Quantitative Skills in Context

Christopher W. Beck
Department of Biology, Emory University

Whether quantitative skills are best taught in the context of disciplinary science classes or in specially-designed courses in math and statistics for science majors is unclear. The aim of this study was to evaluate the quantitative literacy of beginning biology students and explore learning gains in quantitative literacy when quantitative skills are taught in the context of biology. During Spring and Fall 2015, I used the BIOSquare Quantitative Biology Assessment designed by an HHMI collaborative as a pre-test/post-test in my Organismal Form and Function course of approximately 60 students. In addition, I asked demographic questions and questions about previous quantitative training. Students showed a statistically significant increase in quantitative skills with scores on the assessment increasing from 61% to 64%. However, the effect size was small (0.225) and gains differed depending on semester. Pre-test scores were influenced by year in college, gender, URM status, and whether students had taken a discipline-based statistics course or not. Changes in quantitative literacy depended on URM status and whether students had taken a discipline-based statistics course or not.

Introduction

National reports have called for an increased emphasis on quantitative literacy in the biological sciences (NRC 2003, 2009, AAAS 2010). Historically, biology majors have taken math courses (e.g., calculus) in the math department. In some cases, special sections of calculus are developed for life science majors that use examples from biology (Duffus and Olifer 2010, Usher et al. 2010). However, others have pushed for greater integration of quantitative concepts in standard biology courses (Feser et al. 2013). Several studies do suggest that incorporating quantitative skills into standard biology courses can lead to increased quantitative literacy (Speth et al. 2010, Hester et al. 2010). In the current study, I examined how previous quantitative courses influenced quantitative literacy at the beginning of the semester and whether quantitative literacy improved throughout the semester in a course that emphasized graph interpretation.

Literature Cited

AAAS. 2010. *Vision and Change*.
Duffus, D. and Olifer, A. 2010. CBE-Life Sciences Education 9:370-377.
Feser, J. et al. 2013. CBE-Life Sciences Education 12:124–128.
Hester, S et al. 2014. CBE-Life Sciences Education 13:54–64.
NRC. 2003. *BIO2010: Transforming Undergraduate Education for Future Research Biologists*.
NRC. 2009. *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution*.
Speth, E.B. et al. 2010. CBE-Life Sciences Education 9:323–332.
Usher, D.C. et al. 2010. CBE-Life Sciences Education 9:181–188.

Methods

- Pre-test/post-test format
- BIOSquare assessment of quantitative literacy, Version 3
  - http://www.macalester.edu/hhmi/biosquare/
  - 26 questions
  - data distributions, experimental design, graphing, graph interpretation, interactions, math models, probability, variability
  - internal reliability (Cronbach's alpha): 0.69

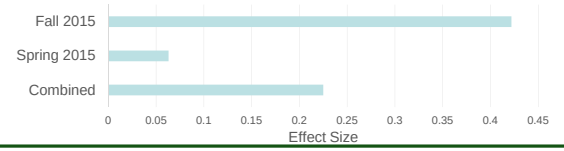
Sample

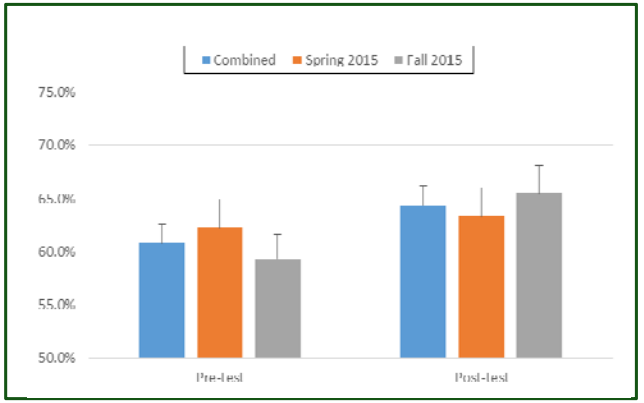
- Class: 16% Freshman, 21% Sophomore, 40% Junior, 24% Senior
- High School Math: 96% Pre-calculus, 82% Calculus – derivatives, 69% Calculus – integrals, 50% Statistics
- College Stats: 21% Math, 6% Disciplinary, 16% QTM
- 61% Female, 21% URM

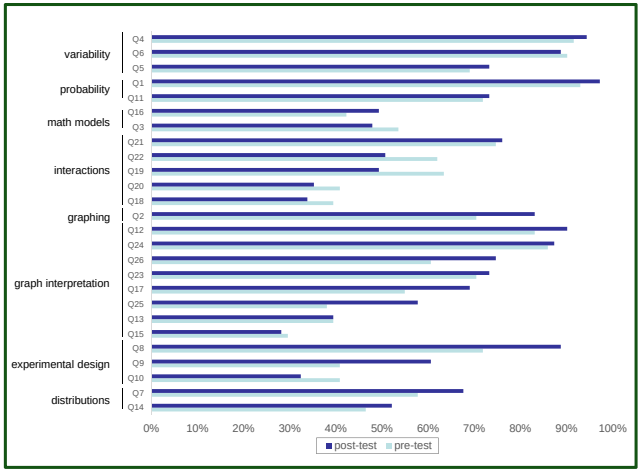
Effects on Pre-test Score

- year in college – sophomores (68%) scored higher than freshmen (57%)
- gender – males (63%) scored higher than females (60%)
  - No bias for any individual items
- URM status – URM students (51%) scored lower than non-URM students (64%)
  - No bias for any individual items
- Students who took discipline-based statistics course (80%) scored higher than those that didn't (60%)

Gains in Quantitative Literacy







Effects on Learning Gains

- Lower gains if student had taken disciplinary statistics
- Lower gains for URM students

Difficult Concepts

- Graph interpretation with log scale
- Correlation versus causation and experimental design
- Graph interpretation and interaction effects