxiety, tension and dissonance that they experienced as they were forced to manage responsibilities that were often in conflict and/or competition. Students found IGERT course work to be valuable and worthwhile but felt that courses were wholly disconnected from coursework in their home departments. Improving communication and engagement across graduate departments would position the IGERT program to improve the level of coordination between IGERT program course requirements and courses students must take to fulfill requirements in their home departments. These issues also existed within and amongst IGERT program courses as well, IGERT program leadership

must carefully consider the sequencing and structuring of program components in an intentional way. Program courses and other components must be mapped and aligned in a manner that reflects the goals and objectives of the program, and a shared commitment to ensuring that all program participants can navigate program courses, research experiences and professional activities in consistent, fair and equitable ways.

Careful attention and acknowledgment of the proper program structure and design must pertain systems of reward as well. Findings indicate that architecture students enrolled in the Masters of Science Architecture program took the IGERT Urban Ecology Studio course as an applied experience and earned up to nine credits in the course. Doctoral students studying Urban Planning and Engineering earned only four credits for taking the same course. Despite the difference in credits earned, all students were still expected to complete the same amount/level of work. This resulted in students feeling frustrated within IGERT courses and impacted students' ability to effectively complete collaborative projects. IGERT program leadership and faculty must always work to ensure the all students have a fair and equitable training experiences in IGERT program courses.

Findings from this study also demonstrate that there was a lack of consistency in defining and understanding what constituted interdisciplinary research. This may be reflective of a lack of consistency and understanding of interdisciplinary research amongst Urban Renewal IGERT faculty as well. These findings support Gamse, Espinosa and Roy (2013) which showed that IGERT project directors struggled to conceptualized interdisciplinary research training and identify core competencies and learning outcomes for assessing interdisciplinary training. IGERT Program leadership



can address this challenge in a number of ways. IGERT Faculty could agree to developing a general program definition/conceptualization of interdisciplinary research or perhaps shared/common approach to interdisciplinary research training. Secondly, IGERT program leadership should acknowledge that there are multiple approaches to interdisciplinary research and research training and ensure that there is some sort of flexibility incorporated in IGERT program coursework, activities and training experiences that allows students to operate within their own individual perspectives as they develop and conduct their own interdisciplinary research projects.

**Implications for diversity.** Findings revealed that the Urban Renewal IGERT program's commitment to diversity was inconsistent, cursory and poorly demonstrated. The program as described in the case description highlighted the ways that the program's plan for addressing issues of racial diversity lacked depth in terms of (1) defining and articulating a shared commitment to issues of diversity and (2) an established plan of action for supporting underrepresented students through their doctoral training. Interview data also revealed that underrepresented students in the Urban Renewal IGERT were not initially aware that the program was committed to encouraging and sustaining racial diversity amongst student participants. Students and faculty acknowledged that the IGERT program was diverse in terms of research interests, disciplinary focus, gender, and lived experience but did not recognize the program as means for recruiting and supporting students from racial populations that are largely underrepresented in STEM fields. A number of IGERT participants noted that the project director was committed to student diversity but that commitment was

recognized as her individual commitment and did not reflect the IGERT program's collective interest. Similarly, there were no intentional programmatic efforts made to support URM IGERT students and contribute to addressing the underrepresentation of Black, Hispanic/Latino and Native American/American Indian students and faculty in the IGERT program, at Hillman University and throughout the fields of science, technology, engineering and math.

The lack of shared commitment to diversity among program leadership is extremely problematic. IGERT programs and graduate departments can take several steps to support URM students and address existing diversity issues in tangible and assessable ways. The process begins with a program collectively acknowledging that racial/ethnic diversity is a shared priority amongst all levels and groups of program participants. Program leadership must facilitate buy-in and/or investment and participation of program participants and provide support and direction in establishing programs and policies that address diversity concerns and express a commitment to the overall success of underrepresented program participants (Tapia & Johnson, 2009).

IGERT programs, doctoral programs, graduate departments and university administration must also be attentive to retaining URM graduate students not just recruiting them. Graduate students of color must be supported in intentional and specific ways. Although this study did not focus on minority faculty it is clear that they must also be supported to fortify their success and ability to mentor URM students. URM IGERT students acknowledged that the IGERT successfully recruited students of underrepresented populations however, they reported that specific services

and activities designed to support and retain URM students did not exist/ were not available. Previous research shows racial identity, as an element of habitus, influences how underrepresented persons navigate graduate school and the academic profession (Cheatham & Phelps, 1995; Ellis, 2001; Espinal, Munoz & Kiyama, 2010; Gopaul, 2011). As such, IGERT programs need to ensure that underrepresented students are supported throughout their graduate training. Students must have awareness of and access to skills and resources that will help them learn to effectively navigate the challenges that they face and succeed in their graduate training. URM students also need safe spaces where they can process the challenges that they may face throughout their graduate training. Additionally, IGERT programs can utilize resources to build community and develop supportive networks for underrepresented students in STEM fields that cross disciplinary boundaries.

**Implications for funding agencies (National Science Foundation).** Support from the National Science Foundation, as the funding agency of the Urban Renewal IGERT, was minimal at best. Communication between NSF and program administration was minimal and critique/feedback on annual report were superficial and focused largely on issues of reporting and not on monitoring and assessing program progress toward the stated priorities and objectives of the program. This lack of feedback had huge implications for program functioning and limited the program's capacity to fully support all IGERT student participants equitably.

The National Science Foundation must provide substantive and specific feedback to IGERT program leadership. Project directors should be made aware of the strengths and weaknesses of their program and have their program efforts

monitored consistently. Without feedback project directors cannot gauge the extent to which the performance of their program is acceptable in terms of meeting prescribed program goals. This may cause project leadership to feel as though their efforts are not recognized, appreciated or valued and may have deleterious impact on an IGERT project's commitment to meeting program goals.

NSF must take steps to engage in substantive useful communication with IGERT program directors on a consistent basis. Additionally, NSF must ensure that project directors feel adequately supported as they manage the significant responsibility of managing their IGERT

It is critical that NSF acknowledge that IGERT programs are complex entities that exist within a number of contexts. Like IGERT students, the leadership of IGERT must negotiate multiple overlapping, and competing responsibilities at once. Program director must manage administrative policy, departments culture/norms and practices, disciplinary differences and institutional priorities while managing an IGERT program that also has its own culture, processes, norms, values, etc. IGERT Project directors and program administrators must be adequately and appropriately trained and supported in order to do their jobs effectively. Ensuring that IGERT program leadership has access to opportunities for training and professional development, information and resources and networks of other IGERT project directors and administrators is requisite to the success and effectiveness of IGERT programs and the students that program serves. This support is critical to sustaining the program's capacity to manage its responsibilities and effectively meet its goal of

affording all IGERT student participants with support and high quality graduate training.

### **Limitations**

Using case study methodology this study explored the Urban Renewal IGERT at Hillman University. The study examined a specific program within a specific context which limits the generalizability of the findings to other IGERT programs, colleges and universities or another STEM graduate education training program. Similarly, the study explores the socialization and training of all student participants of the Urban Renewal IGERT and URM students in the Urban Renewal IGERT. The findings are not generalizable to doctoral students/URM doctoral students in other IGERT programs at Hillman University, doctoral students/ in other IGERT programs, or doctoral students/URM doctoral students in other educational training and support programs. Case study methods positions this research to contribute to the definition and description of a particular interest or phenomena (Merriam, 2009). My intention was to conduct a comprehensive investigation of the Urban Renewal IGERT that afforded a robust description and analysis of the Urban Renewal IGERT program and the training experiences of doctoral student participants. It is the responsibility of the reader to identify and draw the conclusions that are most applicable and appropriate at any given setting.

Another limitation of this study is the limited range of perspectives represented in sample. Although all current and former IGERT student trainees were invited to participate, the students who agreed to be interviewed were all students from the first and second cohorts. Student perspectives from the cohorts three and

four were not represented in interview data however they were represented in the other data sources for the study including the survey and existing program document data. Similarly, this study investigated students' experience in IGERT courses and activities and required participants to recall and reflect on their training from earlier in their graduate study as well as college and pre-doctoral graduate experiences. There is a possibility that students' recollections of experiences during their interviews may differ from their initial perceptions at the time the experience occurred (Merriam, 2009).

## **Conclusions**

Enhancing and addressing existing challenges in STEM graduate education, particularly at the doctoral level, has been a national priority in this country for well over twenty years (Council of Graduate Schools, 2007; COSEPUP, 1995; Gonzalez & Kuenzi, 2012; Golde & Dore, 2001; Kuenzi, 2008; National Science Board, 1997; Nerad & Cerny, 2004, 2000). Through agencies like the National Science Foundation, the federal government has allocated millions of dollars to programs and initiatives that aim to afford graduate students a high quality, world class education, and broaden the participation of persons from underrepresented populations. For example, approximately \$259.08 million of government monies were used to fund programs in the Division of Graduate Education at NSF during the 2014 fiscal year alone (NSF 2015 Budget Request). Intensive and scholarly rigorous study of these programs is critical to fully understanding the various components and dimensions of these efforts and the specific ways that they function to train and support graduate students. Addressing the lack of racial diversity in STEM the educational pipeline and

academic & industrial workforces is another expressed priority of the National Science Foundation and its graduate training programs. Investigating programs like the IGERT provides a perfect opportunity to identify, define, and describe some of the ways that NSF programs and initiatives are recruiting and retaining students from underrepresented populations.

This study adds value to the existing body of research in a number of ways. First, this study identifies and describes the organizational culture of an existing IGERT program. This differentiates this research from other studies that describe the IGERT in terms of its various isolated components and/or its outcomes. Previous research fails to acknowledge the specific processes by which those outcomes are reached. This study allows for a greater understanding of how the components an IGERT program work and function to enhance graduate student training. The research also illuminates the IGERT program as a dynamic phenomenon that is deeply embedded within a number of surrounding departmental, institutional, and disciplinary contexts and environments that all influence the program and program participants in significant ways. Thirdly, this study allows for an exploration of the perception and experiences of student and faculty participants of one program, moving beyond previous studies that have studied a number of programs at once. This positions the study's in-depth, rich and robust, description and analysis of an IGERT program to inform new research and work. This work also serves as an example of how qualitative research can contribute to and complement that quantitative ways that IGERT programs and similar initiatives are evaluated and assessed. Finally, this study uses socialization theory to understand how participants perceive that IGERT

program courses and activities have influenced, enhanced, and/or complicated/limited their graduate training. Additionally, this study is the first of its kind to focus on understanding how students from underrepresented populations experience the IGERT program and the unique ways that an IGERT program has supported their training and development as doctoral students.

This study also has implications for policy and practice. The National Science Foundation can use the findings from this study to inform their decision-making regarding the ways that they can support or better support IGERT projects and project directors in administering IGERT program grants and similar research training programs sponsored by the Department of Graduate Education. Similarly, findings from this study can aid current and future IGERT directors in developing and refining program structures, practices, policies, and relationships to ensure that program participants are properly and equitably trained and supported.



## Appendix A: Recruitment Email for Potential Programs/Case Sites

Greetings,

I hope this message finds you well. I'm reaching out to you today as a 4th year full time doctoral student in the Higher Education program at the University of Maryland College Park. I'm writing my dissertation on the IGERT and vetting potential case sites for my dissertation research study. My study will be a single site case study of an existing IGERT program that will explore and identify the organizational culture of that IGERT program in order to illuminate how IGERT programs train and socialize program participants. Specific attention will be given to understanding the socialization and professional training experiences of the program participants of underrepresented groups.

I was wondering if the < Insert IGERT Program Name> at <Insert Sponsoring/Host College/University> still active. If the program is still active, I would really appreciate the opportunity to ask you a few questions about the program. Should you consent, that conversation will be helpful to me in determining whether or not I should formally pursue your IGERT as a potential site for my dissertation research.

Any information or assistance that you could provide would be greatly appreciated. I can be reached at this email address or via my cell phone at 347-849-6364.

Thanks so much for you time and consideration and I do hope to hear from you soon.

Best,

***Tykeia N. Robinson, MA EdM***

Doctoral Candidate, Higher Education Concentration

Department of Counseling, Higher Education, & Special Education

University of Maryland College Park

College Park, MD 20742

Phone 301-405-6907

Fax 301-314-7255

## Appendix B – Sample Survey

### IGERT Communication Survey

*This survey will contribute to data collection procedures for a larger single site case study that will explore and illuminate the various components, processes, tools and strategies of various IGERT program contexts and the influence of those components on the socialization experiences of the doctoral students who study STEM fields. The purpose of this questionnaire is to understand student perceptions of information transfer. It will assess the frequency of conversations and exchanges between and amongst students, faculty and program administration and gauge/identify the nature and quality of information exchanged as perceived by student program participants.*

**A1. Please check all individuals within the IGERT program who consistently provide you with advice/information that you find useful, helpful, supportive**

*Note: This instruction also applies for persons who may have two or more concurrent roles (I.e. persons that may be a postdoctoral fellow and an IGERT student from a previous cohort). It is possible for a person to have more than one applicable checkmark.*

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/  
Construct: Origin and Nature of Communication)

- My primary or formal advisor
- Another IGERT Faculty mentor
- A IGERT student in my cohort
- A IGERT student from a previous/subsequent cohort
- IGERT Staff (Program Administrator/ Coordinator/ Director)
- A post-doctoral fellow
- External collaborator/partner
- Spouse or partner
- Another family member
- A friend (who is not listed above)
- No one
- Other (please specify)

#### Faculty Contact

*This section asks questions about your relationships with your faculty and specifically faculty within the IGERT Program.*

**B1. Do you choose to make an effort to initiate and maintain consistent communication with IGERT faculty members?**

Yes  No

**B2. In the space provided below please explain why you choose to make an effort to initiate and maintain consistent communication with IGERT faculty members**

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**B3. How many IGERT faculty members do you consider to be your advisors or mentors?**

(Prior Item Carnegie Foundation Survey of Doctoral Students/ Construct: Origin and Nature of Support/Communication, Level of Communication/Interaction)

None  One  Two  Three  Four or more

**B4. What means of communication are most frequently used between you and other IGERT faculty members?**

(New Item/ Construct: Format of Communication/Means of Communication/Type of Communication)

Electronic Correspondence  Formal Training/Lecture

IGERT Program Activity  In Person Conversation  Telephone

Other (Please Specify)

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**B5. How often have your professors within the IGERT Program provided you with the following forms of interaction during the Spring 2014 academic semester (from the first day of classes to and through final exam week): (Mark one in each row)**

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/ Construct: Nature of Communication/Type of Communication)

Question	Frequently (More than 3 times per semester)	Occasionally (2-3 Times per semester)	Not At All
An opportunity to work on a research project			
Advice and guidance about your educational program			
Emotional support and encouragement			
A letter of recommendation			
Honest feedback about your skills and abilities			
Feedback on your academic work (outside of grades)			
Intellectual challenge and stimulation			
An opportunity to discuss coursework outside of class			
Help in achieving your professional goals			

**B6. Please use this space to elaborate on your answer to any question in this section, or tell us anything else you would like us to know about your experiences with IGERT faculty**

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/  
Construct: Nature of Communication/Type of Communication)

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### Primary Advisor Questions

*The next group of questions will focus on your relationship with your primary/formal advisor. Your primary/formal advisor(s) is/are the faculty who formally serve as your academic advisor, dissertation chair, principal investigator, and/or research*

*supervisor. For ease of completing this review, primary/formal advisor(s) will only be referred to as “primary advisor(s)” for subsequent questions in this section.*

**B7. Do you choose to initiate and maintain consistent communication with your primary advisor(s)?**

Yes  No

**In the space provided below please explain why you choose to initiate and maintain consistent communication with your primary advisor**

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**B8. Is your primary advisor an IGERT faculty member or affiliated with the IGERT Program in any way? (If you have multiple primary advisors please select yes if either or any of them are IGERT faculty or affiliated with the IGERT program in any way).**

(New Item/ Construct: Presence of Communication/Frequency of Communication)

Yes  No

**B9. What means of communication are most frequently used between you and your primary advisor?**

(New Item/ Construct: Format/Means of Communication)

Electronic Correspondence  Formal Training/Lecture

IGERT Program Activity  In Person Conversation  Telephone

Other (Please Specify)

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**B10. How often has your primary advisor provided you with the following forms of interaction during the Spring 2014 academic semester (from the first day of classes to and through final exam week): (Mark one in each row)**

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/  
Construct: Nature of Communication/Type of Communication)

Question	Frequently (More than 3 times per semester)	Occasionally (2-3 Times per semester)	Not At All
An opportunity to work on a research project			
Advice and guidance about your educational program			
Emotional support and encouragement			
A letter of recommendation			
Honest feedback about your skills and abilities			
Feedback on your academic work (outside of grades)			
Intellectual challenge and stimulation			
An opportunity to discuss coursework outside of class			
Help in achieving your professional goals			

**B11. Please use this space to elaborate on your answer to any question in this section, or tell us anything else you would like us to know about your experiences with your primary advisor**

Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/ Construct:  
Nature of Communication/Type of Communication)

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**Student/Peer Contact**

*This section asks questions about your relationships with your peers/fellow doctoral student participants within the IGERT Program. Your peers are other students that have been admitted and actively enrolled in your doctoral program, department and/or the IGERT program with you.*

**C1. Do you choose to be an active participant within the community of your peers within your department?**

Yes  No

**C2. In the space provided below please explain your choice to participate or not participate within your department**

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**C3. Do you choose to be an active participant within the community of your peers within the IGERT Program?**

Yes  No

**C4. In the space provided below please explain your choice to participate or not participate within your department**

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**C5. While pursuing doctoral studies, which of the following activities related to participating in your departmental community have you engaged in (Check all that apply.)**

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/  
Construct: Nature of Interaction/Type of Interaction/Sense of the Community  
Amongst Students)

- I served on a departmental committee with faculty
- I played a formal role in faculty hiring (e.g., served on a search committee, interviewed candidates).
- I played a formal role in graduate student admissions (e.g., served on an admissions committee, hosted potential students during campus visits).
- I participated in graduate student events (e.g., social events, orientation for new students, study groups).
- I organized graduate student events.
- I mentored other graduate students.
- I mentored undergraduate students.
- I gave or receive feedback on ideas or work in progress to/from a fellow student.
- I am part of an intellectual network that goes beyond my immediate classmates and includes colleagues senior or junior to myself.
- I know a significant proportion of people in my department (faculty and students) outside my subfield.
- None of the above

Please indicate the level to which you agree or disagree with the following statements:

**C6. Consistent interaction and communication between doctoral students is a critical element in the socialization process of doctoral students.**

- Strongly Agree     Agree     Neither     Disagree     Strongly disagree

**C7. My department supports and promotes consistent interaction and communication between all doctoral students**

- Strongly Agree     Agree     Neither     Disagree     Strongly disagree

**C8. The IGERT program supports and promotes consistent interaction and communication between all IGERT program participants.**

- Strongly Agree     Agree     Neither     Disagree     Strongly disagree







**with IGERT students/fellow participants (Please limit your response to 250 words of less.)**

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/ Construct: Nature of Communication/Type of Communication)

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**IGERT Program Staff/Administration Contact**

*This section asks questions about your relationships with staff and administration within the IGERT Program. Staff and administration are the university/program employees that are responsible for overseeing administrative and fiscal management of grant program services and activities. Persons may have the following titles and/or serve in the following capacities: principal investigator, program director, program administrator, program coordinators, office managers, administrative support etc.*

**D1. Do you communicate/interact with IGERT Program/Staff Administration?**  
(New Item/ Construct: Presence of Communication/Frequency of Communication)

Yes  No

**D2. How many persons that are IGERT Program Staff/Administration do you communicate with regularly?**

(Prior Item Carnegie Foundation Survey of Doctoral Students/ Construct: Origin and Nature of Support/Communication/ Level of Communication/Interaction)

None  One  Two  Three  Four or more

**D3. What means of communication are most frequently used between you and your IGERT Program Staff/Administration?**

(New Item/ Construct: Format of Communication/Mean of Communication/Type of Communication)

Electronic Correspondence  Formal Training/Lecture

IGERT Program Activity  In Person Conversation  Telephone

Other (Please Specify)

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**D4. How often has your IGERT Program Staff/Administration provided you with the following services during the Spring 2014 academic semester (from the first day of finals through final exams week): (Mark one in each row)**

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/ Construct: Nature of Communication/Type of Communication)

Question	Frequently (More than 3 times per semester)	Occasionally (2-3 times per semester)	Not At All
Assistance navigating administrative policy/procedures			
Advice and guidance about your educational program			
Emotional support and encouragement			
A letter of recommendation			
Honest feedback about your skills and abilities			
Feedback on your academic work (outside of grades)			
Intellectual challenge and stimulation			
An opportunity to discuss coursework outside of class			
Help in achieving your professional goals			

**D5. Please use this space to elaborate on your answer to any question in this section, or tell us anything else you would like us to know about your experiences with IGERT Program Staff/Administration (Please limit your response to 250 words of less.)**

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/ Construct: Nature of Communication/Type of Communication)

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**D6. Please indicate the quality of your interactions with the following people at your institution?**

**(1 = Poor, 7= Excellent) Please select not applicable if you do not ever interact with that group of people at your institution.**

(Prior Item/ Revised- National Survey for Student Engagement / Construct: Nature and Perception of Quality of Communication)

	1	2	3	4	5	6	7	Not Applicable
Students								
IGERT Staff								
Faculty								
Student services staff (career services, student activities, housing, etc.)								
Other administrative staff and offices (registrar, financial aid, etc.)								

Demographics

*The following items will assess a small amount of personal descriptive information about you. Your identity is completely private. You are free to skip any questions that you do not wish to answer.*

E1. What discipline are you earning your doctoral degree in?

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/  
Demographics)

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E2. How many years of doctoral study have you completed? \_\_\_\_\_

(Prior Item/Revised- Carnegie Foundation Survey of Doctoral Students/  
Demographics)



*Email Address:* \_\_\_\_\_

*Can we contact you for a follow interview?*  Yes  No

## **Appendix C – Semi Structured Interview Protocols for IGERT Student/ IGERT Faculty & Staff**

### **Pre Interview Script: IGERT Trainees Student Participants**

To be read by the Interviewer prior to each interview. This will introduce the study to the participant, outline interview procedure and afford the opportunity to receive verbal consent to participate.

*“Thank you so much for agreeing to meet with me. I’m very excited for the opportunity to speak with you and I appreciate you taking the time to talk with me. First allow me to tell you a little bit about the study. The goal of this study is to explore doctoral training programs and really gain some understanding of the role of these programs in doctoral training/doctoral education in the STEM fields.*

*I have a few questions here to guide our discussion but please don’t feel bound or limited in answering only these questions. I welcome you to freely share as much or as little as you are comfortable sharing with me about your experiences. The questions are here to support our conversation but I’d really much prefer that our conversation is informal and organic in nature. In the interest of confidentiality, your name, the name of your mentor, and even the name of your IGERT will not be used in any forthcoming manuscript, presentation or publication associated with this study. Your participation in this study is voluntary and you can feel free to stop at any time. I expect the interview to take about 60 minutes to complete however we may finish earlier or exceed our time by a few minutes and either is fine.*

*With your permission I will record the interview to ensure that I’m accurately capturing your responses and so that I can focus on our conversation and not worry about taking notes. Do I have your consent to record our session?*

*Ok, let’s get started. “*

### **Supplemental Demographic Questionnaire**

All student participants will be asked to answer the following demographic questions

1. Please Specify the Following
  - a. Age
  - b. Gender
  - c. Race/Ethnicity
  - d. Class Level
  - e. Degree Program / Major
  - f. Anticipated graduation date
2. Previously Attended Institutions (Please provide requested information for each degree that you have earned)
  - a. Undergraduate Institution
  - b. Undergraduate Major/Minor
  - c. Undergraduate Degree Earned (BA/BS)



- d. Graduate Institution
  - e. Graduate Degree Earned
3. Number of years as an IGERT Trainee/Number of Years Affiliated with the Program

### Interview Questions

Please Note: Examples of follow up questions and/or conversation or discussion probes are provided questions that may or may not require additional probing or prompting.

- What prompted you to apply for an IGERT fellowship?
  - How did you learn about the program?
  - Did any specific person(s) encourage you to apply?
  - What did you hope to gain from participating?
- How would you describe the IGERT Program to a prospective student?
  - How would say the program is organized and structured
  - What is the program's mission, goals/objective?
  - How does the program work?
- What would you say of the culture of the program? How would you define or describe the culture of your IGERT?
  - Who would you say is responsible for developing and sustaining that program culture?
- What kind of training have you received through your participation in the IGERT Grant?
  - Has the IGERT taught you anything specifically?
- Has IGERT influenced your training as a doctoral student or your overall experience as a doctoral student?
  - If so, in what ways?
  - If not, are there any ways that you hope that it would?
- Would you consider the IGERT Program a diversity effort? Why or why not?
  - If so, what are some of program aspects/ components that represent the program's commitment to creating and sustaining diversity in graduate education here at your institution/ more broadly?
  - If not, what are some things that you think the program could do better in terms of the promoting diversity in STEM graduate education/ STEM workforce?
- Do you think this program is designed to attract and retain underrepresented students? Why/why not?

- If so, how?
- If not, do you think there are aspects of program that could be changed to do a better job of recruiting and supporting underrepresented students.
- (For Underrepresented Students)
  - Tell me about your graduate school experience as an underrepresented student?
    - Has your identity as a person of color shaped your graduate experience in any way?
      - If so, please describe
  - What has been your experience of the IGERT as an underrepresented student?
    - Has your identity as a person of color shaped your experience of the IGERT in any way?
      - If so, please describe
  - Do you think this program is designed to attract and retain underrepresented students? Why/why not?
    - If so, how?
    - If not, do you think there are aspects of program that could be changed to do a better job of recruiting and supporting underrepresented students.
- What, if anything, has participating in the IGERT shown/taught you about your work/ science, engineering, or the field in which you work?
- What made you want to pursue your PhD?
  - Are there any specific experiences or critical incidents that solidified your desire to pursue doctoral study?
  - What would having this degree mean to you?
- Tell me about your research?
  - Would you say that the IGERT has contributed to your research, shaped your research interest?
- In your experience what are the most useful/beneficial components of the IGERT? What are the least useful?
  - What do you enjoy most about being and IGERT Trainee?
  - What aspects of the program/program experience have been most beneficial to you?
- Describe your relationship with your IGERT Faculty Mentor?
  - Tell me a bit about the nature of your relationship? How did you meet? How often do you interact?

- Are you satisfied or dissatisfied with the current state of your relationship?
- Would you say that he/she has taught you anything about the field that you work in? What it means to have a PhD?
- What are some important lessons that you've learned (if any) from him/her?
- Describe your relationship with IGERT Program Staff/Administration
  - Tell me a bit about the nature your relationship? How did you meet? How often do you interact?
  - Are you satisfied or dissatisfied with the current state of your relationship? How so? Why or Why not?
  - Would you say that he/she has taught you anything about the field that you work in? What it means to have a PhD?
  - What are some important lessons that you've learned (if any) from him/her?
- Describe your relationship with other students in your cohort/program?
  - Are you close with the other IGERT trainees?
  - Would you say that you've learned from any of your peers and classmates, in word or in deed? If so, what are some of the things that they've taught you?
- What are your goals for after graduation?

**Pre Interview Script: IGERT Faculty/Program Administrators**

To be read by interviewer prior to each interview. This will introduce the study to the participant, outline interview procedure and afford the opportunity to receive verbal consent to participate.

*“Thank you so much for agreeing to meet with me. I’m very excited for the opportunity to speak with you and I appreciate you taking the time to talk with me. First allow me to tell you a little bit about the study. The goal of this study is to explore doctoral training programs and really gain some understanding of the role of these programs in doctoral training/doctoral education in the STEM fields.*

*I have a few questions here to guide our discussion but please don’t feel bound or limited in answering these questions. I welcome you to freely share as much or as little as you are comfortable with. The questions are here to support our conversation but I’d really much prefer that our conversation is informal and organic in nature. In the interest of confidentiality, your name, the name of your mentor, and even the name of your IGERT will not be used in any manuscript, presentation or publication associated with this study. Your participation in this study is voluntary and you can feel free to stop at any time. The interview will probably take about 60*

*minutes to complete but should we finish complete earlier than that or exceed our time by a few minutes; that is fine as well.*

*I will record the interview as to ensure that I'm accurately capturing your responses and so that I can focus on our conversation and not worry so much about taking notes. Do I have your consent to record our session?*

*Ok, let's get started. "*

### **Supplemental Demographic Questionnaire**

All student participants will be asked to answer the following demographic questions

4. Please Specify the Following
  - a. Gender
  - b. Race/Ethnicity
  - c. Position Title
  - d. Department
5. Previously Attended Institutions Previously Attended Institutions (Please provide requested information for each degree that you have earned)
  - a. Undergraduate Institution
  - b. Undergraduate Major/Minor
  - c. Undergraduate Degree Earned (BA/BS)
  - d. Date Undergraduate Degree Earned
  - e. Graduate Institution
  - f. Graduate Degree Earned
  - g. Date Graduate Degree Earned
6. Number of Years Affiliated with the Program

### **Interview Questions**

Please Note: Examples of follow up questions and/or conversation or discussion probes are provided questions that may or may not require additional probing or prompting.

- Tell me about your work?
  - What would you say is your role within the IGERT program?
  - Describe a typical day in your life (in your life or on the job?)
  - How does the IGERT fit in/align with your work?
  - In what ways do you serve/support/contribute to the program?
- How did you first learn about the IGERT program?
  - Tell me what prompted you to become affiliated with the program
  - Are there any specific experiences or critical incidents that solidified your desire to work with the program?

- How did you learn about the program?
- Did any specific person(s) encourage you to apply?
- What did you hope to gain from participating?
- Of course, one could read about the goals of IGERT on the website or in publications, in your opinion or from your perspective what are the goals of the IGERT
  - Do you think that the programs make a significant contribution? If so, in what ways. If not, why not?
  - What is the significance of your work as faculty member/program administrator?
- In your opinion what are the most useful/beneficial components of the IGERT for students? What are the least useful?
  - What do you enjoy most about your work?
  - What aspects of the program/program experience that you feel are most useful to program goals?
- Describe your relationships with other IGERT Faculty?
  - Tell me a bit about the nature your relationship? How did you meet? How often do you interact?
  - Are you satisfied or dissatisfied with the current state of your relationship?
  - Would you say that your affiliation with this program as taught you anything about the field that you work in? What it means to have a PhD?
  - What are some important lessons that you've learned (if any)?
- Describe your relationship with IGERT Trainees/Students
  - Tell me a bit about the nature your relationships? How did you meet? How often do you interact?
  - Are you satisfied or dissatisfied with the current state of your relationships?
  - Would you say that your affiliation with this program as taught you anything about the field that you work in? What it means to have a PhD?
  - What are some important lessons that you've learned (if any) from him/her?
- Can you describe the impact that the IGERT program had on doctoral students trained in STEM? If so, in what ways? If not, are there any ways that you hope that it would?
- Increasing the diversity of the STEM global workforce is a stated goal of the IGERT, are there any specific ways or measures that your take within your programs to recruit and support underrepresented populations? If so, please describe them?

- What, if anything, has participating in the IGERT shown/taught you about your work/ science, engineering, or the field in which you work?

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