# Student Success Strategies in STEM Fields as a Diversity Practice


Dr. Thomas P. Kling

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BRIDGEWATER STATE UNIVERSITY

Leading for Change: Diversity Practices in Higher Ed

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# 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.

# 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

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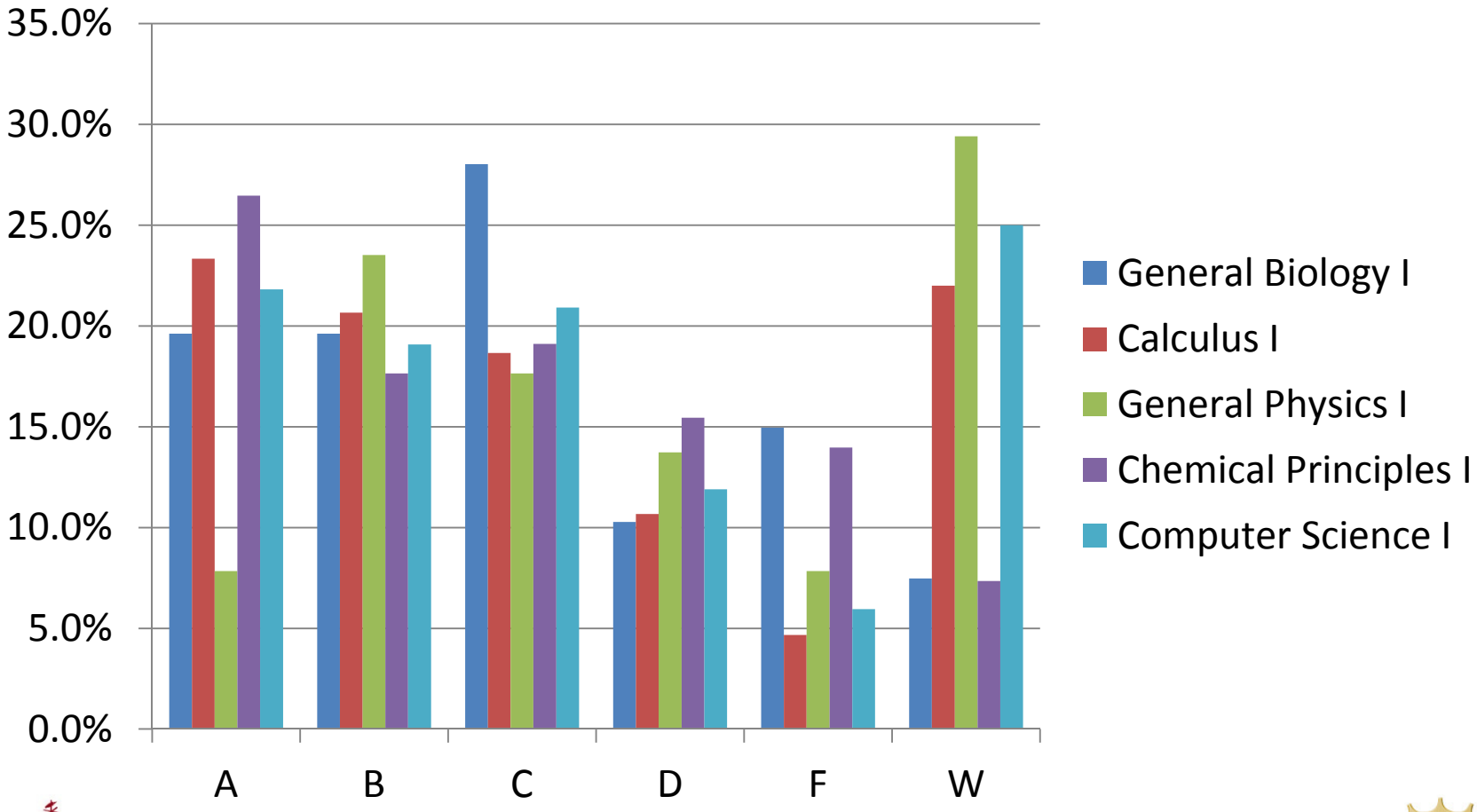
# STREAMS Goal:

## Improve Retention of Science & Math majors so that more students will graduate.

# STEM Student Retention: The Problem (2009 Data)

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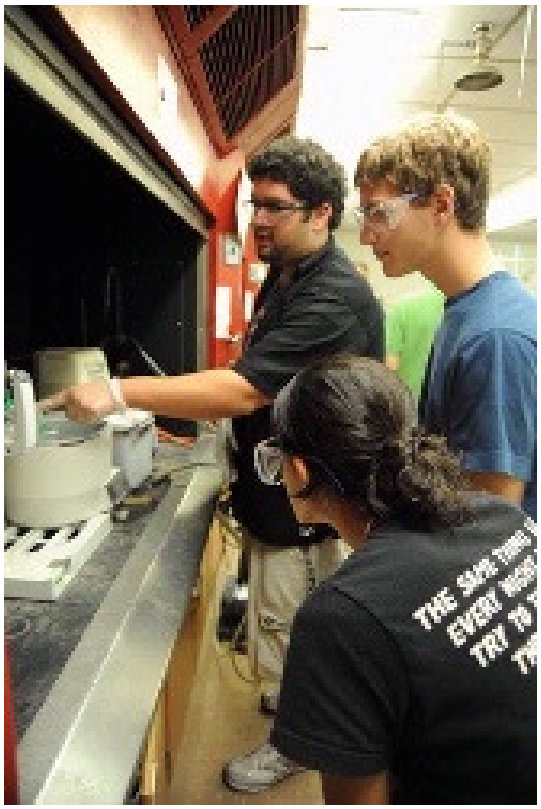
# Multi-approach, Best Practices, Implementation, Assessed=yes



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

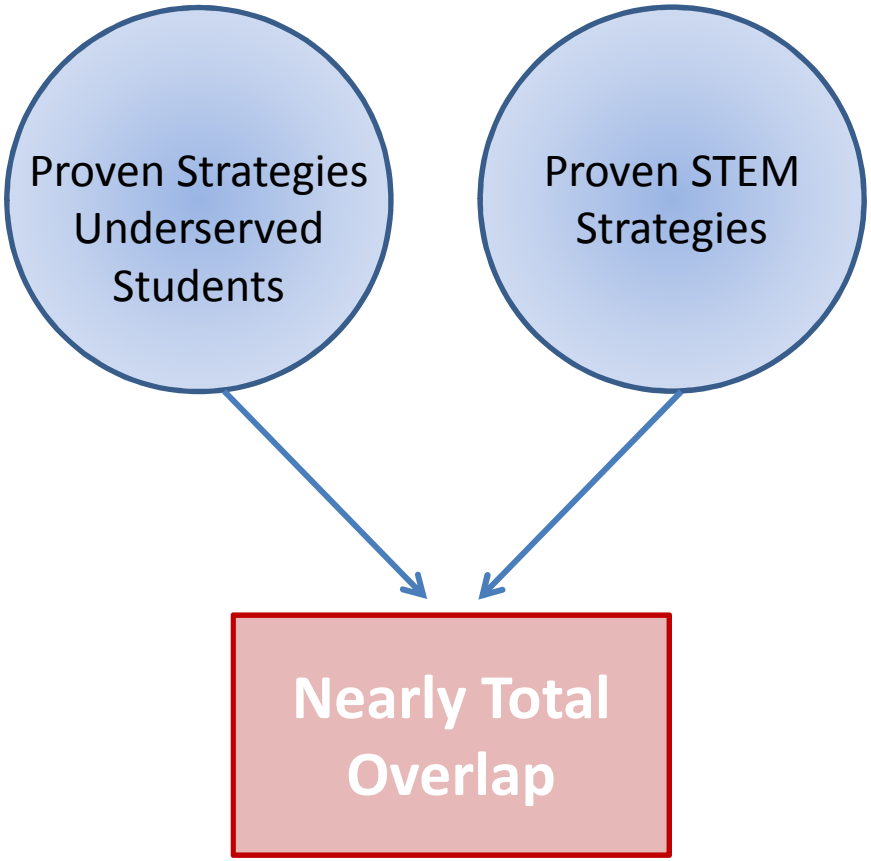
# PERSONAL MOTIVATIONS

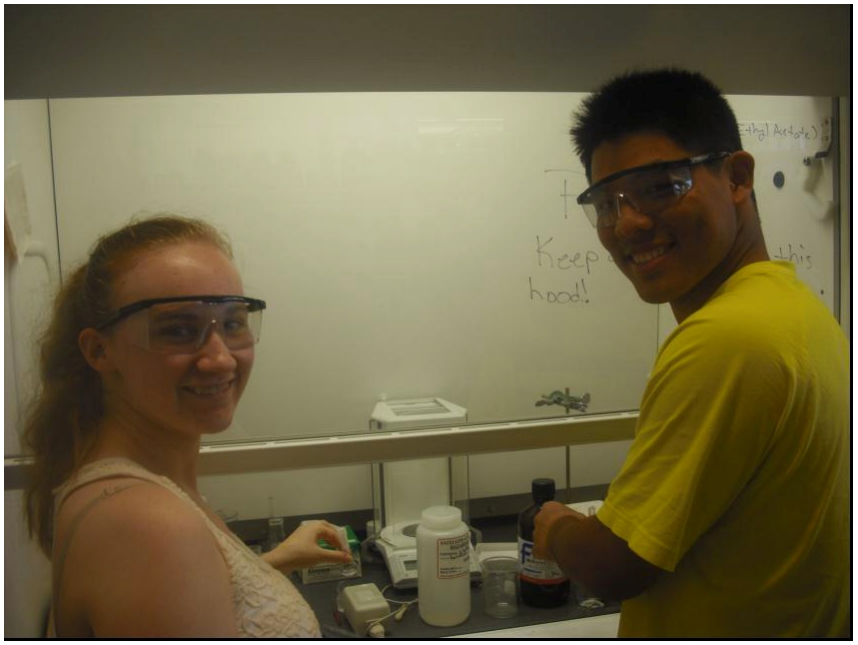
# Reflection 1: Untapped Resources

- 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



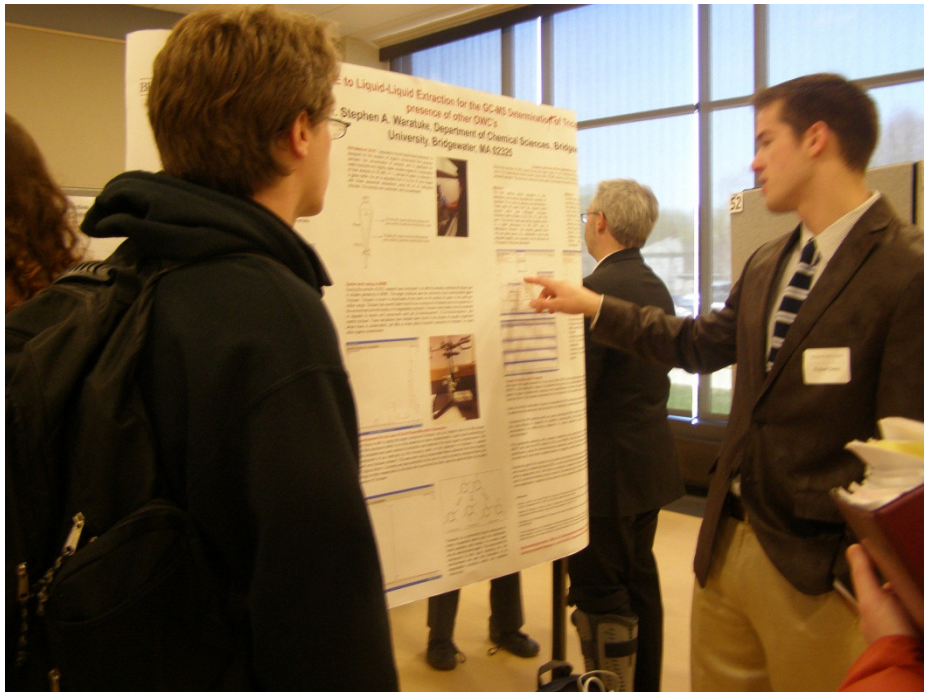



# Guiding Principles


# 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.

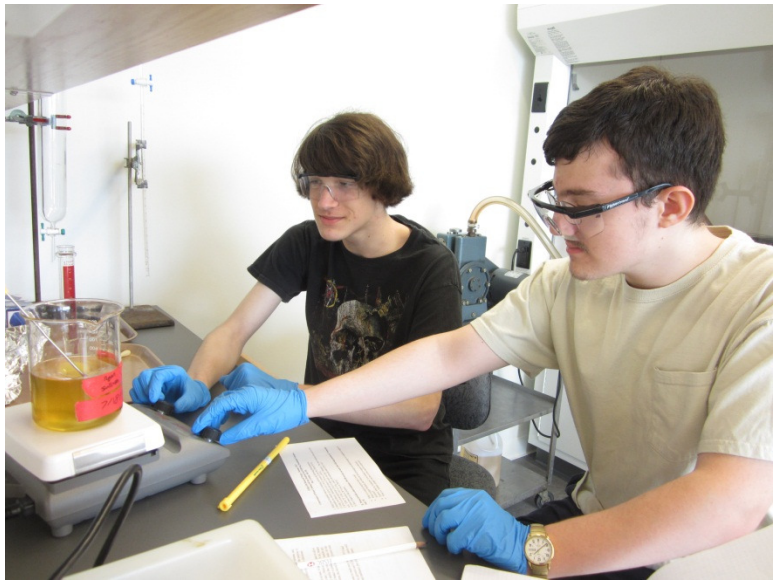
If my department is bleeding away majors, then we have a responsibility to investigate and maybe to take action changing the curriculum.

# PROGRAM COMPONENTS

# 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)

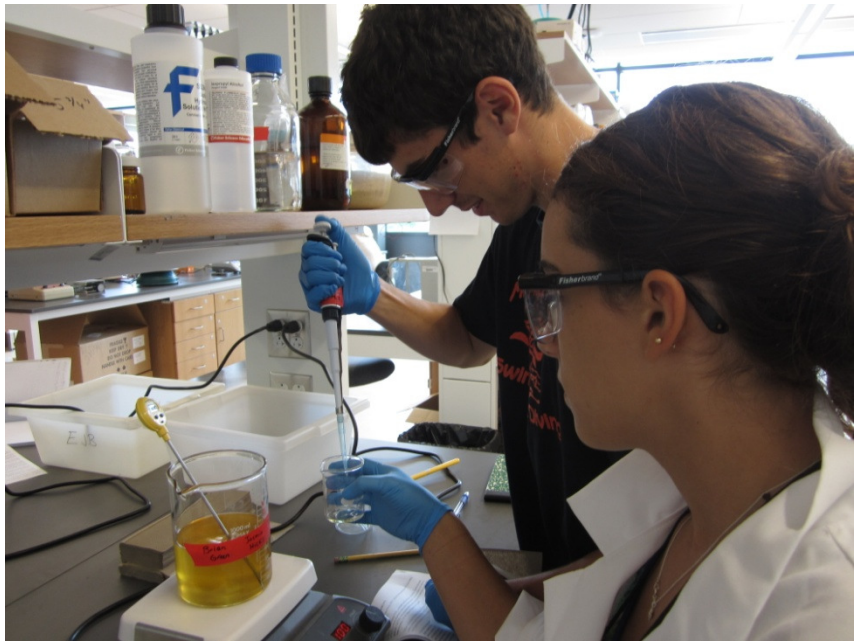


**Early Undergraduate Research:**

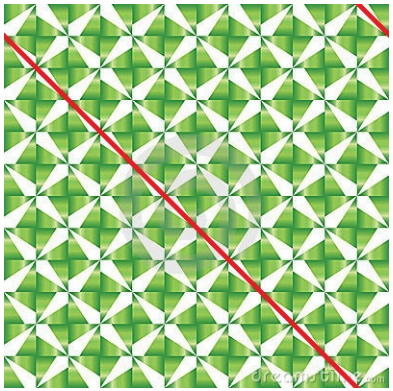
Participants complete about 40 hours of research, with a faculty and peer mentor

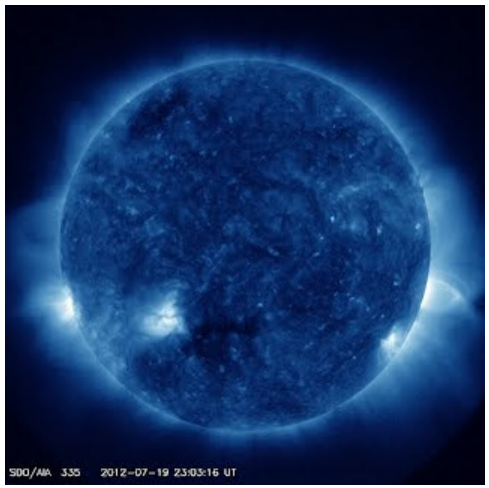
# Summer Bridge Research

- Biology
  - Methanogenic Bacteria in Goats
  - Triclosan Exposure & Bacteria
  - Ankle Angle in Sprints
- Chemistry
  - Biodiesel & Green chem
  - Organophosphorus (OP) pesticides



# More Summer Bridge Research






- Math
  - GIS Modeling for Bus Routes
  - Logarithmic Spirals & MC Escher
- Physics
  - Transits of Exoplanets
  - Solar Variability
  - Asteroid Rotations

# Summer Bridge Surveys

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

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

# 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!"

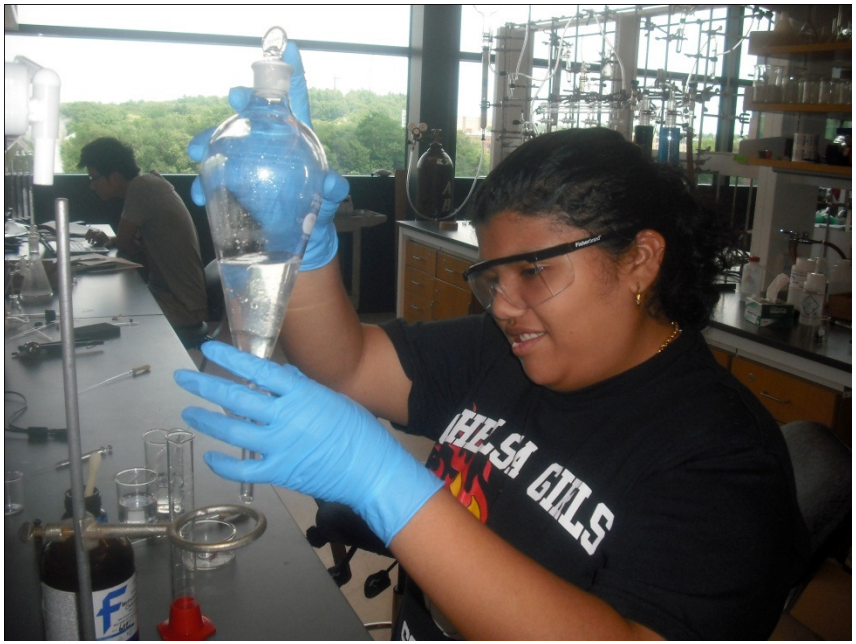
- *What differences do you see in yourself over these three weeks?*
  - "When I first came here I felt stupid. I felt that my high school did not prepare me and now I feel more confident."

# 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

# 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

For 3 cohorts:
Summers 2010, 2011, 2012

- 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

# 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

| Question | Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| The RLC significantly aided me in learning science and mathematics in introductory course. | 40% | 26% | 17% | 11% | 6% |
| The RLC has been influential in my remaining a science or math major. | 34% | 31% | 17% | 14% | 3% |
| The RLC has helped me be more successful as a science or math major. | 43% | 29% | 11% | 11% | 6% |

# 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**

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

# 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

# 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

- **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

# 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

# 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 Pavlicek
- Jonathan Roling
- Polina Sabinin
- Peter Saccocia
- Matt Salomone
- John Santore
- Abdul Sattar
- Irina Seceleanu
- Uma Shama
- Steve Waratuke
- Jeff Williams

# Data Table

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

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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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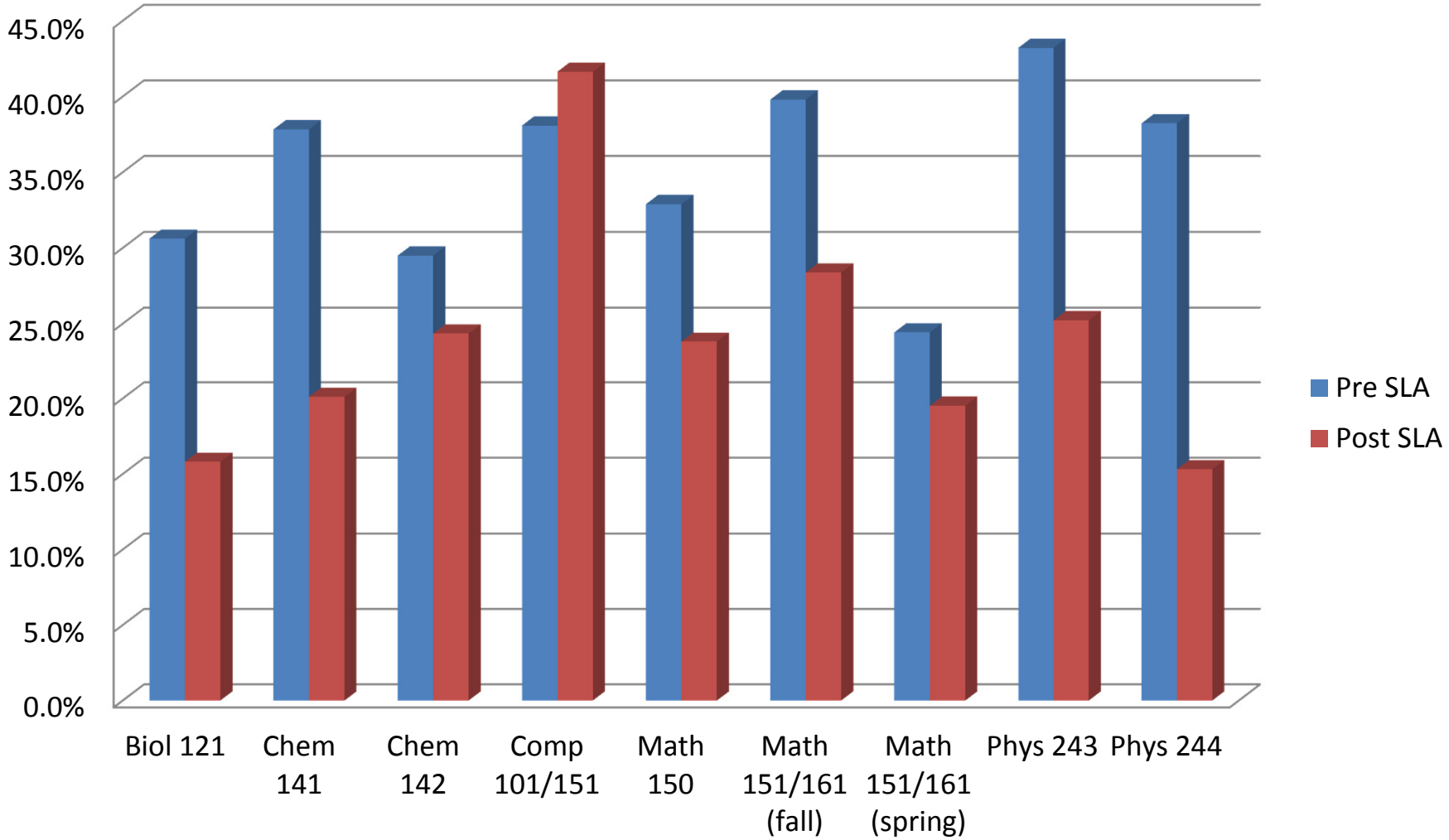
## DFWI Rate, STREAMS SLA Supported Courses

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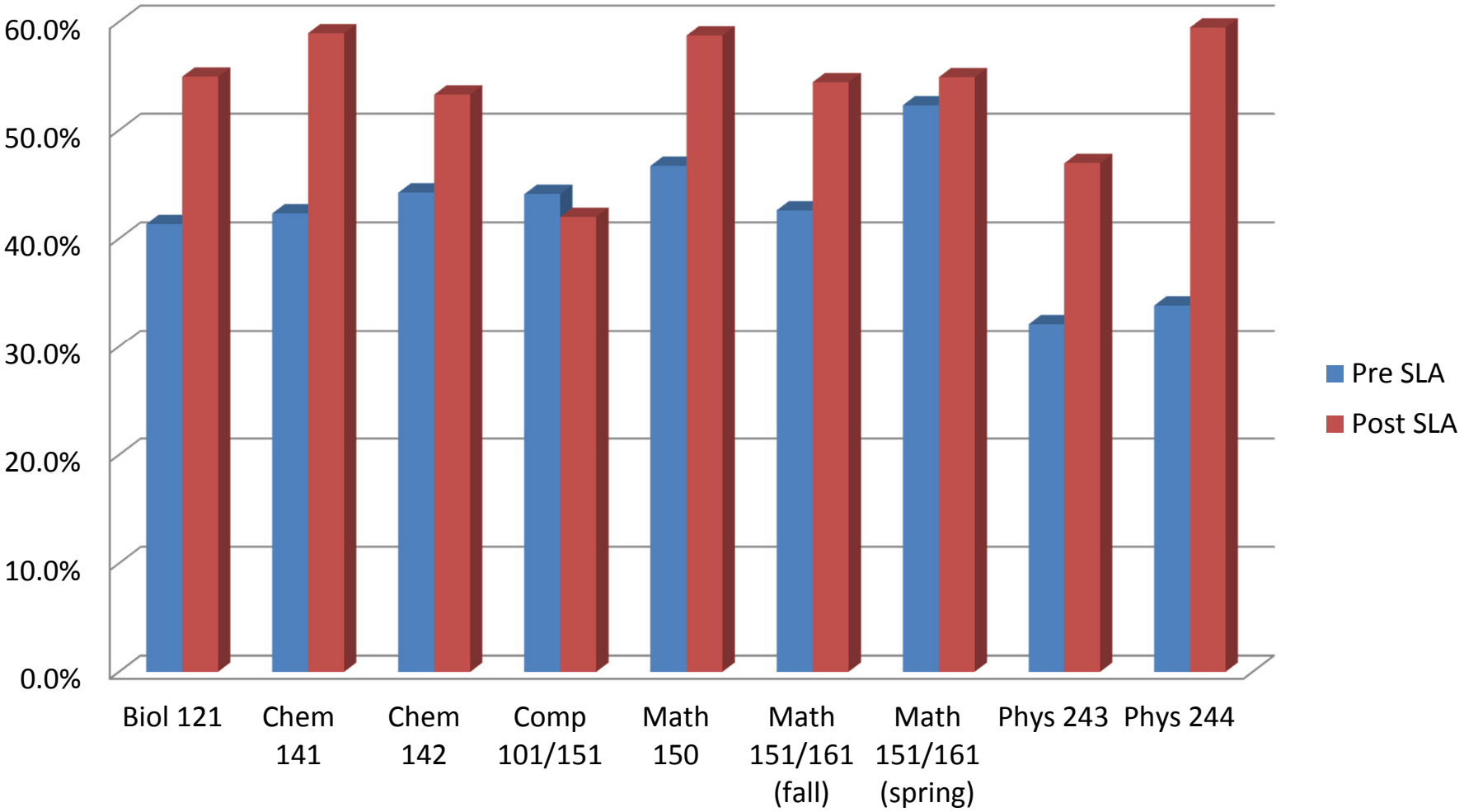
## AB Rate, STREAMS SLA Supported Courses



| | |
|---|---|
| To date, **221** fewer D, F, W, or I grades were assigned since SLA began. | To date, **229** additional grades of A or B have been earned since SLA began. |
| Each year, **107** fewer DFWI grades are assigned because of SLA. | Each year, **110** additional grades of A or B are earned because of SLA. |

# Fall 2011 to 2012 retention by course grade

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

# 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

# Biology 121 Student Population

| | Fall 2008 | Fall 2009 | Fall 2010 | Fall 2011 |
|---|---|---|---|---|
| **Enrollment** | 89 | 107 | 109 | 135 |
| **Biology Majors and (%)** | 62 (70%) | 80 (75%) | 74 (68%) | 102 (76%) |
| **Incoming SAT-Math 25% - 75% quartiles** | 480-560 | 470 – 580 | 460-580 | 460-550 |
| **Women and (%)** | 60 (67%) | 67 (63%) | 73 (67%) | 84 (62%) |
| **First-Time, Full-Time Freshmen and (%)** | 52 (58%) | 67 (63%) | 57 (53%) | 85 (63%) |
| **Minority and (%)** | 12 (13%) | 26 (24%) | 25 (23%) | 42 (31%) |

# DFWI Rates: Biology 121

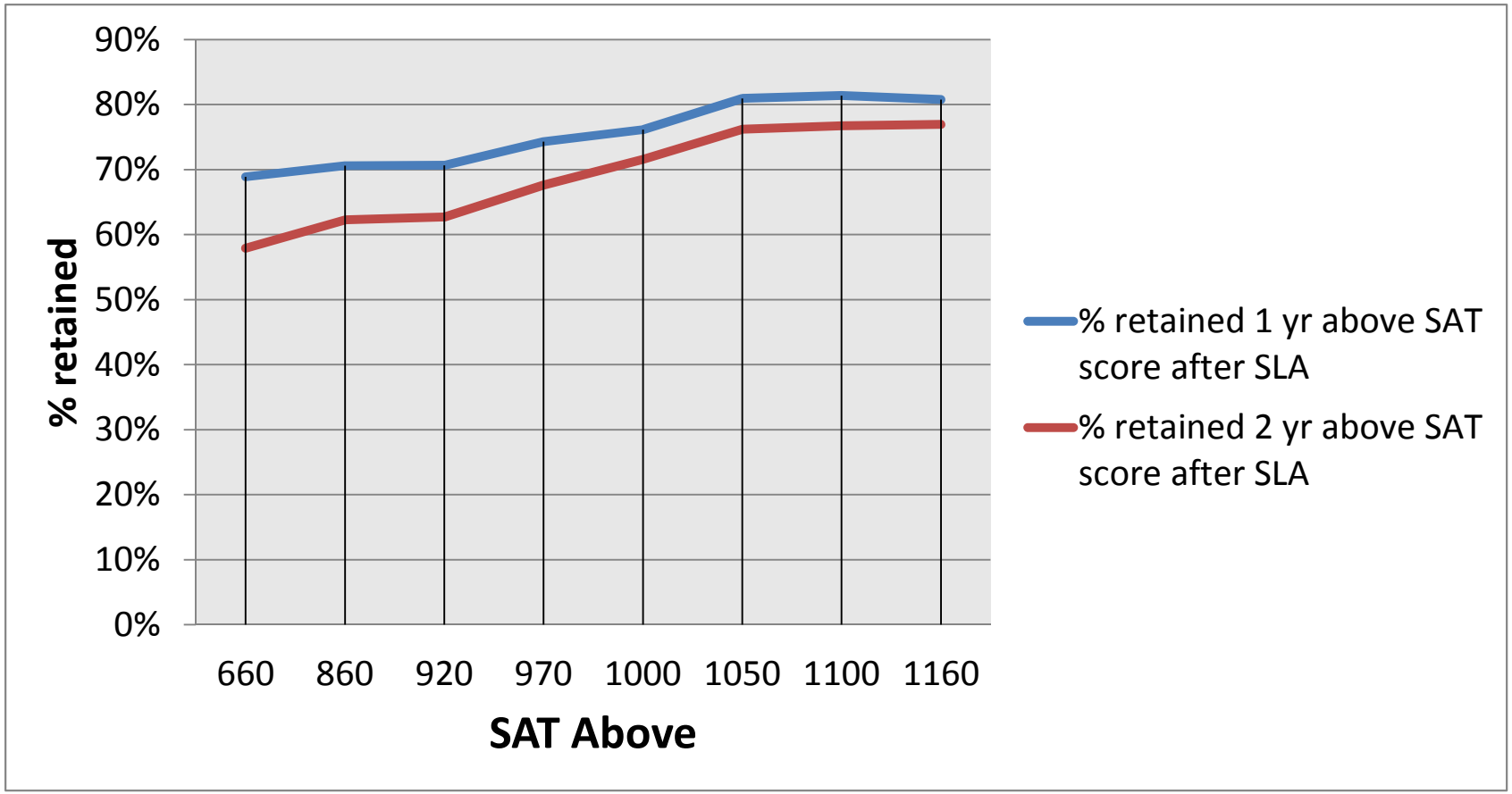
| | N (pre / post SLA) | DFWI % Drop | AB % Gain |
|---|---|---|---|
| **All Students** | (196/244) | **13.4%** | **13.2%** |
| **Men** | (69/87) | 9.7% | **17.4%** |
| **Women** | (127/157) | **15.4%** | **10.8%** |
| **Students of Color** | (38/67) | 8.9% | -0.6% |
| **Biology Majors** | (142/176)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

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

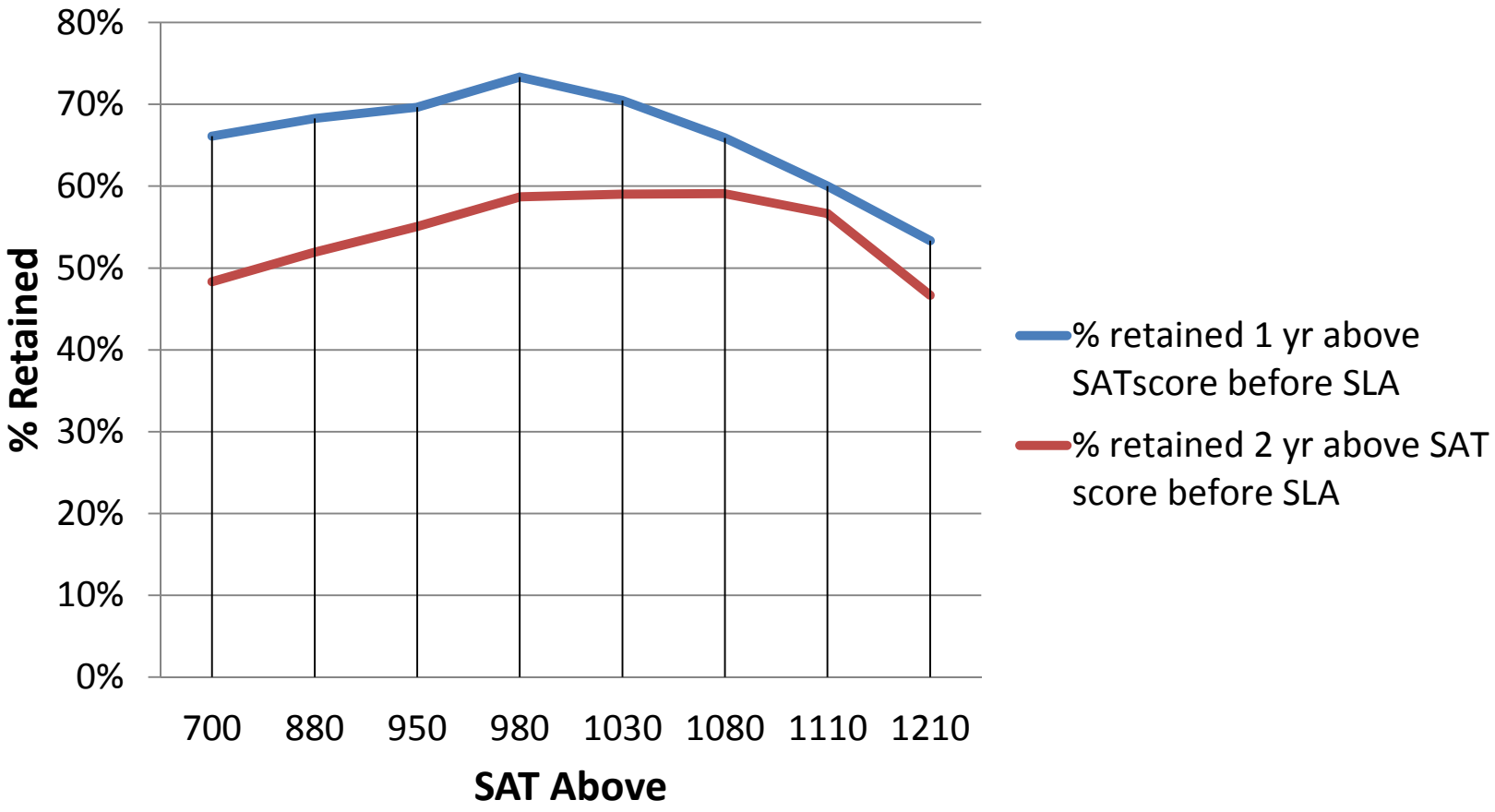
The low number of men and students of color reduces the significance in the DFWI reduction.

The performance of students of color remains a concern.

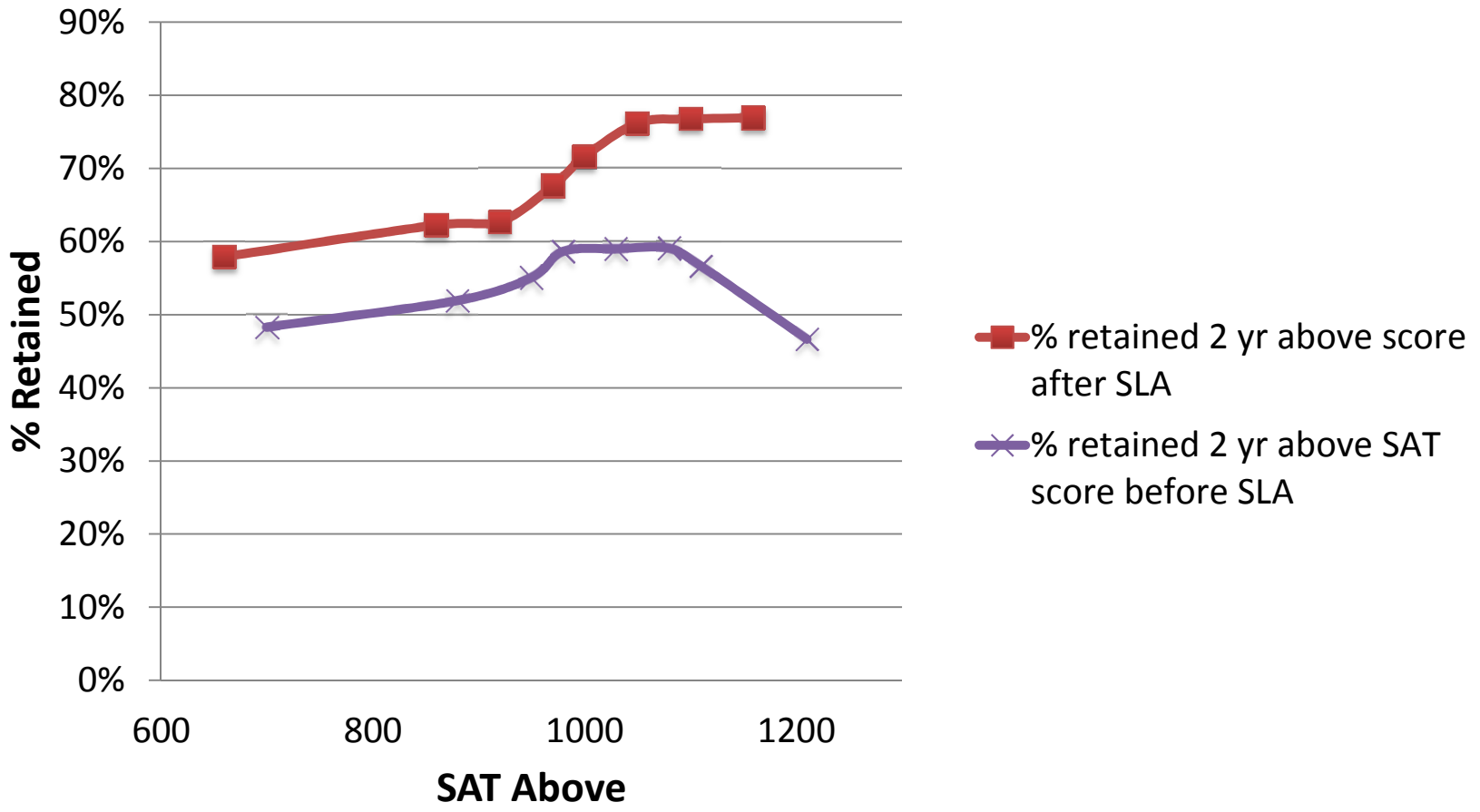
# Relationship with SAT – POST-SLA



# Relationship with SAT – PRE-SLA

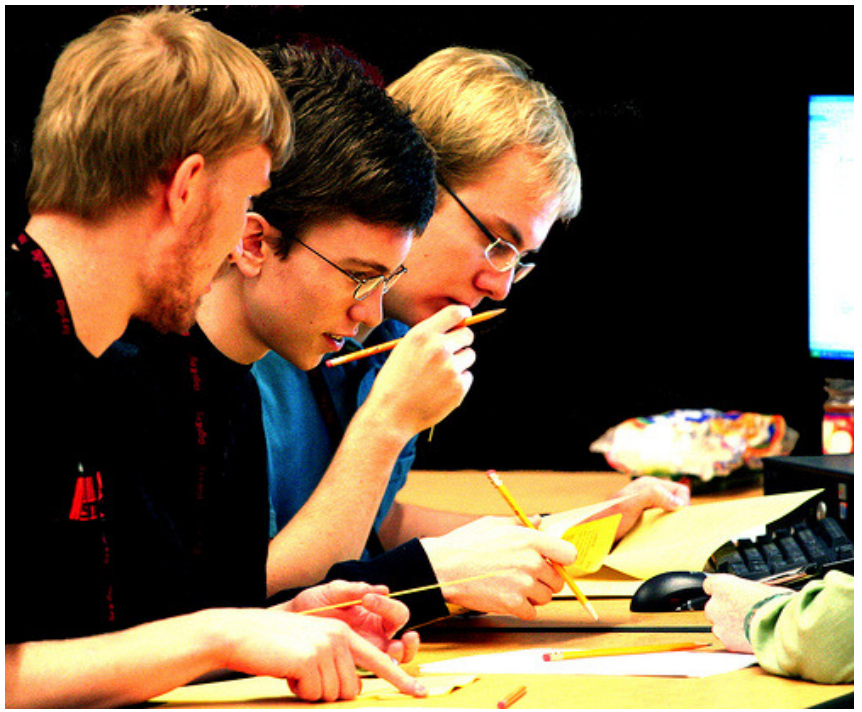


# 2 Year Retention Before and After



# Some comments . . .

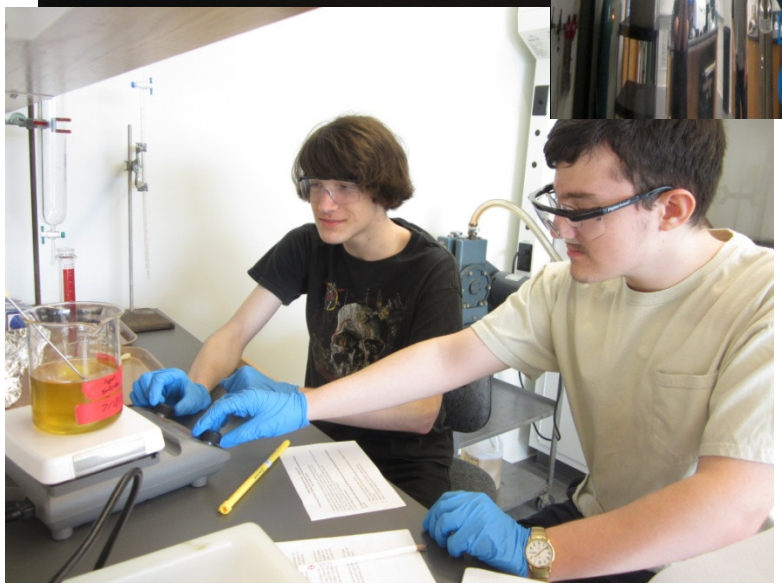
- Technology is making it easier to move away from large lecture sections.
- POGIL – Process Oriented Guided Inquiry Learning – see Dr. Chris Bauer at Univ. of New Hampshire for a way to do inquiry within large sections.
- Does your university promote group study?

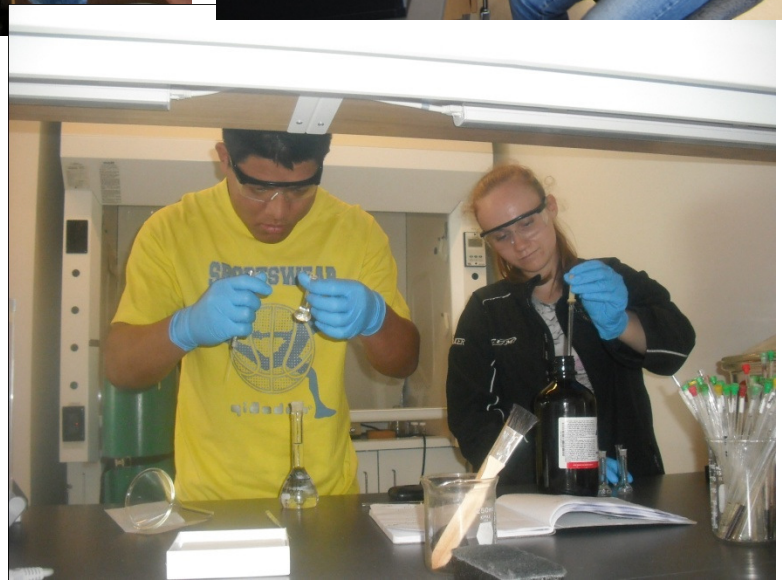


# Before Questions, Reflection 2

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?





tkling@bridgew.edu

www.bridgew.edu/streams

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