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BOARD ON SCIENCE EDUCATION

Undergraduate Research Experiences for STEM Students: Successes, Challenges, and Opportunities

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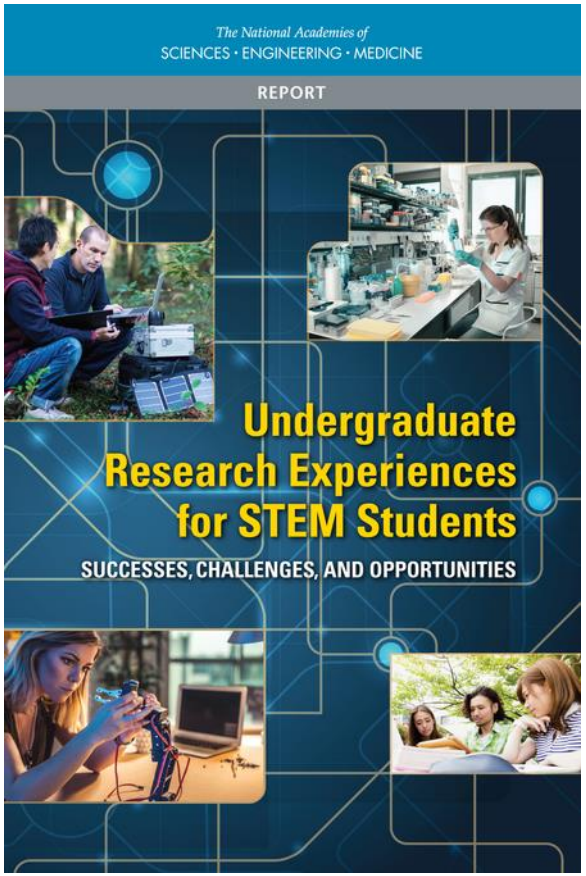

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Motivation for Study

- UREs have rich history & impact for practicing researchers
- Ongoing efforts & calls to improve STEM ed & broaden participation
  - PCAST's *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*
  - AAC&U's *High-Impact Educational Practices: What They Are, Who has Access to Them, and Why They Matter*

Study Charge

- Synthesize literature on STEM UREs
  - Including diversity of UREs & student participation
- Review evidence of benefits
- Critically assess associated costs
- Provide recommendations for research & practice
  - Considerations for design & implementation
- Discuss faculty & departmental admin needs
- Develop conceptual framework
- Create research agenda

Diversity of UREs

Recommendation: Institutions should collect data on student participation in UREs to inform planning & look for opportunities to improve quality & access.

Administrators & faculty at all types of colleges/universities should continually & holistically evaluate the range of UREs that they offer.

given variability

Conceptual Framework

- Developed to capture components that impact how UREs are designed/implemented/evaluated
  - Part 1: Goals for students & principles for design
  - Part 2: Multiple systemic factors of higher ed landscape

Goals:

- Increase participation & retention of STEM students
- Promote STEM disciplinary knowledge & practices
- Integrate students into STEM culture

Design Principles:

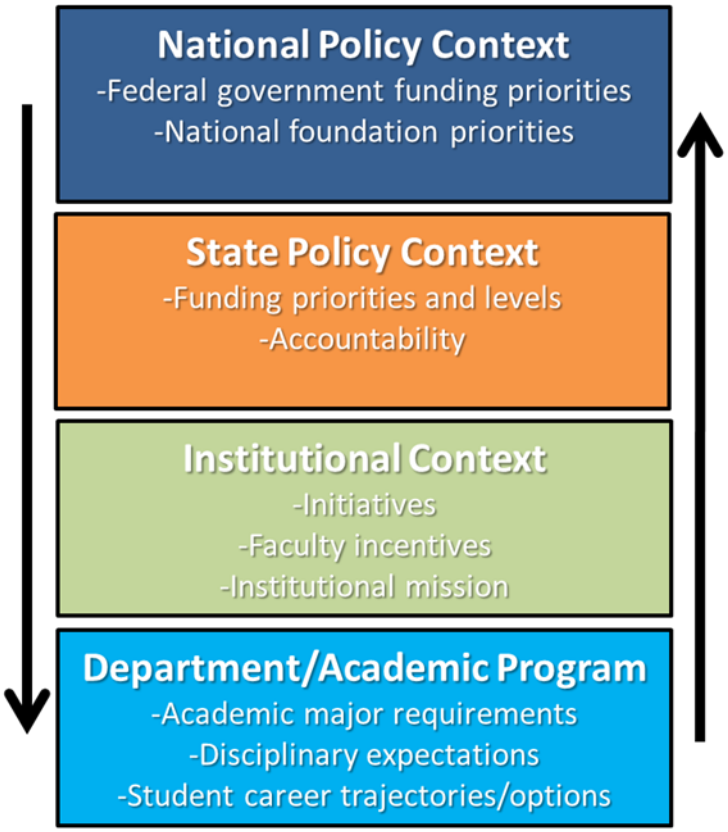
- Make STEM research accessible & relevant
- Promote Autonomy
- Learn from each other
- Make thinking visible

Conceptual Framework

Culture & values of campus, dept, discipline affect design & implementation of UREs

- Availability of funding
- Program goals & supports, including faculty needs
- Mentoring

Systemic factors of higher ed landscape



What is known about UREs

- Most studies descriptive or correlational

Recommendation: Administrators and faculty at colleges & universities should ensure that all who mentor undergraduates in UREs have access to appropriate professional development opportunities to help them grow and succeed in this role.

What is known about UREs

Recommendation: URE program directors should collaborate with education researchers to conduct well-designed studies (see Research Agenda).

Funders should provide appropriate resources to support design, implementation & analysis of URE programs specifically designed to increase evidence base.

Research Agenda

- **REC 1:** Develop & validate tools to assess student outcomes (conceptual knowledge & skills development)
- **REC 2:** Identify & measure variables that explain why specific aspects of UREs have impact (or not) on students participating in a URE
- **REC 3:** Systematically analyze characteristics of UREs & impact on different student populations
- **REC 4:** Impact of URE characteristics on faculty & mentors to understand faculty/mentor benefits
- **REC 5:** Examine specific roles of mentor & impact of mentoring relationship

Implementation of UREs

Conclusions:

Recommendation: Designers of UREs should base design decisions on sound evidence.

- May need to consult with education & social science researchers.
- Professional development materials should be created & made available to faculty.
- Educational & disciplinary societies should consider how can provide resources & connections.

- developing or refining existing programs.

Future Priorities

- Unique assets, resources, priorities, & constraints of department & institution, as well as individual mentors, impact goals & structures of UREs.
- Schools across country showing considerable creativity in using unique resources, repurposing current assets, & leveraging student enthusiasm to increase research opportunities for their students.

Designing for Sustainability

Administrators & faculty at all types of colleges/universities should work together within & across institutions to

- Create culture that supports development of evidence-based, iterative, & continuous refinement of UREs
- Include development, evaluation, & revision of policies & practices to support faculty/mentor participation
- Policies should consider pedagogy, professional development, cross-cultural awareness, hiring practices, compensation, promotion (incentives, rewards), & tenure
- Develop strong & sustainable partnerships with educational & professional societies to share resources

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