P2P Project Co-Directors:

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NSF

Prototype to Production (P2P):
Conditions and Processes for Educating the Engineer of 2020
NSF DUE-0618712
Website: http://www.ed.psu.edu/educ/e2020/p2p

THE ENGINEER OF 2020

PENN STATE

the City College of New York

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1 Study Origins: NAE's *Engineer of E2020*

A vision of the contexts for engineering in 2020:
- Dynamic technological environment
- Complex societal, global, and professional contexts

Attributes of the Engineer of 2020
- Strong analytical skills
- Practical ingenuity
- Creativity
- Communication competencies
- Business, management, and leadership skills
- High ethical standards and professionalism
- Agility, resilience, flexibility

THE ENGINEER OF 2020

2 Expected Outcomes of the P2P Study

Goals
- Provide baseline portrait of engineering education and its readiness to produce the engineers of 2020
- Identify educational practices and conditions in 2- and 4-year institutions that promote learning
- Identify learning-related differences in the experiences of women and underrepresented students
- Develop a comprehensive map of in- and out-of-class experiences influencing student learning
- Validate a conceptual model for future engineering and education studies

Use *Prototype-to-Production* Study (P2P) to:
- Provide a quantitative, nationally representative comparison for six detailed, qualitative case studies
- Triangulate findings of case studies
- Validate hypotheses regarding effective practices identified in case studies

3 Conceptual Framework

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4 Survey Development

5 Methods

Four-Year Institutions
- Population
  - All schools with at least two ABET-accredited undergraduate programs in:
    - Biomedical or bioengineering
    - Chemical engineering
    - Civil engineering
    - Electrical engineering
    - Industrial engineering
    - Mechanical engineering
- Sampling Design
  - 6 X 3 X 2 disproportional stratified random sample
    - 6 disciplines
    - 3 levels of highest degree offered (bachelor's, master's, or doctorate)
    - 2 levels of control (public or private)
  - 9 pre-selected institutions to ensure inclusion of:
    - 6 case study sites from companion study
    - 3 institutions with general engineering programs

Community Colleges
- Sampling Design
  - Purposeful selection of 15 community colleges with the largest numbers of students transferring to a four-year engineering program

6 Sample and Response Rates

P2P Participating Four-Year Institutions (n=32)

Research Institutions (n = 20)
Arizona State University (Main & Polytechnic)[1]
Brigham Young University
Case Western Reserve University
Colorado School of Mines
Dartmouth College
Howard University[1, 2]
Johns Hopkins University
Massachusetts Institute of Technology[1]
Morgan State University[2]
New Jersey Institute of Technology
North Carolina A&T[2]
Purdue University
Stony Brook University
University of Illinois at Urbana-Champaign
University of Michigan[1]
University of New Mexico[3]
University of Texas, El Paso[3]
University of Toledo
Virginia Polytechnic Inst. and State University[1]

Master's Institutions (n = 6)
California Polytechnic State University[1]
California State University, Long Beach
California State University, Los Angeles[3]
Manhattan College
Mercer University
Rose-Hulman Institute of Technology

Baccalaureate/Special Institutions (n = 6)
Harvey Mudd College[1]
Lafayette College
Milwaukee School of Engineering
Ohio Northern University
Penn State Erie, The Behrend College
West Virginia University Inst. of Technology

[1] P360 Institution
[2] Historically Black Colleges or University
[3] Hispanic-Serving Institution

P2P Participating Two-Year Institutions (n=15)
Anne Arundel Community College (MD)
Austin Community College (TX)
Borough of Manhattan Community College (NY)
Brookdale Community College (NJ)
Community College of Baltimore County (MD)
Miami Dade College (FL)
Monroe Community College (NY)
Montgomery College (MD)
Prince George's Community College (MD)
Richland College (TX)
Santa Fe College (FL)
South Texas College (TX)
Union County College (NJ)
Valencia Community College (FL)

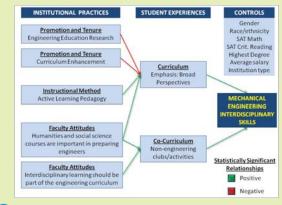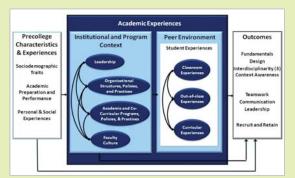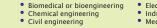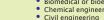|	Number of Surveys Sent	Number of Respondents	Response Rate
Associate Deans	32	29	91%
Program Chairs	125	86	69%
Faculty	2,942	1,119	38%
4-year Students	32,737	5,249	16%
Alumni	7,307	1,403	19%
CC Students	8,261	1,245	15%

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7 Sample Analysis: Interdisciplinary Skills

Variables
- Interdisciplinary Skills: how well students apply perspectives from multiple fields
- Student-reported experiences: curriculum, co-curriculum, pedagogies, climate
- Faculty-reported institutional practices: promotion/tenure, grading practices, instructional methods, attitudes toward ugrad engineering, curriculum planning

Analysis
- Multiple linear regression
  1. Relate student experiences to interdisciplinary skills (ME in this example)
  2. Relate institutional practices to significant student experiences

8 Sample Findings: Interdisciplinary Skills

This Analysis and Interpretations
- Aspects of the curriculum <u>and</u> co-curriculum contribute to interdisciplinary skills
- A greater emphasis in P&T on education research and related activities may reduce faculty time to incorporate other disciplinary perspectives in their courses
- Active learning pedagogies promote the sharing of multiple perspectives through small group activities
- Faculty attitudes toward curricular breadth affect course content and may prompt faculty to urge certain kinds of co-curricular involvement
- Significant relationships differed by engineering sub-discipline (not shown)

Future Analyses
- Follow this approach for each outcome shown in the conceptual framework

9 Research Team

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