



IGERT Study Cover Memo

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Overview of Proposed IGERT Study: How are IGERT projects preparing interdisciplinary researchers?

Program Purpose

Since 1998, the National Science Foundation (NSF) has supported interdisciplinary training of doctoral students across the nation through the **Integrative Graduate Education and Research Traineeships (IGERT) Program**. NSF awards five-year grants to higher education institutions to develop innovative, interdisciplinary doctoral training programs in STEM disciplines, reflecting NSF's commitment to high quality research that increasingly demands interdisciplinary approaches. The IGERT program has three broad goals: (1) to educate Ph.D.-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 establishing models for collaborative research across disciplinary boundaries; and (3) to promote diversity among participating students and the professional science and engineering workforce.

Each IGERT project is overseen by one or more Principal Investigators (PIs) who are faculty members from various departments and/or disciplines both within and across institutions. The faculty members from each IGERT project develop a series of education and research activities in which students and faculty from multiple departments participate. These activities are organized to support an interdisciplinary theme, and include a combination of multidisciplinary research collaborations, cross-departmental lab rotations, interdisciplinary seminars, team-taught courses, and/or off-campus internships, among others. Students from multiple disciplines/departments related to the project's interdisciplinary theme are recruited by faculty members to participate in the program. Most IGERT trainees are enrolled in a single-discipline Ph.D. program and participate in IGERT activities in addition to their department activities; however, some projects develop a new, interdisciplinary degree program for students. Generally, IGERT trainees complete all the requirements of their home department (or discipline within a department) as well as the requirements of the interdisciplinary IGERT project. Trainees receive a graduate stipend of \$30,000 and a cost of education allowance of \$10,500 per year (12 months). On average, trainees participate in the program for two years. Since 1998, the IGERT program has made 260 awards to over 100 lead universities, providing funding for more than 5,800 graduate students.

Rationale for the study

As interdisciplinary science becomes more common, and the demand for scientists who have the skills to conduct interdisciplinary research grows, understanding how to prepare interdisciplinary researchers becomes increasingly salient. The IGERT program represents a large scale investment in *preparing* graduate students to become interdisciplinary researchers.¹ Prior

¹ For the purpose of brevity, "interdisciplinary researchers" are used to represent "interdisciplinary scientists and engineers" throughout this document.

studies of the IGERT program have examined multiple aspects of that preparation, including project-level activities, project implementation, early career outcomes of recent IGERT graduates, and IGERT project Principal Investigators' perceptions of institutional change. NSF has examined the IGERT program using both annual monitoring data as well as targeted evaluation studies that addressed implementation (Chase and Carney, 2001; Chase et al., 2002; Martinez et al., 2006), initial impacts (Carney et al., 2006), and follow-up of IGERT graduates (Carney et al., 2010). However, these studies have not examined a central element of the program: how interdisciplinarity itself is defined and operationalized across IGERT projects. Understanding interdisciplinarity, particularly in terms of how to prepare scientists with the skills needed in an increasingly interdisciplinary research environment is increasingly salient. The current study will focus on the IGERT program's first broad goal: to prepare Ph.D. students to conduct interdisciplinary research. The study will describe how IGERT projects design, provide, and experience interdisciplinary graduate education.

Prior research about interdisciplinary training is also limited. Some researchers acknowledge the challenges associated with preparing interdisciplinary researchers within institutions and departments that are discipline-focused (Coppola, Banaszak Holl, & Karbstein, 2007; Feller, 2006); some researchers have examined context-specific interdisciplinary research models within specific laboratory or disciplinary settings (e.g., Lattuca and Knight, 2010; Nersessian, 2009), while others point to a dearth of empirical research about learning outcomes, methods, or benchmarks for interdisciplinary learning, especially in science and other technical fields (Aboelela et al., 2007; Boix Mansilla, 2006; Borrego & Newswander, 2010; Jacobs & Frickel, 2009; Schilling, 2001; Van Hartesfeldt & Giordan, 2008).

Two recent studies conceptualized likely outcomes of interdisciplinary education. Lattuca and Knight (2010) reviewed the engineering education and higher education literature, and from that review, developed a working definition of interdisciplinary competence. Such interdisciplinary competence is defined as one's ability to understand and utilize knowledge and modes of inquiry drawn from disciplines other than one's own, and that understanding and use of knowledge includes the following skills: a) an appreciation of various disciplinary perspectives; b) an ability to incorporate and evaluate multiple disciplinary approaches to problem-solving; c) an ability to recognize the strengths or weaknesses of one's own disciplinary perspective; and d) an ability to recognize the shared assumptions, skills, or knowledge among disciplines. Borrego and Newswander (2010) conducted an analysis of peer-reviewed literature from interdisciplinary studies in the humanities and social sciences fields and reviewed information from 129 funded IGERT proposals, and from that analysis, identified five similar categories of learning outcomes for interdisciplinary education, including: a) disciplinary grounding; b) integration; c) teamwork; d) communication; and e) critical awareness. Building on the interdisciplinary skills and learning outcomes described in the literature above, as well as feedback from the study's Evaluation Advisory Committee (EAC),² the study team

² The EAC includes: Monica Cox – Director, Pedagogical Evaluation Laboratory and Associate Professor of Engineering/Purdue University; Irwin Feller – Professor Emeritus of Economics/Pennsylvania State

identified the following knowledge, skills and abilities as important in preparing students to conduct interdisciplinary research:

1. Depth of knowledge in one discipline or field of study
2. Ability to recognize the strengths and weaknesses of multiple disciplines
3. Ability to apply the approaches and tools from multiple disciplines to address a research problem
4. Ability to work in a team with individuals trained in different disciplines
5. Ability to communicate research based in one discipline or field of study to academic researchers trained in different disciplines
6. Ability to communicate about interdisciplinary research to non-academic audiences (laypersons)

The study will collect data from IGERT PIs and from currently enrolled IGERT trainees, both those currently funded as well as those who had been funded in prior years (and who are still enrolled in their graduate programs) to learn whether and how they perceive the knowledge, skills, and abilities listed above as important to conducting interdisciplinary research. Further, PIs will be asked how their projects are designed to develop trainees in these areas. The results will provide the program staff with an understanding of program participants' perceptions of the importance of these skills to conducting interdisciplinary research, whether and how projects provide training to develop trainees' skills in these six areas, the frequencies with which various approaches are used, and the successes and challenges reported by the study's IGERT participants.

Research questions

The study will address the following research questions:

1. Whether and in what ways do IGERT participants (PIs and trainees) perceive the knowledge, skills, or abilities drawn from the literature as important to conducting interdisciplinary research?
2. What activities do projects implement to develop trainees' interdisciplinary research capacity, as characterized by these knowledge, skills, or abilities? How do projects assess trainees' development as interdisciplinary scientists?
3. How helpful do trainees perceive their IGERT training to be in developing their capacity to conduct interdisciplinary research as characterized by these six areas?
4. How confident are IGERT trainees of their knowledge, skills, and abilities in these six areas?
5. What challenges do trainees encounter with the IGERT traineeship?

Exhibit 1 below summarizes the study's research questions and data collection sources.

University; Lisa Lattuca – Professor of Higher Education/University of Michigan; and Nancy Nersessian – Regents' Professor of Cognitive Science/Georgia Institute of Technology.

Exhibit 1: Research Questions by Data Sources			
Research Question/Topics	Data Sources		
	Primary Data Collection		Secondary (Extant) Data
	IGERT PIs (Interview)	IGERT Trainees (Survey)	Distance Monitoring Data
1. Whether and in what ways do IGERT participants (PIs and trainees) perceive the knowledge, skills or abilities drawn from the literature as important to conducting interdisciplinary research?			
IGERT trainees' perception of the importance of the knowledge, skills or abilities to conducting <i>interdisciplinary research</i>		✓	
IGERT trainees' perception of the importance of the knowledge, skills or abilities to conducting research in <i>one discipline or field of study</i>		✓	
IGERT trainees' perception of other areas that are important to conducting interdisciplinary research		✓	
IGERT PI's perception of the importance of the knowledge, skills or abilities to conducting interdisciplinary research	✓		
2. What activities do projects implement to develop trainees' interdisciplinary research capacity, as characterized by these knowledge, skills or abilities? How do projects assess trainees' development as interdisciplinary scientists?			
Role of the different IGERT training activities in developing trainees' capacity in the six areas	✓		✓
IGERT faculty's assessment of the development of trainees' interdisciplinary research capacity	✓		✓
3. How helpful do trainees perceive their IGERT training to be in developing their capacity to conduct interdisciplinary research as characterized by these six areas?			
Perceived helpfulness of IGERT training in developing IGERT trainees' capacity in the six areas		✓	
Other knowledge, skills or abilities trainees report that their IGERT training helps to develop		✓	
4. How confident are IGERT trainees of their knowledge, skills, and abilities in these six areas?			
IGERT trainees' perceptions of their confidence in these areas		✓	
5. What challenges do trainees encounter with the IGERT traineeship?			
Perceived challenges to participating in IGERT	✓	✓	✓

Research design

The study will collect data from a purposive sample of active IGERT projects and their participants (PIs and trainees). The study plans to focus specifically on all 40 projects initially funded in the 2007 and 2008 cohorts. These projects meet the following criteria:

- Provide representation from each directorate that supports IGERT projects
- Have been operational long enough to have moved beyond initial implementation
- Have trainees at different points along the graduate education trajectory, and
- Are housed at a variety of higher education institutions

One potential drawback of this approach is that the study findings would not be representative of the full set of IGERT projects; rather, the findings would only be applicable within a particular set of projects funded over a defined three to four year time period. However, the study is not seeking to generalize to all projects, but, as an exploratory and descriptive study, is designed to learn whether and how a subset of projects define and operationalize interdisciplinary training in ways consistent with an emerging literature on interdisciplinary graduate education.

Research data collection

The study will collect data in the 2011-12 academic year from two respondent groups: project PIs and current and formerly funded IGERT trainees who are still enrolled in their doctoral program. As there are no prior studies of interdisciplinary graduate education that apply across diverse disciplinary boundaries *and* that ask about the six skill areas described above, the study has developed new instruments. The study design and instruments have been reviewed by an Evaluation Advisory Committee (EAC) comprised of experts in graduate STEM education, interdisciplinary research in science and engineering, and evaluation of higher education STEM programs.

The EAC provided input on the instruments to ensure that they are appropriate for the study's research questions. Specifically, the EAC reviewed the overall design as well the draft instruments and individual items to ensure that individual items are designed to measure underlying constructs (construct validity) and that the items (and overall instruments) have adequate face validity for respondents who participate in IGERT projects. The EAC members also reviewed the study's data collection plan and strategies to ensure high response rates. Taken together, the EAC comments have informed the study's overall design, instruments, data collection and analysis plan, and therefore serve to enhance the ultimate reliability of study findings. Additionally, both the PI interview and the survey have been and will continue to be pilot tested to ensure clarity of language and concepts, logical sequencing of questions and items, appropriate skip patterns, and ease of navigation (for online surveys). The draft instruments reflect feedback from the EAC and information obtained to date from pilot testing.

Principal Investigator Interviews: The PIs will have first-hand (and current) knowledge of how and why they have designed their training programs to prepare trainees with the skills they believe are essential for interdisciplinary research. The 40 PIs from the 2007 and 2008 cohorts of projects will be interviewed using a semi-structured interview protocol so that the study can collect detailed and potentially project-specific information on project activities, decision-making processes, and assessment of trainees' development of interdisciplinary skills.

Survey of Currently Enrolled IGERT Trainees: The IGERT trainees will have first-hand experience acquiring skills that their respective projects believe are those required of interdisciplinary scientists. The study will field an online survey to all currently enrolled IGERT trainees from the 2007 and 2008 projects. IGERT projects typically support 5 to 10 trainees each year over their five-year grant periods. It is important to note that while projects generally support trainees for some, not all, of their graduate education, projects typically identify all enrolled students as IGERT trainees, whether the students are currently receiving financial support or not. Therefore, it is estimated that each project from these two cohorts will have approximately 17-20 currently enrolled trainees for an estimated total of 750 trainees who will be invited to participate in the survey. The study anticipates an 80 percent response rate, based on recent experience conducting studies of other NSF fellowship programs.

Monitoring data

The study will rely upon the Distance Monitoring System (DMS) data to learn about the sample projects. The DMS is operated by ICF Macro, a survey research and information technology company. Each year, participating projects submit information about numbers of participants (at institution, department, faculty, and student levels), nature/frequency of activities, and selected project accomplishments. Study researchers have reviewed DMS data to inform the development of study instruments (interview protocols and trainee survey), and will continue to use the data to prepare for interviews with individual PIs.

Methodology/instrumentation

Because monitoring system data about projects' activities and participants already exist and will have been reviewed prior to data collection, the study can more efficiently conduct interviews and field surveys, as the study team will already have obtained and reviewed relevant background information. The study team did not find existing survey items or databases from which to select survey items, thus new instruments have been developed for this study. Given that monitoring system data about projects' activities and participants already exist and will have been reviewed prior to data collection, the study can more efficiently conduct interviews and field surveys, as the study team will already have obtained and reviewed relevant background information.

- The PIs will be interviewed using a semi-structured interview protocol so that the study can collect detailed and potentially project-specific information about such topics as: PIs' initial reasons for applying for IGERT funding; how and why project activities help prepare trainees to work in an interdisciplinary environment; how PIs recruit and retain students who can succeed in an interdisciplinary context; and PIs' descriptions of challenges and corresponding strategies in their host departments and institutions. The interviews will take 45 minutes to complete. After developing the final interview protocols, all interviewers will be trained on the interview protocol to standardize questions and prompts across interviewers and interviews. Only Abt staff members with working knowledge of the IGERT program will conduct these semi-structured interviews. Interviews will be scheduled using contact information obtained from the PIs. Interviewees will be assured that information they provide will not be released in any form that identifies them as individuals and their responses will be kept confidential. Interviews will be tape-recorded so that notes can be captured and analyzed using a combination of Microsoft Access and NVivo software packages. The study will use well-established qualitative data analytic techniques to analyze responses in terms of commonalities across projects, institutions, and interdisciplinary clusters or themes. Given that the (interview) sample size is below 50, responses will be reported in terms of numbers of respondents rather than percentages.
- The study will field an online survey to an estimated 750 IGERT trainees. The survey will include questions about which skills trainees report they are developing to become interdisciplinary researchers in their respective contexts, how their respective programs develop/enhance such skills, the specific IGERT activities they perceive as important to the development of their capacity to conduct interdisciplinary research, and the challenges they have experienced in developing interdisciplinary skills. The survey will take approximately 20-25 minutes to complete. Survey responses will be analyzed using descriptive statistics, and will be presented in terms of aggregate frequencies and proportions, and, if possible, in terms of common patterns of responses across projects, institutions, and for trainees, in terms of stage of graduate training.

Limitations

There are three major limitations of the proposed study. First, there is no one commonly-accepted definition of interdisciplinarity, so the dimensions/traits being explored in the study are necessarily exploratory. A second limitation is that student outcomes are self-reported by the trainees—they will be asked about their perceived confidence in skills across these areas to conduct interdisciplinary research. The study is not measuring these skills directly. However, given that there is no commonly accepted definition of interdisciplinarity, nor a commonly accepted set of outcomes, a study that describes perceptions of importance of skills, preparation in these skill areas, and means by which trainees acquire capabilities in these areas can be useful.

Expected Contributions

The study will provide information to the IGERT program staff about how projects operationalize interdisciplinary graduate training, specifically whether and how projects provide training to develop trainees' skills in the six areas hypothesized as important to conducting interdisciplinary research, the frequencies with which various approaches are used, and the successes and challenges reported by the study's IGERT participants. The results of the study can also inform the design of a more rigorous study that can assess whether and how specific training activities are associated with the acquisition of identified skills.

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