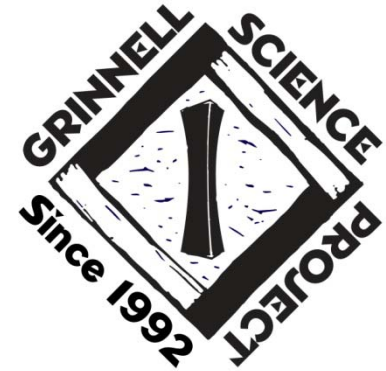


**PKAL /AAC&U: Engaged STEM Learning: From Promising to Pervasive Practices, March, 2011**



# **Comprehensive Changes to STEM Education: Reform to Better Serve the Underserved. The Grinnell Science Project**

**Leslie Gregg-Jolly, Professor of Biology and Associate Dean**

**Mark Schneider, Professor of Physics**

**Jim Swartz, Dack Professor of Chemistry**

**For our Committed Colleagues**

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# Goal of the Grinnell Science Project

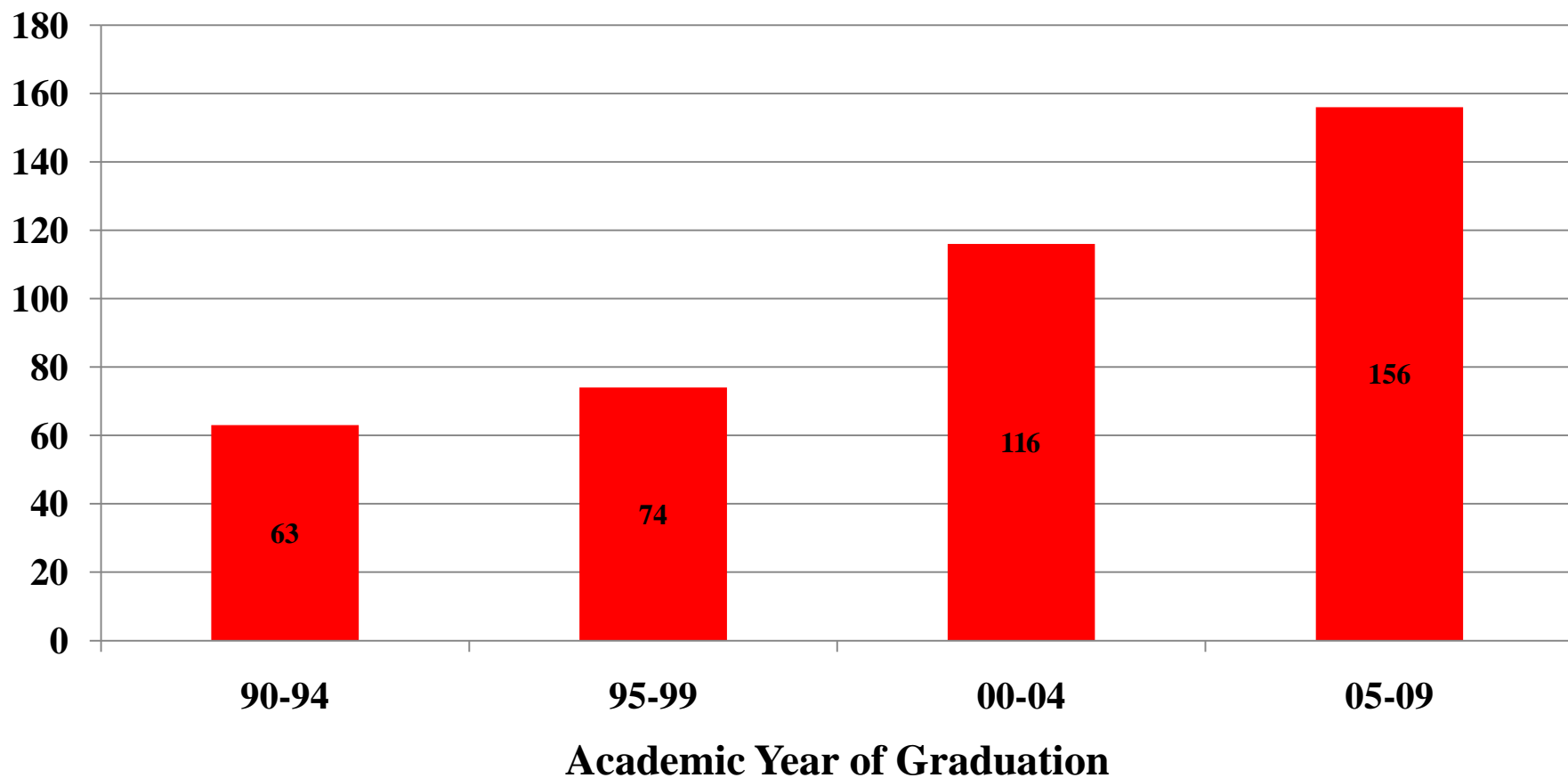
**Improve the environment at Grinnell College to support broader success in the sciences, including students who are members of groups traditionally under-represented in science**



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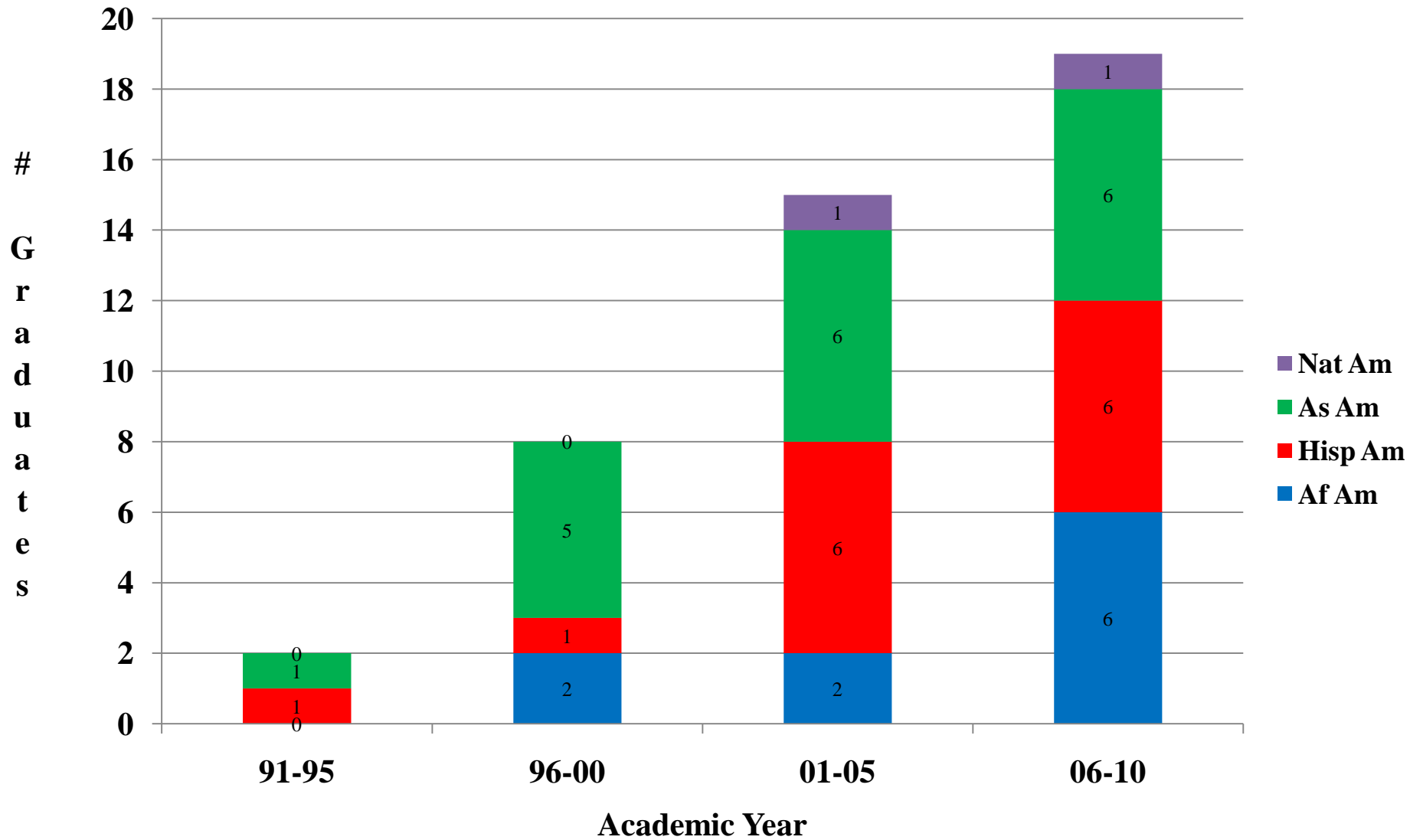
## Number of Women Graduates in Physical and Computational Sciences



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# Number of Physical and Computational Science Graduates



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# Grinnell College

- **General**
  - Private, selective, residential
- **Student Body**
  - 1,600 full-time students
  - 25% Domestic students of color
  - 12% International
- **Curriculum**
  - No distribution or core requirements
- **Science**
  - 35% of students major in science
  - Nearly all students take science and 75% take calculus



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**In the late 1980's we began to worry in an organized way about the lack of women and students of color among our science graduates.**

**There is some evidence that some students are more sensitive to problems with the curriculum and pedagogy and that changes will benefit all students.**



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**What concerns do you have  
about STEM education on your  
campus?**



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# Where We Started

- **“Minority Student Retention Committee”**
- **Some Assertions That We Were Admitting the Wrong Students**



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# National Context

- **Uri Treisman Work at UC Berkeley**
- **Sheila Tobias- “They’re Not Dumb They’re Different”**
- **Experiences of Some HBCUs**
- **Similar projects and work**



# Data Analysis

## Looking at poor grades in introductory math and science at Grinnell

- **Weak correlation with standardized exam scores or high school grades**
- **Correlation with:**
  - **First generation college student**
  - **Graduation from high school with < 50% graduates going on to college**
  - **Being a domestic student of color**



# Data Analysis

## Persistence

- **Women achieved higher grades than men but were less likely to continue their studies of science**
- **Grades for African Americans were a full GPA unit below white students, but often they persisted**



**What existing data might be helpful to you ?**

**How could you use it to test your hypotheses or refine your assessment of any problems?**



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# Barriers to the Successful Study of Science

- **Acclimation to student life and lack of supportive community.**
- **Different learning styles.**
- **Role models and contexts for the study of science.**



# What is GSP?



- A pre-orientation program for students interested in the sciences
- Curricular change in the sciences—new kinds of pedagogy
- Early exposure to research—in and out of class
- A *community* of students, faculty, and student life staff



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# One-Week Pre-orientation

## Participants:

- **New Students: 25-45**  
(demographics...)
- **Faculty directors: 2-3**  
each year; rotates
- **Administrative director: student affairs role; constant over many years**
- **Student Assistants: 6-8**  
upper-class students
- *And almost everyone else in the sciences*



# Pre-orientation Program: Academic

- **Participate in various college- level academic experiences**
  - group and individual projects
  - labs
  - lectures
- **Activities are designed to provide experience in the various contexts that students encounter in science courses.**



# Pre-orientation Program: Social

- Learn about non-academic things to do at Grinnell and beyond
- Make friends
- Have fun!



# Pre-orientation Program: Acclimation



- Students hear perspectives from faculty, staff, and advanced students
- Techniques for succeeding at Grinnell
- Emphasis on resources all students should access



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# After Pre-Orientation/Throughout the Year

- **Social/working groups persist**
- **“Reunions”**
- **Presentations (e.g. Research Opp’s)**
- **Track students’ academic progress by Student Affairs & Faculty**



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# An Illustration: Numerical Scavenger Hunt



**Encompasses many elements:**

- **Getting to know facilities/way around**
- **Academic skills**
- **Group work**
- **Fun (& competition)**
- **Reunion**



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# Pedagogical Goals of Grinnell Science Project

**To respond to different learning and teaching styles through interactive science and mathematics courses**

- Focus on helping participants excel rather than merely avoid failure
- Emphasis on collaborative learning and small group teaching methods
- Faculty sponsorship and support



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# Student Learning

## Curricular and Pedagogical Changes

- **Incorporate more engaged, personal elements into courses.**
- **Multiple learning styles**
- **Students are encouraged to work in groups and be part of a ‘community of learners.’**



# First Approach

**Create more engaged learning based upon national models**

One-credit courses that students taking introductory science courses can take alongside of standard courses

- Small enrollment
- More engaged/discovery activities
- Students work in groups



# First Approach

**Create more engaged learning based upon national models**

~~One-credit courses that students taking introductory science courses can take alongside of standard courses~~

- ~~– Small enrollment~~
- ~~– More engaged/discovery activities~~
- ~~– Students work in groups~~



# Pedagogical Changes

- **Introductory Biology**—A research course
- **Introductory Chemistry**—All sections use modular problems based materials and some are in a workshop format.
- **Introductory Computer Science**—All sections use a workshop format
- **Introductory Physics**—Half of sections are in workshop format



# Role Models and Context

## Early entry into student-faculty research

- We established special short term research opportunities during academic breaks for students who were members of the target population
- We generally increased the number of summer student-faculty research opportunities, with some emphasis on early opportunities for students from the target population



# Foster Peer Mentoring through Science Learning Center

**The Science Learning Center was established and a director appointed to:**

- **Train and support mentors in courses**
- **Tutor students and train peer tutors**
- **Work with faculty members to improve student learning**



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# Supporting Community: A Building that is Welcoming



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# Facilities to Support Pedagogical Change



Current classrooms do not provide adequate space for students to spread out papers, calculators, and computers, nor do they support group problem solving in the classroom. The new classrooms will allow such activities, the moveable chairs and fixed tables will allow groups to gather, and the tables will be equipped with power and network lines to allow use of notebook computers during class sessions.



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# Spaces That Support Community



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# Evolution

- The pre-orientation program is well established. Most faculty members involved have been hired since the program started.
- Over time the pedagogical changes have both accelerated and become essential components of core science courses.
- Early research opportunities have blended into the curriculum and the mainstream of research opportunities.



# GSP led to new Introductory Biology course

**Research-based learning to move away from teaching biology as a collection of facts and toward teaching biology as it is actually practiced.**

150 Introduction to Biological Inquiry (Fall and Spring) 4 credits

An introduction to **how** biologists pose questions, design experiments, analyze data, and communicate scientific information, for prospective biology and biological chemistry majors as well as non-majors. Although individual sections will have different topics and formats, all sections will involve intensive **student-directed investigation** and include a laboratory component. Prerequisite: none. STAFF.



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# BIO 150 Introduction to Biological Inquiry

- Workshop format (linked lecture/lab time ~6 hours/week)
- 20-24 students
- Recommended for both majors and non-majors
- Each section has different emphasis/content focus



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# BIO 150 Introduction to Biological Inquiry

All sections teach similar skills such as using the scientific literature, designing experiments, analyzing data, presenting posters and writing scientific papers



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# Lessons learned

## Turn challenges into opportunities

- Impossible to indentify things every Bio student needs at intro level
- Pedagogical changes designed to respond to a particular group of students' needs turned out to be good for all students

## Experiment & then learn from failures

- Early one credit workshop courses didn't quite work.
- After teaching a new curriculum for only two years, we started planning to change it.

## Group work does make a better product

- Collaboration with other faculty, support centers and student affairs staff help faculty too!



# **GSP breeds success in Bio 150 and Bio 150 breeds success in GSP students**

- **Effective group work, sometimes facilitated by peer mentors**
- **Utilization of resources such as the science learning and writing centers**
- **Multiple learning styles**
- **Students gain skills and confidence that increase opportunities for more intensive research experiences**

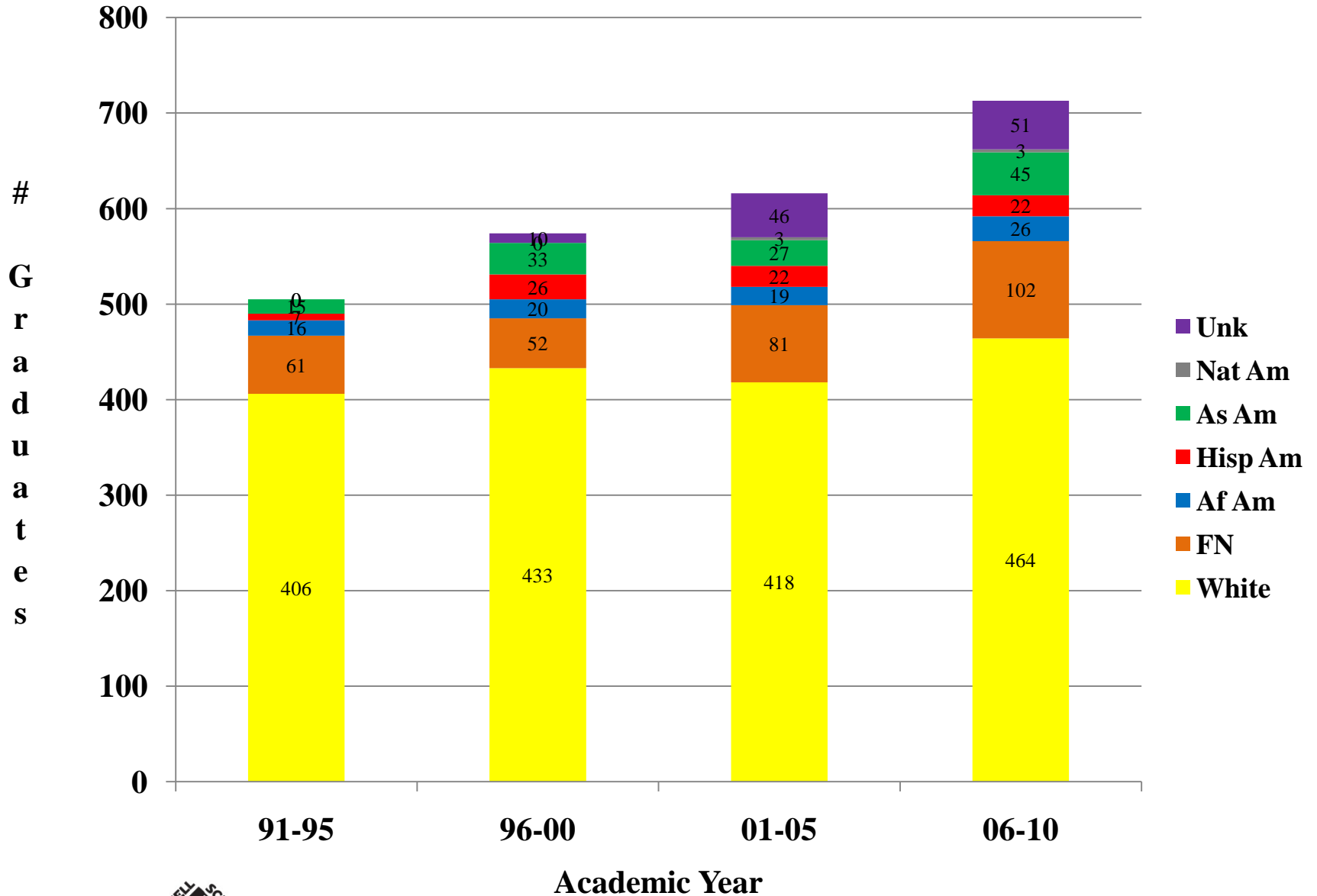


# *Evidence of Success—Statistical*

- **Increased number of students of color**
- **Dramatic increases in areas with most severe underrepresentation (Phys, CS Math)**
- **Improved Science GPA for target group**
- **Significant increase in minority student participation in student life leadership**



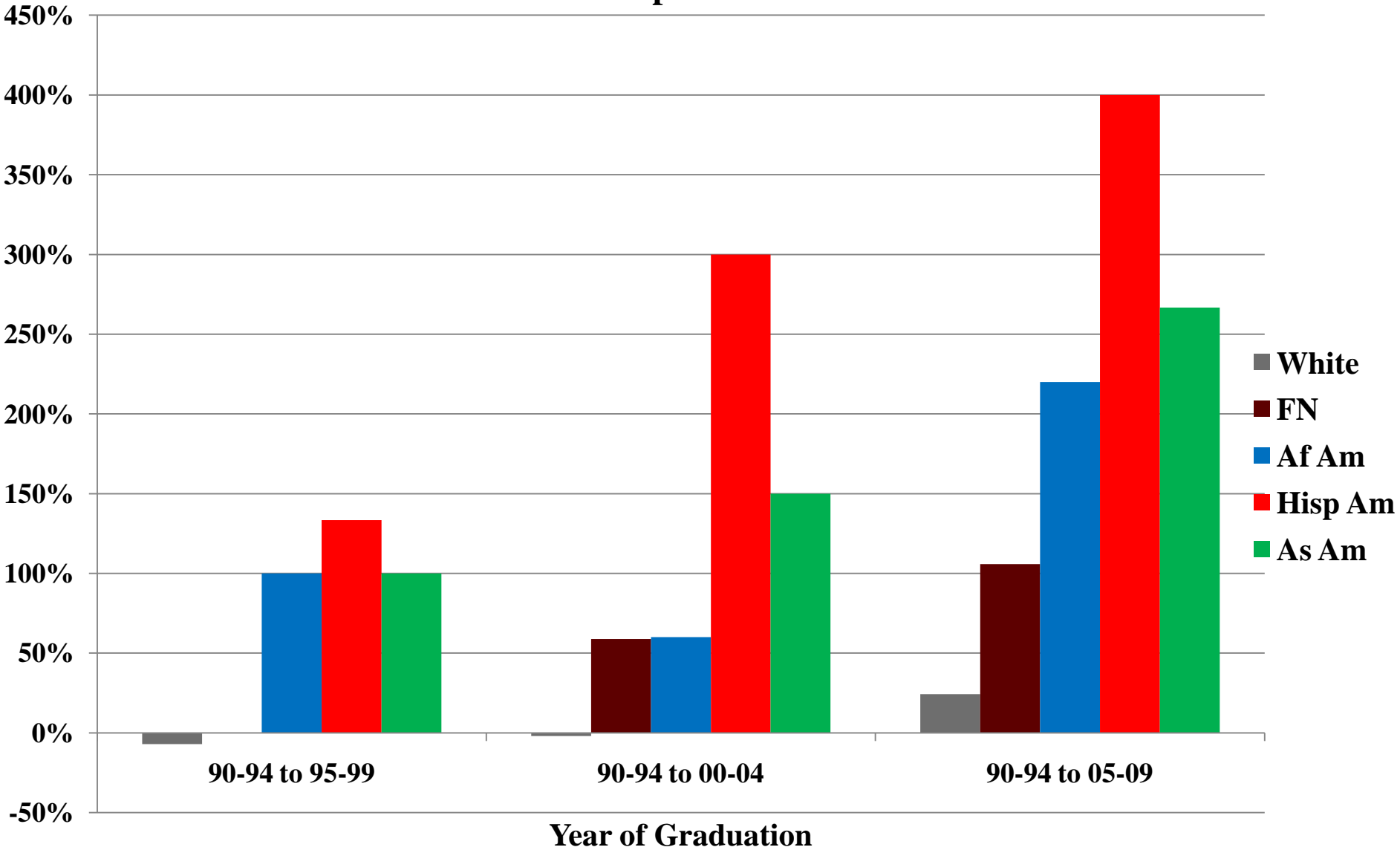
# Number of Science Graduates



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# Cumulative Increase in the Number of Science Graduates in Physics and Computer Science



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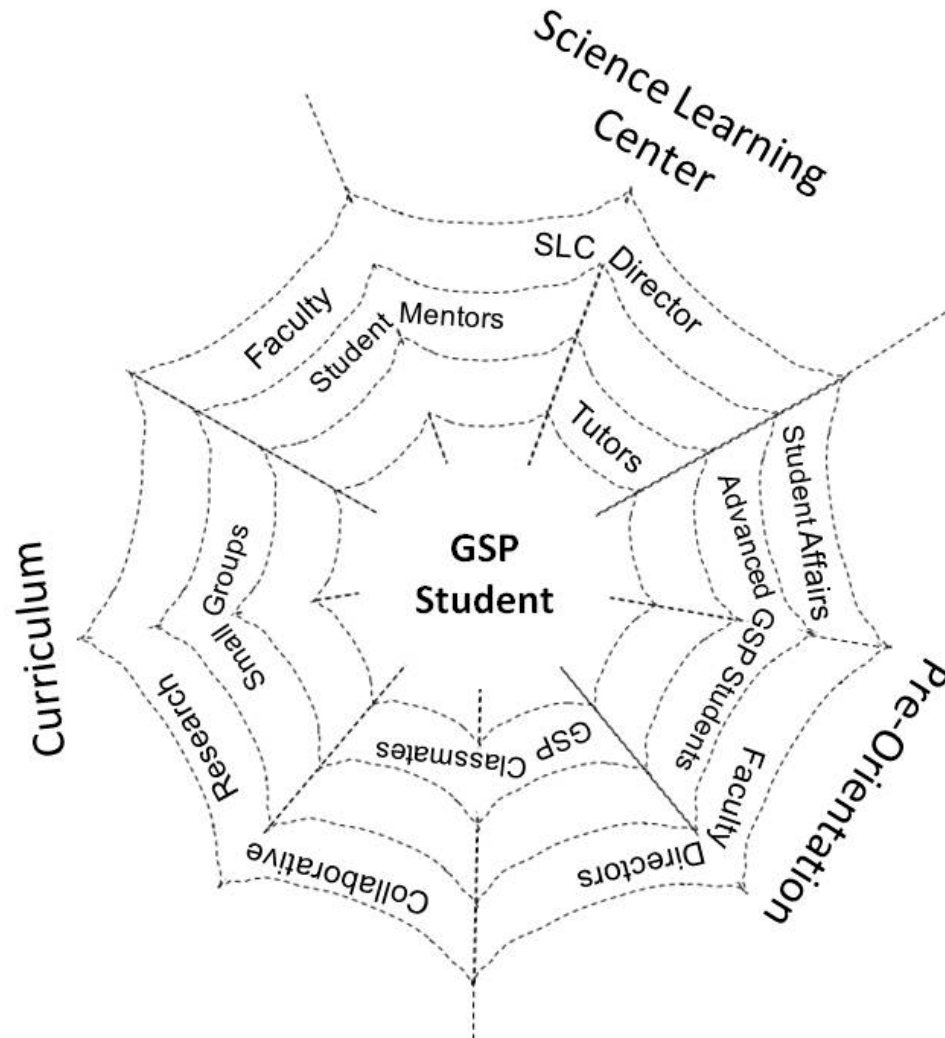


# *Evidence of Success—Qualitative*

- **Improved climate for minorities**
- **Decrease (elimination?) of organized protests by SOC**
- **Dramatically better portrayal of science to prospective students by current students**
- **Eagerness of GSP students to become student assistants for pre-orientation**



# Web of Mentoring



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