Broadening Participation and Cultivating Success in STEM: An Ecological Approach

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AIR Symposium on Using Research to Inform Policies and Practices in STEM Education

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Let’s start with...

THE GOOD NEWS.
STEM Bachelor’s Degrees Awarded to Underrepresented Minority Men, 1990-2011

STEM Bachelor’s Degrees Awarded to Women by Race/Ethnicity, 1990-2011

Number of STEM Bachelor’s Degrees

- Black
- Latina
- American Indian/Alaskan Native
- White
- Asian/Pacific Islander

STEM Doctorates Awarded to Underrepresented Minority Men, 1990-2011

STEM Doctorates Awarded to Women by Race/Ethnicity, 1990-2011

However...

UNDERREPRESENTATION REMAINS A PROBLEM.
Percent Share of STEM Bachelor’s Degrees Earned by Underrepresented Groups, 2010

<table>
<thead>
<tr>
<th>Category</th>
<th>U.S. Population</th>
<th>All Bachelor’s Degrees</th>
<th>STEM B.S. Degrees</th>
<th>NS&amp;E B.S. Degrees</th>
<th>NS&amp;E Doctorates</th>
</tr>
</thead>
<tbody>
<tr>
<td>URM Men</td>
<td>14.5%</td>
<td>6.8%</td>
<td>7.2%</td>
<td>7.8%</td>
<td>4.9%</td>
</tr>
<tr>
<td>White Women</td>
<td>32.4%</td>
<td>36.3%</td>
<td>29.9%</td>
<td>23.1%</td>
<td>25.9%</td>
</tr>
<tr>
<td>Asian Women</td>
<td>2.5%</td>
<td>3.6%</td>
<td>4.8%</td>
<td>5.0%</td>
<td>5.2%</td>
</tr>
<tr>
<td>URM Women</td>
<td>14.5%</td>
<td>11.8%</td>
<td>10.6%</td>
<td>6.3%</td>
<td>4.5%</td>
</tr>
</tbody>
</table>

Percent Share of Bachelor’s Degrees by Gender and Race/Ethnicity in All Fields and Biological Sciences, 2010

Percent Share of Bachelor’s Degrees by Gender and Race/Ethnicity in All Fields and Chemistry, 2010

All Fields

- Female: 57%
- Male: 43%

Chemistry

- Female: 50%
- Male: 50%

Percent Share of Bachelor’s Degrees by Gender and Race/Ethnicity in All Fields and Electrical Engineering, 2010

**All Fields**
- **Female**: 57%
- **Male**: 43%
- **White**: 37%
- **Asian/Pacific Islander**: 6%
- **Black**: 4%
- **Latina/o**: 3%
- **American Indian/Alaskan Native**: 3%
- **Other/Unknown**: 4%

**Electrical Engineering**
- **Female**: 10%
- **Male**: 90%
- **White**: 55%
- **Asian/Pacific Islander**: 8%
- **Black**: 6%
- **Latina/o**: 14%
- **American Indian/Alaskan Native**: <1%
- **Other/Unknown**: 1%


Decades of efforts to broaden participation in STEM have yielded slow, but measurable change.

Progress has been uneven across STEM disciplines and institutions, and for various populations.

Do we need to alter our approach? If so, how?
Well, what have we tried?

THE APPROACH TO BROADENING PARTICIPATION IN STEM HAS EVOLVED OVER TIME.
Evolving Approaches to Broadening Participation in STEM

Why are women and minorities underrepresented among STEM degree holders and in the STEM workforce?

“Fix the Student” Perspective
Evolving Approaches to Broadening Participation in STEM

<table>
<thead>
<tr>
<th>Unprepared</th>
<th>Uninterested</th>
<th>Uninformed</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Remediate “knowledge gaps” in math and science</td>
<td>• Develop positive attitudes toward science</td>
<td>• Become more knowledgeable about STEM career opportunities</td>
</tr>
<tr>
<td>• Close the math and science achievement gap</td>
<td>• Change perceptions of scientists and engineers by finding role models/mentors</td>
<td>• Increase awareness of and application to graduate and research funding opportunities</td>
</tr>
<tr>
<td>• Complete more advanced STEM coursework</td>
<td>• Find connections between science and engineering to daily life</td>
<td></td>
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<tr>
<td>• Engage in research and hone research skills</td>
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</tr>
</tbody>
</table>

“Fix the Student” Perspective
Evolving Approaches to Broadening Participation in STEM

Why are women and minorities underrepresented among STEM degree holders and in the STEM workforce?

"Strengthen Minority Institutions" Perspective

- Lack the capacity to provide STEM education
- Lack of resources and inadequate research infrastructure

“Strengthen Minority Institutions” Perspective
## Evolving Approaches to Broadening Participation in STEM

<table>
<thead>
<tr>
<th>Lack Capacity to offer STEM Education</th>
<th>Lack of Resources and Inadequate Research Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Expand STEM academic program offerings</td>
<td>• Acquire external funding to improve research facilities</td>
</tr>
<tr>
<td>• Establish dual-degree programs with research institutions</td>
<td>• Obtain grants to provide research opportunities for faculty and students</td>
</tr>
<tr>
<td>• Improve teaching quality through training and professional development</td>
<td>• Form partnerships with research universities</td>
</tr>
<tr>
<td>• Reform STEM curriculum to increase retention</td>
<td>• Partner with industry and research institutions to provide research experiences to students</td>
</tr>
<tr>
<td></td>
<td>• Enhance research capabilities of faculty</td>
</tr>
</tbody>
</table>

“Strengthen Minority Institutions” Perspective
Evolving Approaches to Broadening Participation in STEM

Why are women and minorities underrepresented among STEM degree holders and in the STEM workforce?  

“Supporting Individuals” Perspective
Evolving Approaches to Broadening Participation in STEM

<table>
<thead>
<tr>
<th>Unsupported</th>
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<tbody>
<tr>
<td>• Encourage women and minorities to pursue STEM</td>
</tr>
<tr>
<td>• Provide underrepresented students with academic enhancement and support</td>
</tr>
<tr>
<td>• Identify mentors to provide support and guidance with career planning, publishing, and research</td>
</tr>
<tr>
<td>• Provide financial support for undergraduate and graduate education</td>
</tr>
<tr>
<td>• Encourage and facilitate community-building for underrepresented students in STEM</td>
</tr>
</tbody>
</table>

“Supporting Individuals” Perspective
Evolving Approaches to Broadening Participation in STEM

Why are women and minorities underrepresented among STEM degree holders and in the STEM workforce?

“Chilly Climate”

- Institutions lack role-models
- Exclusionary environment for STEM within higher education institutions
- Traditional ways of teaching and doing science discourage women and minorities
- Bias and discrimination

“Institutional Transformation” Perspective
Evolving Approaches to Broadening Participation in STEM

<table>
<thead>
<tr>
<th>Warming Up the “Chilly Climate”</th>
</tr>
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<tbody>
<tr>
<td>• Understand the barriers that prevent women and minorities from pursuing and succeeding in STEM within specific institutional context</td>
</tr>
<tr>
<td>• Make diversity, equity, and inclusiveness in STEM a priority among faculty, staff, and administrators</td>
</tr>
<tr>
<td>• Alter curriculum and teaching approaches to retain women and minorities</td>
</tr>
<tr>
<td>• Aggressively recruit and retain minority and women STEM faculty</td>
</tr>
<tr>
<td>• Develop, implement, and enforce policies to lessen role of discrimination and biases in admissions, hiring, and promotion/tenure processes</td>
</tr>
</tbody>
</table>

“Institutional Transformation” Perspective
So, what ought to change?

TOWARD A MORE COMPREHENSIVE APPROACH.
Broadening Participation in STEM: A Slow, Complex Process

Fix the Student  Create Opportunity

Strengthen Minority-Serving Institutions

Supporting Individuals

Institutional Transformation
A More Comprehensive Approach?

Experiences of URMs and Women in STEM

Create Opportunity

Institutional Transformation

Supporting Individuals

Strengthen Minority-Serving Institutions
Why take an Ecological Approach?

- Social science research demonstrates that educational environments and the interactions with and within that environment can promote and/or inhibit student learning and development.

Key Questions

- How do students relate to and interact with their environment (e.g., campus, social, cultural, sociopolitical, etc.)?
- What factors impact these interactions?
- And, how do these relationships impact STEM outcomes?
Elements of Ecological Systems Theory

Based on Bronfenbrenner & Crouter, 1983

Participation and Outcomes in STEM
What Accounts for Different STEM-Related Outcomes among Students in Seemingly Similar Environments?

Variability in Outcomes are a Function of Context and the Person:

• Quality, nature, and frequency of interactions with faculty and peers vary for different students.

• Different students elicit particular responses from peers, faculty, and others.

• Students derive different meanings from their environment and their interactions with that environment.

• Students differ in their views of their agency in relation to their environment.

Ecological Model of College Student Development (Renn)

**Microsystem:**
An academic, residential, extracurricular, or social setting. 
*Ex: Class, department, lab.*

**Mesosystem:**
Web of interconnected microsystems.  
*Ex: Campus culture, home life, friend group*

Some microsystems are consonant, which tend to favor development; other microsystems are dissonant with inconsistent messages, which don't favor development.

**Exosystem:**
Web of settings that affect a person, some of which do not contain the person.  
*Ex: Parents' workplace, federal policies.*

**Macrosystem:**
Overall pattern of systems of a culture.  
*Ex: Racial/ethnic and gender stereotypes, societal perceptions of science and scientists.*

Adapted from (Renn, 2004)
Going Forward...

**Key Questions**

- How do students relate to and interact with their environment (e.g., campus, social, cultural, sociopolitical, etc.)?

- What factors impact these interactions?

- And, how do these relationships impact STEM outcomes?