

Reinventing Graduate STEM Education

Council of Graduate Schools Annual Meeting
December 3, 2021

Panelists:

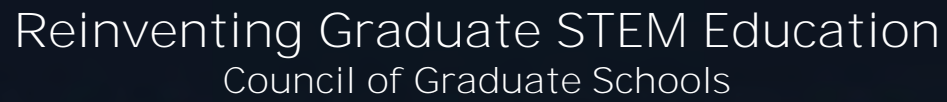
Dr. Nirmala Kannankutty, Senior Advisor, Office of the
Director, NSF

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



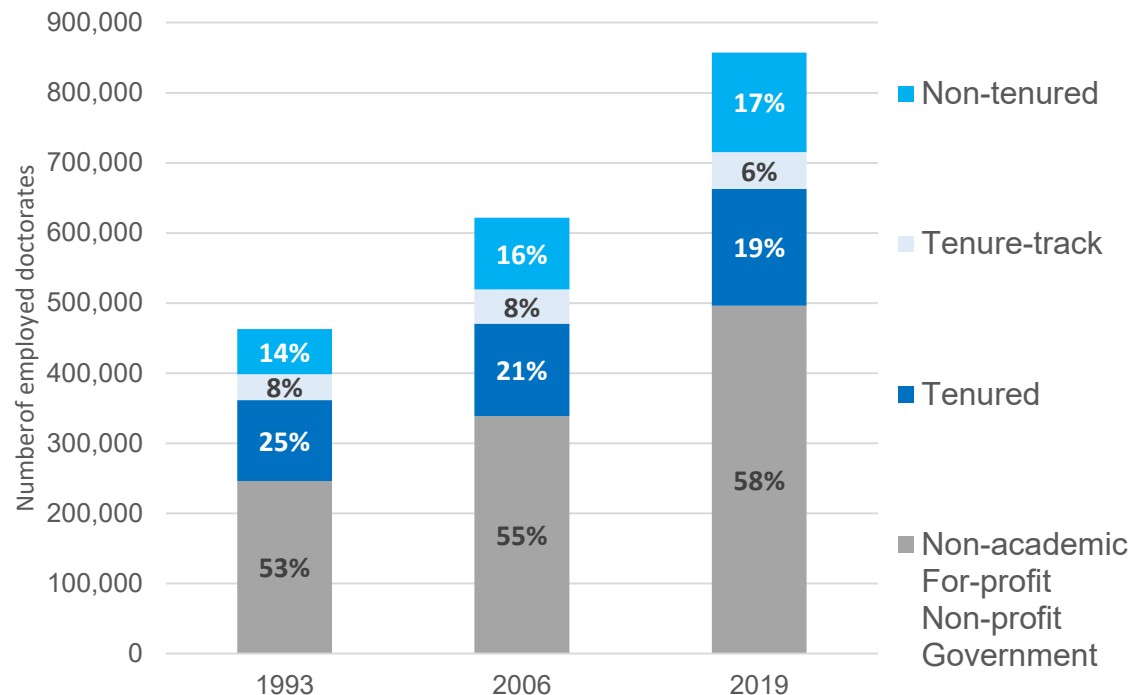
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Systemic Trends for Graduate Education

- 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

Employed, U.S.-trained STEM doctorates by type of position: 1993, 2006 and 2019



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.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2021) of the Survey of Doctorate Recipients.



NASEM Consensus Study on Graduate Education (2018)

Rationale

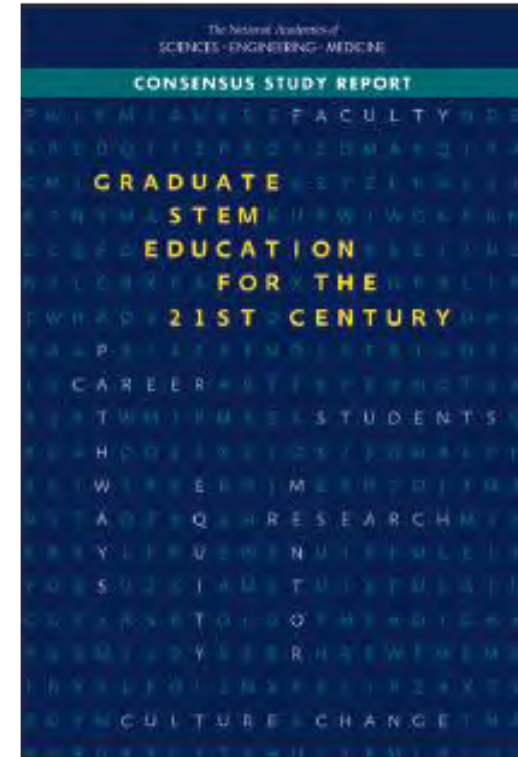
- 20 years since the prior consensus study had been conducted
- Persistent concerns about graduate education; NSF wanted to ensure options for impactful change

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 |] | Institutional change and educational improvement |
| 2. Core Competencies | | |
| 3. Diversity, Equity and Inclusiveness |] | Improved learning environment |
| 4. Optimize Student Experience | | |
| 5. Teaching and Mentoring | | |
| 6. Career Exploration |] | Informed decision- making |
| 7. Data Transparency | | |



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

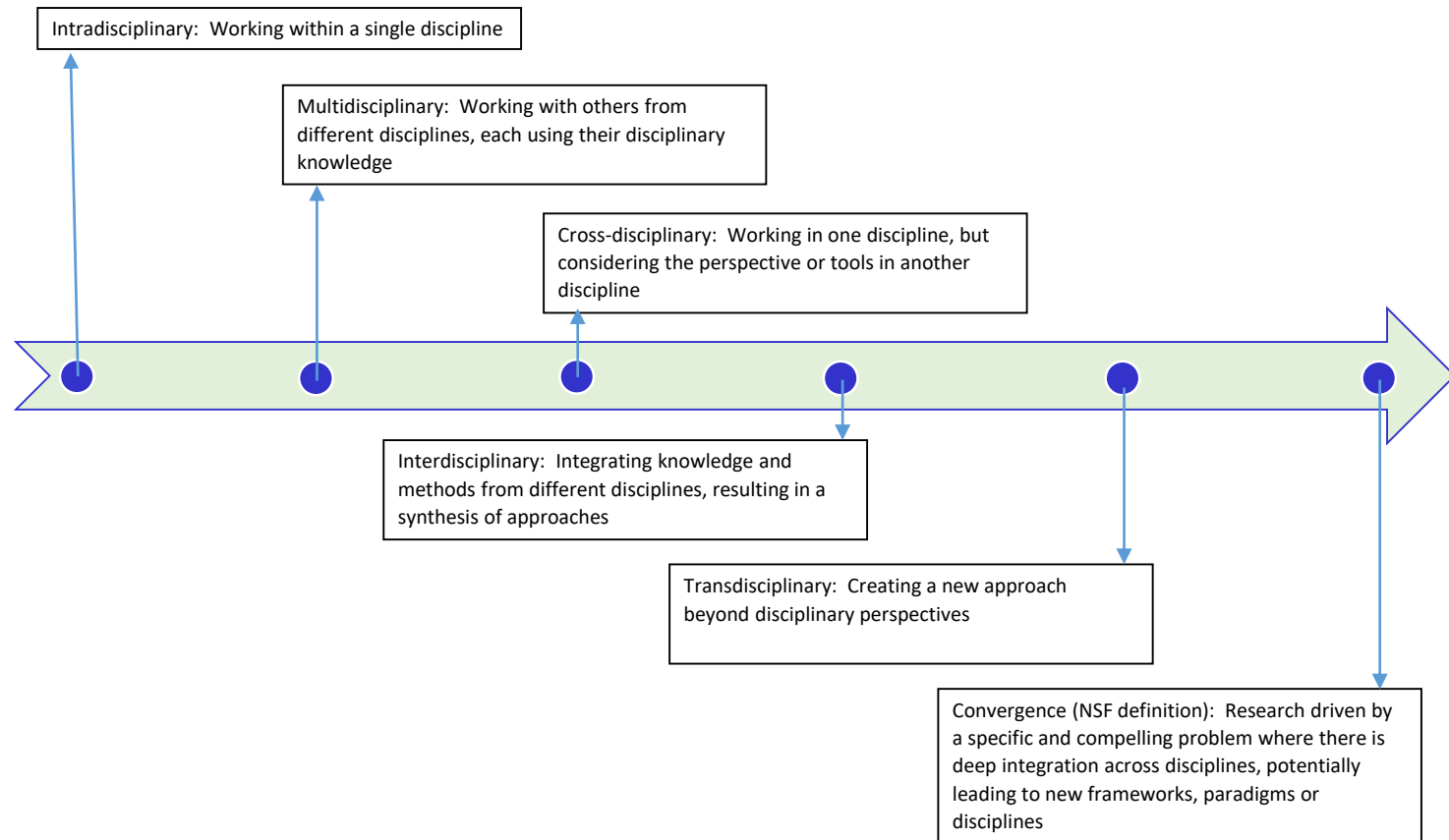
How can the various stakeholders in graduate education enterprise improve our outreach and coordination activities with each other?



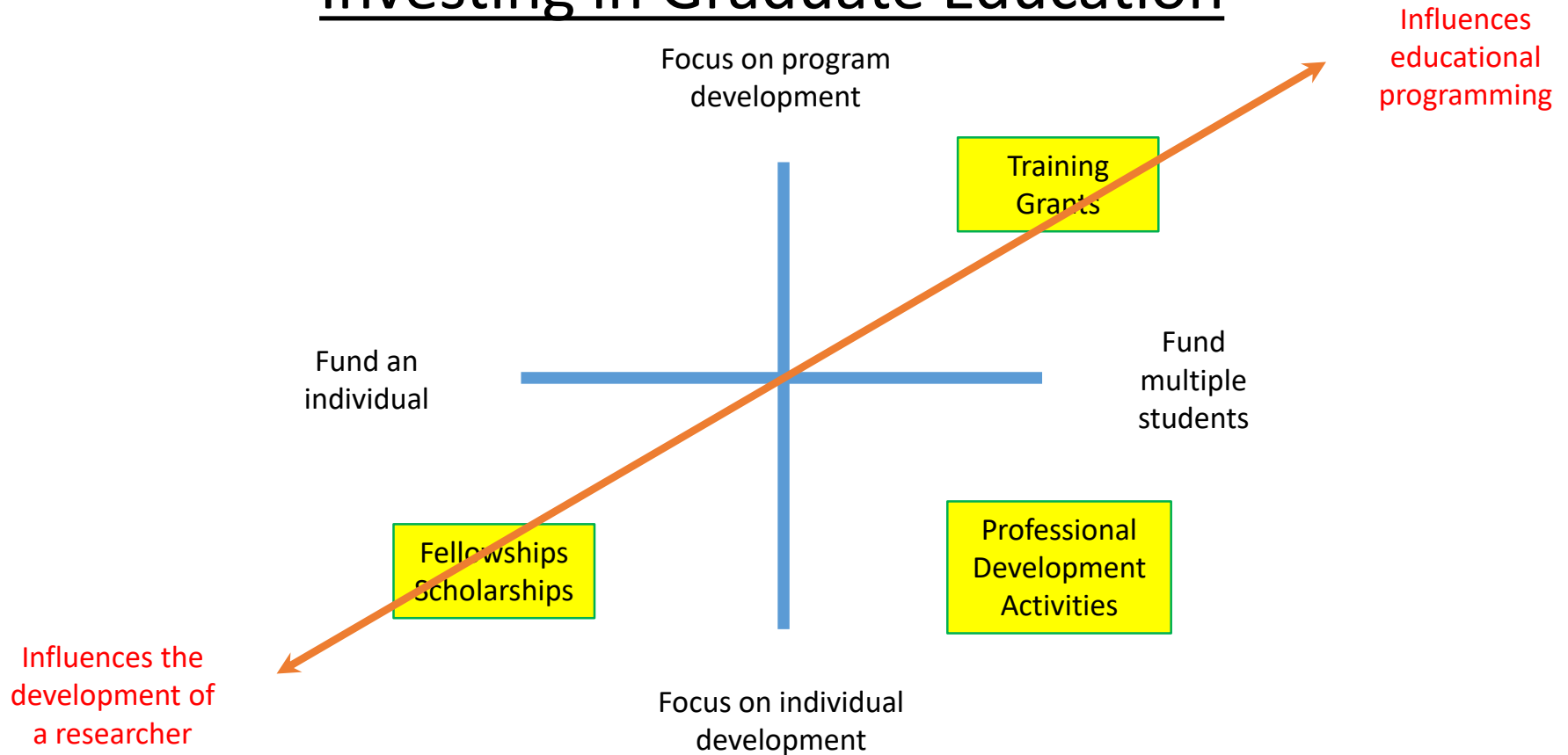
NSF's Vision



Terminology for X-Disciplinary Research

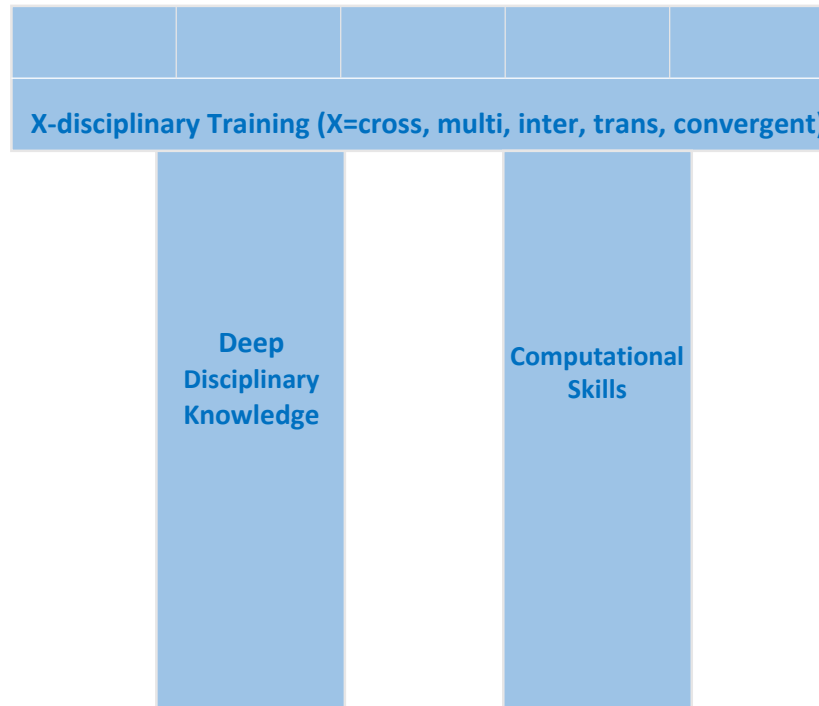


Investing in Graduate Education

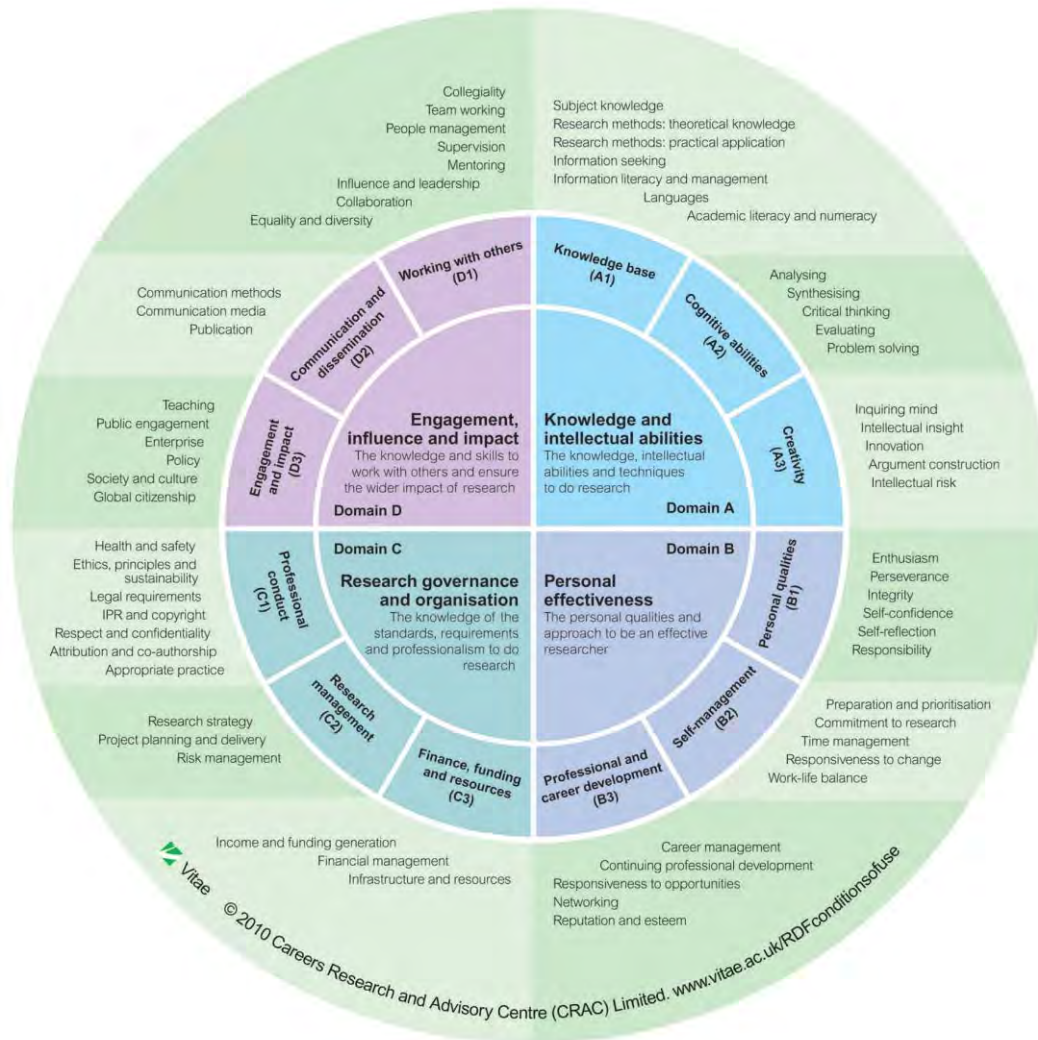


The Pi-Shaped Professional

Teamwork Communication Teaching Leadership Entrepreneurship



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>

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



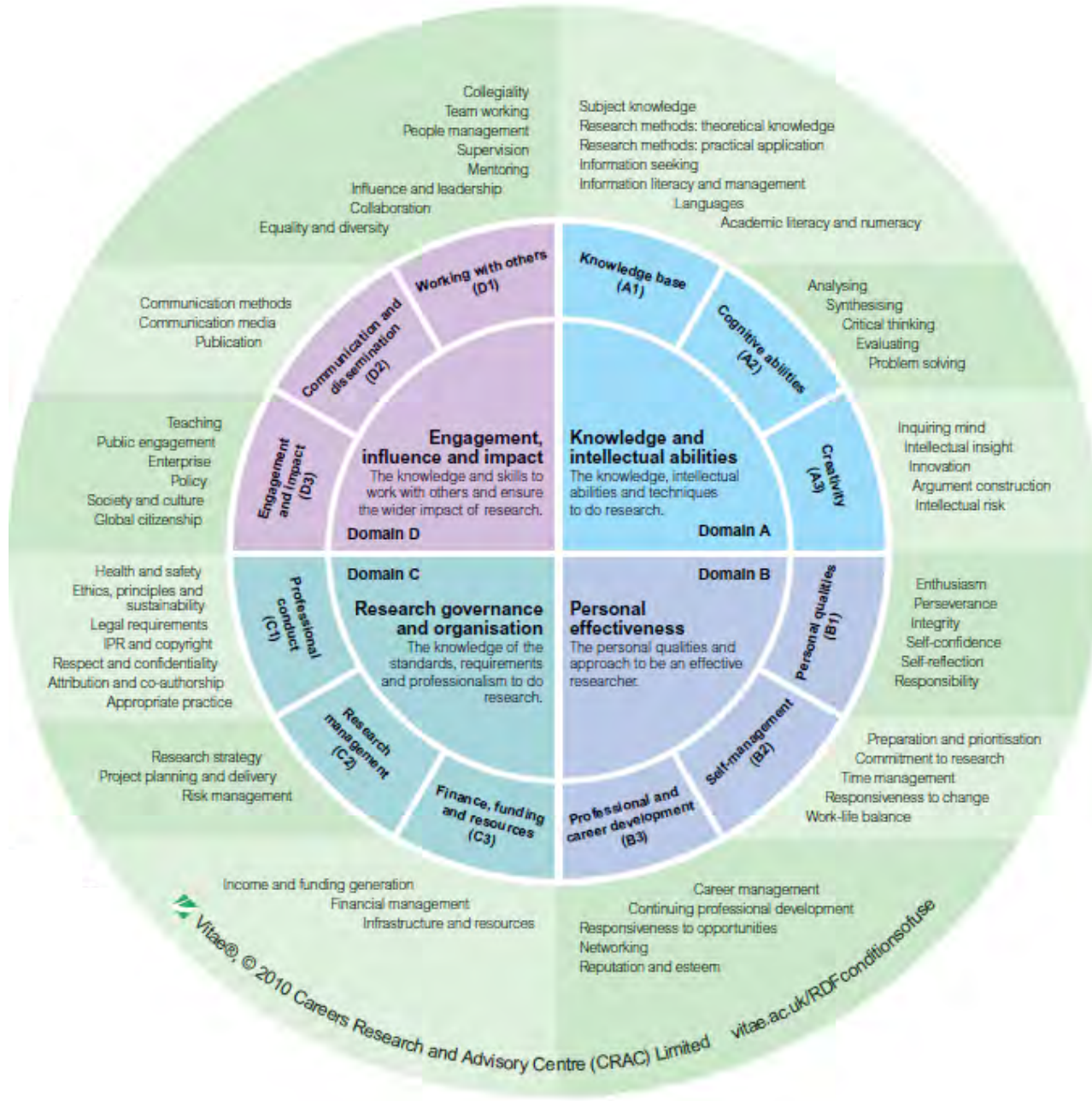
The Importance of Partnerships

External

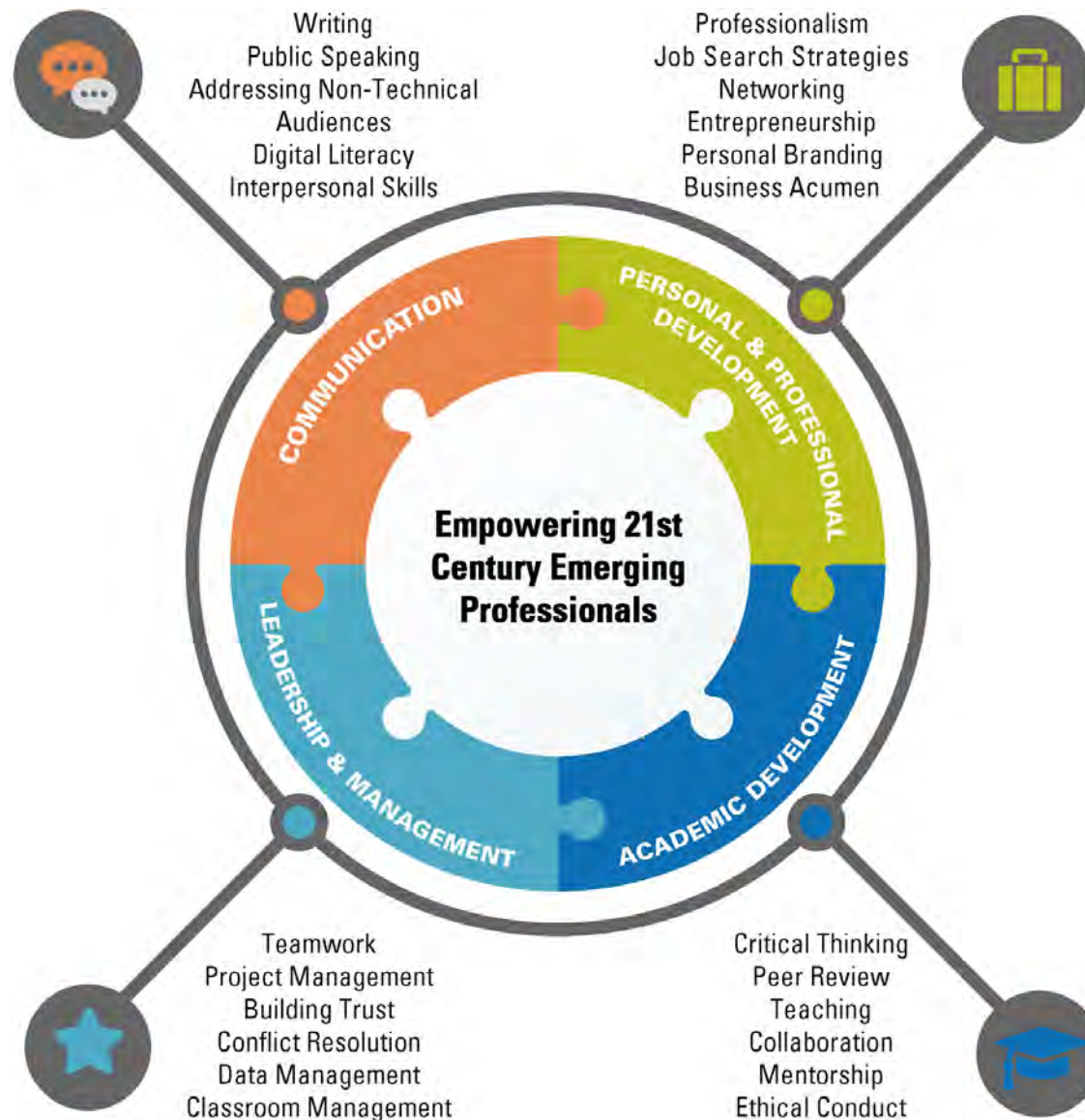


Internal

- 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





National Science Foundation

Accelerate to Industry™

FOUNDED BY THE NC STATE UNIVERSITY GRADUATE SCHOOL

A2i Modules

Job Search
StrategiesCompany
Visit

Internship

Team
PracticumImmersion
Week

Current Academic Partners

NORTH CAROLINA AGRICULTURAL
AND TECHNICAL STATE UNIVERSITYFLORIDA
INTERNATIONAL
UNIVERSITY

PennState

WAKE FOREST
UNIVERSITYNC Central
UNIVERSITYILLINOIS STATE
UNIVERSITY
Illinois' first public university.

Current Industry Partners



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



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Graduate School
& International Education

Kim LaScola Needy, Ph.D., P.E., CFPIM, CPEM
Dean, College of Engineering



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The Graduate School and International Education at the University of Arkansas



4,415

GRADUATE STUDENTS ENROLLED

436 DOCTORAL FELLOWS

1,179
INTERNATIONAL
STUDENTS



151

GRADUATE
DEGREE PROGRAMS

16%

INTERNATIONAL
GRADUATE STUDENTS

71

MASTER OF FINE
ARTS FELLOWS



{22%}



DIVERSITY ENROLLMENT

(STUDENTS WHO SELF IDENTIFY AS
UNDERREPRESENTED MINORITIES— FALL 2020)

1,584

GRADUATE ASSISTANTSHIPS
AWARDED

101

COUNTRIES
REPRESENTED



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rev. Fall 2021



Overview

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

Interdisciplinary Programs



Cell and Molecular
Biology



Environmental
Dynamics



Material Science
and Engineering



Public Policy



Space and
Planetary Sciences



Statistics and
Analytics

- 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

nsfpaad.uark.edu

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Research & Innovation

STEM Graduate Students



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

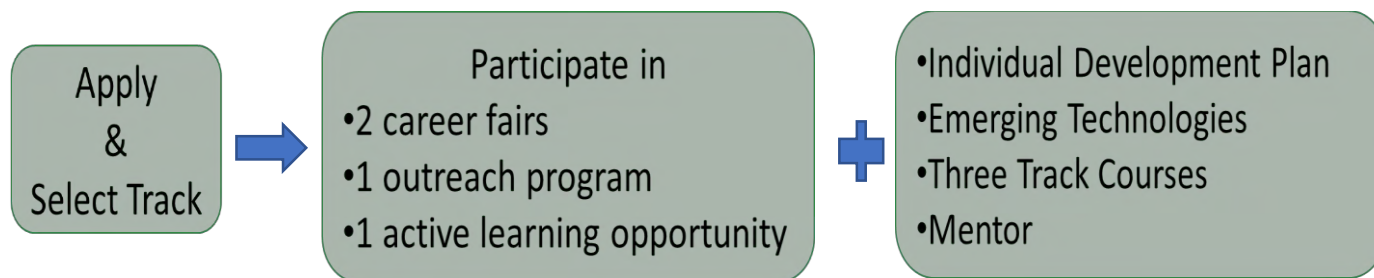
Prototype Development

Company Formation





PAAD Student Program



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



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Research & Innovation

PAAD Faculty Fellows

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

Courses:

- | | |
|--|---|
| • Biology | Proposal Writing/Communication |
| • Chemical Engineering | Safety |
| • Office of Sponsored Programs | Academic Administration |
| • Crop, Soil, and Environmental Sciences | The Business of Plant Breeding |
| • Curriculum and Instruction | Content Integration Strategies for STEM |

Activities:

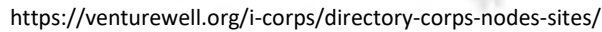
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| • Material Science and Engineering | Trip to visit companies in TX |
| • Physics & Community Health | Workshop on Nanotechnology and Public Health |
| • Music & Technology Ventures | Music Industry Data Index project |



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



Research & Innovation



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