

# Chapter 2: Evaluation Methodology

## Previous Monitoring and Evaluation

Abt Associates has been evaluating for the National Science Foundation (NSF) various facets of the IGERT program since shortly after the program's inception in 1997. Monitoring initially focused on the characteristics of projects at individual universities, and consisted of analyses of data from a web-based Distance Monitoring System completed annually by the project Principal Investigators (PIs), funded trainees, and other students participating in the project.<sup>18</sup> The Web-based survey and resultant database provide descriptive information about each IGERT project (e.g., who participates in the project, how many trainees are funded and for how long, what are the structural elements of the program).

Beginning in 2002, NSF funded a cross-site analysis of the IGERT program, focusing on project implementation and early impacts. Under this work, Abt Associates conducted monitoring site visits with projects in the 1998, 1999, and 2000 cohorts, visiting each project in its third year of implementation. Site visits consisted of face-to-face interviews of PIs, trainees, and key faculty, as well as relevant department, school, and university administrators. Two or three relevant content area scientists also visited each project. These peer scientists, selected from each project's subject area, evaluated the scientific merit of project elements and experiences.

Information from the Distance Monitoring System combined with that collected during site visits has enabled Abt Associates and NSF to develop an in-depth understanding of the implementation of the IGERT program, along with its perceived successes and challenges encountered. The Distance Monitoring System has provided prescribed and consistent data across all IGERT sites, while individual site visits have allowed the collection of site-specific, in-depth information that answers questions raised by the Web-based collection and extends its scope. Together, the two approaches have provided as complete a portrait as possible of the evaluated program.

## The IGERT Impacts Evaluation

Neither of the evaluation approaches described above, however, has enabled NSF to draw comparative conclusions about the impact of the IGERT program as compared with other, non-IGERT experiences. Thus in 2003, NSF contracted with Abt Associates to conduct an *Evaluation of the IGERT Program's Initial Impacts* for participating students, faculty, and institutions, employing a comparison group of non-IGERT individuals. The Impacts Evaluation, which forms the basis of this report, examines differences between groups of individuals – for example, the interdisciplinary nature of IGERT faculty compared with non-IGERT faculty, or the interdisciplinary training of IGERT students compared with non-IGERT students. The Impacts Evaluation also collected information on the degree to which IGERT projects have affected change within their institutions, and the institutional factors that support or hinder such change. The key difference between this study and the evaluation work that preceded it lies in its use of a comparison group to examine program impacts.

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<sup>18</sup> The IGERT Distance Monitoring Web System is maintained by QRC Macro under separate contract.

## Evaluation Questions

The principal objective of the evaluation is to determine the IGERT program's impact on participating students, faculty, and institutions. The primary research questions are outlined below:

### *Student indicators*

- How does an IGERT education differ from that received in a traditional single disciplinary program?
- What is the perceived added value for students of IGERT related educational experiences?

### *Faculty indicators*

- How do IGERT faculty differ from non-IGERT faculty in terms of their teaching, research, mentoring, networking, and productivity?
- How does participation in IGERT impact faculty teaching, research, mentoring, networking, and productivity?
- What is the perceived added value for faculty of participating in IGERT?

### *Institutional indicators*

- How have IGERT projects influenced institutional culture and support for interdisciplinary graduate education?
- How have IGERT projects impacted institutional policies and procedures?
- How have IGERT projects impacted institutional structures?
- What elements of IGERT projects have been institutionalized or adopted by other institutional programs?

### *Recruitment indicators*

- What is the added recruitment value of the IGERT project?
- What are the characteristics of students being recruited into IGERT programs, and how do they differ from traditional graduate students?

## Sampling Methods

### IGERT Sample

In order to allow projects adequate time to implement activities prior to the evaluation, we focused on the first three cohorts of the program. Fifty-two<sup>19</sup> of the 57 IGERT projects funded between 1998 and 2000 participated in the Impacts Evaluation. As many IGERT projects are collaborations of individuals from numerous departments (in some cases, ten or more), we included in the study the

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<sup>19</sup> Five IGERT projects were not included in the study. One was excluded because its structure did not fit the sampling framework of the study: it draws individual students and faculty from a number of different universities, instead of from within one or two institutions. Four other projects declined to participate.

two largest departments from each IGERT project, as measured by the number of IGERT students enrolled.<sup>20</sup>

### **Comparison Group – Non-IGERT Sample**

Once the IGERT sample of departments was identified, a comparison group could be constructed. Several possible comparison groups were considered for this study. First considered was a simple random sample of all non-IGERT institutions in the United States. While this would be nationally representative of non-IGERT sites, it would not take into consideration the quality characteristics of institutions housing the IGERT projects. It is likely that IGERT-funded institutions differ from non-funded institutions along various dimensions (size, types of degrees offered, level of research funding). A random national sample would not address variations in program implementation and quality associated with specific fields of study, or the variety of disciplines included in IGERT projects.

The second possibility considered was to compare IGERT participants to individuals participating in other interdisciplinary graduate programs, either national efforts or specific programs at individual institutions. As there is no organized record of interdisciplinary programs, this method would have first involved an initial review of educational programs across the country to identify appropriate programs. Moreover, while a comparison of IGERT with other interdisciplinary programs would illustrate IGERT's effectiveness in achieving desired interdisciplinary outcomes, it would not address the question of what is gained (or lost) from offering students an interdisciplinary component to their education, as compared with the traditional disciplinary model. It also would not account for general movement in science towards interdisciplinary work. As the latter were questions of primary interest to NSF, this option was rejected.

The third comparison option, which was the one selected for this study, was to compare IGERT participants to individuals from an appropriate set of traditional departmental graduate programs. This method contrasts the IGERT interdisciplinary experience with single department options otherwise available to students. The comparison is *interdisciplinary* against *single department* education, with IGERT as the exemplar of interdisciplinary. Any tendency for scientists in their particular field to be engaging in joint work with other disciplines simply as a matter of overall changes in the research field, and, consequently, in graduate education, is taken into account through the use of this comparison group. The limitation of this choice is that the comparison group may be flawed by selection bias; it is possible that both the character of the IGERT program and the outcomes for participants are more the result of their inherent tendency to seek interdisciplinary interactions than they are the effect of IGERT funding. This limitation was partially addressed by collecting data from non-IGERT sample individuals on the interdisciplinary nature of their education and research.

It was important that the selection of a comparison group account for the academic quality of the doctoral programs involved. We considered various methods of matching IGERT projects against traditional departments. Institutional and departmental data is available on several measures from the Integrated Postsecondary Education Data System, collected by the National Center for Educational

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<sup>20</sup> Two of the IGERT programs have doctoral students housed in an interdisciplinary doctoral program: Bioinformatics and Neuroscience, which are not considered departments at their institutions. In these cases we looked at the two departments housing the greatest numbers of IGERT faculty members.

Statistics. Such data provides no indication of program quality, however. The Carnegie classifications are useful for grouping institutions, but are not specific to individual disciplines. The National Research Council (NRC) periodically ranks doctoral programs, but at the time of the study the latest rankings came from 1995, meaning that we would have been selecting comparisons based on the academic standing of departments nearly ten years earlier. Upon examination we also realized that because the NRC only ranked the top<sup>21</sup> institutions in each category, some of our IGERT departments were not ranked. Other IGERT departments were so new that their relevant fields (e.g., microelectronics, bioinformatics) did not even appear as a rankings category.

To enable the construction of a comparison group that accounted for academic quality and provided a match for all departments in our IGERT sample, we chose to use self-identified peer departments for the IGERT departments. We contacted the department chairs of the selected IGERT departments and asked them to identify for us the departments and institutions with whom they primarily compete for doctoral students. Of the list provided by each chair, we eliminated any programs that were involved with other IGERT projects, then selected the comparison department with characteristics most closely matching the desired IGERT department on the following institutional characteristics: control (public/private), geographic region, number of doctoral degrees granted, number of students enrolled full-time and part-time, and overall number of degrees granted).<sup>22</sup>

Using self-identified peers as a comparison group provides a reasonable approximation of academic quality, if one assumes that departments will compete for students of similar academic ability. The possible bias in this comparison comes from the tendency of academics to identify as their peers individuals or programs which, on other measures, may actually rank slightly higher than themselves (in other words, to self-inflate the comparison). Given the lack of other alternatives, we chose to accept this comparison group, with the understanding that this selection bias may have set a more difficult standard for assessing program impacts.

Department chairs from selected comparison institutions were approached and asked to participate.<sup>23</sup> Once IGERT and comparison departments were identified and recruited into the study, we drew from each a random sample of faculty members and graduate students. Comparison faculty and students were selected in equal proportions to the number of individuals included from each matched IGERT department, to ensure equal distribution across disciplines in both samples. Students must have completed at least two years of coursework, to ensure comparable levels of experience. We also asked chairs to identify the name of a university administrator who could speak to the university's position on interdisciplinary graduate education, as well as the contact information of any doctoral students who graduated from the program between September 2000 and December 2002. The selected administrators were interviewed to learn more about the institutional context in which IGERT projects were operating, and the graduates were sent a pilot graduates survey.

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<sup>21</sup> The 1995 NRC assessment of 41 fields of doctoral study included between 25 and 193 programs, depending on the discipline.

<sup>22</sup> Institutional data was obtained from the U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS).

<sup>23</sup> Very few department chairs declined to participate. If chairs could not be reached, we investigated whether faculty and student e-mail addresses were available through departmental websites instead. If chairs refused, or if contact information was not available via the web, an alternate comparison department was substituted.

## Final Sample Sizes

Exhibit 2.1 shows our final sample size for the IGERT and Non-IGERT samples.

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**Exhibit 2.1**

**Final Sample Sizes**

Respondent Type	IGERT Respondents	Non-IGERT Respondents <sup>a</sup>
Students	361	749
Faculty	390	773
Department Chairs	97	82
PIs	52	--
University Administrators	32	25

<sup>a</sup> Non-IGERT students and faculty were over-sampled to ensure adequate representation to draw statistically significant conclusions about differences between IGERT and Non-IGERT responses.

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## Data Collection Instruments

The 2004 Initial Impacts surveys were administered in the fall of 2004 and spring 2005 as web-based surveys, as follows:

1. Students (IGERT and Non-IGERT)
2. Faculty (IGERT and Non-IGERT)
3. Department chairs (IGERT and Non-IGERT)
4. IGERT PIs

Staff conducted telephone interviews with administrators at IGERT and non-IGERT institutions. Finally, a bibliometric analysis was conducted of CVs of our faculty sample (IGERT and Non-IGERT). A full report on the bibliometric analysis is included as an appendix at the end of this report.

## Response Rates and Sample Characteristics

The final sample for the study was comprised of students, faculty, department chairs and PIs from 52 IGERT projects and, as described above, a carefully constructed comparison sample of non-IGERT students, faculty and department chairs. Resulting sample sizes were large enough to produce a level of precision such that proportions estimated from the full sample would have confidence intervals of plus or minus five percentage points or less. Exhibit 2.2 presents the sample size for each category of respondents and their response rates.

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**Exhibit 2.2****Final Sample Size and Response Rates for Web-Based and Email Surveys**

Respondent Type	IGERT Respondents			Comparison Non-IGERT Respondents		
	N Sent Out	N of Completes	Response Rate <sup>a</sup>	N Sent Out	N of Completes	Response Rate <sup>a</sup>
<b>Web Surveys</b>						
Students	361	306	85%	749	566	76%
Faculty	390	347	89	773	556 <sup>b</sup>	72
Department Chairs	97	85	88	82	59	72
PIs	52	49	94	--	--	--
<b>Telephone Interviews</b>						
University Administrators	32	24	75%	25	16	64%

<sup>a</sup> Response rates calculated on the basis of number of fully and partially completed surveys.

<sup>b</sup> 580 comparison faculty (75% response rate) completed the survey. Of these, 24 faculty reported participating in an IGERT project. Number of completes calculated after eliminating the 24 surveys.

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**Sample Characteristics**

The respondents included in the final IGERT and non-IGERT samples share similar characteristics. Departments included in the study are roughly equivalent in size, having comparable numbers of faculty members and doctoral students (Exhibit 2.3).

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**Exhibit 2.3****Size of IGERT and Non-IGERT Departments**

	IGERT (N=85)	Non-IGERT (N=59)
<b>Number of faculty members</b>		
Median	28	24
Minimum	8	8
Maximum	150	67
<b>Number of doctoral students</b>		
Median	68	70
Minimum	8	6
Maximum	250	320

<sup>a</sup> Four IGERT and one Non-IGERT department chair respondents did not respond to this item.

Note: We have reported the median number of faculty and students rather than the average in order to account for the few respondents who come from institutions where academic departments are housed in larger units.

Source: *Initial Impacts Survey of Department Chairs 2004.*

*Questions: "Approximately how many faculty are in your department? Approximately how many doctoral students are currently enrolled in your department?"*

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The resulting IGERT and non-IGERT samples are also equivalent in disciplinary spread, as portrayed in Exhibit 2.4. Much of the IGERT sample is divided among Engineering (32 percent), Life Sciences (21 percent), and Physical Sciences (21 percent), and the non-IGERT group is distributed in similar proportions.

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**Exhibit 2.4****Discipline Distribution of IGERT and Non-IGERT Department Chairs, Faculty Members, and Students (Completed Surveys)**

	Department Chairs		Faculty		Students	
	IGERT (N=81)	Non-IGERT (N=59)	IGERT (N=337)	Non-IGERT (N=556)	IGERT (N=306)	Non-IGERT (N=566)
Engineering	32%	34%	36%	34%	32%	33%
Life Sciences	21	14	24	21	21	24
Physical Sciences	21	27	17	20	17	17
Social Sciences	7	5	7	7	12	8
Computer Sciences	9	10	5	9	6	6
Environmental Sciences	7	2	5	5	7	5
Mathematical Sciences	1	5	3	3	3	4
Psychology	1	3	3	2	3	2

*Source: Sample Characteristics of Department Chairs, Faculty, and Students based on the sample file for respondents who completed their surveys.*

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Finally, the IGERT and non-IGERT students who responded to the survey are very similar in program status and prior background. The survey sample included students who were at least two years into their program, to allow time for sufficient programmatic experiences. Less than one third of the students had entered their doctoral program with a prior post-undergraduate degree (24 percent IGERT; 31 percent non-IGERT).<sup>24</sup> At the time of reporting most of the students had passed their qualifying examinations and were working on their dissertation research (Exhibit 2.5). The percentage of students at various levels in their programs does not vary for the IGERT or non-IGERT groups, validating comparisons of their reported experiences to date in their graduate programs later in this report.

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<sup>24</sup> There is a significant difference among the non-IGERT students depending on nationality: 19 percent of the United States students had a prior degree, compared with 50 percent of foreign non-IGERT students.

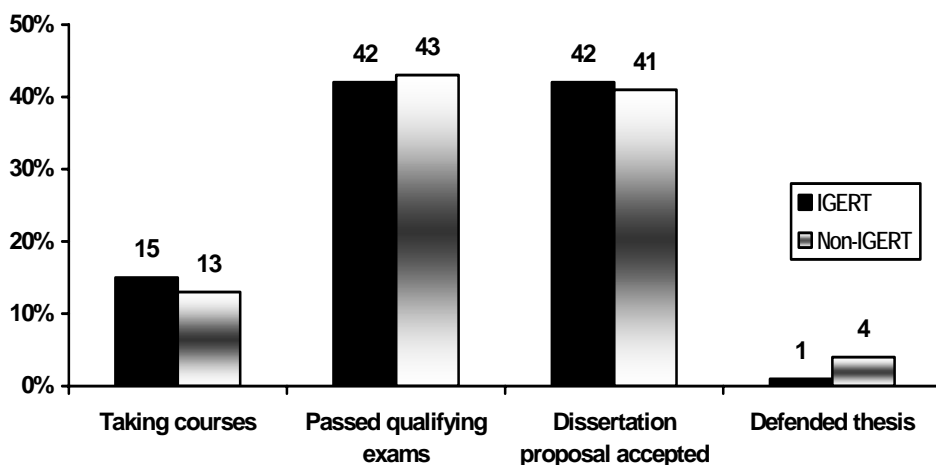
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**Exhibit 2.5**

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**Program Status of IGERT and Non-IGERT Students at Time of Survey**

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IGERT N= 306. Non-IGERT N= 566. Percents do not sum to 100 due to rounding.

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Sources: *Initial Impacts Survey of Students 2004*.

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Question: "What is your current status in your graduate program?"

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### ***A Note about International Students***

All IGERT trainees must be United States citizens or permanent residents. The non-IGERT comparison student sample, however, includes both American and foreign students. Just under two-thirds of the non-IGERT sample are United States citizens (58 percent) or permanent residents (3 percent). The remaining students are foreign nationals (37 percent) or did not report their citizenship (2 percent). Analyses were conducted to examine the difference between native and foreign non-IGERT students. In most cases, there were not significant differences between the groups. Where there were differences, this has been noted in the text. Foreign or non-reported citizenship individuals are also reported separately from the American non-IGERT individuals throughout this report in places where citizenship might be related to the responses (such as in reporting on race and ethnic background, other programs applied to, or international experiences). Otherwise, all non-IGERT students are reported together for data describing their general graduate program experiences (courses taken, research conducted) and levels of preparedness.

### **Prevalence of IGERT Projects in Comparison Institutions**

Constructing a comparison sample of academically equivalent departments for the IGERT-involved departments while avoiding departments involved in other IGERT projects was a challenging task, given the prevalence of IGERT grants in research universities (See Exhibit 2.6). IGERT institutions in 2005 comprise 46 percent of all institutions in the Doctoral/Research University-Extensive Carnegie institutional classifications.



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**Exhibit 2.6****Prevalence of IGERT Grants Among Institutions in Research and Doctoral Carnegie Classifications**

<b>Carnegie Ranking</b>	<b>Number of Institutions with an IGERT Grant</b>	<b>Number of Institutions without an IGERT Grant</b>	<b>Total Number of Institutions in Classification</b>	<b>Percent of Overall Institutions with an IGERT Grant</b>
Doctoral/Research Universities – Extensive	69	82	151	45.7%
Doctoral/Research Universities – Intensive	7	103	110	6.4
Master's Colleges and Universities I	1	494	495	0.2

Notes: Data represents eight cohorts of IGERT projects, funded between 1998 and 2005

Source: *The 2000 Carnegie Classifications*.

*Doctoral/Research Universities—Extensive:* These institutions typically offer a wide range of baccalaureate programs, and they are committed to graduate education through the doctorate. During the period studied, they awarded 50 or more doctoral degrees per year across at least 15 disciplines.

*Doctoral/Research Universities—Intensive:* These institutions typically offer a wide range of baccalaureate programs, and they are committed to graduate education through the doctorate. During the period studied, they awarded at least ten doctoral degrees per year across three or more disciplines, or at least 20 doctoral degrees per year overall.

*Master's Colleges and Universities I:* These institutions typically offer a wide range of baccalaureate programs, and they are committed to graduate education through the master's degree. During the period studied, they awarded 40 or more master's degrees per year across three or more disciplines.

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Due to the prevalence of IGERT projects on college campuses, it was inevitable that some departments included in the comparison sample came from institutions that also housed IGERT grants. Institutions in the final comparison sample were split as follows: 67 percent have an IGERT grant; 33 percent do not. This does not mean that the specific comparison departments selected were involved with IGERT projects – it only means that somewhere else on campus other departments have received an IGERT grant. We confirmed with comparison department chairs at the time of sampling that to their knowledge none of their faculty members were involved with an IGERT project. To verify the chair's information, all comparison faculty were asked whether they were participating in an IGERT grant, and comparison faculty who stated they were directly involved with IGERT were eliminated from our sample. This resulted in four percent of the comparison faculty who completed the survey (N=24) being eliminated from the analysis.

**Analysis Techniques**

Several types of tests were used to measure significant differences between the IGERT and non-IGERT respondents. The chi square test, which measures significant differences of patterns of frequency, was used on frequency tables for categorical variables. Because the chi square test rejects small Ns, we used the Fisher's exact test in place of the chi square when we had a low cell count or empty cells. For example, this test was used for variables that had five point scales. We used the t-

test, which measures the significant difference between means of continuous variables, for those questions where the respondent could write in any number, i.e. number of publications.

## **Organization of This Report**

We have organized this report along the primary goals of the IGERT program as laid out in Chapter 1. Chapter 3 explores the program's goal of educating new U.S. Ph.D. scientists and engineers for the careers of the future, and looks at the impacts of IGERT on participating students. Chapters 4 and 5 describe the ways in which IGERT projects are catalyzing cultural change for faculty (Chapter 4) and institutions (Chapter 5). Chapter 6 examines the success of the IGERT program in increasing participation of individuals from diverse backgrounds. Chapter 7 summarizes evaluation findings and suggests areas for future study. Appendix A presents supplementary data tables from the study, and Appendix B contains the full text of the report summarizing the faculty bibliometric analysis. Unless otherwise noted, all data presented in this report come from the surveys of the Impacts Evaluation. The next chapter explores the educational experiences of IGERT and non-IGERT students, and draws conclusions about the impact of IGERT participation to date for enrolled students.