

# Preparing a Competitive NSF CAREER Proposal

January 2024

Sally Bond

Director of Proposal Strategy and Development

Office of Research

# Grant Writing Website





**Distinctives...Examples...Process**



**Where do you want to be  
in 10 years?**



# What Makes a Good CAREER Proposal?

Not your typical NSF research proposal

- More “path” than project
- Strategic fit with institution
- Clearly transformative research direction
- Creative and integrated education and research

# Research Path Not Project

Funds academic career development of new faculty

“Successful Principal Investigators will propose **creative, effective research and education plans**, developed within the context of the mission, goals, and resources of their organizations, while building a firm foundation for a lifetime of contributions to research, education, and their integration

(CAREER solicitation, page 4)

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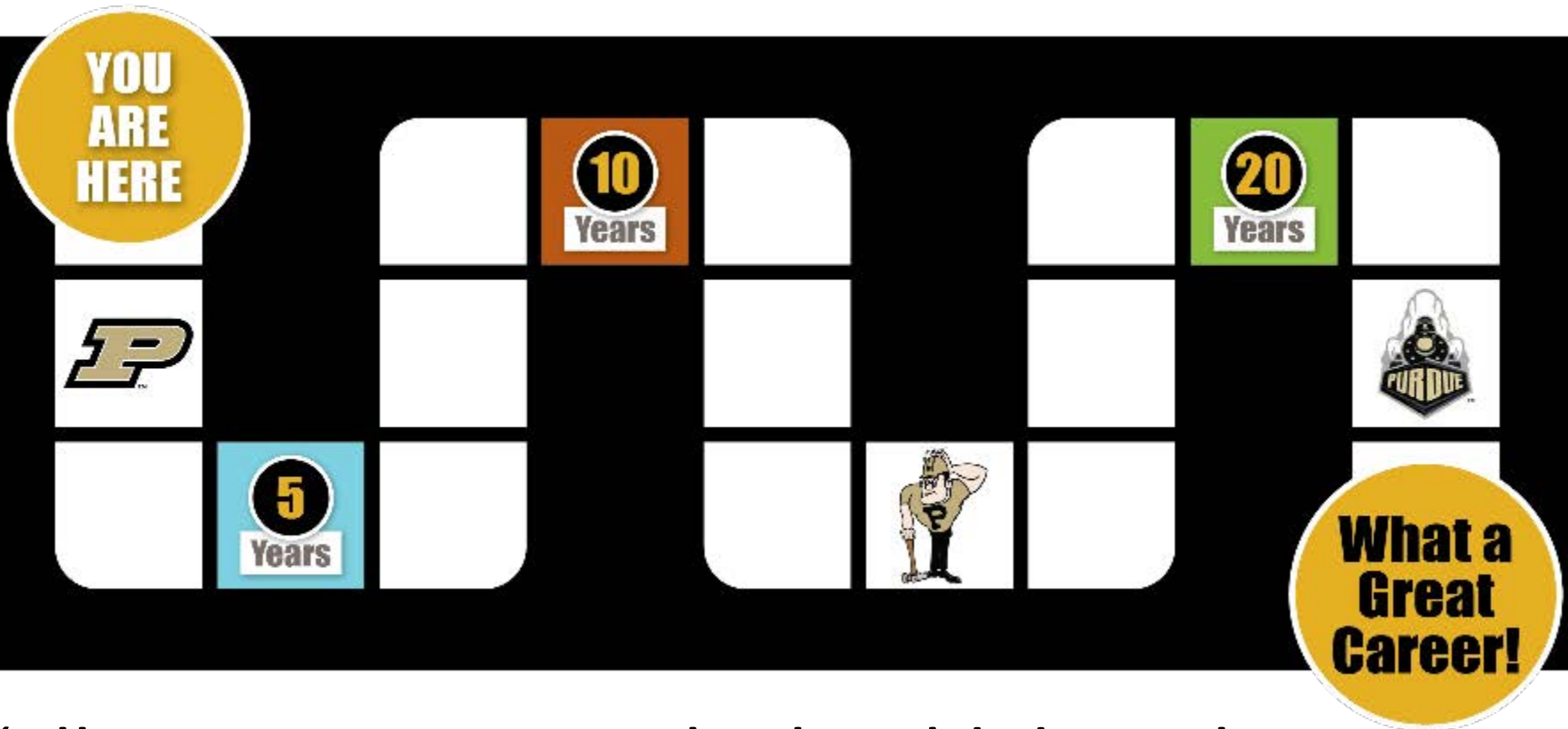
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(CAREER solicitation, page 4)



# Research Path Not Project

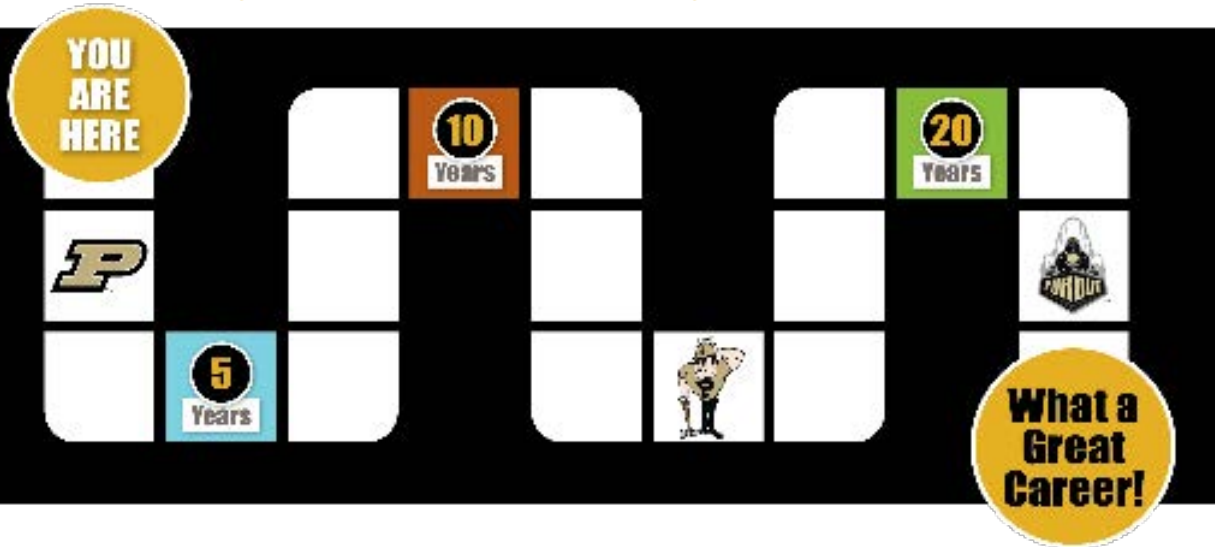
What is your strategic plan?



“All CAREER proposals should describe an integrated path that will lead to a successful career...” (CAREER solicitation, page 4)

# Research Path Not Project

You want your review panel to say this too



...“has made an excellent case for how the proposed research and education plan will help her achieve her personal career vision.”

Reviews from Senay Purzer, Purdue CAREER  
Engineering Education

## Ask yourself blue sky questions...

- What problem do you feel passionate about?
- Where do you want to have a transformative impact?
- In what ways are you prepared to push the frontiers of knowledge?
- Where can you contribute to national needs and priorities?
- Where are you poised to be a thought leader?

# Clear Career and Research Goals

## 1.3 Career objectives

The long term career goal of the PI is to integrate excellence in the science and engineering of nano-structured semiconductor devices with education of future scientists and engineers. Achieving this goal will contribute significantly to the *fundamental knowledge about band, polarization, and strain engineering* of nitride nanostructures and will bring these materials to the level of maturity necessary for infrared commercial applications. The research plans detailed in this proposal naturally continue the PI's previous studies of infrared lasers, and current investigations of correlations between semiconductor structure and infrared optical properties. The proposed program will expand prior and ongoing work to a novel class of nanostructured devices, the nonpolar nitride infrared devices, devices that hold promise for new functionalities in the underdeveloped spectral regions of the infrared. By improving fundamental understanding of the physics and material science of nitride materials, this work will enable ultra-fast and versatile infrared light emitting and detecting devices that will ultimately enhance the performance and wide-acceptance of commercial infrared systems for spectroscopy, telecommunications, sensors, etc.

Oana Malis, Purdue CAREER, Physics

# Vision and Impact

The **goal** of my interdisciplinary research is to develop a robust and scalable computational framework for the emerging field of computational population biology. **Ultimately, this research will enable** biologists in their scientific inquiry to take advantage of new data by focusing on its underlying qualitative (rather than numerical) and explicitly dynamic structure.

Tanya Berger-Wolf CAREER (Univ of Illinois, Chicago)



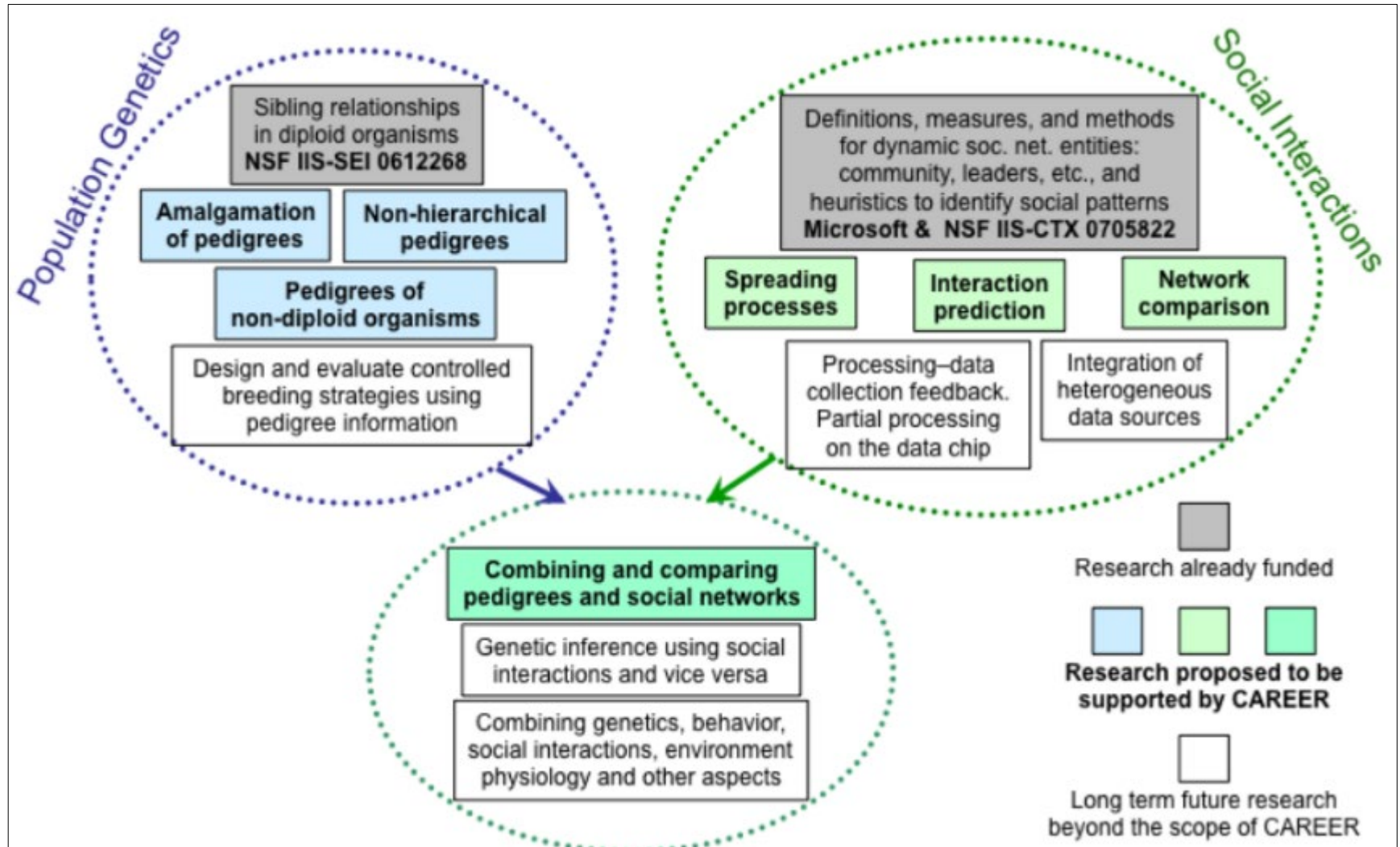
# Vision and Impact

My **long-term goal** is to greatly advance the prediction of hurricane hazard risk on monthly to seasonal timescales. The **overall objective of this CAREER proposal**, which lays the foundation for this long-term goal, is to understand the spatiotemporal variability of the oceanic subtropical highs and its link to variability in landfall. Beyond this proposal, **the outcomes of this work** can be combined with models for storm structure and hazards (wind, storm surge, and rainfall) to create predictive models for hazard risk on monthly to seasonal timescales.

-Dan Chavas, Purdue EAPS CAREER 2020

# Long-Term Pathway

Be specific about what has been done, will be done, and will be done in future



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Oana Malis, Purdue CAREER, Physics



# Institutional Fit



**INSPIRE!**<sup>TM</sup>

The word 'INSPIRE!' is written in a stylized, colorful font. The 'I' is purple, and the rest of the letters are blue. There are three curved lines above the 'I' and a smile-like curve below the 'E'.



# Transformative Research

Why is this work essential?

- Needs to be solved now?
- Says who?
- Radical change in understanding
- Facts and figures of cost to country/industry/communities
- Industries/communities positively impacted by your work



# Transformative Research

Why is this work essential?

This research will have far-reaching effects, delivering new tools to tailor transformative mobility solutions to citizens' needs, decongest urban networks and expand mobility to underserved communities.

Amanda Stathopoulos CAREER 2019  
Civil and Environmental Engineering  
Northwestern University

# Transformative Research

Why is this work essential?

- Needs to be solved now?
- Says who?
- Radical change

**Cannot be incremental**

- Significant figures of cost to country/industry/communities
- Industries/communities positively impacted by your work

# Integrating Education and Research





# Integrating Education and Research

The broader impacts of this proposal include developing a set of educational activities that are focused on characterizing and dealing with risk related to atmospheric extreme events. The motivation for this activity, the plan for carrying out the educational internship, and the plan for assessment are all very good. This is a strength of the proposal and is a reason for this proposal to receive serious consideration.

(Reviewer comments for Dan Chavas, Purdue EAPS, CAREER 2020)

# Integrating Education and Research

Integration is critical...cannot be an afterthought. Innovative but doable.

- What are you passionate about?
- Where do you have a track record to build on?
- Do not reinvent the wheel!
- Both expected and creative initiatives
- Sustainable
- Based on best practices
- Reasonable workload
- Builds your educational leadership





**“Such activities should be consistent with research and best practices in curriculum, pedagogy, and evaluation.”**

**pg 6 solicitation**

# Evidence-based Education

## What are Broader Impacts?



Broader impacts are the potential to benefit society and contribute to the achievement of specific, desired societal outcomes. They may be accomplished through:

1. the research itself
2. activities directly related to research projects
3. activities supported by and complementary to the project

A broader impact **statement** describes benefits and outcomes—not logistics.



"Cords" of research, education and outreach, and diversity-related activities integrate through your project to deliver **broader impacts**. For instance:

- Fuller Participation of Women, Persons with Disabilities, and Underrepresented Minorities in STEM
- Improved STEM Education and Educator Development
- Increased Public Scientific Literacy
- Improved Well-Being of Individuals
- Development of a Diverse, Globally Competitive Workforce
- Increased Partnerships among Academia, Industry, Government, and Non-Profits
- Improved National Security
- Increased U.S. Economic Competitiveness
- Informed Public Policy
- Enhanced Research and Education Infrastructure

(Coming Soon!)

Example Broader Impact Statements from Funded NSF Proposals

Steps to Develop an Education and Workforce Development Plan

Tips for Broadening Participation and Diversity, Equity, and Inclusion Plans

Other Broader Impact Resources

Request a Broader Impact Consultation

# Evidence-based Education

What are Broader Impacts?

Steps to Develop an Education and Workforce Development Plan

Example Broader Impact Statements (login required)

Other Broader Impact Resources

Request a Broader Impact Consultation

## Other Broader Impact Resources

### Purdue Guidance

[Purdue Science K-12 Outreach](#). Partner for STEM professional development programs for K-12, long-term partnerships with school districts across Indiana, and avenues to engage students in standards-based learning activities.

[Purdue Advancing Research Impact in Society \(PARIS\)](#). Professional development opportunities and one-on-one mentoring for faculty and staff interested in increasing their research impact.

### Resources from Professional Organizations and Funded Centers

[Center for Advancing Research Impact in Society \(ARIS\)](#). Funded by the National Science Foundation to build broader impact capacity and scholarship particularly through an online platform of best practices, resources, and partnering opportunities.

[Broader Impacts Wizard](#). Developed by ARIS and Rutgers University to help research teams develop broader impact statements that address the National Science Foundation Broader Impacts Criterion.

[Broader Impacts Guiding Principles and Questions](#). A breakdown of each of the five criteria the National Science Foundation instructs reviewers to use when reviewing broader impacts of a proposal.

[Center for Advancement of Informal Science Education \(CAISE\)](#). Resource center funded by the National Science Foundation's Division of Research on Learning in Formal and Informal Settings (DRL) with over 8,000 resources for evidence-based informal STEM learning.

[AAAS Center for Public Engagement with Science and Technology](#). Provides opportunities and resources for scientists to engage with policymakers and the general public.

[American Society for Cell Biology \(ASCB\)](#). Programs and grants for scientists to engage with the public.

[BPCnet Resource Portal](#). Computing Research Association initiative, supported by the National Science Foundation CISE directorate, provides curated resources for diversifying the computing community.

### STEM Education Research Literature and Landmark Publications

(Substantiate your gap analysis and best practice initiatives)

[Education Resources Information Center \(ERIC\)](#). Online library of education research and information.

[Institute of Education Sciences \(IES\)](#). Scientific evidence for grounding education best practices, including the What Works Clearinghouse.

The proposed internship program is based on research that demonstrates the utility of a cohort-based approach.

(Reviewer comments for Dan Chavas, Purdue EAPS CAREER 2020)





# Think Beyond Business as Usual

- Co-developed/cross-listed course
- Innovative undergraduate instruction
- K-12 teachers and students
- Service learning
- Entrepreneurship (include I-Corps!)
- Outreach through summer camps
- Partnerships with museums and informal science learning organizations
- Citizen science and public STEM literacy

# Consider Diversity for Broader Impact

- How will you attract and mentor diverse students?
- Underserved rural areas, disabled, gender diversity, veterans
- Don't quantify
- Can involve teachers recruited from schools with particular demographics



This Faculty Early Career Development Program (CAREER) research addresses a gap in current approaches by integrating quantitative and qualitative multi-disciplinary insights and developing methods to study how society adapts to evolving mobility technologies. Integrating insights from the social sciences in existing passenger and logistics system models will help understand how adoption behaviors are affected by diverse community beliefs and culture in rapidly changing mobility contexts. This research will have far-reaching effects, delivering new tools to tailor transformative mobility solutions to citizens' needs, decongest urban networks and expand mobility to underserved communities. The project includes educational efforts where students evaluate engineering solutions that align with human behavior and livability goals. The project will also develop online educational material and training tools for Chicago high school teachers, to promote careers in engineering in diverse communities.

Amanda Stathopoulos CAREER 2019  
Civil and Environmental Engineering  
Northwestern University

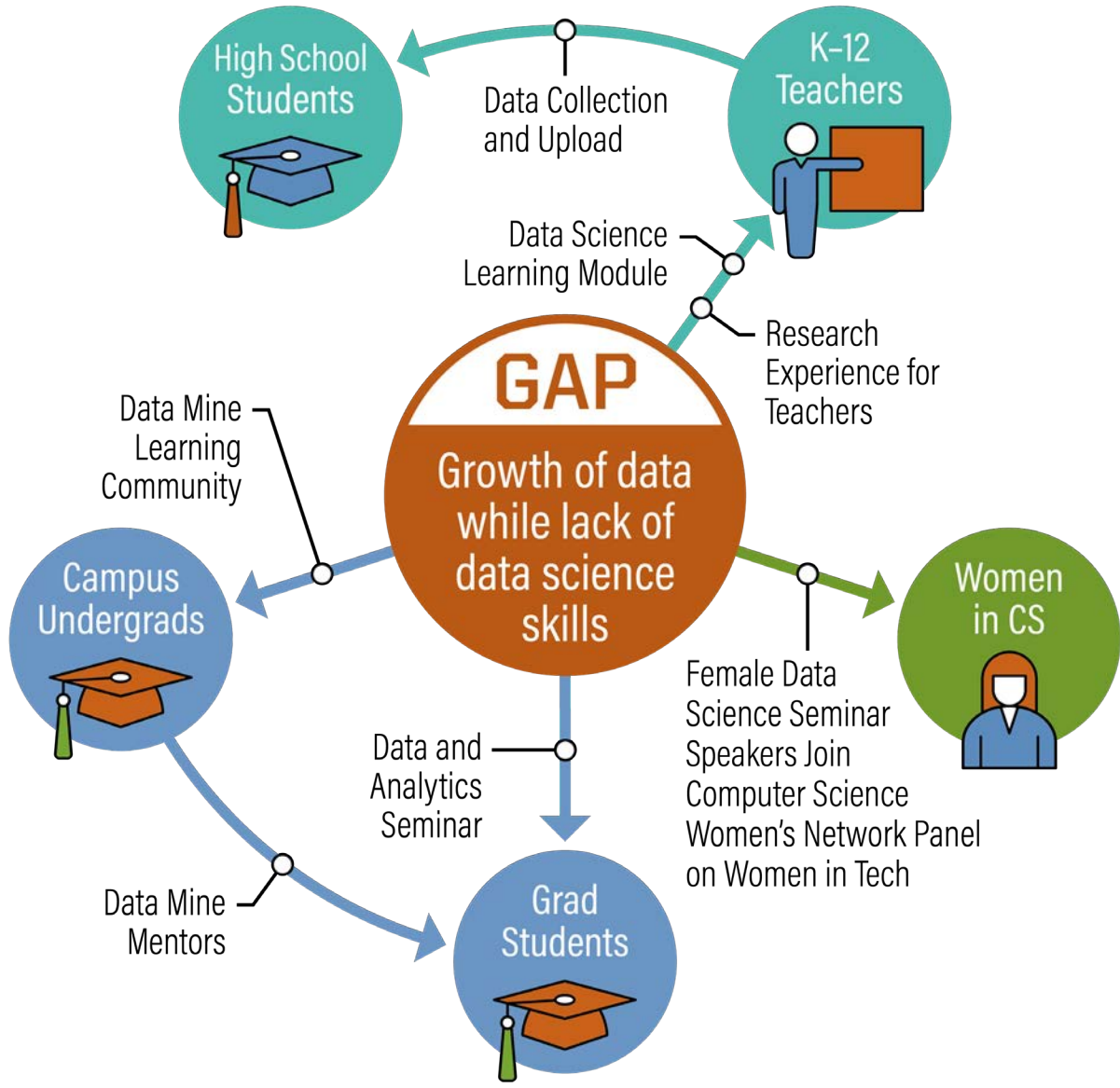
## Question....

“Of the many students I have mentored in my lab, six of them have been female undergraduates, one has been Hispanic, and one has been African American.”

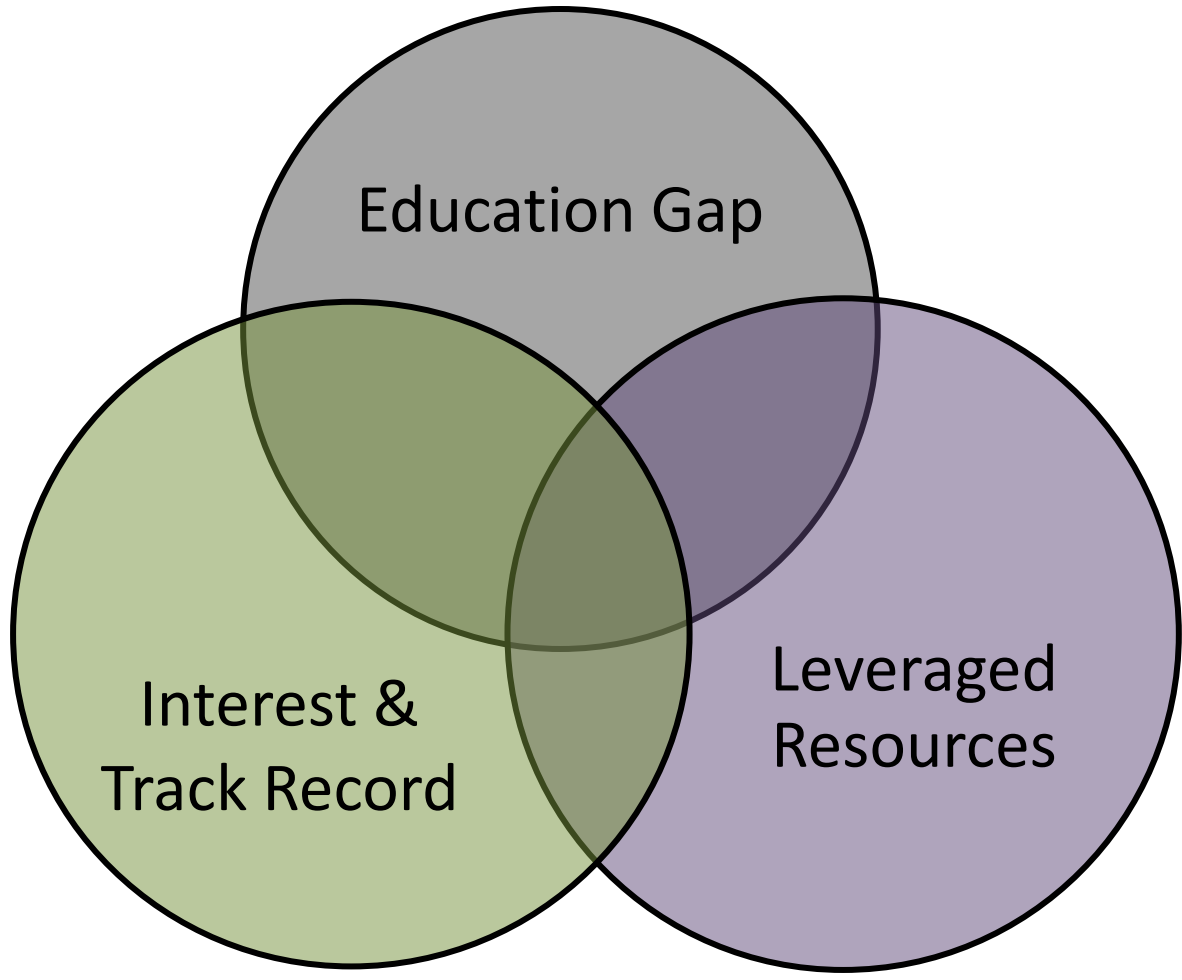
## Question....

“I will recruit two underrepresented graduate students to work on this project.”

# Where to Start?

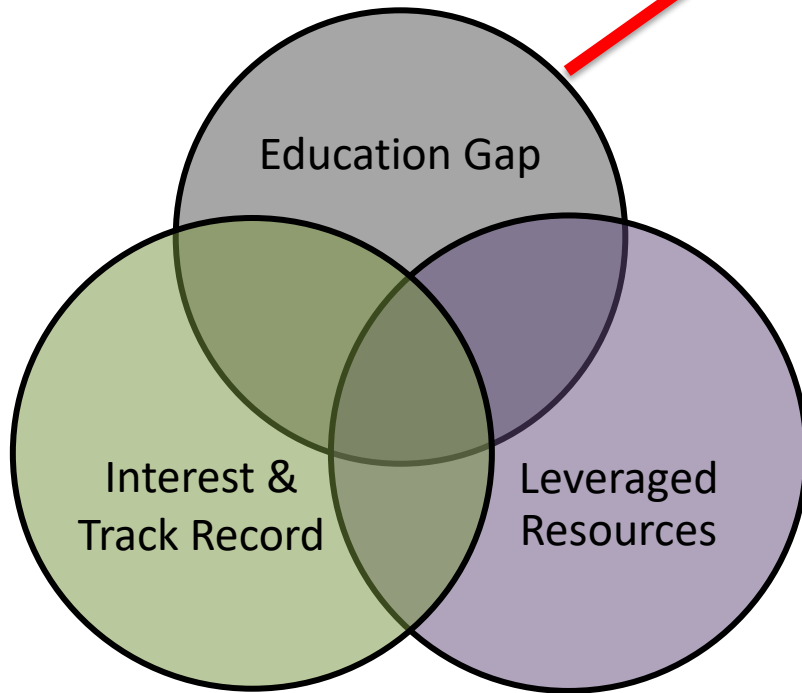


# Where to Start?

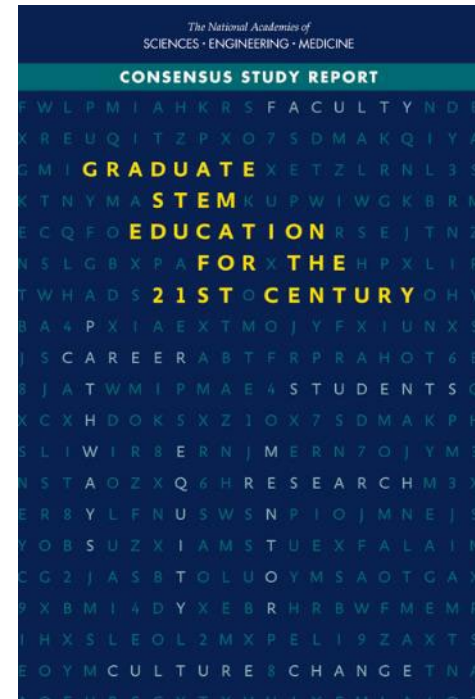
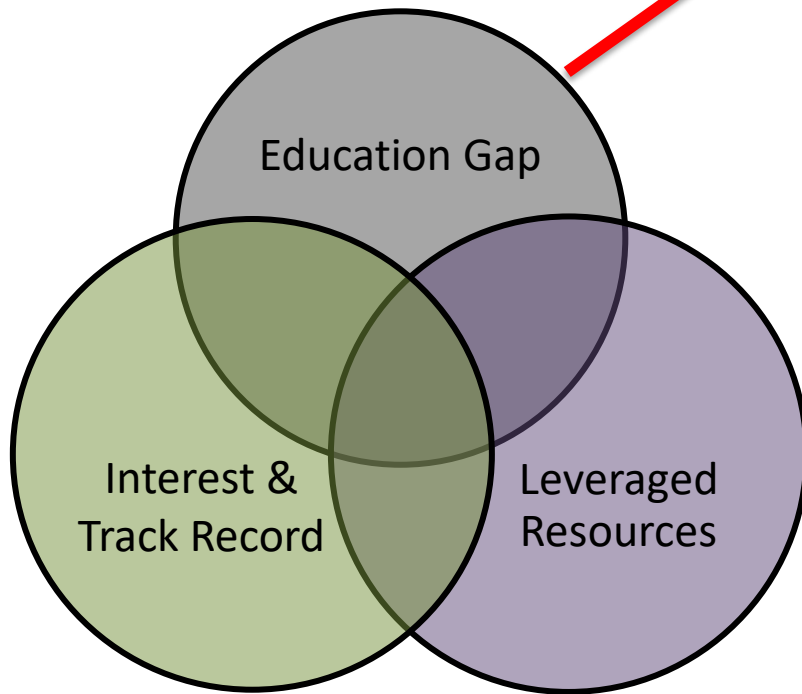




**Grad students learn “microethics” of responsible research conduct such as publishing norms but lack “macroethics” of ethical and cultural issues surrounding their work’s impacts on society.**



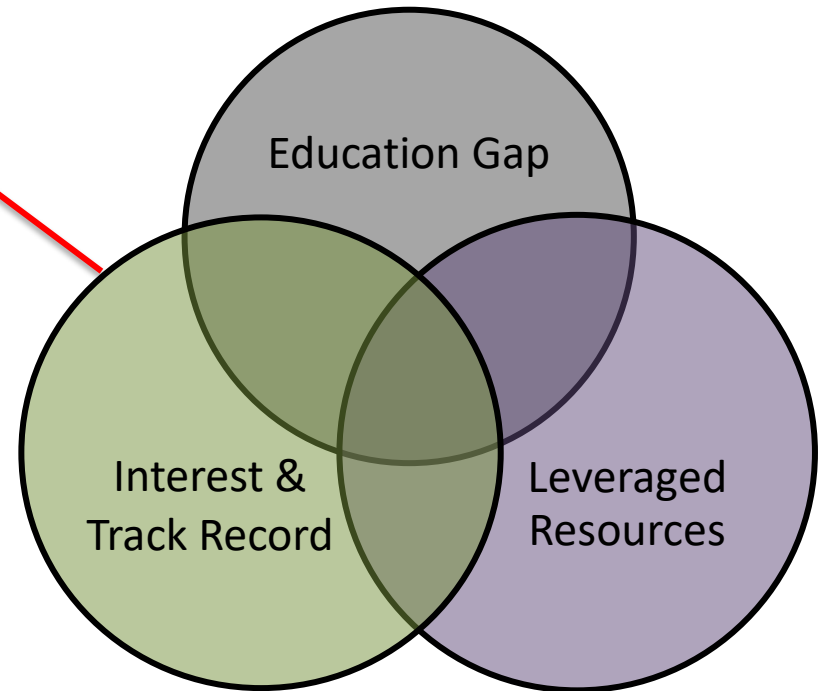
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National Academies of Sciences, Engineering, and Medicine 2018. *Graduate STEM Education for the 21st Century*. Washington, DC: The National Academies Press.

Previously collaborated  
(guest speaker) to  
incorporate societal  
implications and economic  
analysis into your  
undergrad engineering  
course.

Served as faculty panelist  
for Engineering Ethics  
Colloquium

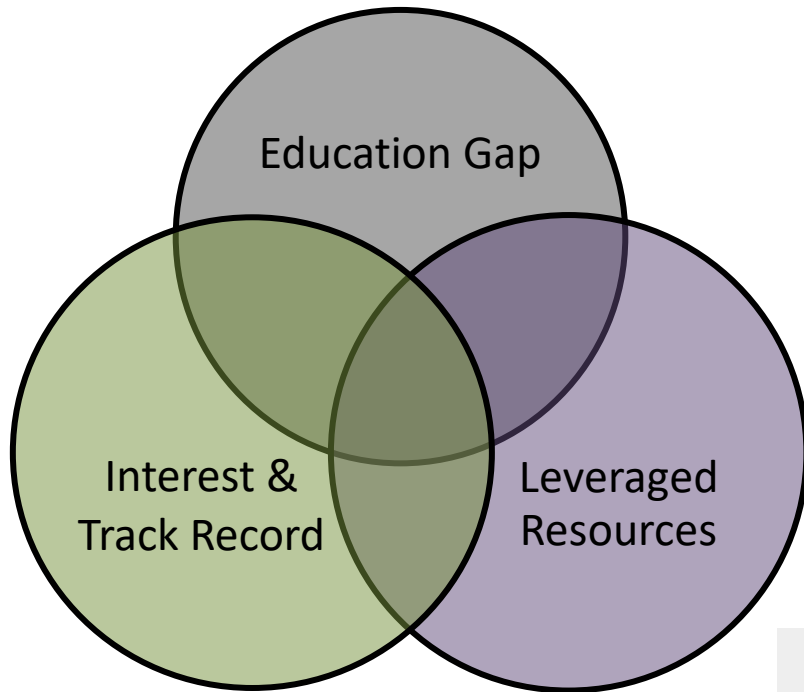


**ENGINEERING ETHICS COLLOQUIUM**

Come support Honors College seniors as they present ethics case studies and participate in a panel with Purdue faculty!

**PART I**  
**APRIL 30 | 11AM-1 PM | HCRS STEAM LAB**  
Student Presenters:  
Beau DeLaeF | Dan Gentilini | Reis Lehman  
Lauren Miller | Myranda Moye | Paul Silver  
Faculty Panelists:  
Prof. Andrew Brightman | Prof. Daniel Kelly | Prof. Carla Zoltowski

**PART II**  
**MAY 1 | 9-11AM | HCRS STEAM LAB**  
Student Presenters:  
Scott Criswell | Jonah Newton | Katherine Rothe  
Luke Upton | Trevor Waldman  
Faculty Panelists:  
Prof. Michael Loui | Prof. Tom Shih | Prof. Timothy Whalen



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Faculty and Students working on global challenges.

PPRI aims to bring the talents of the university community to bear on global challenge issues, catalyzing new areas of research and enhancing the impact of that research.

[Discover How](#)



**AUTONOMOUS TRANSPORTATION**

Our transportation system will likely undergo major transformation in the coming decades as technology allows us to move people and freight in safer and more efficient ways.

[Learn More](#)



**DRONE REGULATORY RESEARCH**

Drones are growing in popularity and varying in their use – this growth and evolution is progressing at a greater pace than the regulations needed to ensure safety and security.

[Learn More](#)

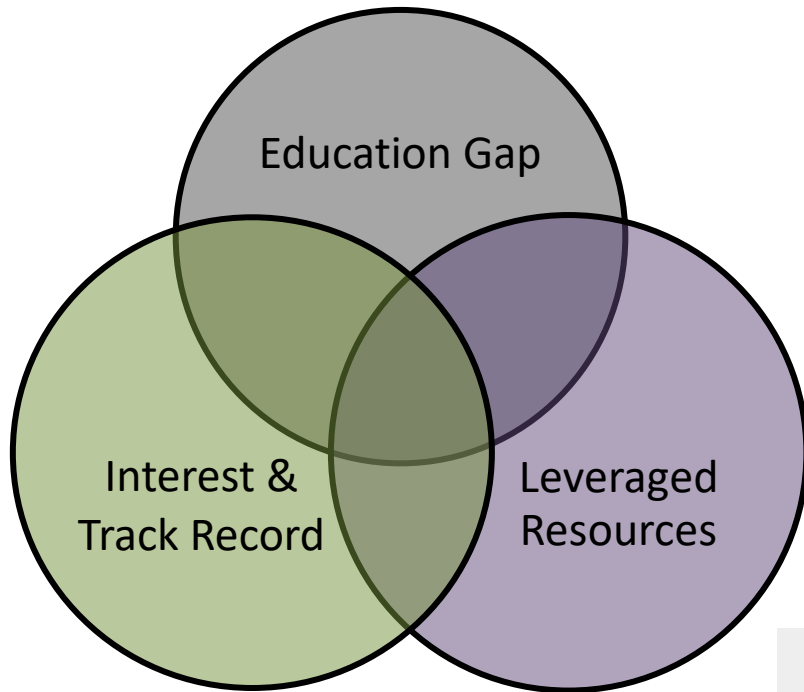


**GRAND CHALLENGES RESEARCH**

The Andrew W. Mellon Foundation supports a unique approach to global grand challenges research, scholarly publishing and communication at Purdue.

[Visit Site](#)





## Purdue Policy Lab undergraduate honors class on *Policy Alternatives for Grand Challenges*

- Collaborate to develop case study
- Grad students help as part of professional development

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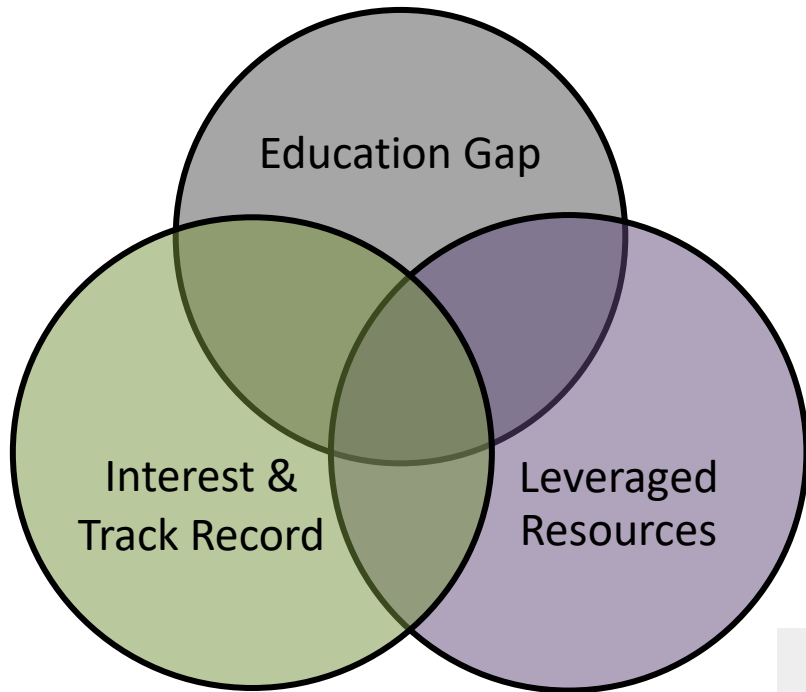
[Learn More](#)



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## Purdue Policy Lab undergraduate honors class on *Policy Alternatives for Grand Challenges*

- Collaborate to develop case study
- Grad students help as part of professional development

**Collaborate with PPRI (with grad students) to author policy brief**

The screenshot shows the website for the Purdue Policy Research Institute. At the top, it features the "Purdue University Discovery Park" logo and the text "Purdue Policy Research Institute". Below this is a navigation menu with links for Home, About, Policy Research, Autonomous Transportation, Grand Challenges Research Initiatives, Purdue Peace Project, News, and Events. The main content area has a large image of a woman looking at a computer screen. Overlaid on this image is the text: "Faculty and Students working on global challenges. PPRI aims to bring the talents of the university community to bear on global challenge issues, catalyzing new areas of research and enhancing the impact of that research." A "Discover How" button is visible below the text.



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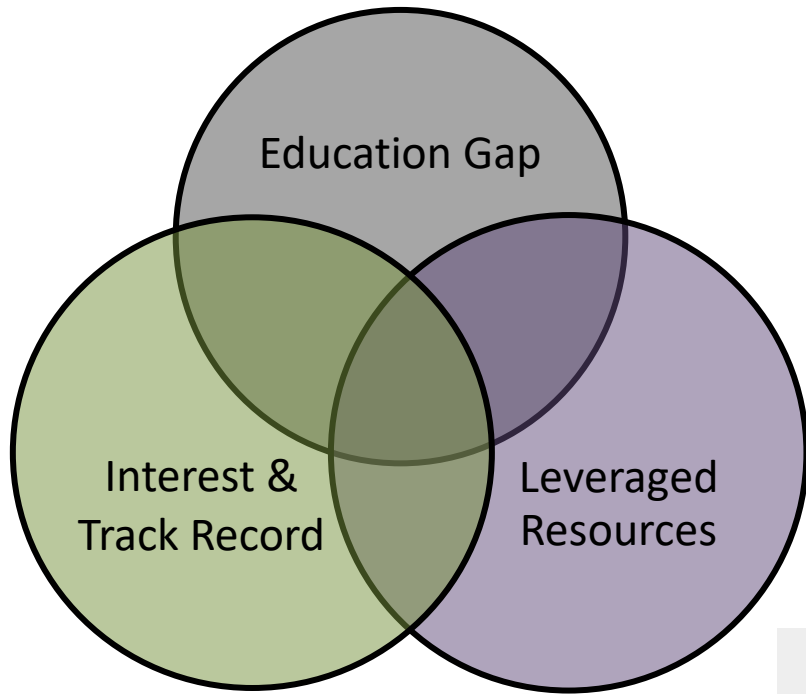
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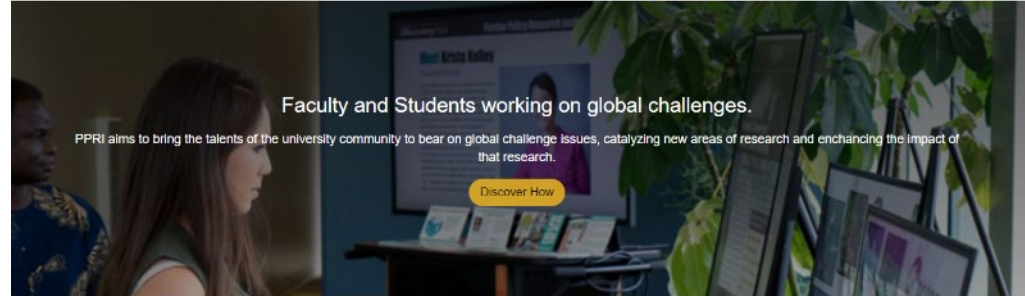


- About DURi
- Contact

### Discovery Park Undergraduate Research Internship Program (DURi)

#### Announcement to Faculty and Students about DURi: Summer 2019

Discovery Park is seeking faculty proposals in support of the Discovery Park Undergraduate Research Internship program. The DURi program supports undergraduate interdisciplinary teams while they investigate problems in various strategic areas over the course of 10 weeks (approximately May 20-July 26).



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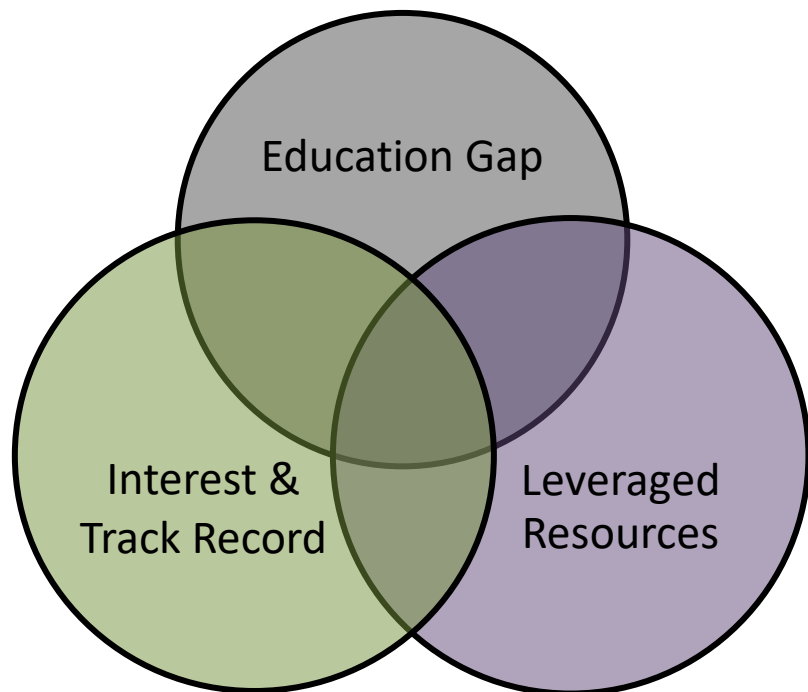
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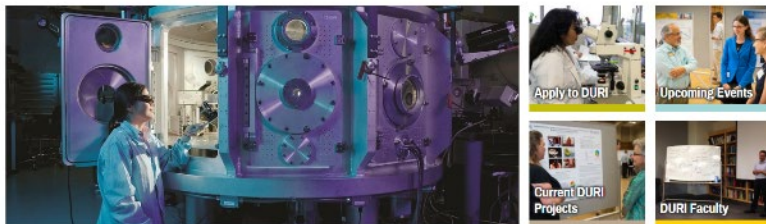
The Andrew W. Mellon Foundation supports a unique approach to global grand challenges research, scholarly publishing and communication at Purdue.

[Visit Site](#)



## Best-practice undergraduate research as Discovery Park provides:

- Cohort experience that includes professional development
- Recruitment
- Assessment
- Research poster and undergraduate research journal



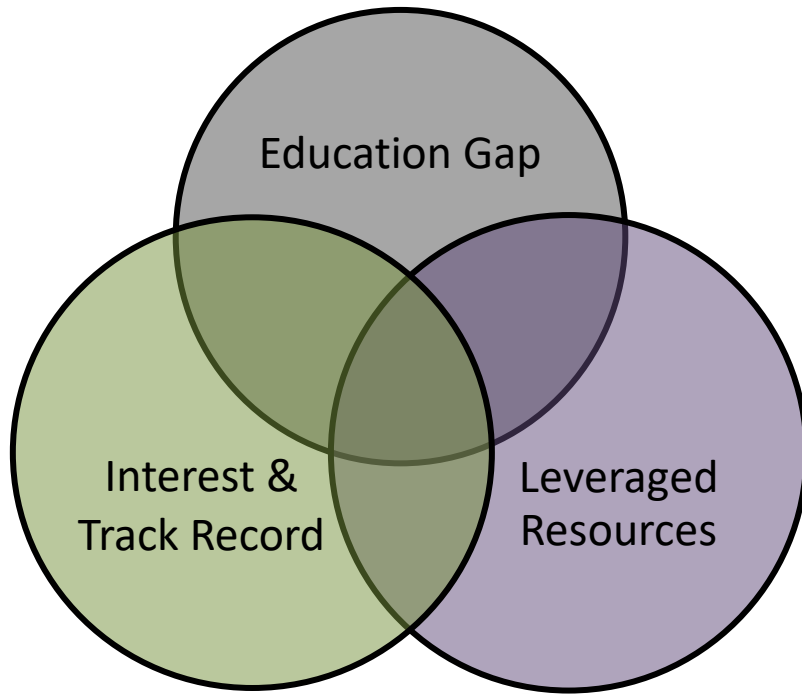
About DURIP  
Contact

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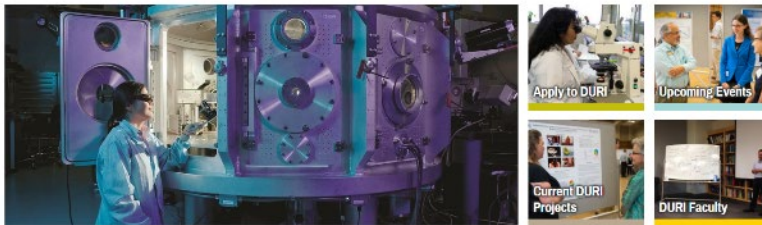


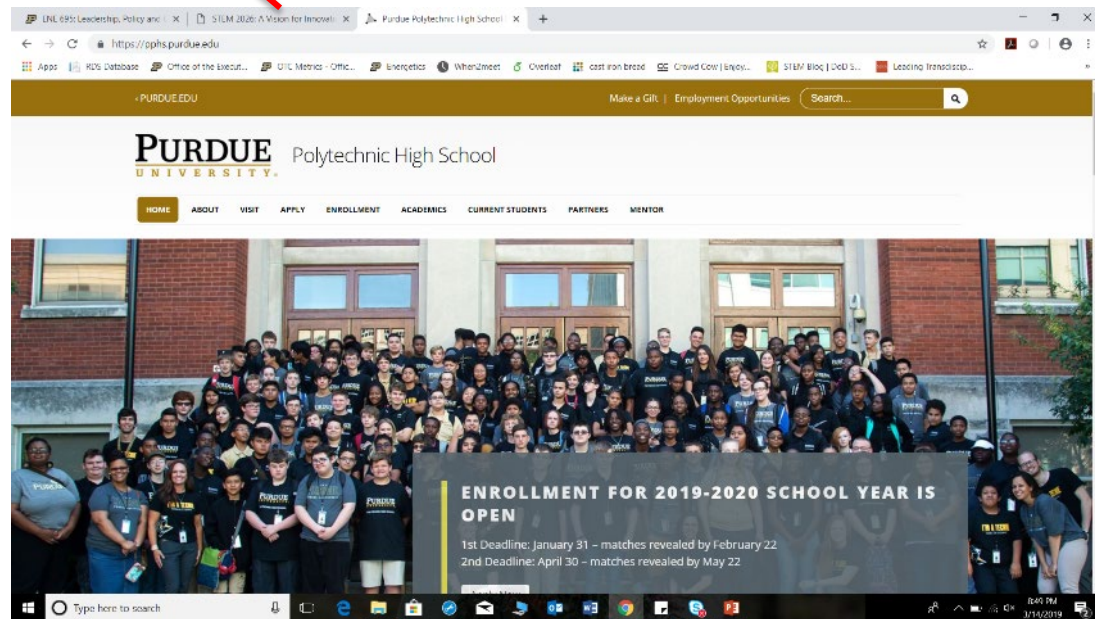
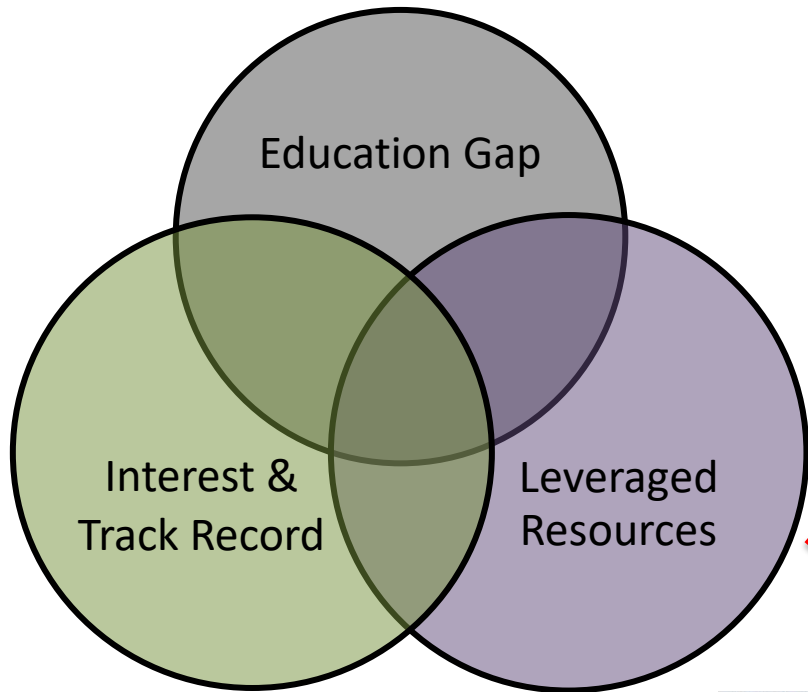
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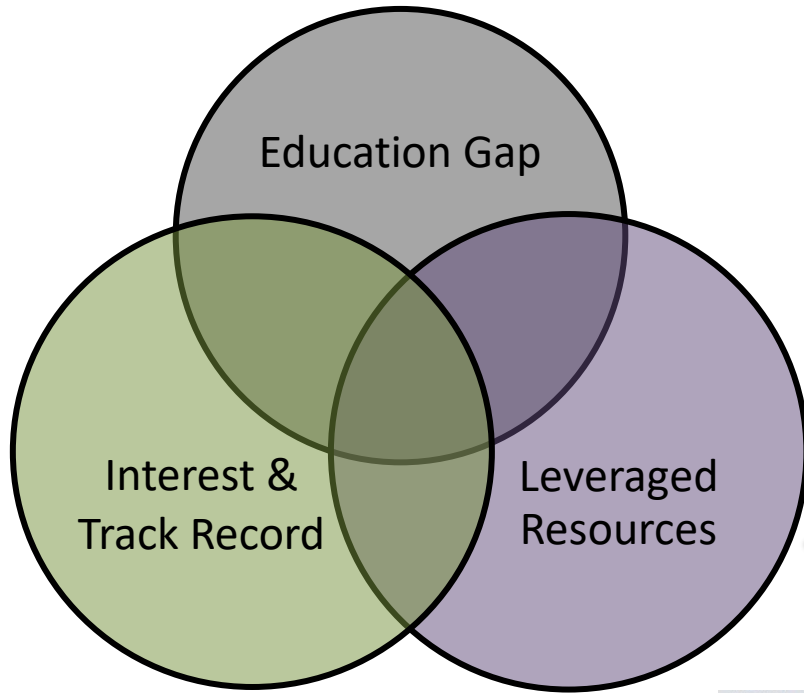
- Cohort experience that includes professional development
- Recruitment
- Assessment
- Research poster and undergraduate research journal

*Evidence for apprentice-style research experience with separate research groups that meet together as a cohort focused on learning about research.*

National Academies of Sciences, Engineering, and Medicine. (2017). Undergraduate Research Experiences for STEM Students: Successes, Challenges, and Opportunities. Washington, DC: The National Academies Press.

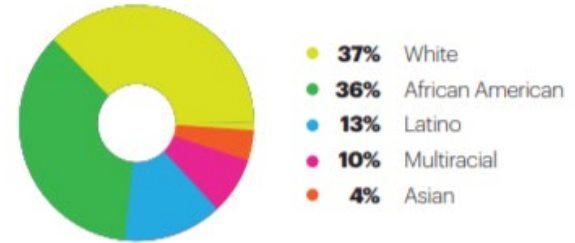






## Projected Student Demographics (at Full Enrollment)

**Student Enrollment:** 600 Students (Grades 9-12)

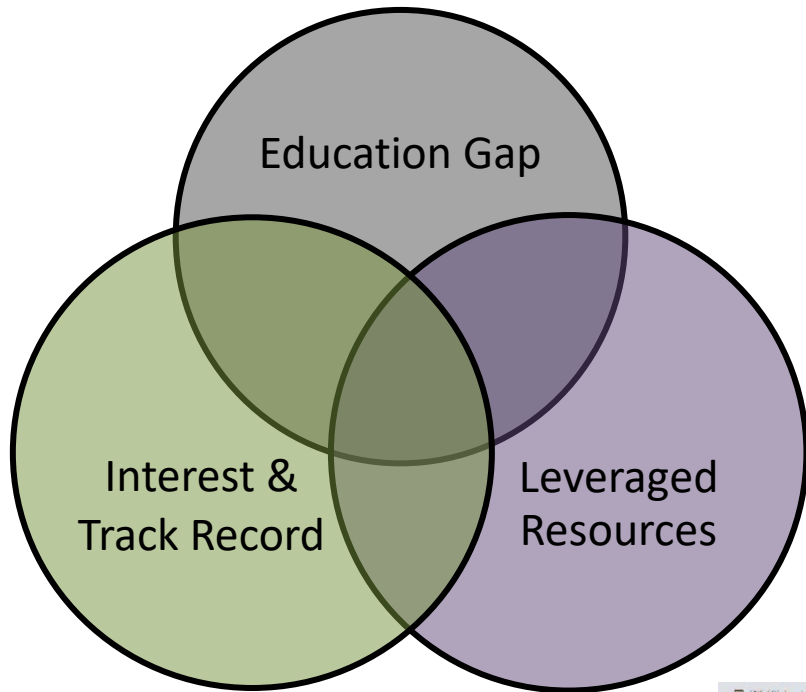


**65%**  
ELIGIBLE FOR  
FREE OR REDUCED  
PRICE LUNCH

**13%**  
ELIGIBLE FOR  
SPECIAL-EDUCATION  
SERVICES

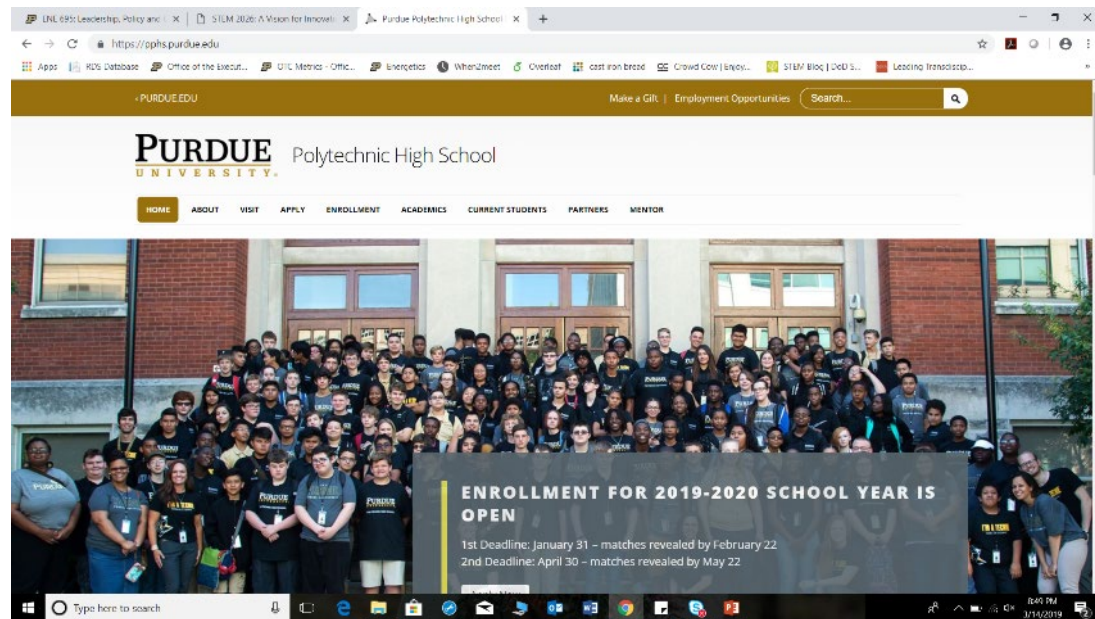
**17%**  
ARE ENGLISH  
LANGUAGE  
LEARNERS

The screenshot shows the website for Purdue Polytechnic High School. The header includes the Purdue University logo and the school name. A navigation menu contains links for HOME, ABOUT, VISIT, APPLY, ENROLLMENT, ACADEMICS, CURRENT STUDENTS, PARTNERS, and MENTOR. Below the navigation is a large group photo of students and staff. A text overlay on the photo reads: "ENROLLMENT FOR 2019-2020 SCHOOL YEAR IS OPEN". Below this, it lists the deadlines: "1st Deadline: January 31 - matches revealed by February 22" and "2nd Deadline: April 30 - matches revealed by May 22". The browser's address bar shows the URL "https://pphs.purdue.edu".

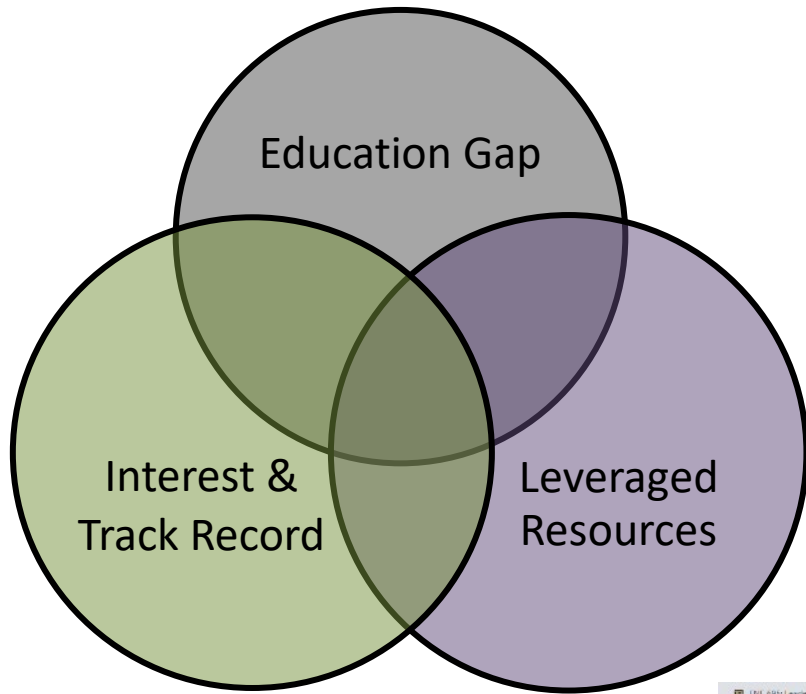


## Research Experience for Teachers for Purdue Polytechnic High School teachers

- Research mentored by grad student
- RET-produced policy module for HS





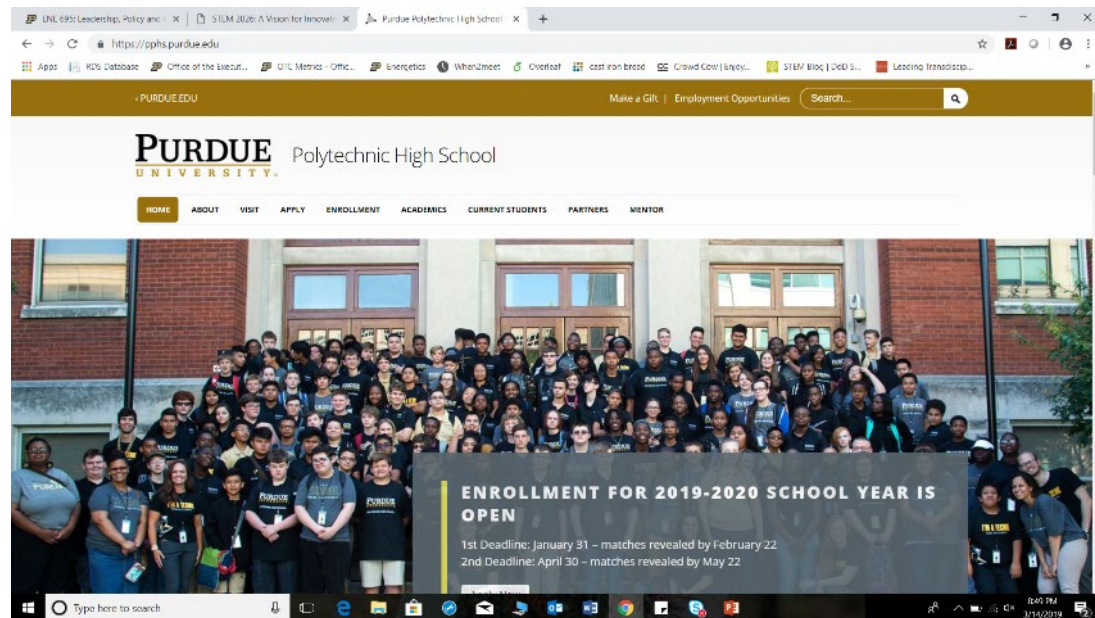


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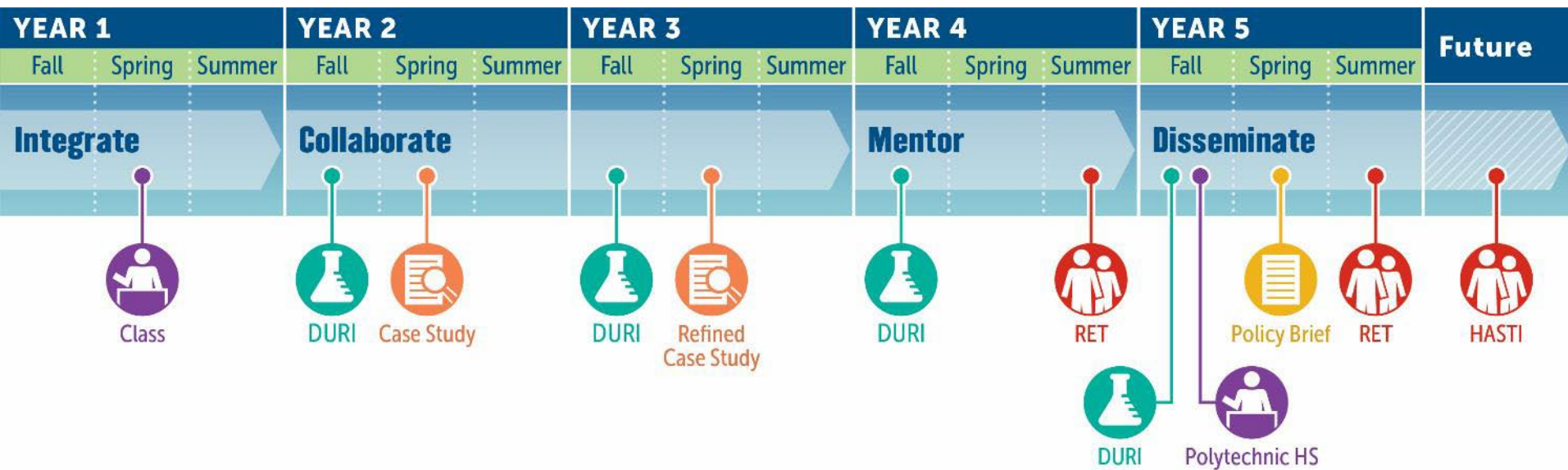
- Research mentored by grad student
- RET-produced policy module for HS

Research suggests that an interdisciplinary approach can enhance students' learning and better model STEM processes in the real world (Volmert et al., 2013, p. 5).

...active, inquiry-based experiences support students' learning and persistence in a field (Freeman et al., 2014; National Research Council, 2012a)



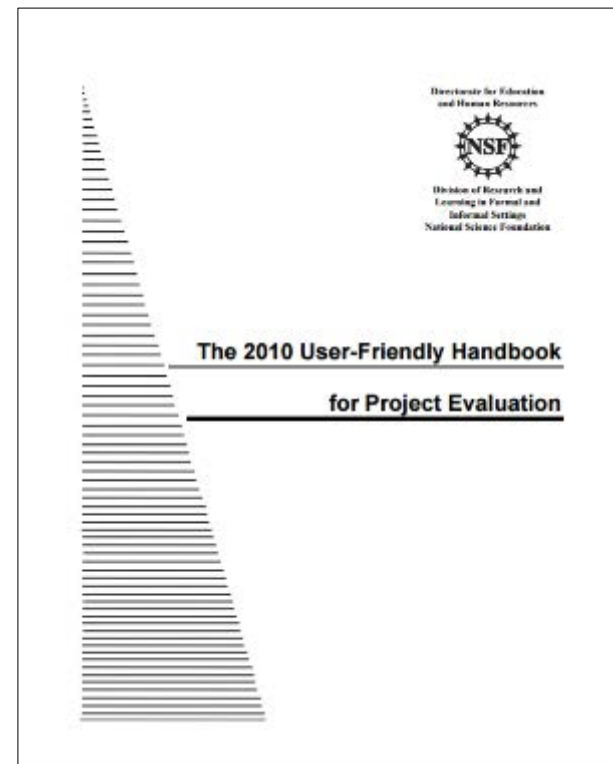
# Phased Approach



# Take Educational Assessment Seriously



*W.K. Kellogg Foundation  
Logic Model Development Guide*





# Take Educational Assessment Seriously

Consider an integrated advisory board. Need commitment letters.

## XI. PROJECT ADVISORY BOARD

Members of my CAREER Advisory Board, listed below, are experts in engineering, cognitive psychology, and innovation education. The assessment review panel will formally meet five times during the project. I will also have on-one-one meetings with my advisors when necessary throughout the project. I have already had detailed meetings with each one of them as I prepared this proposal.

**Mary Besterfield-Sacre** (*Associate Professor and Fulton C. Noss Faculty Fellow, Swanson School of Engineering, Industrial Engineering, University of Pittsburgh*): Dr. Besterfield-Sacre's research expertise includes engineering education evaluation methodologies and quality improvement in manufacturing and service organizations. She is a renowned expert in assessment and evaluation in engineering education and for her research on innovation, which has been funded by the NSF and NCIIA.

**Nathalie Duval-Couetil** (*Director, Certificate in Entrepreneurship and Innovation Program, Associate Director, Burton Morgan Center for Entrepreneurship*): Dr. Duval-Couetil has launched and currently leads Purdue's university-wide multidisciplinary undergraduate entrepreneurship program. This program has involved over 2,000 students from all majors since 2005. She also leads initiatives on leadership education for women. Dr. Duval-Couetil also has experience in market research and business strategy consulting in Europe and the United States. She will contribute to this project in significant ways through her diverse expertise and by helping recruit student participants.

**Vincent Duffy** (*Associate Professor, Industrial Engineering and Agricultural and Biological Engineering,*



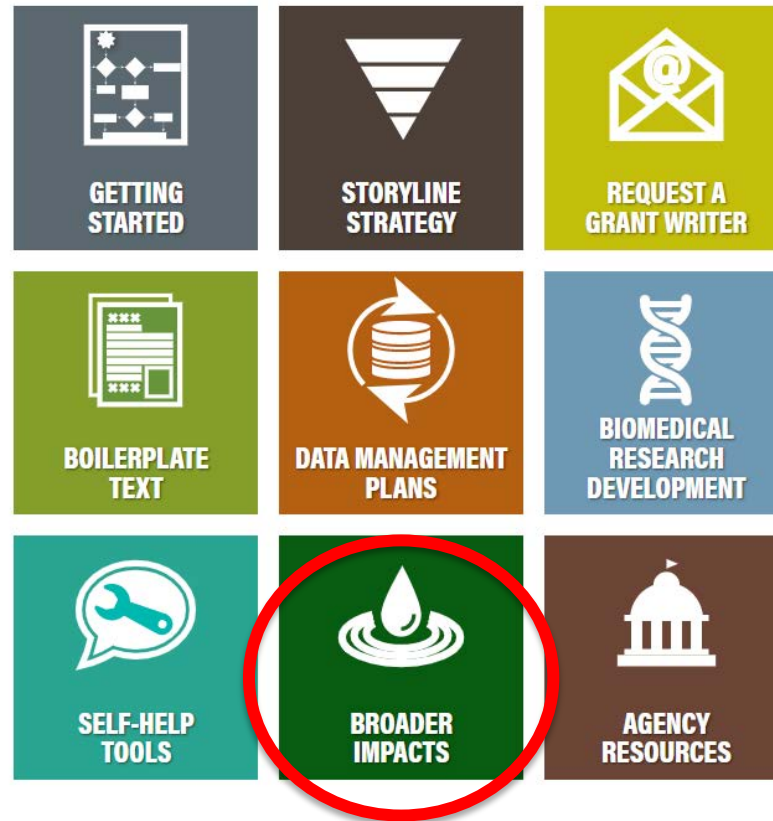
# Education and Outreach Resources



Ed Berger  
Director of Innovation Hub  
bergere@purdue.edu



Bill Bayley  
Director of Science K-12 Outreach  
wbayley@purdue.edu



OVPR Online  
Resources and  
Proposal  
Development  
Assistance

# Integrating for Broader Impacts

## What are Broader Impacts?



Broader impacts are the potential to benefit society and contribute to the achievement of specific, desired societal outcomes. They may be accomplished through:

1. the research itself
2. activities directly related to research projects
3. activities supported by and complementary to the project

A broader impact **statement** describes benefits and outcomes—not logistics.



“Cords” of research, education and outreach, and diversity-related activities integrate through your project to deliver **broader impacts**. For instance:

- Fuller Participation of Women, Persons with Disabilities, and Underrepresented Minorities in STEM
- Improved STEM Education and Educator Development
- Increased Public Scientific Literacy
- Improved Well-Being of Individuals
- Development of a Diverse, Globally Competitive Workforce
- Increased Partnerships among Academia, Industry, Government, and Non-Profits
- Improved National Security
- Increased U.S. Economic Competitiveness
- Informed Public Policy
- Enhanced Research and Education Infrastructure

(Coming Soon!)

**Example Broader  
Impact Statements  
from Funded NSF  
Proposals**

**Steps to Develop  
an Education and  
Workforce  
Development Plan**

**Tips for  
Broadening  
Participation and  
Diversity, Equity,  
and Inclusion  
Plans**



# Example Activities

What are Broader Impacts?

Steps to Develop an Education and Workforce Development Plan

Example Broader Impact Statements (login required)

Other Broader Impact Resources

Request a Broader Impact Consultation



## Fuller Participation of Women, Persons with Disabilities, and Underrepresented Minorities in STEM

Broader impacts can integrate one or multiple "cords" of research, education and outreach, and diversity activities, as mapped in examples below:

		Center thrust leadership has high percentage of women and leverages NSF-funded, campus-wide ADVANCE (Organizational Change for Gender Equity in STEM Academic Professions) initiatives for center professional development.	
		Partner with the Purdue Integrative Data Science Initiative to develop a center-focused Data Mine Learning Community that leverages Data Mine participation track record of 70% female students, 20% Black females, 1 deaf student.	
		Host lab tours for Graduate Diversity Visitation Program that sponsors 100+ URM students to campus	
		Leverage the Summer Research Opportunity Program in the Purdue Graduate School that gives priority to undergraduate students from underrepresented groups in science.	
		Partner with the Purdue Veteran Success Center to recruit two veteran STEM students for academic year research projects.	
		Develop a one-credit course <i>Leadership and Diversity in Science and Technology</i> that will raise awareness of challenges and opportunities facing diverse workplaces and build skills for fostering sensitivity and group productivity.	
		Collaborate with Women in Engineering Program to design Purdue Road School-related learning activities through demonstrations of connected vehicles and hands-on multi-modal congestion experiments that introduce middle school girls to transportation engineering careers.	
			Develop a Network for Earthquake Engineering Simulation with strong international partners that share complementary facilities, establish standards and protocols to enable cyberinfrastructure linkages, and train next-generation earthquake engineers. NEEShub accessible resources and computational infrastructure will better enable full participation of students from HBCU, MSI, and PUI institutions.
			Develop novel optical ultrafast microscope instrument through two distinct phases: (1) diverse participation and professional development in development efforts, and (2) broad access to the instrument in operation. In Phase 1, development will include underserved and minority populations recruited through the Purdue University-led NSF REU program "Analyze This!" Phase 2 will promote user-friendly and time-saving features of the novel instrument to increase access across diverse disciplinary fields as well as from primarily undergraduate institutions and public/private sector users.
			Use behavioral and MRI data to determine neurological basis of related math and reading disabilities presenting in STEM-related subjects.
		Collaborate with Deaf Kids CODE to provide workshops at Purdue for deaf middle and high school students. Participants design and 3D print mobile microrobots using the 3D printer acquired for research on microbiotic systems.	

# Education Plan Process

## Steps to an Education and Workforce Development Plan

### The Best Education and Workforce Development (EWD) Plans:

- Are tailored to the specific research
- Are sustainable and scalable
- Include the right expertise
- Leverage institutional resources
- Have rationale from the literature
- Advance diversity, equity, and inclusion when possible
- Add an appropriate budget
- Do not name partners without permission

Click each step for details.





## 1.2 Broader Impacts

**Impacts on IoT Security and Society.** Compositional reasoning in physical environments is a critical issue facing the current IoT system infrastructure. This work will provide composite system model construction tools, formal policies, verification algorithms, program analysis techniques, practices, and experience in developing safe and secure IoT systems. Success in the research activities will fundamentally alter the way IoT systems are built, and validation and testing practices are conducted. This will result in verifiably safe and secure systems and have ramifications wherever IoT devices are used (e.g., industrial control systems, manufacturing and chemical plants, smart homes). Our contributions will make certification of composable IoT environments feasible with regard to time, effort, and money; thus, they have the potential to identify design flaws that leads to dangerous system states and protect users and companies against malicious attacks. Close collaborations with manufacturing centers and industry researchers will help realize the results of this work in working IoT systems. These results will build trust in national infrastructure and protect citizens.

**Education, Outreach, and Dissemination.** PI Celik will work with K-12 teachers to develop introductory computer security modules for high school courses (Detailed in **Sec. 5**). Through these modules, high school students will gain basic computer security and secure programming skills. Such computer literacy opportunities could inform STEM career pathways but also infuse fundamental computer security awareness in the context of societal implications. By incorporating proposed research activities into grad/undergrad courses, integrating a novel secure system verification lab into his courses, and offering summer and academic year research experiences, students will solidify theoretical content with an interactive IoT simulator and testbed, and gain experience with security analysis of critical IoT infrastructure. To inform policymakers of the risks posed by the composition of IoT devices, the PI will work with the Center for Education and Research in Information Assurance and Security (CERIAS) [36] to participate in public debates/government efforts and provide technical talks for the target audience. Research results will be published in top security conferences, and tools, policies, teaching, and workshop materials will be made publicly available.

**Broadening Participation in Computing.** The PI will involve grad/undergrad students in his research activities through programming assignments, tool development, and MSc and honor theses (Detailed in **Sec. 5**). This will give them opportunities to gain the knowledge and skills required to understand the operation of (safety-critical) IoT systems, and their security analysis. These results will contribute to the creation of a workforce skilled in securing IoT and allow the deployment of increasingly trustworthy systems. To increase the participation of women, minorities, and underrepresented communities in different aspects of the project, PI Celik will leverage Purdue outreach efforts including Purdue Summer Undergraduate Research Fellowship (SURF) program and Mentors for Aspiring Girls in Computing (MAGIC) [107] to help advertise his research activities. PI Celik has also applied as a mentor for Louis Stokes Alliance Minority Participation Program (LSAMP) [126] to recruit students from racial and ethnic groups underrepresented in STEM.

Broader impacts statement is not the same as an education plan, but it synthesizes societal impacts, including from your education plan.

Berkay Celik  
Purdue 2022 CAREER Award,  
Computer Science

# Plan of Action

		By:	Mon 2/12	Mon 2/26	Mon 3/11	April				May				Mon 6/10	Mon 6/24	Mon 7/8	Mon 7/15	Mon 7/22
Phase 1: Visioning	<b>Analysis and Planning</b>																	
	Read abstracts of funded CAREERS for directorate fit and identify appropriate program/PO																	
	Notify Pre-Award Center for assigned specialist																	
	<b>Storyline Development</b>																	
	• What is the problem?																	
	• What has been done already to address this problem?																	
	• What is the gap that still remains?																	
	• How do you propose to address this gap?																	
	Map out long-term pathway and vision																	
	Research and education goals																	
Identify win themes/discriminators																		
<b>Program Officer Input</b>																		
Draft concept paper for PO																		
Concept paper reviewed internally																		
Revise concept paper																		
Email one-pager to PO/ request appt																		
Revise storyline based on PO feedback																		
Phase 2: Integration	<b>Proposed Outline</b>																	
	Develop detailed outline																	
	Identify graphics needed																	
	<b>Partnerships</b>																	
	Recruit any collaborators, if needed																	
	Recruit advisory board members, if needed																	
Identify assessment partner, if needed																		
Collect letters of commitment (TEMPLATE)																		
Request dept head letter/provide bullet points																		
Phase 3: Production	<b>Proposal Writing and Editing</b>																	
	Develop NSF bio on SciENCY to reflect research & education																	
	Use outline to write sections																	
	Edit																	
	Give near final draft to internal reviewers																	
	Revise based on review																	
	Write data management plan																	
	Complete Collaborators and Other Affiliations																	
	Write postdoc mentoring plan, if needed																	
	Write budget justification																	
	Write facilities document (use epubs)																	
	Write one-page summary																	
	Final check of references																	
Final budget & draft narrative to PreAward																		
Submit all final supplementary documents																		
Submit project narrative																		

# Tell a Compelling Story

## Four logic questions

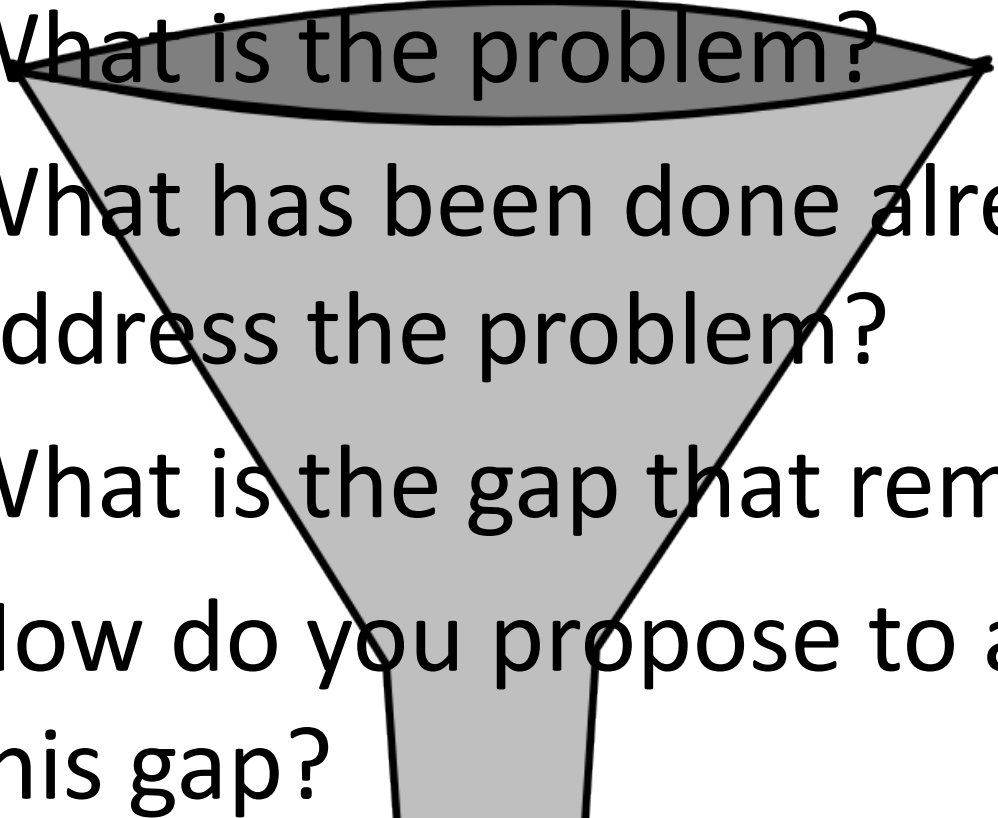
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- What is the problem?
- What has been done already to address the problem?
- What is the gap that remains?
- How do you propose to address this gap?



# Tell a Compelling Story

Logic flow goes from broad to narrower

- 
- What is the problem?
  - What has been done already to address the problem?
  - What is the gap that remains?
  - How do you propose to address this gap?



# Tell a Compelling Story

Where? Very first part of your introduction.

Despite the crucial link between engineering and innovation, research on engineering innovation education is limited. The challenge, however, is not the volume of studies on this topic but the integration and application of research. Prior studies conducted by cognitive scientists, design researchers, and business scholars highlight some of the individual characteristics important for creativity, characteristics of innovators and entrepreneurs, and the critical role of organizations in supporting innovation. However, very little is known about how engineering students approach innovation and ways to measure these processes and their outcomes. Hence, this study will examine engineering students' cognitions, motivations, and predispositions using interviews and think-aloud protocols. Their processes will then be analyzed to identify possible curricular, gender, and cultural differences among students. Senay Purzer, Engineering Education

# Tell a Compelling Story

*Sets up the logical flow and significance for your proposal. Hooks reviewer.*

In 2013, 61% of raw energy (namely, coal, natural gas, and oil) was wasted as heat because of the low efficiency of power conversion. A thermophotovoltaic (TPV) system desirable for its low maintenance and quiet, portable operation can uniquely capture this waste heat as electricity by using thermal photons (discrete units or quanta of light) whose energies match the bandgap of the photovoltaic (PV) cell. However, TPV systems emit the vast majority of thermal photons at low energies, thus greatly reducing efficiencies. To overcome this barrier, we propose to develop a highly innovative approach to TPV, which we call thermo-photonics (TPX), by redirecting thermal photons into useful energies matching the PV cell. TPX can significantly increase the efficiency of TPV converters up to 50%. What is more, this device may efficiently utilize standard silicon PV technology, thus ensuring a relatively easy transfer to commercial development when the concept is proven.

Peter Bermel, Electrical and Computer Engineering,  
2014 Purdue CAREER Awardee

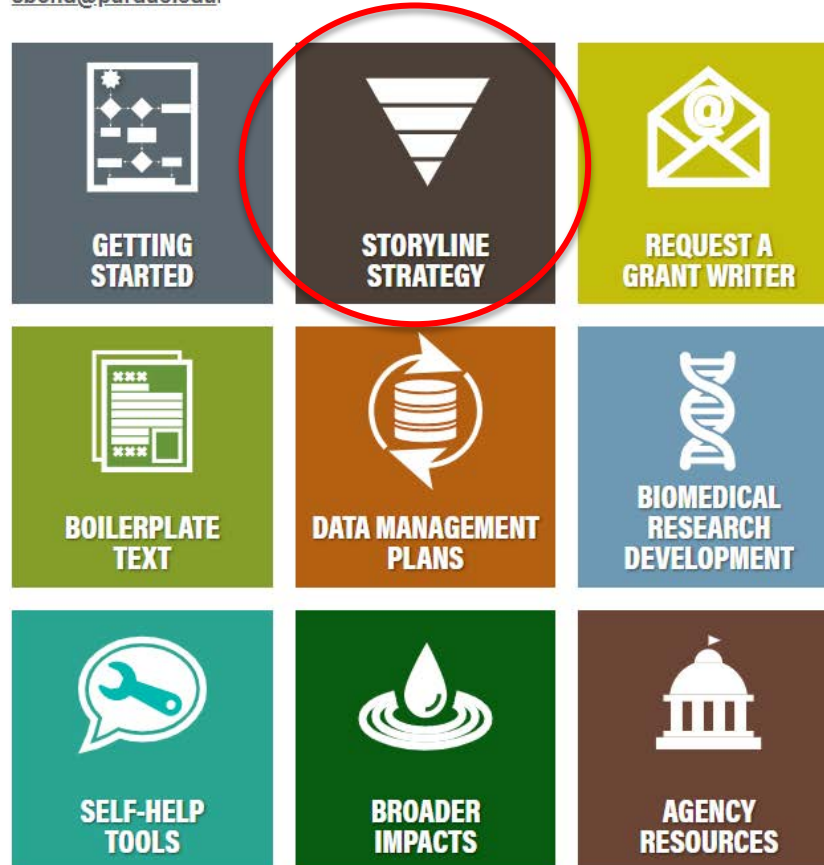
# Tell a Compelling Story

Storyline examples on website

<https://www.purdue.edu/research/funding-and-grant-writing/grant-writing-support.php>

## Grant Writing Support

Welcome to the Research Development Services grant writing support site. Here you can access resources for your proposal development as well as request hands-on help from our team of grant writers. If you have any questions, contact [sbond@purdue.edu](mailto:sbond@purdue.edu).



# Storyline is Basis for PO Discussion

## Create a one-page brief

### Preparing for a Successful Meeting with Your Program Officer

#### You are more likely to receive valuable insight into the funding potential of your idea if you follow these steps:

- Make contact early (at least several months in advance).
- Do not make a “cold call.” Email a one-page concept paper along with your agency biosketch and request a phone appointment to discuss.
- Develop your concept paper using the format below. Grant writers in the Office of Research and Partnerships can help you develop this text. Email sbond@purdue.edu to request help.

**Why a one-pager?** Distilling your ideas into a brief summary — one that starts with a compelling storyline — will best communicate project relevance, highlight the logic of your approach, and allow targeted rather than general feedback. Many program officers will not read more than one page since multiple pages represent a proposal review rather than an idea review. While you will not be told if you are “fundable,” the program officer can assess for program fit.

### For NIH Use Specific Aims Page

#### Start with storyline:

- What is the human health problem?
- What has been done already to address this problem?
- What is the gap that still exists?
- How do you propose to address this gap?

**Briefly mention why this team is ideal for the project.**

**Aim X: Use a bold, concrete objective for each aim.** Describe each aim in one to three sentences that convey why this work needs to be done as well as what and how.

**End with paragraph on expected outcomes.**

### For All Other Funding Agencies Use Concept Page

#### Start with storyline:

- What is the problem?
- What has been done already to address this problem?
- What is the gap that still exists?
- How do you propose to address this gap?

**List your goals/objectives.**

**Describe why this team is ideal for the project.**

**Overview methodology.**

**Summarize impact of your success.**



# Storyline is Basis for P0 Discussion

Create a one-page brief

**One-page** concept paper includes:

- concise storyline
- career vision/integrative goals
- brief qualifications...why you?
- overview of methodology/approach including education integration
- impact and why transformative

# Contacting Your Program Officer

Do not make a 'cold call'

- Identify your program officer
- Contact PO(s) to request phone or in person conversation
- Include:
  - one-page concept paper
  - NSF-compliant biographical sketch

# Contacting Your Program Officer

Do not make a 'cold call'

- Identify your program officer
- Contact PO(s) to request phone or in person conversation
- Include:
  - one-page concept paper
  - NSF-compliant biographical sketch
- **IN YOUR MEETING, LISTEN MORE THAN TALK**

# Questions to Ask Program Officer

Contact by middle of May at the latest. Get moving on that storyline!

Ask questions such as:

1. Does my research goal fit well with your program?
2. Is this the right scope? Do I need more preliminary data?
3. What is the typical award size?
4. What type of review? Ad Hoc or Panel?
5. What is preference for RET/REUs?



# Know Reviewing Mechanism

Ad hoc +/- Panel	Mostly Panel
GEO	ENG
BIO	CISE
SBE	HER
MPS: DHE, DMR	MPS: AST, DMS

# Always Outline before Writing

## Possible Outline for CAREER Project Description

- Use “I” instead of “we” or “our” because this is about YOUR five-year career path. (However, one-page summary is required to be third person.)
- 15 pages for project narrative
- No URLs allowed except in the references. No alt tags in references.
- Avoid passive voice whenever possible
- Include quality graphics and figures with clear captions. Do not just label but use the caption to walk the reviewers through the visual and/or provide the take away point.

### 1. Significance and Rationale (~1 page)

- Provide a compelling storyline that excites your reviewers. Use logic flow of:
  - What is the problem?
  - What has been done already to address this problem?
  - What is the gap that still remains?
  - How do you propose to address this gap?
- State your vision for how this will launch you into novel contributions in your career
  - you must be proposing novel work rather than incremental
- Include both research and education goals
- Include summary sentence on impact of your project success

### 2. Broader Impacts (at least ½ page)

- Put this section early on instead of the end. Reviewers read more carefully at outset, and this BI text builds a case for the significance of your proposed work. You want them to read it early as a lens for the rest of your proposal.
- Cover both how your project will benefit society and how you will broaden participation. Can include translational potential.
- Refer to Broader Impacts resources on the grant writing website at: <https://www.purdue.edu/research/oevpr/funding-and-grant-writing/grant-writing-support/broader-impacts.php> for BI ideas

### 3. Approach

- Provide a short paragraph overview of your research plan approach before describing details of your plan

#### 3.1 Background

- **not** a literature review. Cite key references strategically particularly in light of “what has been done already to address this problem?”

#### 3.2 Preliminary Data

- Three options for where to describe preliminary data: embedded within background section, a separate subsection such as this 3.2 (most common), or per objective.

#### 3.3 Research Objectives

- Include 2-4 sentences providing roadmap for objectives and how they integrate.

- Note: If you have any collaborators, clearly explain their roles in the appropriate section
- Note: If you will need special equipment or instruments, include text on how you will acquire these resources or gain access to existing ones, e.g. national labs

#### Objective 1/Phase 1 title

- Technical gap or research questions addressed
- Methods and procedures
- Potential problems and alternative solutions (e.g. risk mitigation)
- Expected outcomes
  - State significance

#### Objective 2/Phase 2 title

- Technical gap or research questions addressed
- Methods and procedures
- Potential problems and alternative solutions (e.g. risk mitigation)
- Expected outcomes
  - State significance

#### Objective 3/Phase 3 title

- Etc.

### 4. Integration of Education and Research [~ 3 pages long]

- State the education problem/gap you are addressing and how this motivates your plan
- Include an education goal (see section 1)
- Include a description of your preliminary work in the educational arena. Have you already revised or created a new course? Have you led a workshop for undergraduates or high school students? Include text regarding your experience and motivation.
- Activities
  - Be sure to cite key educational documents as rationale for why these activities are a best practice.
  - Be creative. If you have existing or basic educational initiatives, show how you are expanding in new ways
  - Leverage institutional resources and expertise. Do not reinvent the wheel.
  - Budget for activities. 10% is common.
- Describe how your work uniquely integrates research and education
- Include student/participant recruitment mechanisms that will ensure broad/diverse participation
- Include a clear assessment/evaluation mechanism for each activity

### 5. Prior NSF Support

- If you have received NSF funding (as PI, co-PI, senior personnel) in the past five years, you must report on one award most relevant to this CAREER proposal.

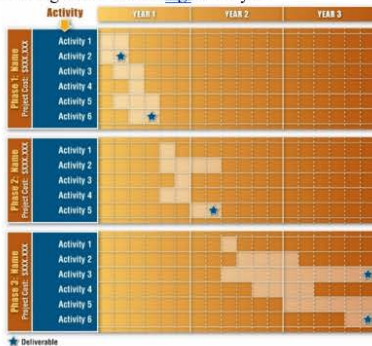
# Always Outline before Writing

- use prescribed format given in the NSF Grant Proposal Guide, especially in regard to separate subheadings of *intellectual merit* and *broader impacts* and referencing resulting products/publications from this previous award. Here is an example:

**NEES Operations** (0927178; \$81,761,788; 10/2009-9/2014), **PI: J. Ramirez**, Purdue University will lead, manage, operate, and maintain George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) with 14 earthquake engineering and tsunami experimental facilities locally operated by universities across the U.S. and NEEShub cyber platform for collaboration. **NEEShub, Intellectual merit:** NEES Community and Communication Center's four-year tenure as headquarters for NEES Operations has facilitated an unprecedented cultural change in how research is performed in earthquake engineering in a new outside-the-university collaboration model using improved data sharing capabilities and tool co-location at NEEShub. Serves as both as an intellectual and practical model for all disaster-related fields that involve distributed sites. **Broader impacts:** Diverse group of PIs and professional staff bring a new level of management innovation and capacity building to NEES network-wide operations. NEEShub provides broader access to experimental data, extensive simulation resources, and research-grade inquiry tools and streamlined data sharing capabilities. NEEShub now has 5700 registered users, thousands of data downloads from the Project Warehouse per quarter, and more than 55,000 contributors from over 182 nations. Example publications, products, tools from this effort: NEEShub platform for cyber collaboration; Buckle and Ramirez, 2010, Ramirez, 2010; and Browning et al, 2013.

## 6. Task Management

- Include a timeline of activities (research and education)
- Consider using an advisory board
  - Provide feedback on your progress and offer risk mitigation input
  - Could include representation for research, education, as well as diversity
- If you include names of people who have agreed to serve on your board, you must have letters of commitment from them
- Consider using a Gantt chart e.g. this style:



## 7. Dissemination

- For both research and education results

## 8. Career Development and Success Factors (optional)

- Could include a five-year overview of your career development and deliverables
- Briefly state where you see your teaching, research, and service in 5, 10, and 20 years
- Make a summary statement about how well-positioned you are to build on a record of success as a researcher and educator, align with institutional strategic plans, and leverage significant institutional resources
- Build a case for why you are an outstanding researcher/educator who will use this CAREER as a launching pad to potentially transformative work
- Describe how institutional capacity (infrastructure etc) is here at Purdue to help you succeed
- Describe how award will help you to collaborate better
- Describe ultimate impact on your career path and contributions to the field



# Make Good Use of Conceptual Graphics

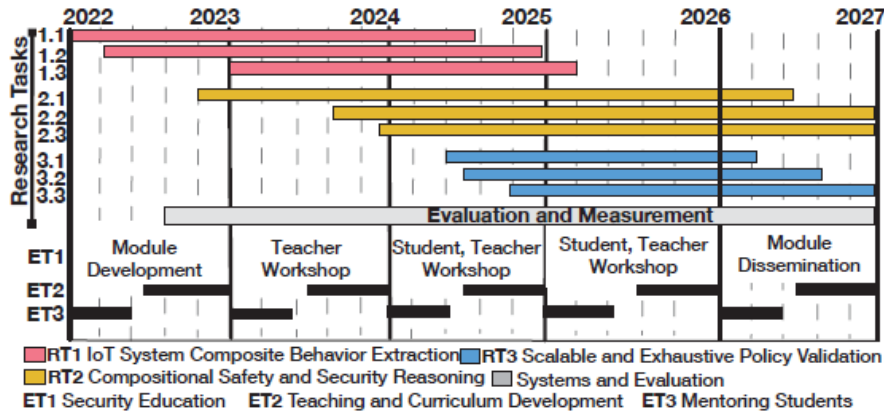


Fig. 6: Proposed Project Timeline

Berkay Celik, Purdue CAREER, CS

OBJECTIVES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<b>Bayesian Predictive Modeling of Demand-Climate Nexus</b>					
Train, test, and validate SBRVM-based predictive models					
Identify key risk factors					
<b>Hazard Risk Analytics (Development and Validation)</b>					
Heatwaves					
Droughts					
<b>Simulate Demand Evolution Under Climate and Technology Change</b>					
Simulation design, testing validation					
Response surface modeling (training, testing, and validation)					
Survey design and implementation					
Simulation-based hypothesis testing under climate, technology, and policy change					
<b>Robust Strategy Identification</b>					
Scenario-discovery and trade-off analysis					
Measuring and monitoring sustainability and resilience					
Assessments, evaluations, and visual analytics					
Robust strategy identification					
<b>Education &amp; Outreach</b>					
Duke Energy Academy at Purdue					
Engagement with Purdue Women in Engineering					
Engagement with minority-serving institutions					
Interdisciplinary course on hazard science					
Pedagogy assessment and evaluation					

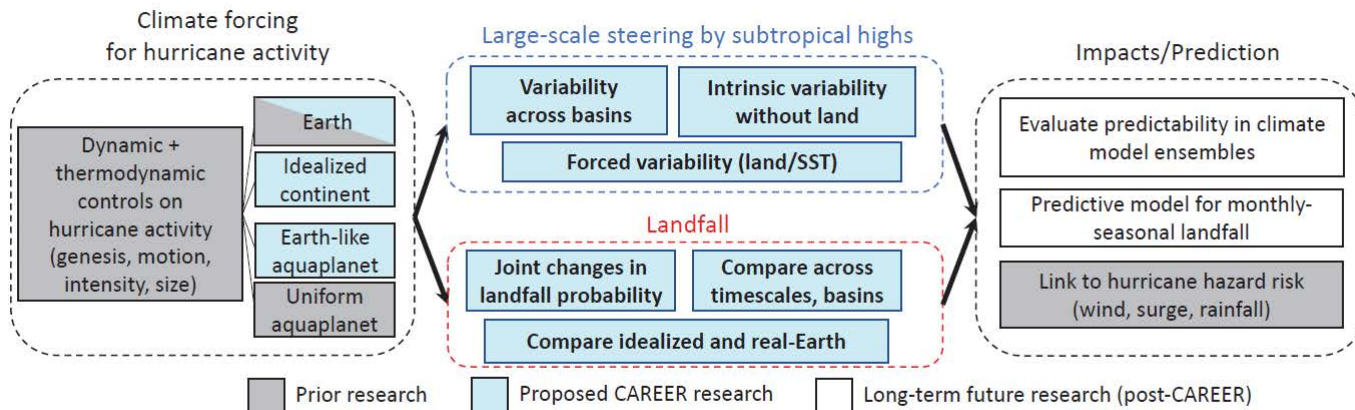


Figure 1: Schematic of the how this proposal fits into my long-term research goals.

Dan Chavas, Purdue EAPS CAREER

Roshi Nateghi,  
Civil Engineering



# Resubmission Strategy

- Take the criticism well
- Look for patterns in the comments
- If you do not agree with the technical comments, get input from research mentors
- Work with grant writers to identify and fix issues with the storyline, readability, organization and broader impacts
- Discuss planned revisions with program officer

# Top 10 CAREER Mistakes

10. Difficult to read with small fonts, illegible figures, too many acronyms
9. Unsubstantiated use of “innovative,” “novel,” “transformative”
8. Poor distinction between preliminary results and proposed work
7. Incremental research with narrow focus

# NSF Top Ten Mistakes

6. Long sentences and unclear writing
5. Too similar to PhD work
4. Business-as-usual education plan
3. Little impact in broader impacts
2. Treating as a regular proposal instead of long-term trajectory

# NSF Top Ten Mistakes

## **1. Research plan lacking cohesion**

- Collection of loosely related ideas
- No gap identified to provide rationalization

*Tell a story with your  
narrative*



Questions?