Celebrating Partnerships:
2015 NACME Continuum Meeting

Falls Church Marriott, Fairview Park
Falls Church, VA

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The Big Study:
Success Factors for Minorities in Engineering

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THE BIG STUDY

• Study of success factors for minorities in engineering:
  – Possible facilitative program factors
  – University environment factors
  – School adjustment factors
  – Background factors
  – Personality factors

• Seeking positive factors; ask different questions
  – Question of focus—on the positive; what works
WHY THE BIG STUDY?

• Why was it funded?
• Sparse academic literature focusing solely on engineering students
  – Lumped together with other sciences; rarely disaggregated
  – Yet, engineers said to be different
  – Driven not by need to know; but to solve problems (to do, to build, to fix, to make work)

• Existing studies:
  – Engineering personality; reputed introversion
  – Studies of learning styles suited to engineering
WHY THE BIG STUDY?

• Precious little literature on minorities in engineering, save for retention statistics

• Many negative factors:
  – High drop-out rates
  – Lack of encouragement; especially if bright
  – Need for programmatic intervention
  – Lesser cognitive development in PWIs vs. HBCUs
  – Like blacks in college in general

• Little known about Hispanic students
  – Little difference in adjustment profiles of MSIs and PWIs
PURPOSE OF THE BIG STUDY

• Fill in gaps in our understanding
• In three (3) phases—two complete
• 1) Gather institutional statistics on minority and non-minority students
  – Most effective schools in graduating minorities
  – Comparative performance of minority/non-minority
• 2) Focus groups to get to know these students
  – To design a comprehensive survey
  – Focus groups at 11 Universities with 176 students on entry into and experiences in engineering education; also 55 faculty/staff
• 3) Comprehensive on-line survey
  – To assess effects of program participation, and adjustment
I: INSTITUTIONAL STATISTICS

• Institutions asked to provide 1-year retention rates, 4 and 6-year graduation rates
• What colleges are best at graduating minorities?
• Focus on 6-Year graduation rates
• Based on 26 participating colleges
## 1. Highest 6-Year Graduation Rates: RAW RATES

<table>
<thead>
<tr>
<th>School</th>
<th>Minority</th>
<th>Non-Minority</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Georgia Tech</td>
<td>78.2%</td>
<td>82.7%</td>
<td>-4.5%</td>
</tr>
<tr>
<td>2-Virginia Tech</td>
<td>60.0%</td>
<td>67.7%</td>
<td>-7.7%</td>
</tr>
<tr>
<td>3-Missouri S&amp;T</td>
<td>56.0%</td>
<td>58.0%</td>
<td>-2.0%</td>
</tr>
<tr>
<td>4-U Colorado Boulder</td>
<td>56.0%</td>
<td>58.0%</td>
<td>-2.0%</td>
</tr>
<tr>
<td>5-U of Michigan</td>
<td>51.0%</td>
<td>79.0%</td>
<td>-28.0%</td>
</tr>
</tbody>
</table>
1. Minority vs. Non-Minority Test Scores

<table>
<thead>
<tr>
<th>Category</th>
<th>Minority</th>
<th>Non-Minority</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Students</td>
<td>1124.8</td>
<td>1210.7</td>
</tr>
<tr>
<td>African-American Males</td>
<td>1103.9</td>
<td>1213.3</td>
</tr>
<tr>
<td>African-American Females</td>
<td>1109.5</td>
<td>1210.7</td>
</tr>
<tr>
<td>Hispanic Males</td>
<td>1159.8</td>
<td>1204.9</td>
</tr>
<tr>
<td>Hispanic Females</td>
<td>1134.7</td>
<td>1213.3</td>
</tr>
</tbody>
</table>

*p < .01 for all comparisons*
## I. Highest 6-Year Graduation Rates: ADJUSTED RATES

<table>
<thead>
<tr>
<th>School</th>
<th>Minority Adjusted</th>
<th>Minority Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Georgia Tech</td>
<td>59.4%</td>
<td>78.2%</td>
</tr>
<tr>
<td>2-UT El Paso</td>
<td>53.6%</td>
<td>41.0%</td>
</tr>
<tr>
<td>3-North Carolina A&amp;T</td>
<td>52.4%</td>
<td>48.0%</td>
</tr>
<tr>
<td>4-Kettering</td>
<td>51.9%</td>
<td>48.1%</td>
</tr>
<tr>
<td>5-Missouri S&amp;T</td>
<td>49.6%</td>
<td>56.0%</td>
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</table>
I. Average 6 Year Graduation Rates

\( n = 25 \)

<table>
<thead>
<tr>
<th></th>
<th>Non-Minorities</th>
<th>Minorities</th>
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</thead>
<tbody>
<tr>
<td>Raw Rates ( p &lt; .01 )</td>
<td>50.10%</td>
<td>37.30%</td>
</tr>
<tr>
<td>Adjusted Rates NS</td>
<td>46.70%</td>
<td>40.40%</td>
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</table>
I. Raw and Adjusted Average Academic Performance

<table>
<thead>
<tr>
<th>Category</th>
<th>Non-Minorities</th>
<th>Minorities</th>
<th>Adjusted Non-Minorities</th>
<th>Adjusted Minorities</th>
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</thead>
<tbody>
<tr>
<td>GPA Adj-p&lt;.01</td>
<td>2.99</td>
<td>2.95</td>
<td>2.84</td>
<td>3.09</td>
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<tr>
<td>GPA in Math Adj-NS</td>
<td>2.76</td>
<td>2.69</td>
<td>2.61</td>
<td>2.61</td>
</tr>
<tr>
<td>GPA in Sci Adj-p&lt;.05</td>
<td>2.87</td>
<td>2.81</td>
<td>2.61</td>
<td>2.61</td>
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<tr>
<td>GPA in Engr Adj-NS</td>
<td>3.11</td>
<td>3.06</td>
<td>2.99</td>
<td>3.04</td>
</tr>
</tbody>
</table>
I. Comparative Academic Performance

• Minority test scores are lower ($p < .05$)
• With test scores matched (adjusted), differences remain; but not in **Math** or **Engineering**
• What you would expect?
  – African American students have long history of performance decrements compared to majority students
  – Interpreted as “Stereotype Threat”
  – Some evidence of it here in overall GPA & Science GPA
• Female students perform better across all groups
I. Phase 1 Success Factors

• 1) Effective programs that:
  – Not only attract good students
  – Make the most of what they get

• 2) Good verbal and analytical skills
  – AKA Better test scores
  – Help equalize academic performances
II. FOCUS GROUP CONVERSATIONS

• To get a feel for the students
• Arranged at 11 institutions
• 167 students; 55 faculty/staff
• Were videotaped
• Students are not representative; involved and known to staff
• Involved, participatory students
• Inspiring group
II. Pathways into Engineering

• Are engineers born or made?
• Are they engineers by natural inclination or can we develop them through our programmatic efforts?
• These students talk as if they were born to be engineers:
  – “I like to make things, tear them apart and put them back together.”
  – “My family is full of engineers; my father’s an engineer, my aunt is an engineer, my brother is an engineer.”
  – “I had to be a professional of some kind, due to family pressure.”
  – “I’m good at math, so engineering was a logical choice.”
• Program influence was not evident until the high school years.
II. About Math

• **Is math the limited factor for success in engineering?:**
  – “Math rules.”
  – “You have to love it.”
  – “It’s like a language that we communicate in.”
  – “Knowing I’m good at something that everyone shies away from—is good.”
  – “If you don’t love math, you probably shouldn’t be an engineer.”
  – “It’s a tool we use in all the sciences.”
  – “Behind the wall of engineering – is math.” “You can’t get away from it;”
  – “I was originally bad at it; now I like it.”
  – “It’s a love-hate thing.”
  – “Math is like an old girlfriend—just accept the fact that she will be in your life forever.”
II. Engineering School Experience

- On their instructors:
  - “Some are good; some are not”

- On prejudice and racism:
  - “We know it’s out there”
  - “It just makes us work harder”
  - “Here (at an HBCU) they try to prepare us for the realities”

- On gender issues:
  - Women go on record to document being ignored, etc.

- On working together:
  - “We help each other”
  - “There’s plenty of help for any one who needs it”
  - Advice to new students: “Network;” “Form study groups”

- Are they introverted? --Not with each other

- Goals—to graduate
II. Phase 2A Success Factors

• Success according to students:
• 1) Skill in math—the basic lingua franca
• 2) Problem-solving mentality
  – Treats failure, racism, poor instructors as just another problem to solve
• 3) Group work
  – Study groups
  – Reliance on one-another
III. FOCUS GROUP MINI-SURVEYS

• Focus group discussions can be dominated by strong personalities
• Mini-surveys allow all individuals to voice opinions
• Students responded to four (4) questions:
  – first 3 were open-end (requiring content analysis);
  – 4th requiring assessments of program component experience
III(1). How Did You Become Interested In Engineering?

• Major pathways into engineering:
  – 1) Skill in mathematics – 38%
  – 2) Love of science – 34%
  – 3) Family influence – 21%

• Noteworthy:
  – Pre-college experience – 19%
  – Like to make, fix, tear apart, put back together – 17%
III(1). Pathways into Engineering: Focus Group Mini-Survey

- Math Skill: Students 38.00%, Faculty 32.00%
- Love of Science: Students 34.00%, Faculty 17.00%
- Family Influence: Students 21.00%, Faculty 15.00%
- Pre-College Experience: Students 19.00%, Faculty 15.00%
- Making/Fixing Things: Students 17.00%, Faculty 0.10%
III(2). What Does It Take To Succeed In Engineering?

• Student responses:
  – 1) Dedication & motivation to succeed – 48%
  – 2) Work hard; put in the effort – 30%
  – 3) Network – 30%

• Faculty/Staff responses:
  – 1) Network – 30%
III(3). What Advice Would You Give to Incoming Minority Students?

• Student responses:
  – 1) Focus – 31%
  – 2) Network – 30%
  – 3) Be dedicated; stay motivated – 18%
III(3). Advice to Incoming Minority Students

- Focus: 31.00% (Students), 17.90% (Faculty/Staff)
- Network: 30.00% (Students), 47.80% (Faculty/Staff)
- Dedication/Motivation: 18.00% (Students), 17.40% (Faculty/Staff)
- Campus Involvement: 17.00% (Students), 17.40% (Faculty/Staff)
- Use Resources: 17.00% (Students), 23.90% (Faculty/Staff)
III(4). Assessments of Program Component Experience
IV. FOCUS FROUP MINI-SURVEY RESPONSES BY STUDENT SUCCESS

• Measures of Student Success
  – 1. Reported GPA
  – 2. Classification – Year – Longevity
  – 3. Average Test Scores for the Institution
  – 4. Average 6-Graduation Rates for the Institution
# IV. Mini-Survey Success Factors

<table>
<thead>
<tr>
<th>Factor 1:</th>
<th>Hands-On/Experience Based Program Components</th>
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<tbody>
<tr>
<td>Internship Evaluation</td>
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<tr>
<td>Project/Problem Based Courses Evaluation</td>
<td>.700</td>
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<tr>
<td>Research Experience Evaluation</td>
<td>.699</td>
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<table>
<thead>
<tr>
<th>Factor 2:</th>
<th>Desire for the Opportunities in Engineering</th>
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<tbody>
<tr>
<td>Q2_Desire</td>
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<tr>
<td>Q1_Opportunities</td>
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<table>
<thead>
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<th>Factor 3:</th>
<th>Use Available Resources</th>
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<tr>
<td>Q3_(Use) Resources</td>
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<tr>
<td>Q2_(Use) Resources</td>
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<th>Factor 4:</th>
<th>Dedication vs. Time Management</th>
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<tbody>
<tr>
<td>Q3_Dedication/Motivation</td>
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<tr>
<td>Q3_Time_CW</td>
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<th>Factor 5:</th>
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<tr>
<td>Q2_Programs</td>
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### IV. Ethnic/Gender Mini-Survey

**Success Factor:**

**Psychological Resilience**

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<th>Factor</th>
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<tr>
<td>Factor 1:</td>
<td>Right Mindset</td>
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<td>Q3 (Right) Personality/Lifestyle</td>
<td>.826</td>
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<tr>
<td>Q3_Believe in Yourself _ CW</td>
<td>.765</td>
</tr>
</tbody>
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CONCLUSIONS:
Success Factors So Far

• From institutional statistical analyses:
  – Verbal & Analytical Reasoning
  – Being in effective program: NCAT; Kettering

• From Focus group conversations:
  – Skill in math
  – Problem-solving mentality
  – Group-work, including study groups, networking

• From focus group mini-survey regression analyses:
  – Hands-on, experience-based program components
  – Psychological resilience