Student Success Strategies in STEM Fields as a Diversity Practice

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August 14, 2013
STREAMS: NSF STEP Grant
DUE-0969109

• **ST**udent
• **R**etention
• **E**nhancement
• **A**cross
• **M**athematics &
• **S**cience
• 5 years, $1 million, May 2010-2015

PAL Colin Gregory (left) explaining some details in studio physics.

Leading for Change: Diversity Practices in Higher Ed
Session Goals

• Discuss a range of initiatives related to student success, what has been learned at BSU

• Help conference participants reflect on the underlying structures of their local academic & support programs as they relate to success of a diverse range of students
STREAMS GRANT

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STREAMS Goal:
Improve Retention of Science & Math majors so that more students will graduate.

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STEM Student Retention: The Problem (2009 Data)

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Multi-approach, Best Practices, Implementation, Assessed=yes

- Summer Bridge – Incoming Freshmen
- Course Pedagogy
- Structured Learning Assistance – key gateways
- Residential Learning Community
- Transfer Advising, local CC
- Mentoring
PERSONAL MOTIVATIONS

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Reflection 1: Untapped Resources

• Who are faculty and staff at my institution not currently involved in diversity work who would be motivated to join?

• What explicit and implicit incentives and disincentives are in place at my institution?
Intervention Strategies

- Proven Strategies Underserved Students
- Proven STEM Strategies

Nearly Total Overlap

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Guiding Principles

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Guiding Principles

• Inquiry-based learning
• Small groups, senior undergraduate peer-led
• Every student participates
• Focus on learning, not on skill deficits
• Connect new students to departments (upper-level students, faculty, staff) both socially & academically
Faculty have to own it.

If a large number of students are not passing my class, it is my responsibility to change the learning environment.

I have to teach the students I have in front on me, not the students I wish I had in front of me.

If my department is bleeding away majors, then we have a responsibility to investigate and maybe to take action changing the curriculum.
PROGRAM COMPONENTS

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Summer Bridge

Designed for 16 incoming freshmen STEM majors.

• Residential, 3 week program
• Complete 2 college courses
  • Writing Intensive First Year Seminar (Scientists at Work)
  • Integrated Science & Math (some calculus, some pre-calculus – applied mathematics)

Early Undergraduate Research:

Participants complete about 40 hours of research, with a faculty and peer mentor

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Summer Bridge Research

• Biology
  – Methanogenic Bacteria in Goats
  – Triclosan Exposure & Bacteria
  – Ankle Angle in Sprints

• Chemistry
  – Biodiesel & Green chem
  – Organophosphorus (OP) pesticides

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More Summer Bridge Research

- **Math**
  - GIS Modeling for Bus Routes
  - Logarithmic Spirals & MC Escher

- **Physics**
  - Transits of Exoplanets
  - Solar Variability
  - Asteroid Rotations

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### Summer Bridge Surveys

#### Percentage of Summer Bridge Participants who Agree or Strongly Agree with Each LEARNING Statement

<table>
<thead>
<tr>
<th>Statement</th>
<th>% Agree or Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I learned some material in science and/or math that was new to me.</td>
<td>100%</td>
</tr>
<tr>
<td>I improved my ability to attack problems in science and math.</td>
<td>81%</td>
</tr>
<tr>
<td>I improved my ability to think critically.</td>
<td>88%</td>
</tr>
<tr>
<td>I improved my writing skills.</td>
<td>81%</td>
</tr>
<tr>
<td>I improved my lab skills.</td>
<td>81%</td>
</tr>
<tr>
<td>I gained a clearer understanding of the work that scientists and mathematicians do.</td>
<td>88%</td>
</tr>
<tr>
<td>I learned to use what I already knew in some practical ways.</td>
<td>81%</td>
</tr>
<tr>
<td>I improved my time management.</td>
<td>81%</td>
</tr>
<tr>
<td>This program made me think about learning in new ways.</td>
<td>81%</td>
</tr>
<tr>
<td>I improved my ability to work as a member of a team.</td>
<td>75%</td>
</tr>
<tr>
<td>I improved my ability to work with people who are very different from me.</td>
<td>75%</td>
</tr>
</tbody>
</table>
Summer Bridge Focus Groups

• “The course instructors made me examine my values by prodding me to put meaningful effort into my work rather than drivel.”

• “This experience and the people I have met has helped me to realize that there is more than just what I have seen out there and more to learn about college.”
• “It helped me get a grasp on the differences between high school work and college work. It's been a really great experience for me and I definitely want to try to be a mentor or and RA for next year!”

• **What differences do you see in yourself over these three weeks?**
  – “When I first came here I felt stupid. I felt that my high school did not prepare me and now I feel more confident.”
Background Numbers: BSU STEM Retention

- 20% of full-time, first time STEM majors do not return to BSU for a second year
- About 55% of FT-FT STEM majors remain in STEM after 1 year
- About 40% of FT-FT STEM majors remain in STEM after 2 years

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Characteristics of Summer Bridge Students

- 16 of 47 students were students of color
- 25 of 47 students were women
- Average SAT = 1056
- 20 of 47 students placed into pre-calculus
- 7 of 47 students placed into Targeted Writing I
Summer Bridge Retention


• 47 total students in 2010, 2011, 2012
• 31 total students in 2010 & 2011 cohorts
• 85% remain in STEM after 1 year
• 81% remain in STEM after 2 years

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Grades / Credits / Leadership

• Higher GPA
• More credits earned after 1 & 2 years
• More STEM courses passed after 1 & 2 years
• Large presence in leadership roles in departments / colleges
• Large presence in undergraduate research
Residential Learning Community

• Began in 2011-2012 AY
• Better grades
• Slightly higher retention
• 40 first year STEM majors
• 6-10 upper level STEM majors
• Special Programs, study, focus

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<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree nor Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The RLC significantly aided me in learning science and mathematics in introductory course.</td>
<td>40%</td>
<td>26%</td>
<td>17%</td>
<td>11%</td>
<td>6%</td>
</tr>
<tr>
<td>The RLC has been influential in my remaining a science or math major.</td>
<td>34%</td>
<td>31%</td>
<td>17%</td>
<td>14%</td>
<td>3%</td>
</tr>
<tr>
<td>The RLC has helped me be more successful as a science or math major.</td>
<td>43%</td>
<td>29%</td>
<td>11%</td>
<td>11%</td>
<td>6%</td>
</tr>
</tbody>
</table>
More RLC Survey Results

Table 4

Percentage of participants who *Agree or Strongly Agree* with each of the following Statements regarding General impact of the program

<table>
<thead>
<tr>
<th>Statement</th>
<th>% Agree or Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compared to when I entered BSU, I now have greater confidence in my academic abilities.</td>
<td>65</td>
</tr>
<tr>
<td>Compared to when I entered BSU, I now have greater confidence in myself socially.</td>
<td>82</td>
</tr>
<tr>
<td>This year has changed me in a positive way.</td>
<td>86</td>
</tr>
<tr>
<td>We have developed our own way of doing things as part of the science and math learning community.</td>
<td>59</td>
</tr>
<tr>
<td>I gained important knowledge related to my major.</td>
<td>77</td>
</tr>
<tr>
<td>I came into the year with basic knowledge in my major, but I learned to think about it in new ways.</td>
<td>94</td>
</tr>
<tr>
<td>I came into the year with basic knowledge in my major, but I learned to use it in some practical ways.</td>
<td>82</td>
</tr>
<tr>
<td>This year as a math or science major at BSU has been intense.</td>
<td>77</td>
</tr>
</tbody>
</table>
Transfer Student Work

• Partner with Cape Cod Community College and Massasoit Community College
  – Course development grants at the CC level to create / implement new courses to aid is smooth transfer
  – Local visits / better advising

• Transfer Advising Working Group at BSU
BSU Transfer Guidelines (All Departments)

**Physics BA or BS Programs:**

To transfer to BSU as a sophomore you will need to have completed the following courses. This should allow graduation with a BA or BS in **three years**:  
• General Physics I and II (PHYS 243 and 244) - Calculus Based.  
  NOTE: Algebra based physics is NOT acceptable – make sure the course you take is calculus based and equivalent to PHYS 243 and 244, not PHYS 181 and 182.  
• Single Variable Calculus I & II (MATH 161 and 162).  
  NOTE: Elements of Calculus I and II (MATH 141 and 142) are NOT acceptable. Ensure the course you take is equivalent to MATH 161 and 162.

To transfer to BSU as a junior you will need to have completed the following courses. This should allow for graduation with a BA or BS in **two years**:  
• General Physics I and II (PHYS 243 & 244) - Calculus Based.  
• Single Variable Calculus I & II (MATH 161 and 162).  
• Chemical Principles I and II (CHEM 141 and 142).  
• Calculus III and Differential Equations (MATH 261 and 316) BS DEGREE ONLY.  
• If possible, take Modern Physics PHYS401 through SACHEM.
Mentoring

• Formal program
  — Failure!
  — Student time constraints
  — Existing 1st Year Advising
  — Lack of dedicated focus
  — (See Northeastern for positive program)

• Informal working
  — PALs, RLC, etc.

Physics major Tyler Holloway (red) with summer bridge students.
Development & Structured Learning Assistance

COURSE STRUCTURES

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Google search on “lecture class”

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STREAMS Learning Approach

**Course Development Grants**
- Design different approach for their class
  - Small group
  - Inquiry
  - Writing-to-learn, Writing-Across-the-Curriculum
  - Inclusiveness
  - Flipped Classrooms
- Sharing Opportunities

**Structured Learning Assistance**
- Departmental designed
  - Undergrad peer-led
  - Generally required for all students
  - Small groups of 6-8 students
  - Structured activities written by faculty
  - Range of models
- Collect lots of data

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• **Biology 121** (bio & some chem)  
  – 142 students in fall 2012

• **Chemistry 141 & 142** (chem, bio & physics)  
  – 316 students in fall 2012 & spring 2013

• **Computer Science 151** (comp sci & some math)  
  – 178 students in fall 2012 & spring 2013

• **Math 150** (math, physics & some chem) – NEW!  
  – 126 students in fall 2012 & spring 2013

• **Math 161** (math, physics & some chem)  
  – 188 students in fall 2012 & spring 2013

• **Physics 243 & 244** (physics, chem & some math)  
  – 107 students in fall 2012 & spring 2013

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Scale

• Five Departments involved – about 18 faculty directly teaching classes involved
• Supports ~ 1500 enrolled students per year
• Nearly 100% participation (mandatory co-registration)
• BSU College of Science and Mathematics enrollment is about 1100 majors
• ~ 45 paid senior undergrads

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Why Successful? Faculty Involvement

- Martina Arndt
- Chris Bloch
- Darcy Boellstorff
- Jeff Bowen
- Ed Brush
- Hang-Ling Chang
- Bob Cicerone
- Chadi El Kari
- Dick Enright
- Paul Fairbanks
- Laura Gross
- Steve Haefner
- James Hayes-Bohanon
- Ward Heilman
- Joe Hernandez
- Seikyung Jung
- Steve Kaczmarek
- Annela Kelly
- Jamie Kern
- Tammy King
- Thomas Kling
- Meredith Krevosky
- Mike Krol
- Michael Leen
- Shannon Lockard
- Samer Lone
- Borianna Marintcheva
- Jenna Mendell
- Timothy Mitchell
- Chifuru Noda
- Laura Norman
- Don Padgett
- Glenn Pavliceck
- Jonathan Roling
- Polina Sabinin
- Peter Saccocia
- Matt Salomone
- John Santore
- Abdul Sattar
- Irina Seceleanu
- Uma Shama
- Steve Waratuke
- Jeff Williams

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## Data Table

<table>
<thead>
<tr>
<th>Course</th>
<th>Semesters before/after</th>
<th>N before SLA</th>
<th>N after SLA</th>
<th>DFWI % before</th>
<th>DFWI % after</th>
<th>AB % before</th>
<th>AB % after</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio 121</td>
<td>Fall 08,09 / Fall 10,11,12</td>
<td>196</td>
<td>386</td>
<td>30.6%</td>
<td><strong>15.8%</strong></td>
<td>41.3%</td>
<td><strong>54.9%</strong></td>
</tr>
<tr>
<td>Chem 141</td>
<td>Fall 09,10 / Fall 11, Spring 12, Fall 12</td>
<td>267</td>
<td>363</td>
<td>37.8%</td>
<td><strong>20.1%</strong></td>
<td>42.3%</td>
<td><strong>59.0%</strong></td>
</tr>
<tr>
<td>Chem 142</td>
<td>Spring 10,11 / Fall 11, Spring 12,13</td>
<td>217</td>
<td>304</td>
<td>29.5%</td>
<td>24.3%</td>
<td>44.2%</td>
<td><strong>53.3%</strong></td>
</tr>
<tr>
<td>Math 151/161 (fall)</td>
<td>Fall 09,10 / Fall 11, 12</td>
<td>284</td>
<td>215</td>
<td>39.8%</td>
<td><strong>28.4%</strong></td>
<td>42.6%</td>
<td><strong>54.4%</strong></td>
</tr>
<tr>
<td>Math 151/161 (spring)</td>
<td>Spring 10,11 / Spring 12,13</td>
<td>262</td>
<td>164</td>
<td>24.4%</td>
<td>19.5%</td>
<td>52.3%</td>
<td>54.9%</td>
</tr>
<tr>
<td>Physics 243</td>
<td>AYs 09-10, 10-11 / AYs 11-12, 12-13</td>
<td>162</td>
<td>115</td>
<td>43.2%</td>
<td><strong>25.2%</strong></td>
<td>32.1%</td>
<td><strong>47.0%</strong></td>
</tr>
<tr>
<td>Physics 244</td>
<td>Fall 09-Fall10 / Spring 11-13</td>
<td>68</td>
<td>111</td>
<td>38.2%</td>
<td><strong>15.3%</strong></td>
<td>33.8%</td>
<td><strong>59.5%</strong></td>
</tr>
<tr>
<td>Comp 151</td>
<td>Fall09-Fall11 / Spring 12-13</td>
<td>365</td>
<td>257</td>
<td>38.1%</td>
<td>41.6%</td>
<td>44.1%</td>
<td>42.0%</td>
</tr>
<tr>
<td>Math 150</td>
<td>AY 11-12 / AY 12-13</td>
<td>152</td>
<td>126</td>
<td>32.9%</td>
<td><strong>23.8%</strong></td>
<td>46.7%</td>
<td><strong>58.7%</strong></td>
</tr>
</tbody>
</table>

Items in **bold red** are statistically significant changes at $p < 0.01$. (The null hypothesis that SLA made no difference in the DFWI % or AB % fails at $p < 0.01$.)

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AB Rate, STREAMS SLA Supported Courses

Leading for Change: Diversity Practices in Higher Ed
<table>
<thead>
<tr>
<th>To date, <strong>221</strong> fewer D, F, W, or I grades were assigned since SLA began.</th>
<th>To date, <strong>229</strong> additional grades of A or B have been earned since SLA began.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each year, <strong>107</strong> fewer DFWI grades are assigned because of SLA.</td>
<td>Each year, <strong>110</strong> additional grades of A or B are earned because of SLA.</td>
</tr>
</tbody>
</table>

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Fall 2011 to 2012 retention by course grade

<table>
<thead>
<tr>
<th>Course (Fall 2011)</th>
<th>Overall Retention of Majors</th>
<th>B- or better</th>
<th>C- or better</th>
<th>D, F, W, I</th>
<th>DFWI Rate for Majors</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 121</td>
<td>72%</td>
<td>87%</td>
<td>77%</td>
<td>39%</td>
<td>18%</td>
</tr>
<tr>
<td>CHEM 141</td>
<td>74%</td>
<td>84%</td>
<td>83%</td>
<td>25%</td>
<td>11%</td>
</tr>
<tr>
<td>MATH 161</td>
<td><strong>60%</strong></td>
<td>87%</td>
<td>78%</td>
<td>8%</td>
<td><strong>26%</strong></td>
</tr>
<tr>
<td>PHYSICS 243 / 244</td>
<td>73%</td>
<td>75%</td>
<td>80%</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>COMP 151</td>
<td>46%</td>
<td>62%</td>
<td>63%</td>
<td>15%</td>
<td><strong>35%</strong></td>
</tr>
<tr>
<td>Total</td>
<td>65%</td>
<td>82%</td>
<td>76%</td>
<td>27%</td>
<td>22%</td>
</tr>
</tbody>
</table>
More Details, Biology 121

- First to implement SLA
- Cleanest change – lecture remains same, added SLA
- SLA is 75 minute, group of 8, peer-led SLA
- Some focus on note-taking

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# Biology 121 Student Population

<table>
<thead>
<tr>
<th></th>
<th>Fall 2008</th>
<th>Fall 2009</th>
<th>Fall 2010</th>
<th>Fall 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enrollment</strong></td>
<td>89</td>
<td>107</td>
<td>109</td>
<td>135</td>
</tr>
<tr>
<td><strong>Biology Majors and (%)</strong></td>
<td>62 (70%)</td>
<td>80 (75%)</td>
<td>74 (68%)</td>
<td>102 (76%)</td>
</tr>
<tr>
<td><strong>Incoming SAT-Math 25% - 75% quartiles</strong></td>
<td>480-560</td>
<td>470 – 580</td>
<td>460-580</td>
<td>460-550</td>
</tr>
<tr>
<td><strong>Women and (%)</strong></td>
<td>60 (67%)</td>
<td>67 (63%)</td>
<td>73 (67%)</td>
<td>84 (62%)</td>
</tr>
<tr>
<td><strong>First-Time, Full-Time Freshmen and (%)</strong></td>
<td>52 (58%)</td>
<td>67 (63%)</td>
<td>57 (53%)</td>
<td>85 (63%)</td>
</tr>
<tr>
<td><strong>Minority and (%)</strong></td>
<td>12 (13%)</td>
<td>26 (24%)</td>
<td>25 (23%)</td>
<td>42 (31%)</td>
</tr>
</tbody>
</table>
# DFWI Rates: Biology 121

<table>
<thead>
<tr>
<th></th>
<th>N (pre / post SLA)</th>
<th>DFWI % Drop</th>
<th>AB % Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Students</td>
<td>(196/244)</td>
<td>13.4%</td>
<td>13.2%</td>
</tr>
<tr>
<td>Men</td>
<td>(69/87)</td>
<td>9.7%</td>
<td>17.4%</td>
</tr>
<tr>
<td>Women</td>
<td>(127/157)</td>
<td>15.4%</td>
<td>10.8%</td>
</tr>
<tr>
<td>Students of Color</td>
<td>(38/67)</td>
<td>8.9%</td>
<td>-0.6%</td>
</tr>
<tr>
<td>Biology Majors</td>
<td>(142/176)</td>
<td>10.12%</td>
<td>13.27%</td>
</tr>
<tr>
<td>Freshmen</td>
<td>(119/142)</td>
<td>12.08%</td>
<td>11.48%</td>
</tr>
</tbody>
</table>

In bold red, changes significant at the p < 0.05 level.

The low number of men and students of color reduces the significance in the DFWI reduction.

The performance of students of color remains a concern.
Relationship with SAT – POST-SLA

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Relationship with SAT – PRE-SLA

![Graph showing the relationship between SAT scores and retention rates before SLA. The graph includes two lines: one for % retained 1 yr above SAT score before SLA (in blue) and another for % retained 2 yr above SAT score before SLA (in red).]

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2 Year Retention Before and After

% Retained

- % retained 2 yr above score after SLA
- % retained 2 yr above SAT score before SLA

SAT Above

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Some comments . . .

- Technology is making it easier to move away from large lecture sections.
- POGIL – Process Oriented Guided Inquiry Learning – see Dr. Chris Bauer at Univ. of New Hampshire for a way to do inquiry within large sections.
- Does your university promote group study?
Before Questions, Reflection 2

Please take some time to talk with the colleagues from your institution. Consider discussing

• Where do students at my institution do the hard work in their classes? What support do they have during this time?

• What structures at my institution promote teaching in an interactive manner?