



# **IGERT and Nanoscience**

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# **Integrative Graduate Education and Research Traineeships (IGERT)**

- Interdisciplinary theme
- Emerging research area
- Innovative models for graduate training
- Catalyze a cultural change in graduate education
  - For graduate students
  - For faculty
  - For institutions



# **COSEPUP Report 1995**

## **Reshaping the Graduate Education of Scientists and Engineers**

- ✦ Produce more versatile scientists and engineers
  - A greater range of academic options
  - Greater training in a variety of career skills
  - Avoid compromising
    - Local option
    - Excellence in research
    - Time to degree
    - Broader participation



# IGERT History and Data

- First awards made in 1998
- 2-stage competition, ~450 preliminary and ~100 full proposals/year
- 195 total awards, including renewals
- 5 years/~\$3 M total/award
- To date, IGERTS are in
  - 96 lead institutions
  - In 39 states plus the District of Columbia
- Supporting nearly 1500 trainees/year/\$30K
- ~ 4,000 trainees supported overall

# Today's Predictions and IGERT Solutions

- Research ↑ interdisciplinary
  - Work across disciplines
- Research ↑ collaborative
  - Teamwork
- Research ↑ varied settings
  - Preparation for varied careers
- Research ↑ global
  - International activities and experiences

# Examples of IGERT Project Interdisciplinary Themes

- Smart sensors and integrated devices
- Biosphere-atmosphere research
- Molecularly designed materials
- Assistive technology
- Sequential decision-making
- Sustainability
- Astrobiology



# Nanoscience in IGERT

- 21 awards including 3 renewals with nano\* in the title
- Numerous others with nano components
- Nano\*
  - Scale
  - Science
  - Technology
  - Materials
  - Medical
  - Particle
  - Pharmaceutical
  - Photonics
  - Probes
  - As well as fabrication, electronics, laminates, machines, biomaterials, and devices as nano\* terms in abstracts

# Universities with IGERTs with Nano\* in the Title

- University of Washington
- University of New Mexico (2)
- University of Utah
- Vanderbilt-Fisk
- Tuskegee
- University of Minnesota
- CUNY City College
- Drexel-U. Pennsylvania
- University of Oregon
- Johns Hopkins
- UC Berkeley
- Cornell
- Rutgers
- Northeastern
- U Mass Amherst
- Rice
- UC Davis





# Educational Features of IGERT Projects

- New curricula
  - Interdisciplinary courses, laboratories, seminars, often team-taught
  - Student-taught interdisciplinary courses
  - Distance learning, videoconferencing
- New integrative experiences
  - “boot camps,” workshops, retreats
  - Team projects and teamwork exercises
  - Student-lead and -organized meetings
  - Laboratory rotations; co-advising
- Internships
  - Industry, national laboratory, research institute
  - International

# Further Educational Features of IGERT Projects

- Communications training
  - K-12, general public, government
- Ethics and responsible conduct of research
  - Tailored to IGERT topic
- IP, patents, business plans
- Professional Development
- Activities for broadening participation

# Examples of Nano\* Courses

- Fundamental Physics and Chemistry of Nanomaterials; Interfacial Phenomena in Nanostructured Materials (Johns Hopkins U.)
- Nanosystems Design for Biology and Medicine (Northeastern U.)
- Nanotechnology: From Lab to Product (U. Mass Amherst)
- Nanotechnology-Based Drug Delivery (Rutgers U.)
- Frontiers in Nanotechnology (U. Washington)
- Quantum Engineering of Nanostructures (U. Texas at Austin)
- Nanoscale Materials; Molecular Modeling of Polymers and Nanocomposites (Tuskegee U.)

# Examples of Credentials

- Certificates, minors, concentrations
  - Minor in Nanoparticle Science and Engineering (U. Minnesota)
  - Certificate program in Nanotechnology (Drexel-U. Pennsylvania)
  - Certificate program in Biomedical Science and Engineering with Concentration in Nanotechnology (U. New Mexico)
  - Designated Emphasis in Nanoscale Science and Engineering (UC Berkeley)
- Dual degree programs
  - Home department and Nanotechnology (U. Washington)
- Doctoral programs
  - Ph.D. in Nanoscience and Microsystems (U. New Mexico)

# IGERT Partnerships

- Within universities: between faculty, departments, schools, colleges
- Between universities:
  - Leverage resources
  - Broaden participation
- Outside academia
  - National laboratories and research institutes
  - Industry
  - International universities and institutions
- At the funding agency level

# **IGERT Evaluation Study**

## **Initial Impacts**

- ✦ Both IGERT and non-IGERT samples of first three cohorts (1998-2000)
  - Graduate Students
  - Faculty
  - Administrators

## Results: Students

- Program more attractive to students (increased applications)
- IGERT students have more diverse career goals and report better preparation for non-academic careers
- IGERT students have more and take more opportunities to conduct research off campus (including internationally)

# **IGERT Students are Better Prepared For:**

- Responsible conduct of research
- Learning about other disciplines
- Working across disciplines
- Collaboration and teamwork
- Communications inside and outside own field
- Communication with the general public



# IGERT Faculty

- Do more team teaching
- Have written more research grants with faculty outside own discipline
- Receive more new research grants
- Mentor more graduate students outside home department
- Publish more outside own discipline
- (and say they get better students)

# Institutions

- Faculty report that institutional support for interdisciplinary graduate education has increased
- Participating faculty increased each year
- Departmental research focus broadened

# Institutionalization

- New department policies stressing interdisciplinary coursework (68%)
- Changes in degree requirements (47%)
- New certificates (47%)
- Increased access to other disciplines, expertise, research facilities
- Cross-institution adoption of IGERT program elements

# Challenges

- ✦ Students
- ✦ Faculty
- ✦ Institutions

# Future Evaluations

- Next three cohorts of IGERT
- Trainee post-graduation follow-up

# Find Out More About IGERT

- <http://www.IGERT.org>
  - Searchable site maintained by contractor
- [http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=12759&org=DGE&from=home](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12759&org=DGE&from=home)
  - IGERT home page at NSF
  - Program solicitation
- <http://www.nsf.gov/pubs/2006/nsf0617/index.jsp>
  - Impacts of IGERT evaluation