

## Chapter 3: Impacts on Students

This chapter examines the IGERT program's success in meeting its goal of educating the scientists and engineers of the future 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. We explore ways in which IGERT students are gaining interdisciplinary perspectives; developing research skills; receiving professional training in areas such as working in teams and communication; developing an international perspective; and being prepared for a wide range of careers. This chapter addresses the following research questions:

- 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?

### The IGERT Model of Education

The IGERT model of graduate education for doctoral students as laid out in the program solicitation<sup>25</sup> has five components (emphasis added):

- The IGERT project should be organized around an **interdisciplinary theme** involving a diverse group of faculty members, which provides a framework for **integrating research and education** and for promoting collaborative efforts within and across departments and institutions.
- Students should gain the **breadth of skills**, strengths, and understanding to work in an interdisciplinary environment while being **well grounded with depth of knowledge** in a major field.
- Students should receive experience relevant to both **academic and nonacademic careers**. This may involve such activities as internships and mentoring in industrial, national laboratory, academic, or other settings.
- Globalization of research and career opportunities places importance on providing students with an **international perspective**. This may be gained through programs within the institution, or through strongly integrated, collaborative research experiences and/or fieldwork at foreign institutions and sites.
- The graduate experience should contribute to the **professional and personal development** of the students and equip them to understand and integrate scientific, technical, business, social, ethical, and policy issues to confront the challenging problems of the future.

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<sup>25</sup> IGERT Program Solicitation NSF 05-517.

Individual grantees exercise considerable latitude in organizing their own IGERT projects within specific institutional contexts to achieve these program goals. This chapter presents evidence that IGERT projects are addressing the program elements outlined above.

## Interdisciplinary Experiences

The words “interdisciplinary” and “multidisciplinary” are often used interchangeably to refer to work completed at the intersection or boundary of multiple fields. Indeed, the first two IGERT program solicitations referred to “multidisciplinary” research and education, after which the solicitation language was changed to use the word “interdisciplinary.” Reflecting this usage, we use the term interdisciplinary graduate education in this report<sup>26</sup> to refer to the wide range of activities in which IGERT participants engage, which might include:

- education pursued by an individual in multiple disciplines, where each discipline is taught by educators situated in single disciplines but the disciplines are not necessarily related to each other;
- education involving issues that can only be studied by integrating parts of existing disciplines into a new discipline; or
- education involving issues that require individuals to have substantial knowledge of multiple disciplines.<sup>27</sup>

IGERT projects have adopted different interpretations of what it means to organize graduate education around an interdisciplinary theme. One fifth of the PIs (22 percent) expect their students to become experts in more than one field. More report that students in their projects will have mastery of one field and be able to work with scientists in other fields (63 percent), and/or that they are educating students who know and can use the techniques of multiple disciplines (59 percent).<sup>28</sup> Reflecting this usage, we use the term interdisciplinary graduate education in this report<sup>29</sup> to refer to the wide range of activities in which IGERT participants engage.

The first program component outlined above states that in organizing around an interdisciplinary theme, projects are to involve faculty and students from diverse disciplinary backgrounds in an environment in which research and education are integrated, and which allows students to develop the ability to work in an interdisciplinary environment, while maintaining depth in their own field. By

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<sup>26</sup> The term “multidisciplinary” is used in this report in a few cases where question items were worded accordingly.

<sup>27</sup> Adopted from: Kockelmans, Joseph. “Why Interdisciplinary?” *Interdisciplinarity and Higher Education*. University Park: The Pennsylvania State University Press, 1979, 123-160.

<sup>28</sup> Initial Impacts Survey of PIs 2004. PIs were asked the degree to which each statement described the goals of their IGERT projects, on a five-point scale from “Not at all” to “Completely.” Reporting here the percent that chose “Completely” for each of three separate items. Percents do not sum to 100 because these are separate items.

<sup>29</sup> The term “multidisciplinary” is used in this report in a few cases where question items were worded accordingly.

exposing students to individuals, methods, and tools from multiple disciplines, NSF intends that IGERT projects will produce doctoral graduates more capable of conducting interdisciplinary research.

To address these goals, IGERT projects fund trainees from a variety of disciplines, provide instruction by faculty from multiple disciplines, allow trainees to participate in research with faculty from multiple disciplines, and/or offer courses that draw on multiple disciplinary fields.<sup>30</sup>

These departures from traditional doctoral education organization result in broadened experiences for IGERT students (Exhibit 3.1). Nearly all IGERT students report having access to disciplines and expertise outside of their home department, compared with only two thirds of non-IGERT students. IGERT students are also significantly more likely than non-IGERT students to report having opportunities to study multiple disciplines, or to have taken courses that exposed them to the laboratories or research techniques of multiple disciplines. Outside the classroom, significantly more IGERT students than non-IGERT students report that they have worked on research projects involving multiple disciplines, rotated through laboratories in multiple disciplines or attended a professional conference outside their home discipline. And while one-quarter of IGERT students report having participated in the development or teaching of any multidisciplinary/interdisciplinary course, or in any other multidisciplinary/interdisciplinary educational effort, only one-eighth of non-IGERT students have done the same.<sup>31</sup>

IGERT projects often prepare students for cross-discipline communication with “bridge” courses, targeted courses designed to bring individuals quickly up to speed in disciplines outside their own field. Thus IGERT students (61 percent) are twice as likely as non-IGERT students (29 percent) to report that they have taken courses to learn background content knowledge outside their own field ( $p < .0001$ ).

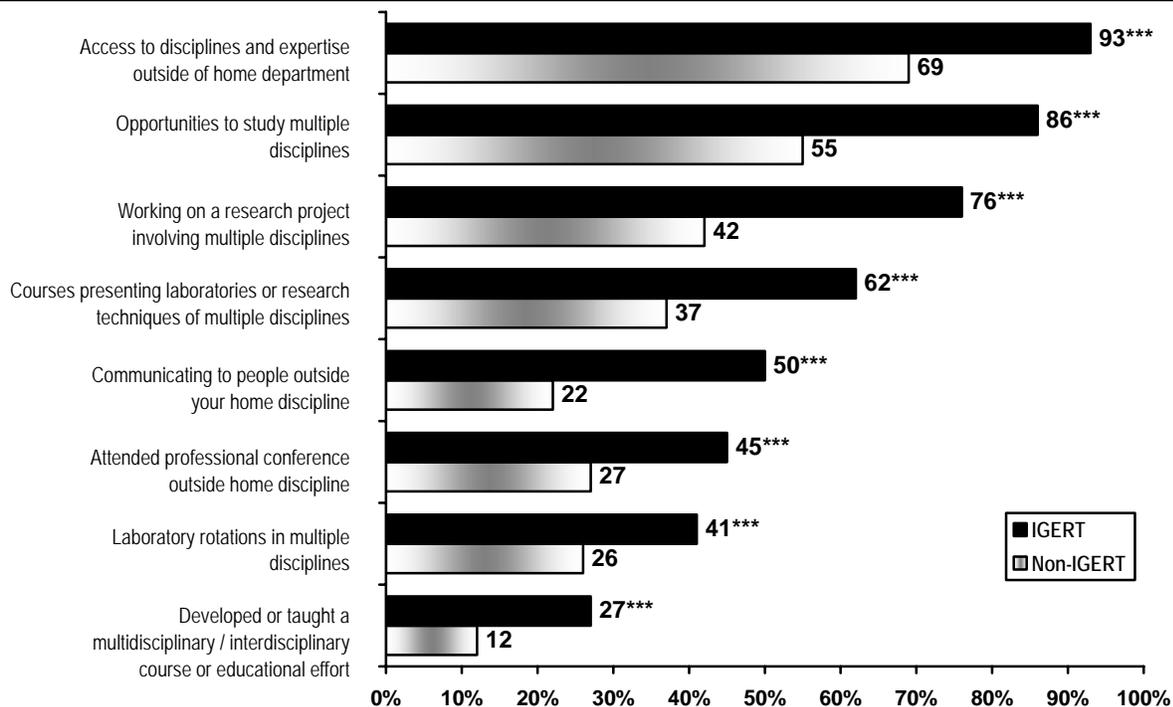
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<sup>30</sup> IGERT Distance Monitoring Web System, 2003: Survey of PIs.

<sup>31</sup> All differences are significant at the  $p < .0001$  level.

### Exhibit 3.1

#### Interdisciplinary Educational Experiences of IGERT and Non-IGERT Students



IGERT N ranges from 303-306. Non-IGERT N ranges from 559-566. Range is due to missing responses.

Significance denoted as: \*\*\* (  $p < .0001$  )

Source: *Initial Impacts Survey of Students 2004.*

Questions: “Which of the following benefits or opportunities have you received as part of your graduate program?” “Have the following interactions been part of your graduate program?” “Have the following research experiences been part of your graduate training?” “Have you ever attended a professional conference in a field outside your home discipline?”

### Interdisciplinary Interactions

Part of the interdisciplinary experience of IGERT students comes from interactions with students and faculty members from other disciplines. Most of the PIs (82 percent) indicated that their projects provide students with opportunities to interact with faculty members in other disciplines in ways that are not available to other students. As a result, as shown in Exhibit 3.2, IGERT students report more opportunities to interact with faculty members in other departments than do their non-IGERT counterparts. IGERT students have also worked significantly more with faculty from other universities, and with public or government laboratory scientists (see Exhibit 3.4). It is thus not surprising that about four-fifths of IGERT students (83 percent) but only slightly more than half (57 percent) of non-IGERT students report that they have developed the ability to communicate with and work on research problems with researchers from more than one discipline.

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**Exhibit 3.2****Percent of IGERT and Non-IGERT Students Reporting They Have Worked with Faculty from Their Own or Different Departments on Research Projects During Their Graduate Program**

<i>I have worked with...</i>	IGERT (N=306)	Non-IGERT (N=566)
Faculty at my institution in my home department/ academic unit	98%	94%
Faculty at my institution in other departments/academic units	71	50 ***

Significance denoted as: \*\*\* ( $p < .0001$ )

Source: *Initial Impacts Survey of Students 2004.*

Question: "With which of the following types of people have you worked on research projects while in your current graduate program? Check all that apply."

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Interaction with multiple faculty members is formalized by many projects through requirements regarding dissertation advisors. More IGERT students than non-IGERT students report they have multiple formal advisors (56 versus 31 percent,  $p < .0001$ ), and IGERT students are twice as likely as non-IGERT students to have a faculty member advisor from a department other than their own home discipline (48 versus 22 percent,  $p < .0001$ ).

In addition to working with faculty, IGERT students also report working with students from multiple disciplines. Three quarters of the IGERT students (76 percent) have worked on a research project involving students from multiple disciplines, compared with only 42 percent of non-IGERT students ( $p < .0001$ ). IGERT students are twice as likely as non-IGERT students to have worked on research projects with students with different disciplinary backgrounds (64 versus 36 percent, respectively,  $p < .0001$ ).

IGERT students clearly receive more interdisciplinary experiences than non-IGERT students. Interestingly, 46 percent of non-IGERT students agreed with the statement that they wish they had received more exposure to other disciplines as part of their graduate program. Thus IGERT students are not the only individuals interested in interdisciplinary education, and differences between IGERT and non-IGERT students are not attributable solely to differing ambitions of the two.

## Depth versus Breadth of Knowledge

The second IGERT program component calls for students to gain the breadth of skills, strengths, and understanding to work in an interdisciplinary environment while being well grounded with depth of knowledge in a major field. Interested stakeholders have sometimes wondered if participation in IGERT interdisciplinary graduate education decreases students' depth of knowledge in their chosen doctoral field,<sup>32</sup> but students in IGERT programs do not perceive such a problem. Equal numbers of IGERT and non-IGERT students agree with the statement that they are able to study their home field

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<sup>32</sup> The issue was raised, for example, at the 2005 meeting of IGERT Participants held in Washington D.C.

in as much depth as they would like (84 versus 82 percent, respectively), and that their program has well prepared them to know their own discipline in depth (80 versus 81 percent).<sup>33</sup>

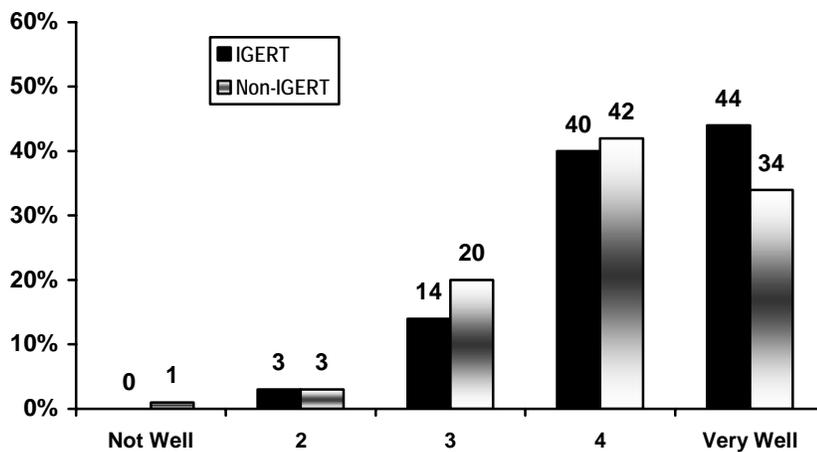
It is possible that this observed equality of responses is due to IGERT students having different expectations of the level of depth they want to have in their chosen field compared to non-IGERT students, and that the level of depth achieved by IGERT students is actually lower than that achieved by non-IGERT students. Faculty data, however, do not indicate this to be the case. Only 21 percent of the PIs surveyed agreed<sup>34</sup> with the statement, “IGERT students lose some content expertise by spending time working across disciplines.” Further, when faculty were asked how well they thought their students were being prepared to know their own discipline in depth, IGERT faculty described their IGERT students as similarly prepared to know their own discipline in depth as did non-IGERT faculty of their respective doctoral students (Exhibit 3.3).

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**Exhibit 3.3**

**Percent of IGERT and Non-IGERT Faculty Indicating That Their Students Are Prepared to Know Their Own Discipline in Depth**

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IGERT N = 339, Non-IGERT N = 546.

Note: Eight IGERT faculty and ten non-IGERT faculty indicated “N/A” for this item and were excluded from this chart.

Source: *Initial Impacts Survey of Faculty 2004.*

*Question: “How well do you think that your [IGERT graduate students] [graduate students] are being prepared to know their own discipline in depth?”*

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<sup>33</sup> Reporting the percentage choosing 4 or 5 on a 5-point scale from 1 (Strongly Disagree) to 5 (Strongly Agree).

<sup>34</sup> Reporting the percentage choosing 4 or 5 on a 5-point scale from 1 (Strongly Disagree) to 5 (Strongly Agree).

This agreement in faculty responses is not due to varying opinions of IGERT and non-IGERT faculty members on the importance of disciplinary depth of knowledge. Equal portions of both groups believe that it is “very important”<sup>35</sup> that students graduating with a Ph.D. in their field know their own discipline in depth (79 versus 81 percent, respectively). If one assumes that IGERT faculty and non-IGERT faculty share similar expectations of disciplinary depth of knowledge for doctoral students, then the consensus among most PIs, students, and faculty is that participation in IGERT does not decrease depth of knowledge in students’ chosen doctoral field.

## **Preparation for Diverse Careers**

The third component specified in the program solicitation states that IGERT students should receive experience relevant to both academic and nonacademic careers, and suggests that such training may include such activities as internships and mentoring in industrial, national laboratory, academic, or other settings. IGERT projects provide students with a variety of experiences that expose them to both academic and nonacademic careers, and IGERT students report feeling better prepared for a wider range of careers than do non-IGERT students. There are no observable differences between the two groups, however, in their career goals.

### **Exposure to Diverse Careers**

One method of exposing students to different careers, both academic and non-academic, is to allow for opportunities for IGERT students to work on research projects with individuals from a range of occupations. IGERT projects vary in the extent to which such opportunities are provided. As a result of these opportunities, IGERT students are significantly more likely to report having worked with individuals from other universities or government laboratories in the U.S. (Exhibit 3.4). More IGERT students also reported working with international scientists, industrial scientists, and other individuals outside academia, but the difference was not significant compared to non-IGERT students.

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<sup>35</sup> Reporting the percentage choosing ‘4’ or ‘5’ on a scale of 1 (Not important) to 5 (Very important).

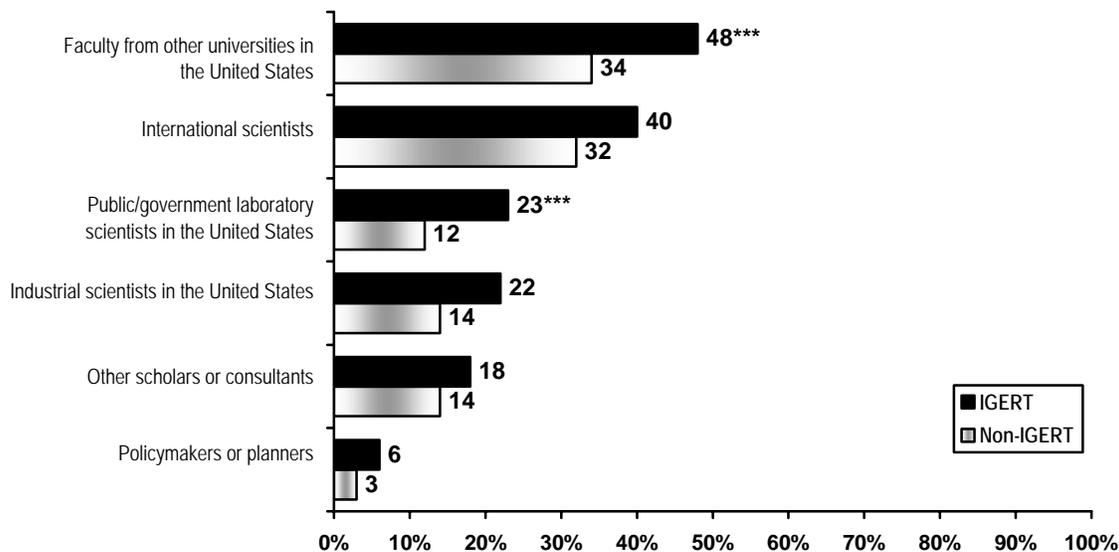
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**Exhibit 3.4**

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**Percent of IGERT and Non-IGERT Students Reporting They Have Worked With Various Individuals on Research Projects During Their Graduate Program**

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IGERT N=306. Non-IGERT N=566. Significance denoted as: \*\*\* (p < .0001)

Source: *Initial Impacts Survey of Students 2004.*

Question: "With which of the following types of people have you worked on research projects while in your current graduate program? Check all that apply."

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A second method of exposing students to different careers is to provide opportunities to conduct internships or work off campus in other environments. Eighty percent of PIs report that their projects provide opportunities for IGERT students to conduct research off campus that are not offered to other students. As a result, 71 percent of IGERT students, but only 47 percent of non-IGERT students, report they have had opportunities to conduct research, study, or work off-campus (p<.0001). As described in Chapter 2, most of the students in the sample have completed their coursework and are working on their dissertation, meaning it is likely that if they plan to conduct an internship while in graduate school they probably had already done so at the time of the survey. While a minority of both groups of students report having actually taken part in an internship lasting a month or more with private sector industries or businesses, public sector laboratories or agencies, or other organizations, twice as many IGERT students have done so (29 percent) as have non-IGERT students (15 percent). Site visit interviews conducted by Abt Associates with students revealed that many students did not want to conduct an extended internship because of the extra time involved, and felt that they had already gained many extra experiences as part of their IGERT participation. Student survey responses indicate that whether or not they conduct an internship, IGERT students are significantly more likely to have the opportunity available to do so than non-IGERT students – 70 versus 40 percent had internship opportunities available (Exhibit 3.5).

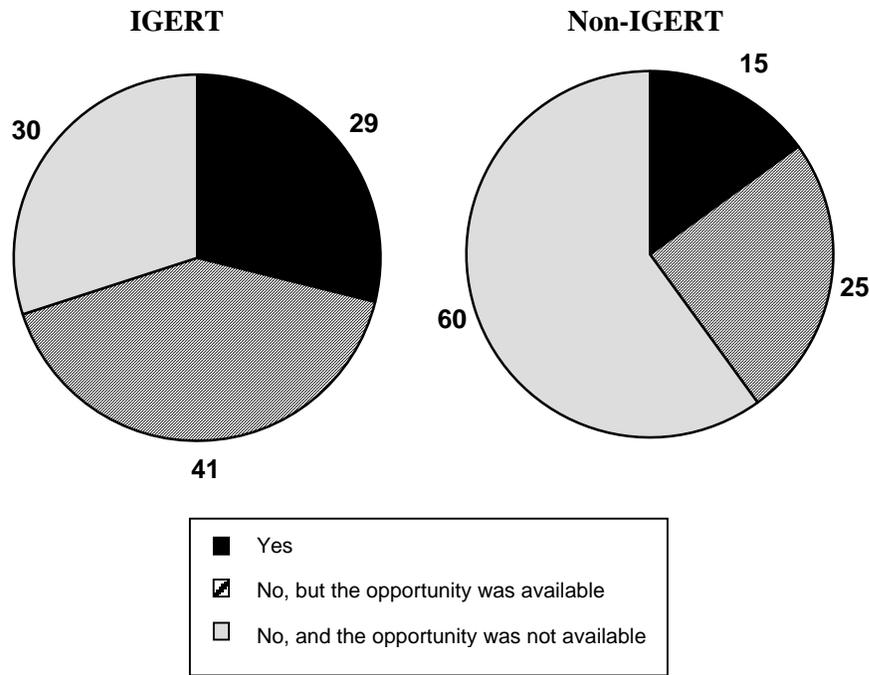
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**Exhibit 3.5**

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**Percent of IGERT and Non-IGERT Students Reporting Opportunities to Conduct an Off-Campus Internship**

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IGERT N=306, Non-IGERT N=566.

Note: If “Yes” and “No, but the opportunity was available” are combined into one response indicating that the opportunity to conduct an internship was available, the difference between the IGERT students (70 percent) and non-IGERT students (40 percent) is statistically significant at  $p < .0001$ .

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Source: *Initial Impacts Survey of Students 2004*.

Question: “Have you taken part in any internships lasting a month or more with private sector industries or businesses, with public sector laboratories or agencies, or in any other setting?”

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### Perceptions of Career Preparation

How well do students think they are being prepared for various careers? IGERT and non-IGERT students have varying perceptions of how well their programs are preparing them for a wide range of career possibilities. Nearly two-thirds (63 percent) of IGERT students agree with the statement that they are being prepared for a wide range of career possibilities. Fewer non-IGERT students (44 percent) feel the same way ( $p < .0001$ ).

Similar proportions of IGERT and non-IGERT students report that their program is preparing them to understand and work in an academic setting (82 versus 78 percent)<sup>36</sup>. Students are far less likely to feel that their graduate program is well preparing them to work outside of academia (such as in

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<sup>36</sup> Reporting the percent choosing 4 or 5 on a scale of 1 (Not well) to 5 (Very well) when asked “how well has your graduate program prepared you to...?”

industry). Still, 40 percent of IGERT students report such preparation, compared with 29 percent of non-IGERT students ( $p < .001$ ).

Very few IGERT students are concerned that participating in an interdisciplinary program may harm their ability to get a traditional job in their own field (15 percent). Indeed, the pilot results from the survey of graduates suggest that IGERT graduates may have an easier time of finding a job than non-IGERT graduates: only 8 percent of IGERT graduates reported it was difficult to find their current job, compared with 25 percent of non-IGERT graduates.<sup>37</sup>

### Students' Career Goals

Despite having received different opportunities and experiences, IGERT students and non-IGERT students report similar career goals (Exhibit 3.6). One third of all students are most interested in pursuing a faculty position at a research university, while another third want to obtain a research position either in industry or at an academically affiliated institute.

Pilot results from the graduate survey suggest slight<sup>38</sup> differences in the initial careers IGERT and non-IGERT students enter upon graduation. The most frequent positions held by the graduates, excluding postdoctoral positions, included faculty positions at research universities (43 percent IGERT, 39 percent non-IGERT); research positions in academic institutes (18 percent IGERT; 4 percent non-IGERT); and research positions in industry (14 percent IGERT; 26 percent non-IGERT).

#### Exhibit 3.6

##### Career Goals of IGERT and Non-IGERT Students

	IGERT (N=302) <sup>a</sup>	Non-IGERT (N=566)
Faculty position at a research university	32%	35%
Researcher in industry	23	25
Researcher in an academic or affiliated institute/center	14	14
Faculty position at any other college	11	14
Self-employment	6	4
Researcher in a public or private policy environment	4	2
Policymaker/Planner	3	1
Working in a nonprofit/foundation environment	2	2
Other	4	2

<sup>a</sup> Frequency missing = 4

Source: *Initial Impacts Survey of Students 2004*.

Question: 'Which one of the following careers are you most interested in pursuing after graduation?'

<sup>37</sup> Reporting the percent of graduates choosing 4 or 5 on a scale of 5 (Very difficult) to 1 (Not difficult at all) when asked, "How difficult was it to find your current job?" (IGERT N=38; non-IGERT N=28)

<sup>38</sup> Note that the sample size is small (37 IGERT; 29 non-IGERT) so that the significance of differences cannot be determined, and each individual response represents several percentage points.

## Development of an International Perspective

Providing students with an international perspective is another area in which the IGERT program places emphasis, with the intent of preparing students for global research and career opportunities. The program solicitation states that an international perspective may be gained through programs within the institution, or through strongly integrated, collaborative research experiences and/or fieldwork at foreign institutions and sites. The IGERT program's emphasis on international experiences has varied with time, with selected projects receiving supplemental funding to support international activities. Thirty-three percent of the projects in the first three cohorts have received international supplements as of 2005.<sup>39</sup> The percentage of projects receiving this funding has increased during that time for those cohorts: 29 percent of the 1998 projects received a supplement, compared with 33 percent of the 1999 projects, and 37 percent of the 2000 projects.

### International Experiences

Not all IGERT projects have activities in place explicitly aimed at furthering the international perspective of their students, despite the program expectation that they do so. Indeed, as of the 2004 web monitoring survey, 28 percent of the PIs indicated they had not yet begun to address this goal. While this percent was higher for PIs in newer cohorts, there were some PIs in each of the earlier cohorts who also indicated they have not begun addressing this goal, further suggesting that international activities are not part of all projects.<sup>40</sup>

Nonetheless, many IGERT programs have developed activities and requirements aimed at developing an international perspective in their students, including:

- working with international scientists in the U.S.;
- working with international scientists abroad (often through internships); and
- international travel or conference attendance.

### *Working with international scientists in the United States*

Student collaboration with international scientists most frequently occurs when international scientists visit the United States to participate in research. There is some indication that IGERT students are more likely to have these experiences than non-IGERT students. Seventy-seven percent of IGERT students, and 66 percent of non-IGERT students, report they have worked within the United States with scientists of other nationalities ( $p < .001$ ). Most students also report that during their graduate work they have communicated and worked with people of different cultures, nationalities, or backgrounds (87 percent IGERT; 79 percent non-IGERT). IGERT students at projects that have received supplemental international funding do not vary from IGERT students at projects without such funding on these items.

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<sup>39</sup> Data from the IGERT Program Office, National Science Foundation.

<sup>40</sup> Percent of PIs indicating "Not Begun" when asked about the status of achieving the goal of "Developing Students' International Perspective," by cohort: 1998 (18%); 1999 (19%); 2000 (11%); 2001 (14%); 2002 (33%); 2003 (71%). 2004 Web Monitoring Survey of PIs.

### ***Working with international scientists abroad***

Fewer students (23 percent IGERT; 17 percent non-IGERT) report having worked with scientists of other nationalities in those scientists' home countries. In part this may be because only some projects offer such opportunities: 58 percent of PIs report that some of their trainees work with foreign scientists or engineers outside the U.S., and 14 percent have opportunities available for students to work with private companies abroad.<sup>41</sup> It appears that the international supplements are used to foster such opportunities, because IGERT students at projects with international supplemental funding are more likely to have worked abroad (31 percent) than IGERT students at projects without supplements (16 percent).

### ***International travel and conference attendance***

Significantly more IGERT students (87 percent) than non-IGERT students (66 percent) report that they receive opportunities for travel as part of their graduate program ( $p < .0001$ ). This travel could be domestic or international, but when asked whether they had attended any international conferences within the past two years, 37 percent of IGERT versus 27 percent of non-IGERT students said they had done so. There is no difference in such attendance among non-IGERT students between domestic or foreign students.

### **International Perspective**

IGERT students and non-IGERT students are equally likely to report that they are familiar with current research being conducted in their field in foreign countries (66 versus 68 percent, respectively), but as outlined above, they differ in the types of experiences they are afforded to interact or collaborate with international researchers. As a result, some IGERT students believe they are better prepared to collaborate with international scientists in the future. IGERT students (38 percent) are more likely to report feeling "very well prepared" to collaborate with international scientists than their non-IGERT counterparts (28 percent). IGERT students at projects where PIs indicated they have begun addressing this program goal are even more likely as well. These numbers are overall generally lower than other items, suggesting less emphasis on international training than other elements.

## **Professional Training**

The final IGERT program component calls for the IGERT graduate experience to contribute to the professional and personal developments of students and equip them to understand and integrate scientific, technical, business, social, ethical, and policy issues to confront the challenging problems of the future. Professional training of IGERT students as examined in this study falls into three main areas: providing students with the research training they will need, preparing students to work in teams, and equipping them with the written and oral communication skills needed in a variety of settings.

### **Preparation to Conduct Research**

Many IGERT projects develop research experiences specifically for their IGERT students, which often involve courses on research methods, training in the ethical conduct of research, and access to cutting-edge technology or instrumentation. Sixty-seven percent of the PIs report, for example, that

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<sup>41</sup> IGERT Distance Monitoring Web System, 2003.

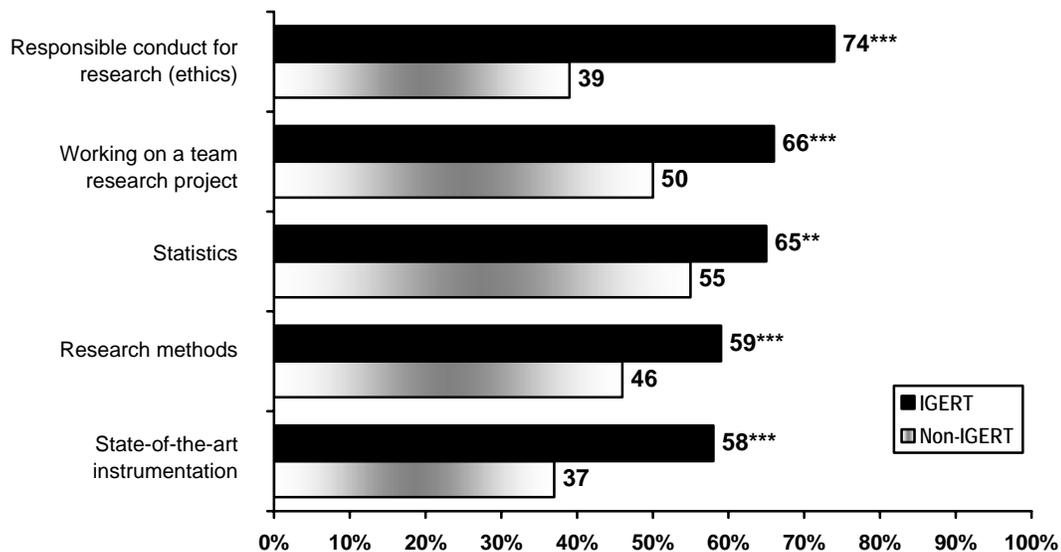
their IGERT project offers IGERT students access to equipment that is not offered to other students. IGERT and non-IGERT students were asked whether they had taken courses or received formal training (workshops, seminars, retreats, etc.) in several research related areas, including research methods, statistics, ethics, and instrumentation. Overall IGERT students were significantly more likely to report such experiences than non-IGERT students, as shown in Exhibit 3.7. The greatest difference between the two groups was reported in training or coursework in the responsible conduct of research, suggesting that the IGERT program’s encouragement for projects to provide students with training in research ethics has been influential. IGERT students were also significantly more likely to report receiving formal training or coursework in research methods, statistics, and state-of-the-art instrumentation.

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**Exhibit 3.7**

**Percent of IGERT and Non-IGERT Students Reporting Research-Related Training**

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IGERT N=306. Non-IGERT N=566.

Significance denoted as: \* (p<.01) \*\* (p<.001) \*\*\* (p<.0001)

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Source: *Initial Impacts Survey of Students 2004.*

*Question: ‘Have you received formal training or taken courses in the following areas? ‘Training’ includes workshops, seminars, retreats, special sessions within a course, etc.’*

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Do the extra research experiences reported by IGERT students lead to better preparation to conduct research? To some extent it appears so, at least with regards to the ethical conduct of research (Exhibit 3.8). While both IGERT and non-IGERT students report that their graduate program is well preparing them to conduct high quality research, IGERT students are significantly more likely to report that their graduate program is preparing them well to conduct research in an ethical manner (p<.0001).

**Exhibit 3.8**

**How well is your graduate program preparing you to conduct research? (Percent of Students)**

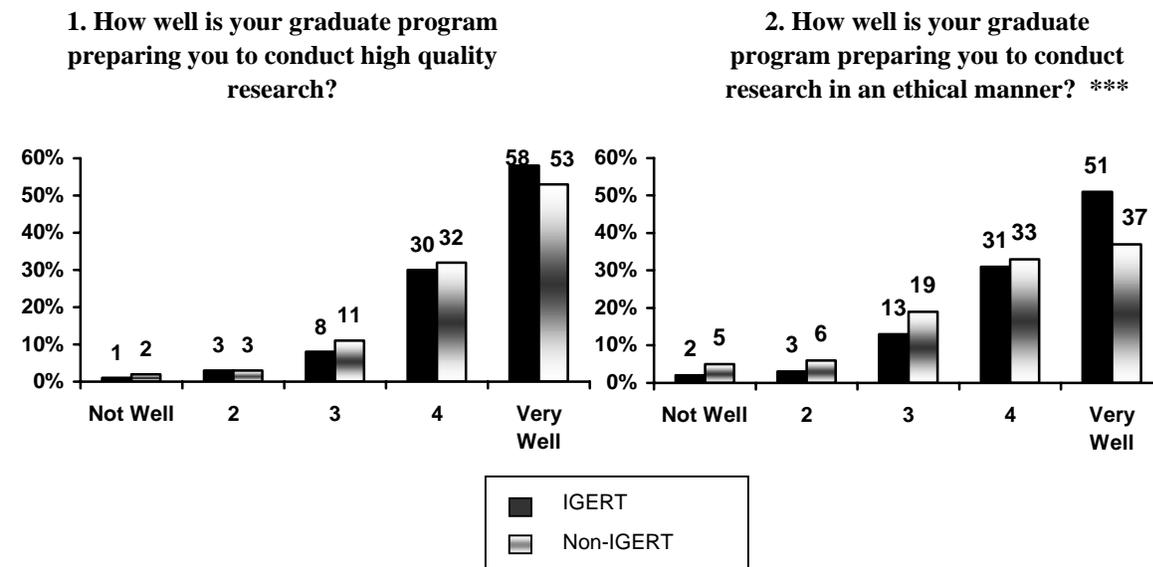


Chart 1: IGERT N=306. Non-IGERT N=565.

Chart 2: IGERT N=302. Non-IGERT N=542.

Note: Chart 1: One Non-IGERT individual responded N/A and has been excluded from these exhibits.

Chart 2: Four IGERT and twenty-four Non-IGERT individuals responded N/A and have been excluded from these exhibits.

Significance denoted as: \* (p<.01) \*\* (p<.001) \*\*\* (p<.0001)

Source: *Initial Impacts Survey of Students 2004.*

*Question: On a scale of one to five, where one represents "Not Well" and five represents "Very Well" how well do you think your graduate program is preparing you for the following activities?*

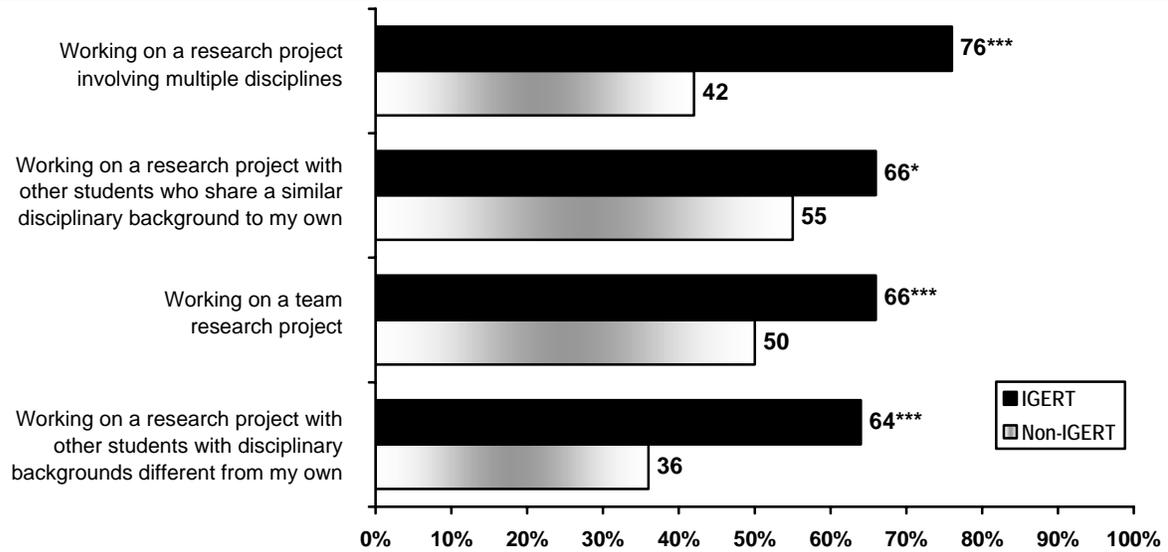
**Preparation to Work in Teams**

IGERT projects provide trainees opportunities to work in teams both within their own disciplines and with faculty members and students from other disciplines. Many projects require students to complete projects in multidisciplinary teams as part of their IGERT training. As a result, IGERT students are far more likely to report team research experiences than non-IGERT students, especially when those teams are multidisciplinary and involve students from other disciplines (Exhibit 3.9). Thus it is not surprising that IGERT students feel far better prepared to work in multidisciplinary teams in the future than do non-IGERT students, as shown in Exhibit 3.10 (p<.0001).

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**Exhibit 3.9****Teamwork Experiences Reported By IGERT and Non-IGERT Students**

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Notes: IGERT N=306. Non-IGERT N=566.

Significance denoted as: \* (p<.01) \*\* (p<.001) \*\*\* (p<.0001)

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Source: *Initial Impacts Survey of Students 2004.*

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*Question: "Have the following research experiences been part of your graduate training?"*

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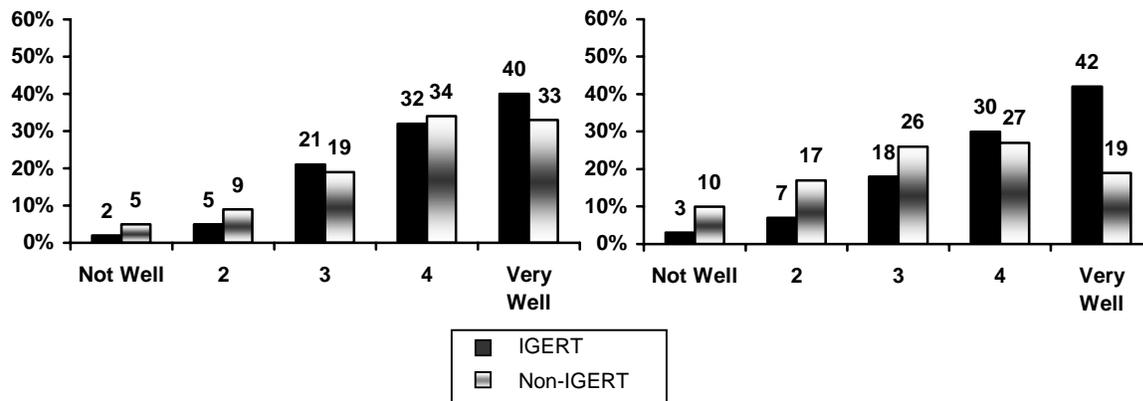
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**Exhibit 3.10****How well is your graduate program preparing you to work in teams? (IGERT and Non-IGERT students)**

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**1. How well is your graduate program preparing you to work in research teams within your discipline?**

**2. How well is your graduate program preparing you to work in multidisciplinary teams? \*\*\***



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Chart 1: IGERT N=304. Non-IGERT N=559.

Chart 2: IGERT N=302. Non-IGERT N=546.

Notes: Several respondents choosing "N/A" were excluded:

Chart 1: IGERT (2), non-IGERT (7)

Chart 2: IGERT (4), non-IGERT (20). Percents may not sum to 100 due to rounding.

Significance denoted as: \* (p<.01) \*\* (p<.001) \*\*\* (p<.0001)

Source: *Initial Impacts Survey of Students 2004.*

*Question: "On a scale of one to five, where one represents 'Not Well' and five represents 'Very Well,' how well do you think your graduate program is preparing you for the following activities?"*

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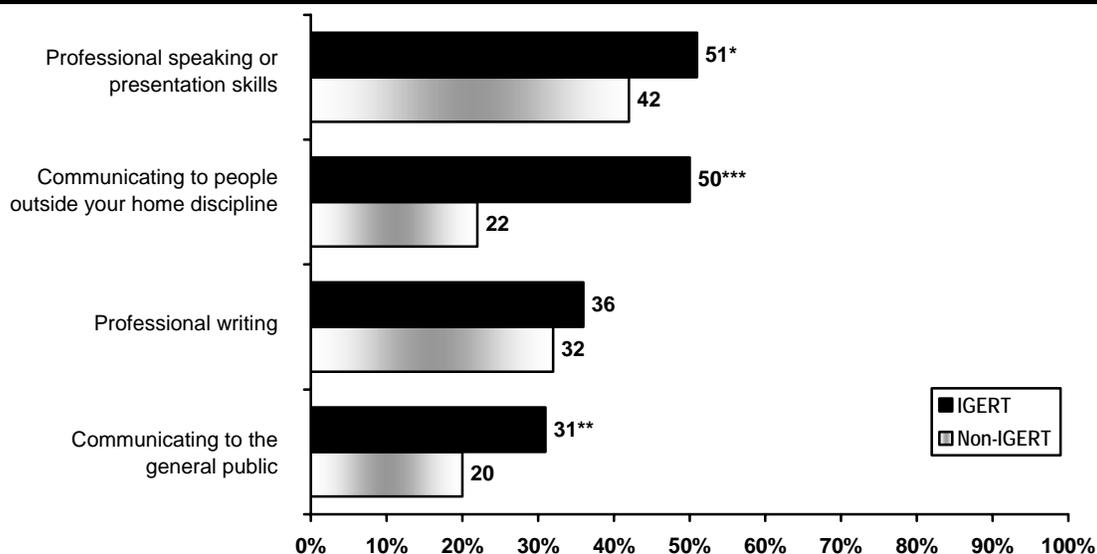
## Communication Skills

IGERT projects formally address the development of trainees' communication skills in various ways (written, oral) and with various audiences (scientists in their own field, scientists in other fields, non-scientists). Students also learn communication skills informally, through other activities (such as internships, working in teams, or working with other scientists). IGERT students are less likely to report having received formal training or coursework on communication strategies than they are some of the other activities reported elsewhere in this chapter. However, they are still more likely than non-IGERT students to report such communication oriented training, and significantly more likely to have received training in communicating to people outside their own discipline or to the general public (Exhibit 3.11).

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**Exhibit 3.11****Percent of IGERT and Non-IGERT Students Reporting Having Received Training or Coursework in Communication**

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IGERT N=306. Non-IGERT N=566.

Significance denoted as: \* (p<.01) \*\* (p<.001) \*\*\* (p<.0001)

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Source: *Initial Impacts Survey of Students 2004.*

*Question: 'Have you received formal training or taken courses in the following areas? 'Training' includes workshops, seminars, retreats, special sessions within a course, etc.'*

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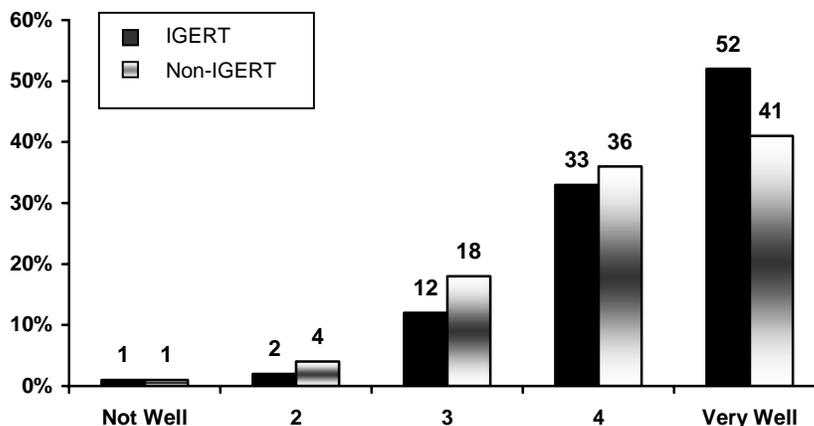
As a result of these experiences, IGERT students feel somewhat more prepared than non-IGERT students to communicate with people inside of their field, and much more prepared to communicate with people outside their own field. They are somewhat more likely to feel prepared to communicate research findings to the general public (Exhibit 3.12).

**Exhibit 3.12**

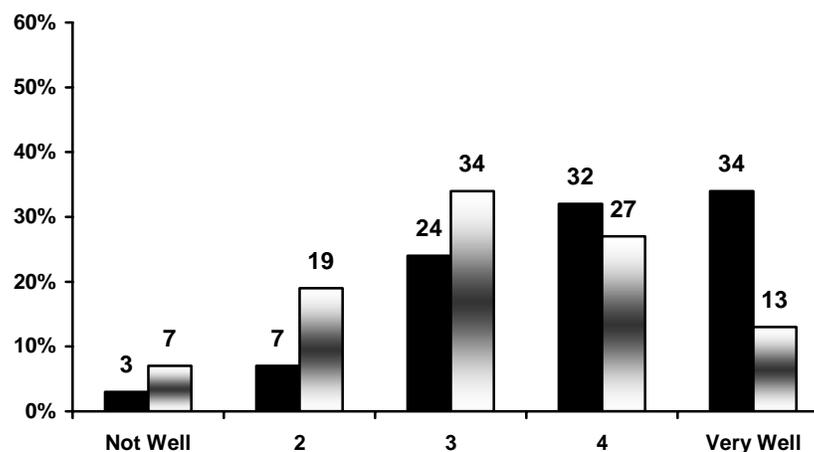
**Student Perceptions of How Well Their Program is Preparing Them to Communicate with Various Individuals**

*“My program is preparing me to...”*

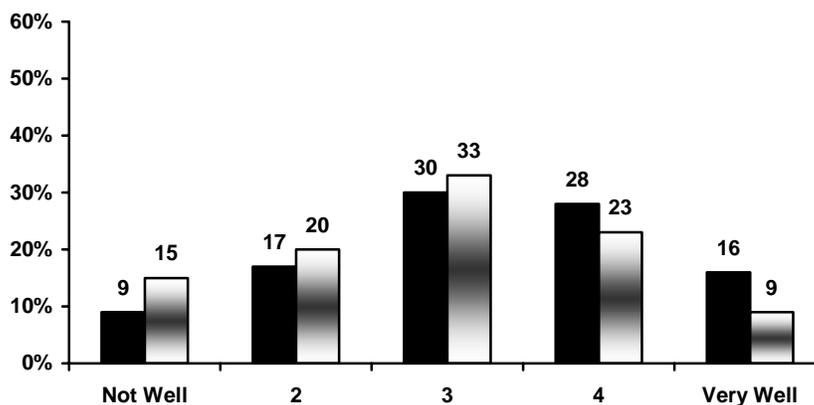
**Communicate with people inside my field**  
\*\*



**Communicate with people outside my field**  
\*\*\*



**Communicate research findings to the general public**  
\*\*\*



Ns vary due to exclusion of “N/A” responses as follows: Communicate with people inside my field: IGERT N=306. Non-IGERT N=565. Communicate with people outside my field: IGERT N=306. Non-IGERT N=563. Communicate research findings to the general public: IGERT N=302. Non-IGERT N=555.  
Significance denoted as: \* (p<.01) \*\* (p<.001) \*\*\* (p<.0001)

Source: Initial Impacts Survey of Students 2004.

Question: “How well do you think your graduate program is preparing you for the following activities?”

## Summary

IGERT projects have successfully developed new educational experiences for students in the areas emphasized in the program solicitation. IGERT students receive more extensive interdisciplinary training than non-IGERT peers, but maintain depth of study in their chosen fields. IGERT students consistently report greater opportunities to learn about other disciplines, interact with faculty and students from other disciplines, and work on projects involving multiple disciplines. They are better prepared to work in multidisciplinary teams and communicate with people outside their own fields. At the same time, according to both faculty and students, the level of in-depth preparation in students' fields is similar for IGERT and non-IGERT participants.

The IGERT experience provides students with significantly broader professional and personal skills for their future careers. IGERT students receive greater training in teamwork, presentation, and communication skills, and are twice as likely as non-IGERT students to have received formal training in research ethics, an area emphasized by the IGERT program. Participation in the IGERT program provides broader career exposure as well, with IGERT students reporting more opportunities to conduct off-campus internships and interact with people outside their home institutions and outside academia. Overall, the educational experiences reported by IGERT students are quite different from those reported by non-IGERT students, and as a result, IGERT students report feeling better prepared for their future professions, as measured by the data collected, than non-IGERT students. In the next chapter, we explore the impacts of the IGERT program on participating faculty members.

