Improving Quantitative Skills of Life Science Majors at CSULA

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CSUPERB

Quantitative Biology Network Meeting

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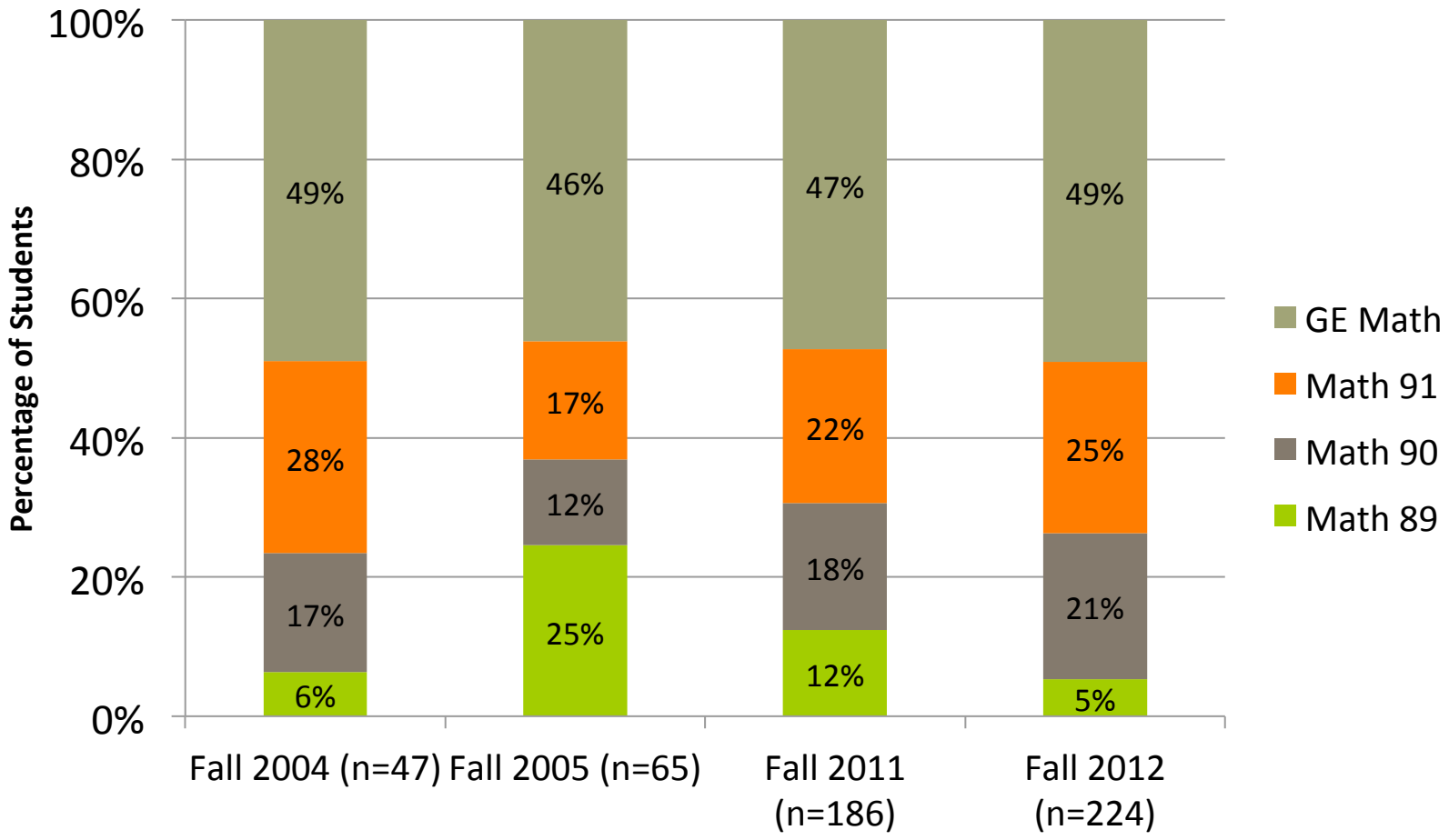
BIO 2012 - Call to Action

- In response to BIO 2012, faculty from biology, mathematics, physics, biochemistry and computer science applied for a special NIH T36 training grant
- Goal: Improve quantitative skills of life science students
- Phase II Grant awarded for 2008-2013 (NIH 5T36 GM078013), 1.57 Million
- Nine Institutions received this type of grant

Curricular Project Components

- **Curricular Revisions in required courses for Life Sciences Majors**
  - Introductory biology course series
  - **Mathematics sequence**
  - Introductory physics sequence
- **Creation of Bioinformatics Minor**
- **New Cross-listed UD modeling course (elective)**

Math Placement of Biology majors



NOTE: Biology and microbiology majors only.

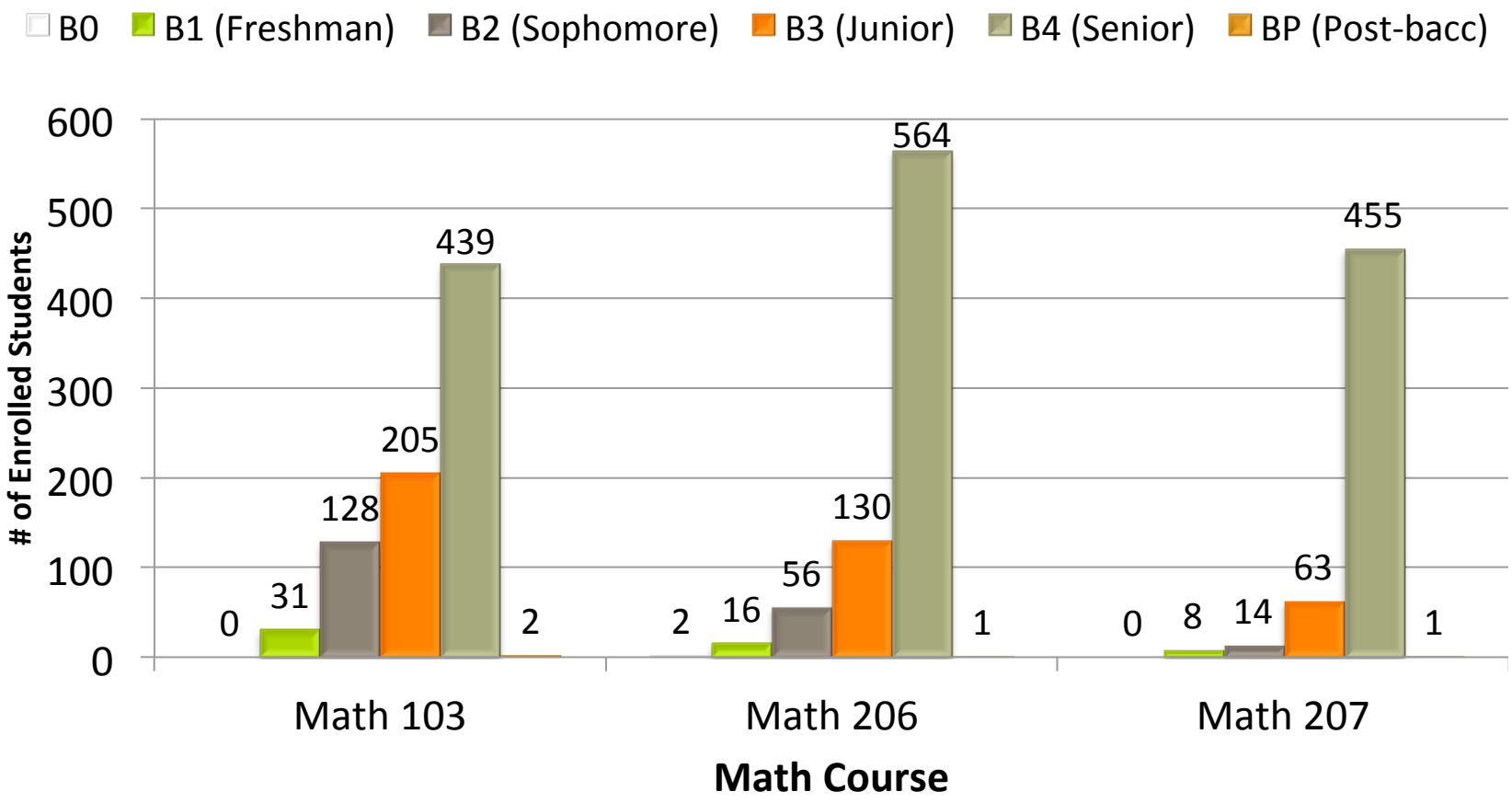
Previous Curriculum

- **Required for biology majors:**
  - Calculus I (Math 206 - Differentiation)
  - Calculus II (Math 207- Integration)
  - Prerequisites: College Algebra and Trigonometry (Math 103)
- **Required for microbiology majors**
  - College Algebra and Trigonometry

Previous Curriculum

- Connections between mathematics courses and biology courses **almost non-existent**
- Trigonometry prerequisite for UD biostatistics course
- Students take Calculus courses late in their major and struggle with it

Biology and Micro Majors Math Course Enrollment by Academic Status: 2004-05



Comparison of Courses

Old Course	New Course
Math 102, College Algebra	Math 104A: PreCalculus – College Algebra
Math 103 Trigonometry	**Math 105 – Introduction to Mathematical Models in Biology**
Math 206, Calculus I (Differentiation)	**Math 204, Applied Calculus I**
Math 207, Calculus II (Integration)	**Math 205, Applied Calculus II**

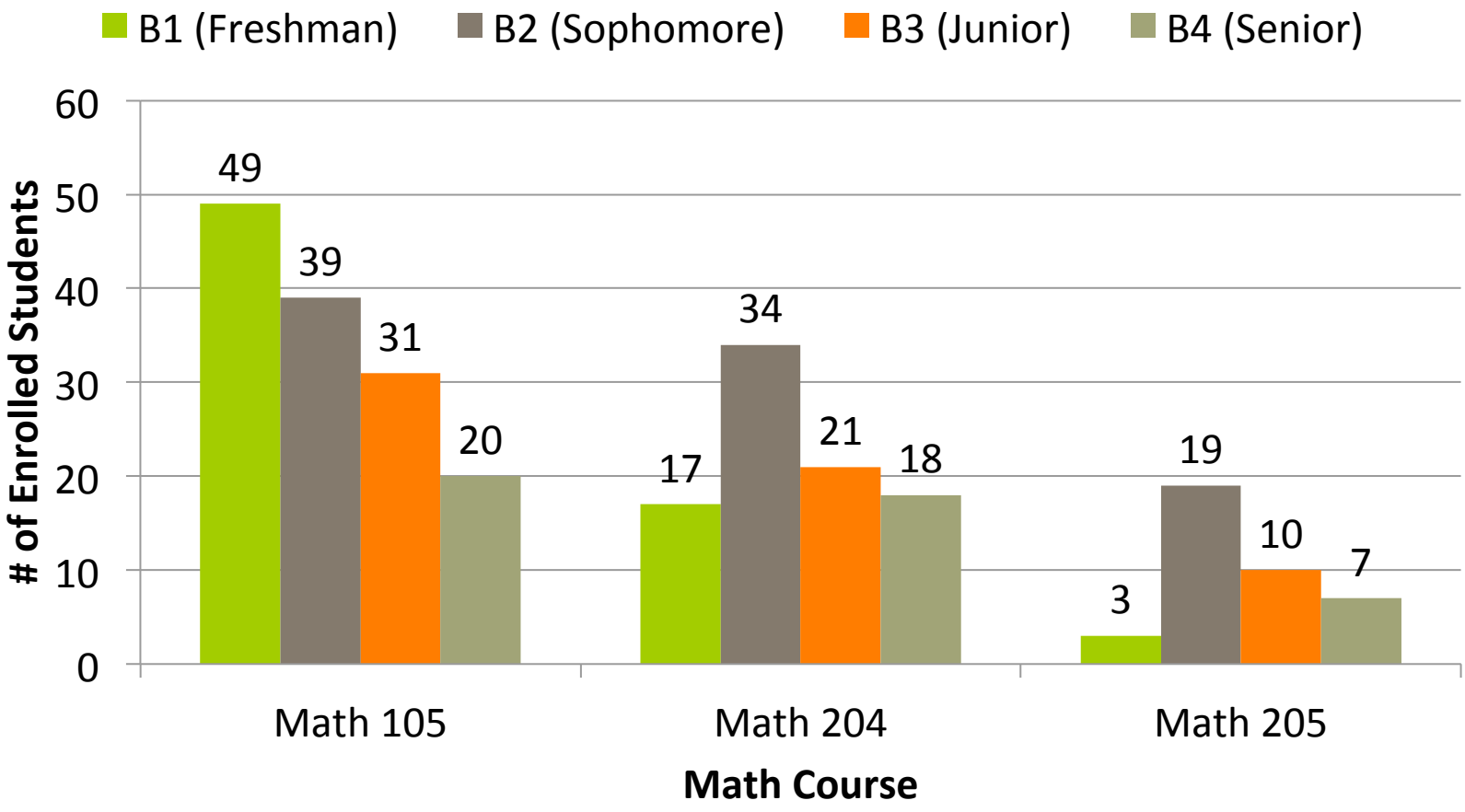
New Curriculum

- **Required for biology majors:**
  - **Applied Calculus I (Math 204 - Differentiation)**
  - **Applied Calculus II (Math 205 - Integration & Intro Differential Equations)**
  - Prerequisites: College Algebra & **Introduction to Mathematical Models in Biology (Math 105)**
- **Required for microbiology majors**
  - **Introduction to Mathematical Models in Biology (Math 105)**
  - **Applied Calculus I (Math 204 - Differentiation)**
  - Prerequisite: College Algebra

New Curriculum

- Mathematics courses **focus on biological applications**
- Introductory Biology sequence now has **math co-requisites** (College Algebra co-requisite for first course, Intro to Modeling recommended for 2nd course)
- Students in the new sequence **complete their mathematics much earlier**

Biology and Micro Majors Math Course Enrollment by Academic Status: 2011-12



Math 105 – Introduction to Mathematical Models in Biology

- **New course that focuses on**
  - Discrete dynamical systems
  - Exponential and sine/cosine functions
  - Basic probability
  - Markov chains
- **Excel activities and assignments**
  - Graphs with Excel
  - Cobwebbing
  - Fitting data to sine function by estimating relevant parameters

Math 204 – Applied Calculus I

- **New course that focuses on**
  - Differentiation as rate of change
  - Stability of equilibria
  - Long-term behavior of the system
  - Introduction to Differential Equations
- **Excel activities and assignments**
  - Connections between graph of function and derivative
  - Limits of functions
  - Newton's Method
  - Stability of equilibria

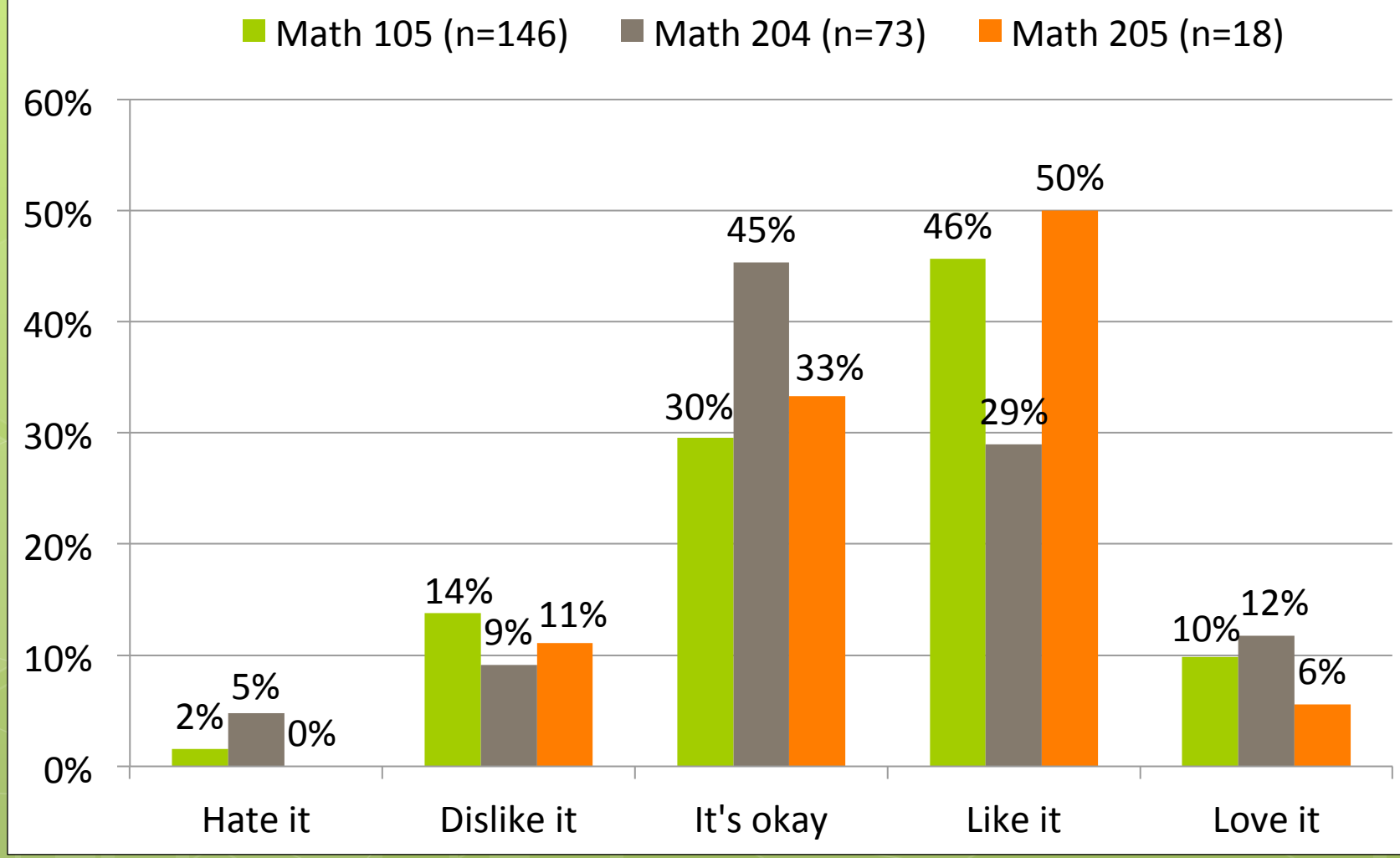
Math 205 – Applied Calculus II

- **New course that focuses on**
  - Methods of integration, including integration by parts and u-substitution
  - Solving pure-time and autonomous DEs of one variable
  - Qualitative analysis of systems of 2 variables (e.g. predator-prey)
- **Excel and Mathematica activities and assignments**
  - Euler's method for solving DEs (pure-time, autonomous and systems)
  - Vector fields for dynamics of systems

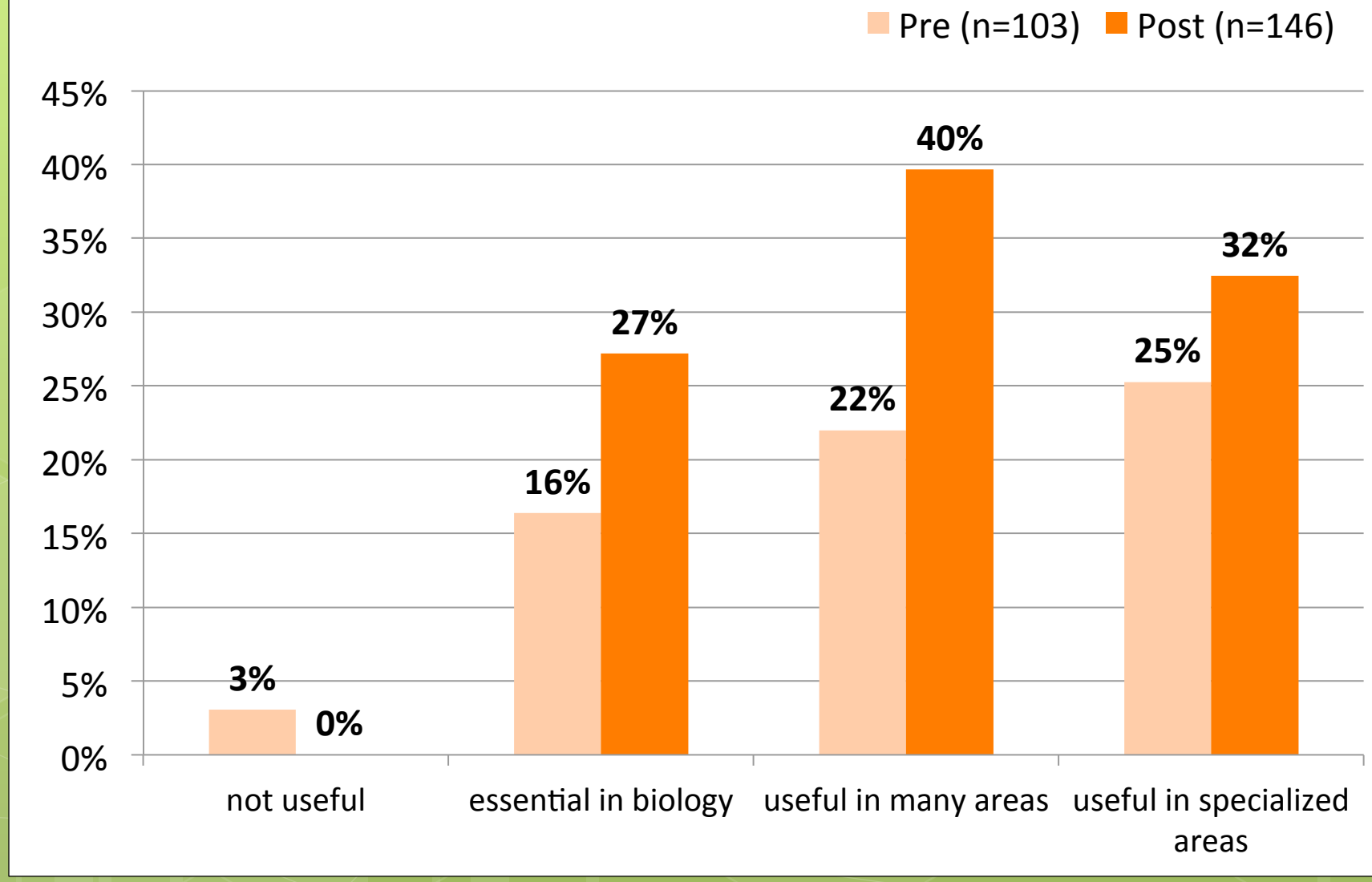
Assessment

- Pre- and post tests on
  - Attitudes towards mathematics
  - Usefulness of mathematics in biology career
  - Understanding graphs, charts, tables
  - Understanding math behind biological concepts
  - Ability to use Excel to explore biological concepts

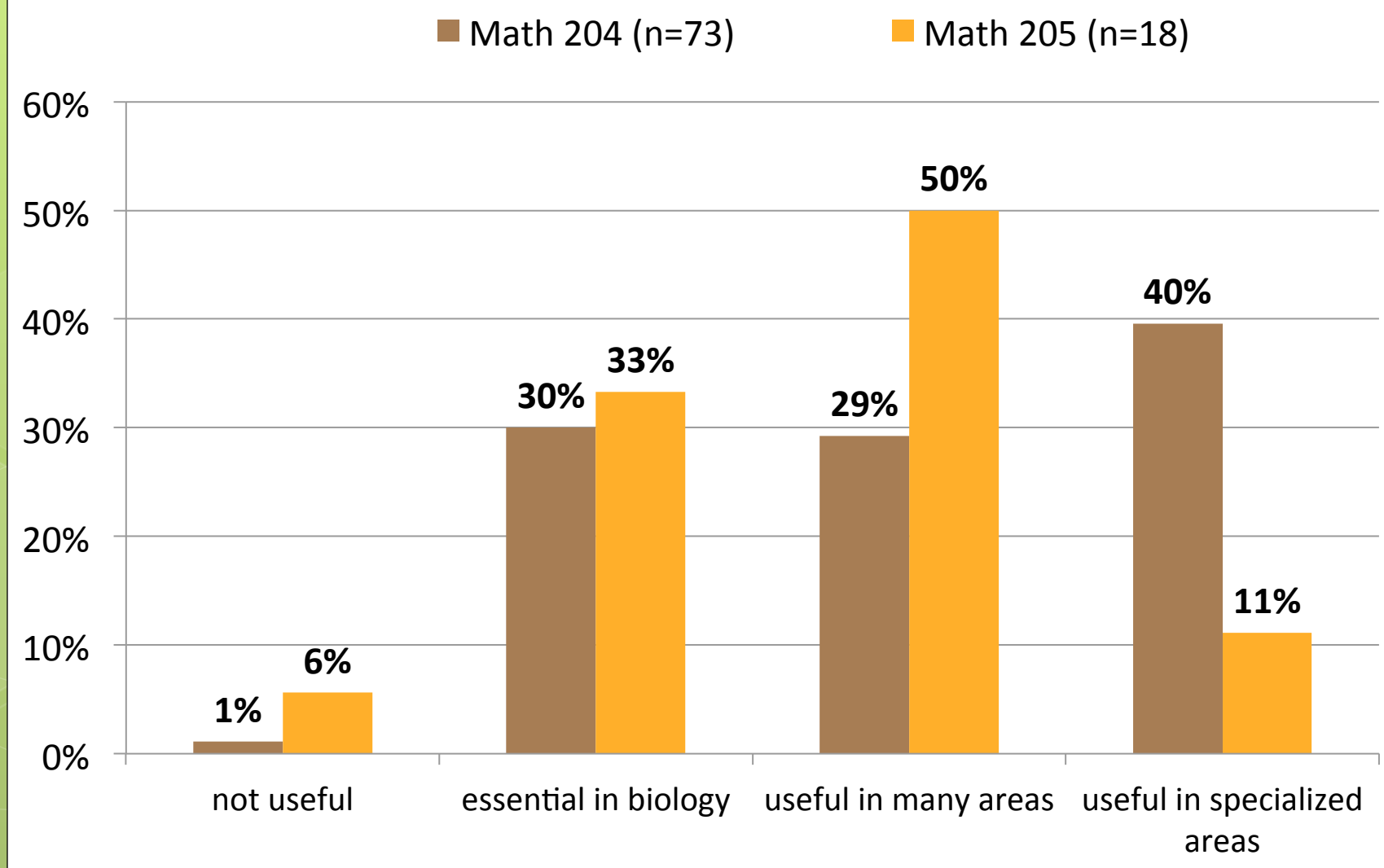
Students' Attitudes Toward Mathematics by Course (Fall 2011 – Spring 2012)



Usefulness of Math in Biology Career
Math 105 (Fall 2011-Spring 2012)



Usefulness of Math in Biology Career
Math 204 & 205 (Fall 2011-Spring 2012)



NOTE: Only post-data available for Math 204 and Math 205.

Student comments (Math 105 & 204)

Elaborate on why (or why not) you think mathematics is important to your biology degree and career goal.

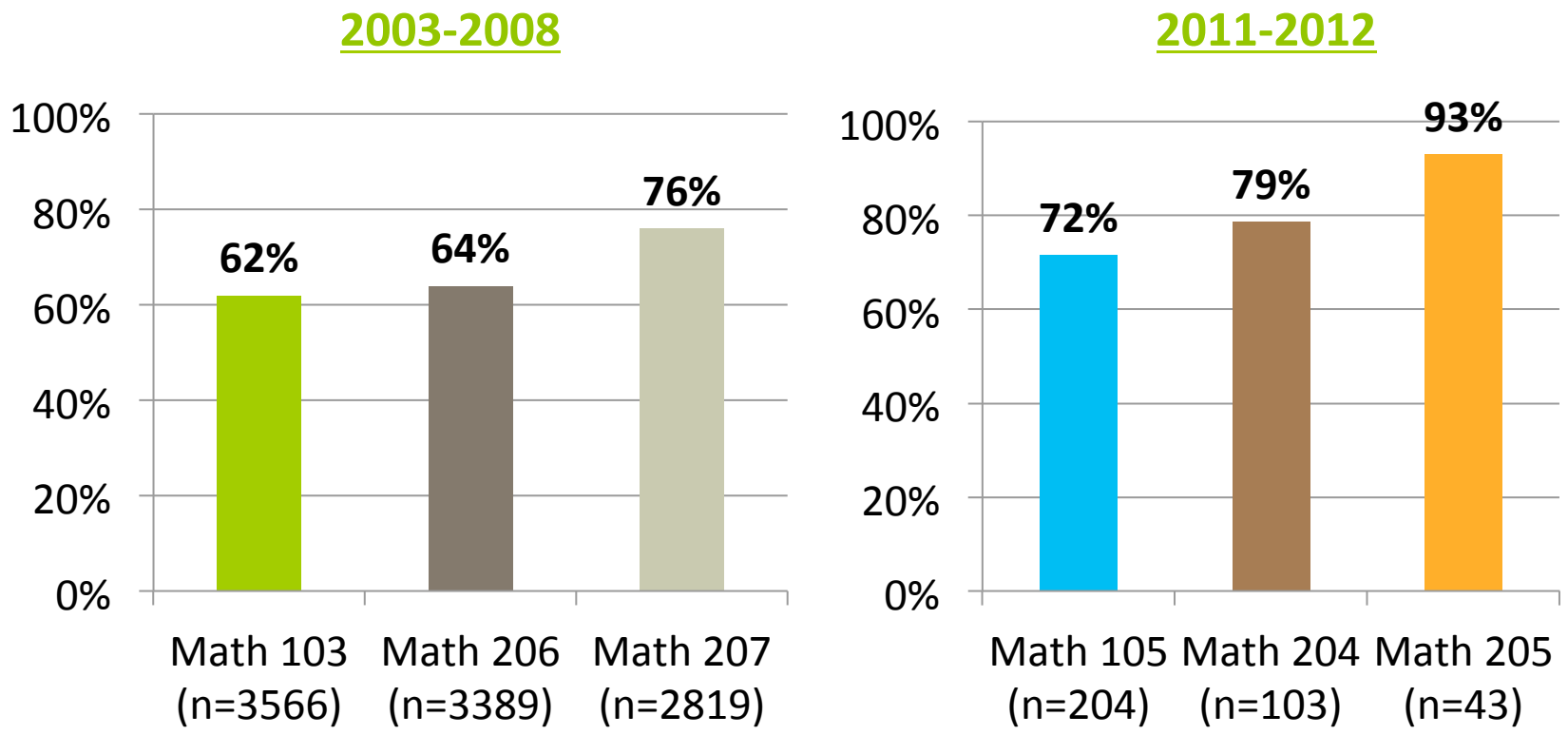
- Math is essential to biology for figuring out probability of alleles and genetics….**Until this class I didn't know exactly how essential math was to biology**.
- I have taken **biology 100B** and I had hard time with the part when it came to genetics and alleles. **This class actually helped me understand how to compute the percentages of an offspring with certain phenotype qualities.**
- **It is extremely important, unfortunately**. I have a hard time understanding math so while I know it is important it doesn't necessarily mean I enjoy it. **But when applied to specific situations that are interesting it is less abstract and easier to understand.**
- Mathematics is important to my biology and my career goal because I am interested in research and I believe that **the more math I know, the more credible and valuable my future experiments can be**.

Student comments (Math 105)

What did you like best about Math 105? What is the most interesting thing you learned in Math 105?

- **I liked that I was able to learn how exactly math concepts were used in biology**.
- Some interesting concepts that regard my career goal. **Focuses on many other careers that involve biology besides the medical field**.
- The most interesting thing I learned in Math 105 was **how useful math is in the biological world & how it goes hand in hand.**
- What was interesting was the majority of the material I learned **applied to real life situations** that I may run into in the workplace.
- Overall, how biology used in math is interesting and as a biology major. **I liked seeing how math is useful for once.**

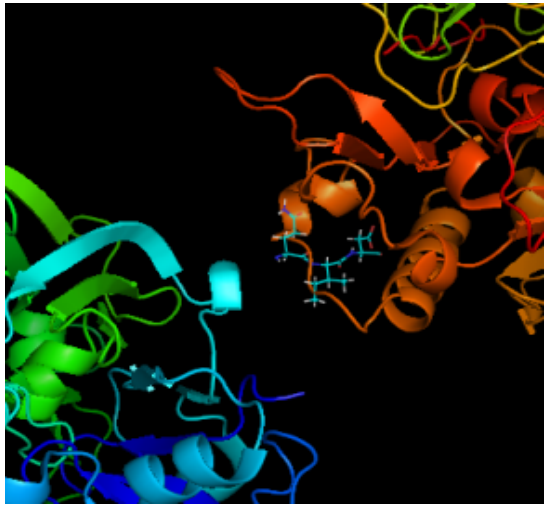
Math Course Pass Rates:



Challenges

- Curriculum change takes time
- Different culture of departments (unit structure, lab courses, etc)
- Finding enough instructors willing to teach applied materials and using computers
- Finding a good text
- Getting biology faculty comfortable with teaching using a more quantitative approach
- Transfer student advisement (no course equivalent to Math 105 exists) and integration into the Applied Calculus sequence w/o the Math 105 course





BINF Minor

- Target Audience = Biology and CS majors
- LD requirements:
  - 2 Programming courses
  - 2 biology courses
  - 1 stats/probability course
- Half of these required by respective majors

Upper division requirements

- **BINF 400** - **Bioinformatics and Computational Biology** (Fall 2012)
- **BINF 401** -**Machine Learning Applications in Molecular Life Sciences** (Winter 2013)
- **BINF 402** – **Phylogenomics** (Winter 2013)
- **BINF 403** - **Process Estimation and Detection in Cellular Biology** (Spring 2013)
- **BINF 450** - **Advanced Topics in Bioinformatics and Computational Biology** (Spring 2013)

New Upper Division Elective

- Developed a cross-listed math biology modeling course **Math/Biol 480**
- Math majors prerequisite will be Calculus I&II, Linear Algebra and Differential Equations
- Biology majors will have Math 105, 204 and 205 as prerequisite.
- Course taught by both math and biology faculty (alternating)
- First offered in Spring 2013
- Also potentially useful course for graduate biology majors