Reinventing Graduate STEM Education
Council of Graduate Schools Annual Meeting
December 3, 2021

Panelists:
Dr. Nirmala Kannankutty, Senior Advisor, Office of the Director, NSF
Dr. Peter Harries, Dean of the Graduate School, North Carolina State University
Dr. Kim LaScola Needy, Dean of Engineering, University of Arkansas

Moderator:
Dr. Karen S. Coats, Associate Provost and Dean of the Graduate School, The University of Southern Mississippi
Reinventing Graduate STEM Education
Council of Graduate Schools

Nimmi Kannankutty, Senior Advisor
Office of the Director
National Science Foundation
December 3, 2021
Systemic Trends for Graduate Education

- Greater interdisciplinary and team focus
- Increase in international students
- Dynamic pathways and careers - students more readily move across fields, institutions, sectors of the economy, and countries
- Greater racial/ethnic diversity and higher proportion of female students, but change has come very slowly in representation


NOTES: Non-academic includes all positions in the government or business/industry sectors, or in precollege institutions. Tenured, tenure-track and non-tenured refer to all positions in postsecondary educational institutions. Non-tenured includes individuals who are not on the tenure track as well as those in positions where tenure is not applicable.

NASEM Consensus Study on Graduate Education (2018)

Rationale
• 20 years since the prior consensus study had been conducted
• Persistent concerns about graduate education; NSF wanted to ensure options for impactful change

Outcomes
• Affirmation of the strength of US STEM graduate education - “gold standard”
• Adaptation needed to address emerging needs

Features
• Statement of themes for improving STEM graduate education
• Features of an “ideal” STEM graduate education
• Key recommendations by stakeholder group (e.g. funding agencies; private foundations and nongovernmental organizations; IHEs, graduate schools, departments and programs; faculty members; professional societies; employers; and graduate students)
Improving Graduate Education

1. Adaptability
2. Core Competencies
3. Diversity, Equity and Inclusiveness
4. Optimize Student Experience
5. Teaching and Mentoring
6. Career Exploration
7. Data Transparency

Institutional change and educational improvement

Improved learning environment

Informed decision-making
A Framework for Response – Division of Graduate Education

1. Research
   How can we employ research programs to better understand the graduate education enterprise?

2. Programs
   How can we update our research and training programs to modernize graduate education?

3. Policies
   What policy changes can the stakeholders employ to a) better understand the institutional interventions and students that are funded; and b) to support institutional changes in support of graduate education modernization?

4. Outreach and Coordination
   How can the various stakeholders in graduate education enterprise improve our outreach and coordination activities with each other?
NSF’s Vision

Advancing the frontiers of research into the future
Ensuring accessibility and inclusivity
Securing global leadership

Innovation

Partnership
Terminology for X-Disciplinary Research

- **Intradisciplinary:** Working within a single discipline
- **Multidisciplinary:** Working with others from different disciplines, each using their disciplinary knowledge
- **Cross-disciplinary:** Working in one discipline, but considering the perspective or tools in another discipline
- **Interdisciplinary:** Integrating knowledge and methods from different disciplines, resulting in a synthesis of approaches
- **Transdisciplinary:** Creating a new approach beyond disciplinary perspectives
- **Convergence (NSF definition):** Research driven by a specific and compelling problem where there is deep integration across disciplines, potentially leading to new frameworks, paradigms or disciplines
Investing in Graduate Education

Focus on program development

Fund an individual

Fellowships
Scholarships

Influences the development of a researcher

Fund multiple students

Training Grants

Focus on individual development

Professional Development Activities

Influences educational programming
The Pi-Shaped Professional

Teamwork  Communication  Teaching  Leadership  Entrepreneurship

X-disciplinary Training (X=cross, multi, inter, trans, convergent)

Deep Disciplinary Knowledge

Computational Skills
Example: Researcher Development Framework

- Developed in the UK
- Comprehensive list of life-long competencies for researchers
- Provides an opportunity to develop research on these domains in the US graduate education context
- [https://www.vitae.ac.uk/vitae-publications/rdf-related](https://www.vitae.ac.uk/vitae-publications/rdf-related)
Innovative Programs to Address Contemporary Needs

North Carolina State University
- Industry Partnerships
- Professional Development

University of Arkansas
- Interdisciplinary Training
- Non-STEM Experiences
- Entrepreneurship
The Perspective from NC State
• Land-grant institution
• Almost 10,000 graduate students
• 10 Colleges
• 60+ doctoral programs
• 100+ master’s programs
• 75+ corporate, government and non-profit partners on Centennial Campus
The Importance of Partnerships

- Impact of Research Triangle Park
  - Proximity to a broad range of companies, NGOs, and other government-based entities
  - Growing workforce needs → tied to the Apple, Fuji-Diosynth, and Google
- Partners beyond RTP
  - Other industry connections
  - Engagement with National Labs
- Building a network of alumni supporters
- Engaging with other units, both academic and more service-oriented, across campus
Professional Development Framework

Empowering 21st Century Emerging Professionals

Communication
- Writing
- Public Speaking
- Addressing Non-Technical Audiences
- Digital Literacy
- Interpersonal Skills

Personal & Professional Development
- Professionalism
- Job Search Strategies
- Networking
- Entrepreneurship
- Personal Branding
- Business Acumen

Leadership & Management
- Teamwork
- Project Management
- Building Trust
- Conflict Resolution
- Data Management
- Classroom Management

Academic Development
- Critical Thinking
- Peer Review
- Teaching
- Collaboration
- Mentorship
- Ethical Conduct
Challenges

• COVID-19 disruptions

• Developing effective and sustainable internship pathways

• Building an understanding of graduate education

• Addressing issues of diversity, equity, and inclusion
  • Committee on DEI in Graduate Education → involving faculty, staff, and administrators from units across the university
Kim LaScola Needy, Ph.D., P.E., CFPIM, CPEM
Dean, College of Engineering
<table>
<thead>
<tr>
<th>The Graduate School and International Education at the University of Arkansas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4,415</strong></td>
</tr>
<tr>
<td>GRADUATE STUDENTS ENROLLED</td>
</tr>
<tr>
<td><strong>436</strong></td>
</tr>
<tr>
<td>DOCTORAL FELLOWS</td>
</tr>
<tr>
<td><strong>1,179</strong></td>
</tr>
<tr>
<td>INTERNATIONAL STUDENTS</td>
</tr>
<tr>
<td><strong>1,584</strong></td>
</tr>
<tr>
<td>GRADUATE ASSISTANTSHIPS AWARDED</td>
</tr>
</tbody>
</table>
Overview

• Interdisciplinary Programs
• NRT-IGE: STEM Professional Awareness, Advancement, and Development (PAAD)
• NSF Innovation Corps
• Final Takeaways
Interdisciplinary Programs

- Fall 2021, 262 students (14% of total doctoral enrollment) are in interdisciplinary programs
- 2020-21 graduation year, awarded 33 interdisciplinary master’s degrees (2.69% of total) and 32 interdisciplinary doctoral degrees (15.38% of total)
- 600+ program alumni
- 35+ disciplines incorporated
- Examining a 7th program in Data Science

CEMB is our largest Ph.D. program on campus; and has the largest (or sometimes second largest) enrollment of international students
PUBPPH is our most diverse doctoral program
MSEN is our only entrepreneurial STEM degree
NRT-IGE: STEM Professional Awareness, Advancement, and Development (PAAD)

**Motivation:** Provide STEM graduate students with the *non-STEM experiences* needed to be successful in STEM careers.

**Funding and Interdisciplinary Collaboration Opportunities for Faculty and Students**

This material is based upon work supported by the National Science Foundation under Grant Number 1735204. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.
Student participants receive professional development beyond research by taking courses and participating in enrichment activities in one (or more) areas: Patent Law, Public Policy/Government, Business/Commercialization, and Academia.

- Access to industry, government, nonprofit leaders
- Travel allowance of up to $1,500 for enrichment activity (conference, job fair, outreach, not research focused)
- Professional development activities in addition to taking PAAD-approved courses (career planning and outreach)
- At least fifteen (15) PAAD Students will be selected each year and will be supported during the three-year grant.
Core Course: Emerging Technologies = Real World

Company interactions
Projects/Proposals
Calculations
Consulting
Multiple-week Project
Sponsored Research Project
Overseeing Senior Design Project
Prototype Development
Company Formation

Walmart

HD Nursing

LYCUS LTD.

AURORA DIGITAL SIGNAGE

UNITED INITIATORS

CLEAR Ballistics

UNIVERSITY OF ARKANSAS Research & Innovation
PAAD Student Program

Apply & Select Track

Participate in
- 2 career fairs
- 1 outreach program
- 1 active learning opportunity

- Individual Development Plan
- Emerging Technologies
- Three Track Courses
- Mentor

nsfpaad.uark.edu
3 Cohorts of PAAD Students

51 Students representing 24 Departments/Programs in 5 Colleges/Schools

- Ag Ed/Communication
- Anthropology
- Architecture
- Biology
- Biological Engineering
- Biomedical Engineering
- Cell and Molecular Biology
- Chemistry/Biochemistry

- Chemical Engineering
- Civil Engineering
- Community Health
- Electrical Engineering
- Entomology/Plant Pathology
- Exercise Science
- Food Science
- Geology/Geosciences

- Kinesiology
- Material Science and Engineering
- Physics
- Poultry Science
- Psychology
- Public Health
- Public Policy
- Statistics and Analytics

2018 PAAD Students and Faculty
PAAD Faculty Fellows

10 Faculty and Staff – 5 new courses and 3 new activities

Courses:
• Biology
• Chemical Engineering
• Office of Sponsored Programs
• Crop, Soil, and Environmental Sciences
• Curriculum and Instruction

Proposal Writing/Communication
Safety
Academic Administration
The Business of Plant Breeding
Content Integration Strategies for STEM

Activities:
• Material Science and Engineering
• Physics & Community Health
• Music & Technology Ventures

Trip to visit companies in TX
Workshop on Nanotechnology and Public Health
Music Industry Data Index project
I-Corps Program

University of Arkansas I-Corps Commercialization

**STEM Training in Entrepreneurship Practices (STEP)** Program

- Learn how to identify and evaluate market opportunities by applying the lean startup methodology
- Receive up to $3,250 in seed funding to assist with customer discovery, market research, prototype design, and/or testing
- Receive weekly mentoring from an experienced instructional team and benefit from sharing your experiences across a statewide cohort
- Establish “lineage” and eligibility for the larger-scale national I-Corps program and other NSF programs
Final Takeaways

• Exciting research lies at the intersection of disciplines, hence we must invest in **interdisciplinary programs**
• We must prepare STEM students both technically and professionally
• We must train STEM students to take inventions from the laboratory to the marketplace to improve our world