A Decade of
Quantitative Reasoning at
Kalamazoo College:
The Early Years

Distribution Requirements:

- **Pre 1996**
  - Three courses from the Division of Natural Sciences (Chemistry, Physics, Biology, Mathematics, Computer Science)
  - Not all three in Mathematics
- **Post 1996**
  - Two courses from Science Division
  - One Quantitative Reasoning course
  - No "double-dipping"

Preparations for QR Across the Curriculum

- QR Committee Named
  - Representation from Sociology, Economics, Psychology, Chemistry, Mathematics
  - Chaired by Biologist
- "Best Practices" Studied
  - MAA Report: "Quantitative Reasoning for College Graduates: A Complement to the Standards", Linda Sons, Editor
  - Project Kaleidoscope: Quantitative Reasoning Workshop, Santa Fe, Summer, 1996
  - Mount Holyoke College, Case Studies in Quantitative Literacy, Fall, 1996
  - Pew Consortium Visitation Grant: Visited St. Olaf and Macalester Colleges, Fall, 1996

Program Rationalized; Expectations Defined

- "The reason to be literate in science and mathematics is the same as to be literate in history, literature, philosophy, or art. Ignorance causes lives to be lived superficially." – *Project Kaleidoscope, What Works: Building Natural Science Communities*
- "The courses will be (1) those where real-world topics provide the context for learning and practicing quantitative reasoning and (2) those where quantitative reasoning is used to explore more fully topics encountered in the world around us."– *Educational Policies Committee, Guidelines for Quantitative Reasoning Courses*
- "A course will satisfy the quantitative reasoning requirement if students in the course develop their ability in all of the first three areas, and three of the last four [following] areas:"

1. **Organize Ideas Effectively**
   - Use quantitative language and mathematical symbols to clarify ideas
   - Use sketches, diagrams, graphs, tables, and other mathematical models to analyze situations
2. **Communicate Ideas and Information Clearly**
   - Write and speak about quantitative ideas clearly in words
   - Use mathematical notation correctly
   - Present relevant data effectively, using graphs and tables when appropriate
3. **Construct and Defend and Argument Using Evidence Persuasively**
   - Reason deductively
   - Use statistics appropriately
   - Use estimates and error analysis
4. **Interpret and Create Graphs and Tables**
   - Understand Cartesian coordinates
   - Convert information given by a formula, graph, or table to another format
   - Understand the significance of the slope and concavity of a graph
   - Understand histograms and other ways to present data
   - Use a software package such as Excel, Cricket Graph, Derive Maple, Mathematica, MATLAB, etc. to work with data presentation
5. **Use Various Measurement Scales to Interpret Data**
   - Convert between scales
   - Convert units
   - Use appropriate scaling in graphs and tables
6. **Apply Simple Mathematical Models**
   - Use various functions as mathematical models
   - Use algebra to make predictions from mathematical models
7. **Interpret Statistics**
   - Understand the meaning of mean, standard deviation, correlation coefficient, and regression lines
   - Use a software package such as Fastat, Minitab, SPSS, etc.

New Courses:

- **Math 105: Quantitative Reasoning and Statistical Analysis** An introduction to some of the quantitative techniques used to clarify ordinary experience and to some of the statistical ideas used to shape public policy and human sciences, with emphasis on the concepts involved in producing, organizing, and drawing conclusions from data.
- **Soc/Anthro 212: Quantitative Analysis and Statistical Reasoning** An introduction to the use of quantitative analysis and statistical reasoning in the fields of sociology, anthropology, and human development and social relations. The course will emphasize understanding and critiquing data and conclusions, and students will produce data sets as well. Students will develop skill in using SPSS.
- Both of these courses use *Concepts and Controversies* by David Moore

The Complete List: 8 Departments, 22 Courses

- **Chem:** Introductory Chemistry II
- **Comp. Sci:** Intro to Programming w/Lab
- **Econ:** Quantitative Methods I; Quantitative Methods II
- **Interdisciplinary:** Dynamic Models in Social Science
- **Math:** Mathematical Reasoning Through Problem Solving; Quantitative Reasoning and Statistical Analysis; Calculus With Review*; Intermediate Calculus; Calculus I, II, III; Linear Algebra; Applied Stats I and II
- **Physics:** Astronomy; Energy and Environment; Musical Acoustics; Introductory Physics w/Lab I, II
- **Psych:** Experimental Methods
- **Soc/Anthro:** Quantitative Analysis and Statistical Reasoning

What worked:

- College has a common understanding of its "Quantitative Reasoning" expectations
- Elementary statistics now part of the curriculum

What didn't:

- Quantitative Reasoning Committee never found a permanent home
- Haphazard articulation between introductory (Type 1) and follow-up (Type 2)

A Decade of Quantitative Reasoning at Kalamazoo

The Later Years

Eric Nordmoe

Outline

- Assessment background
- Why assess QR?
- How to assess QR?
- Current status

QR Assessment Background

- 1992-93 Self-study promised extensive assessment program
- 1993-1996: Change happens
- 1999: Ad hoc Assessment committee formed
  - Initial focus: Assessment of General Education

Why Assess QR?

- Are the goals of the QR general education requirements being met?
- Identify strengths and weaknesses of the program
  - Patterns across courses
  - Course-specific issues

Omnibus Assessment Tools

- Class of 2000 Longitudinal Survey
- 2001 Alumni Survey
- Survey of Alumni with Doctorates (current)

QR Assessment Tools

1. Pre-post testing
    - Are measurable improvements in general skills achieved over the course of a quarter?
2. Self-reported competencies
    - Are students more confident in their abilities after taking a QR course?
    - Have attitudes toward QR changed?

1. Pre-Post Testing

- "Equivalent" 20-question multiple choice exams developed to test performance against general QR skills list
- Pre- and post-tests administered
  - First and last days of quarter
- Administered in two classes:
  - Applied Statistics: Math 260
  - Quantitative Reasoning and Statistical Analysis: Math 105

Questions 9)-11) are based on the following information:

After teaching a course many times, an instructor developed a model for predicting a student's final exam score from the midterm exam score. Specifically, the model is

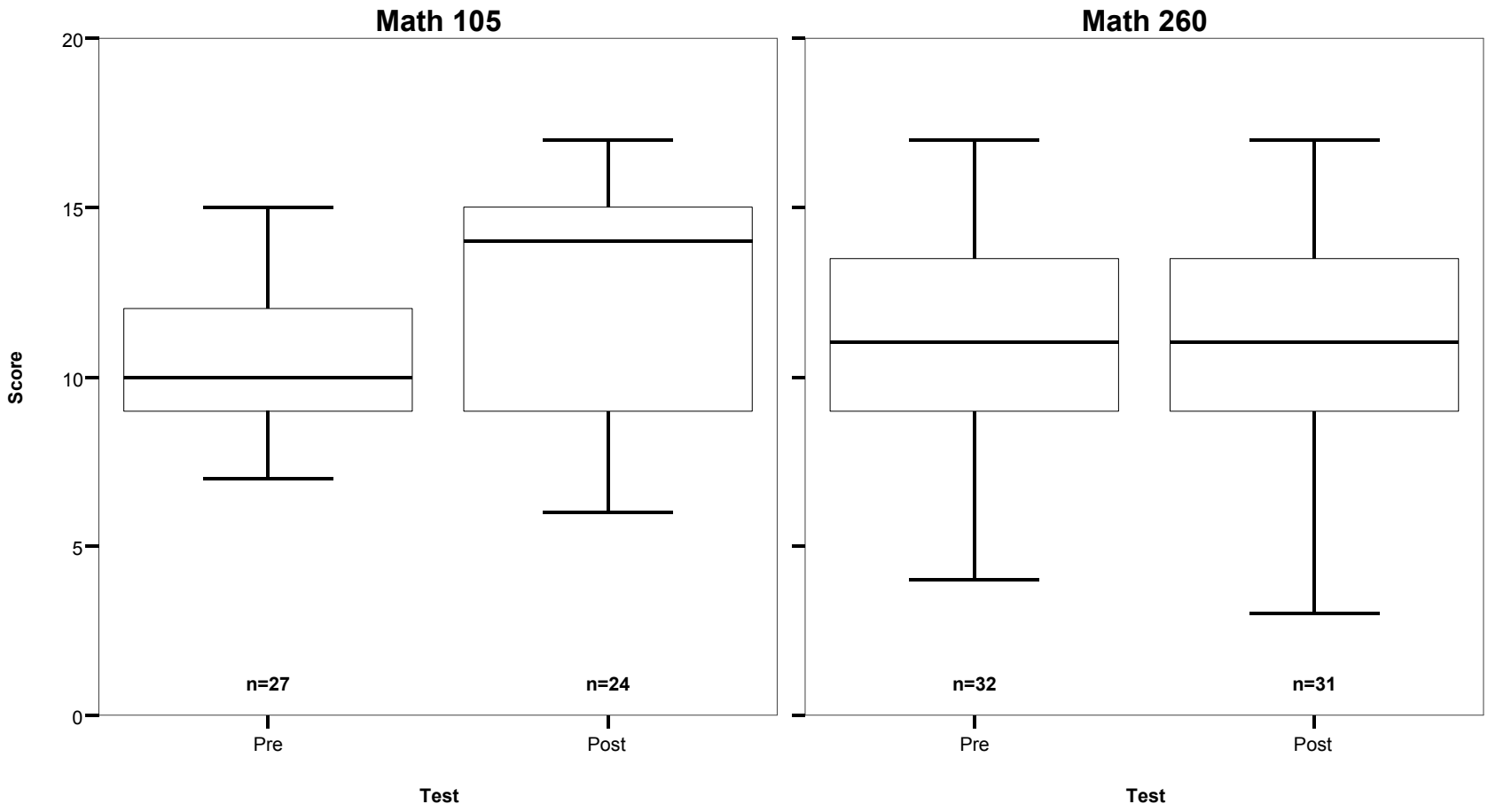
$$y = \frac{1}{2}x + 50$$

where x represents the midterm exam score (as a percent) and y represents the predicted final exam score (also as a percent). While the model provided useful predictions, prediction errors of five percentage points or more were not uncommon.

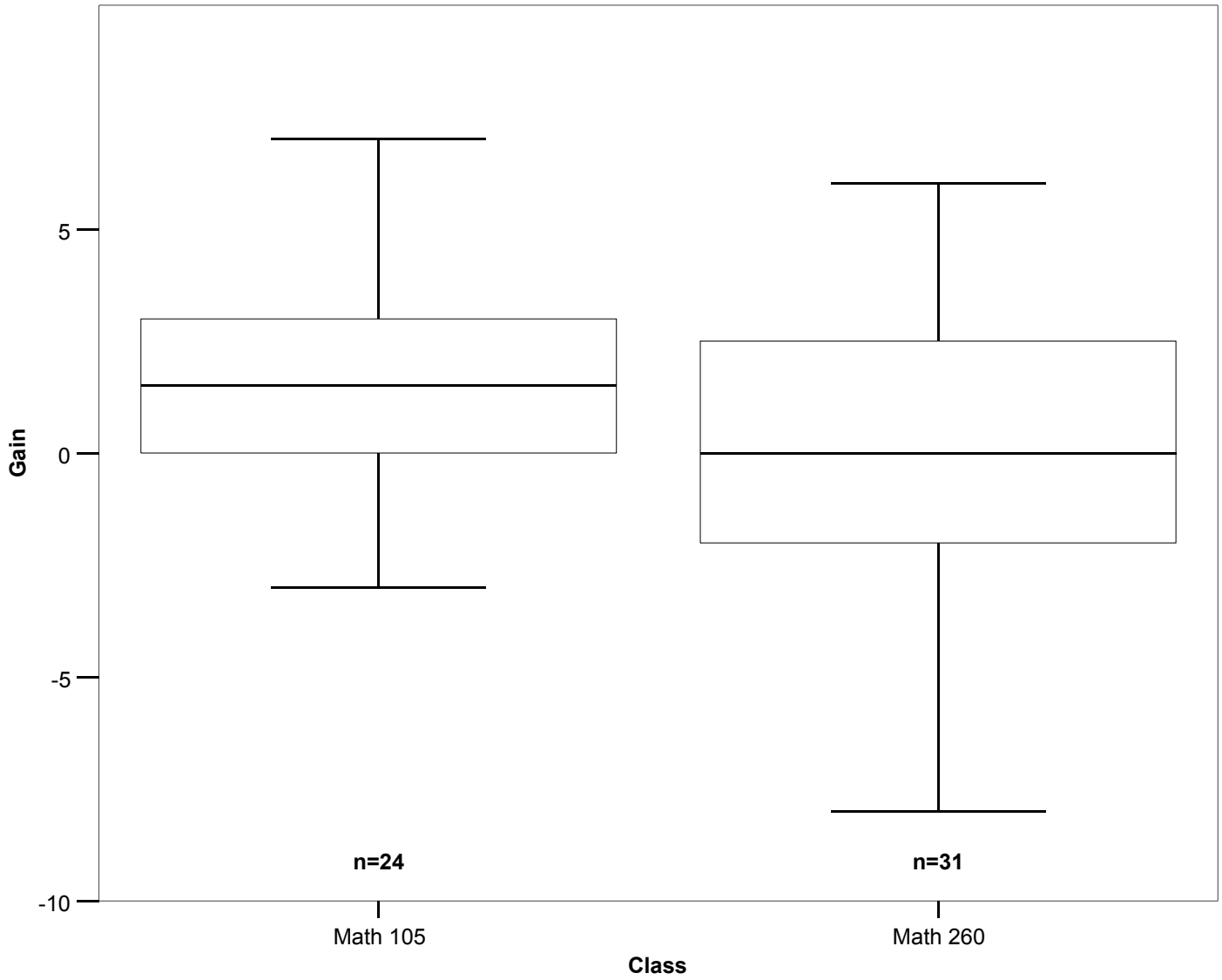
9) Suppose a student scored 90 percent correct on the midterm exam. According to the model, what would be the predicted exam score for the final exam?
   a) 45
   b) 90
   c) 95
   d) 100
   e) Cannot be determined from the model.

10) The model correctly predicted that Joe would score 100 percent on his final exam. What score did he achieve on his midterm exam?
   a) 45
   b) 90
   c) 95
   d) 100
   e) Cannot be determined from the model.

11) John scores 10 points higher than Matt on the midterm. What does the model predict about their final exam scores?
   a) John is predicted to score 5 points higher than Matt on the final exam.
   b) John is predicted to score 10 points higher than Matt on the final exam.
   c) John is predicted to score 25 points higher than Matt on the final exam.
   d) John is predicted to score 50 points higher than Matt on the final exam.
   e) None of the above.


Math 105
Math 260
Score
20
15
10
5
0
n=27
n=24
n=32
n=31
Pre
Post
Pre
Post
Test
Test

Pre to Post QR Score Gains



Thoughts on Pre-Post Testing

- Strengths
  - Attempts to measure skill gains objectively
  - Relatively easy to administer and track
- Weaknesses
  - Difficult to develop valid and reliable instruments (in multiple versions)
  - Measurable skill gains may be content-specific, not suited to a single QR exam

Attempt at Self-Reported Assessment

- Self-assessment of QR skills and attitudes
  - Forced-choice QR skill ratings
  - Open-end attitudes toward the course and QR activities
- Administered in several QR courses Spring 2002
- Results discussed with individual QR instructors

QUANTITATIVE REASONING COURSE ASSESSMENT

Thank you for your cooperation with this brief assessment. Your participation will help us to improve the way quantitative reasoning is learned at K College.

Thinking about this quantitative reasoning course, please answer the following questions thoughtfully and completely: You may use the reverse side if you need more space for any question.

1. How would you rate your ability to do each of the following, and how much did this course contribute to your ability in each area? (circle the appropriate number)

	Rating of your ability in this area Low				High	**Contribution of this course** Very little				A great deal
Organize quantitative ideas effectively	1	2	3	4	5	1	2	3	4	5
Communicate quantitative ideas and information clearly	1	2	3	4	5	1	2	3	4	5
Construct and defend an argument using quantitative evidence persuasively	1	2	3	4	5	1	2	3	4	5
Interpret and create graphs and tables	1	2	3	4	5	1	2	3	4	5
Use various measurement scales when interpreting data	1	2	3	4	5	1	2	3	4	5
Apply simple mathematical models	1	2	3	4	5	1	2	3	4	5
Interpret statistics (e.g., mean, standard deviation, etc.)	1	2	3	4	5	1	2	3	4	5

2. What aspects of this course did you find most challenging?

3. In what ways do you anticipate using the information and skills you have acquired in this course?

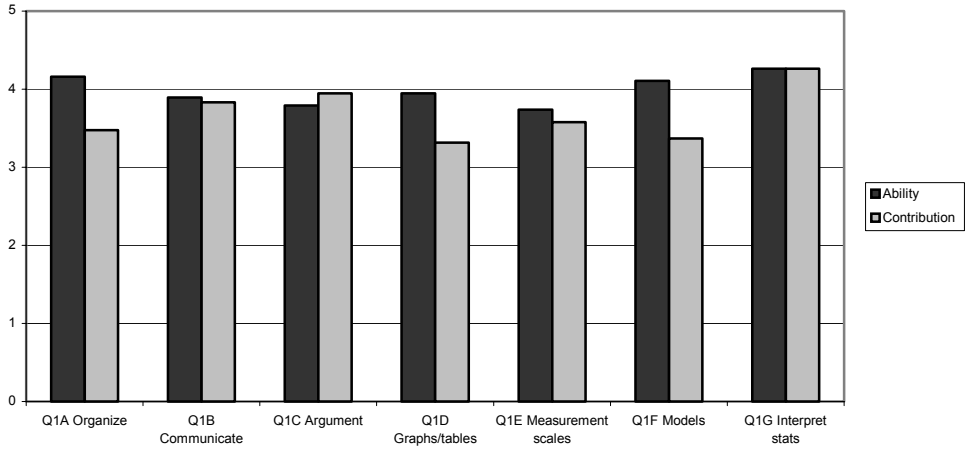
4. What kinds of quantitative activities are you more likely to undertake *now* that you wouldn't have *before* taking this course?

5. How has this course changed your attitudes toward quantitative information?

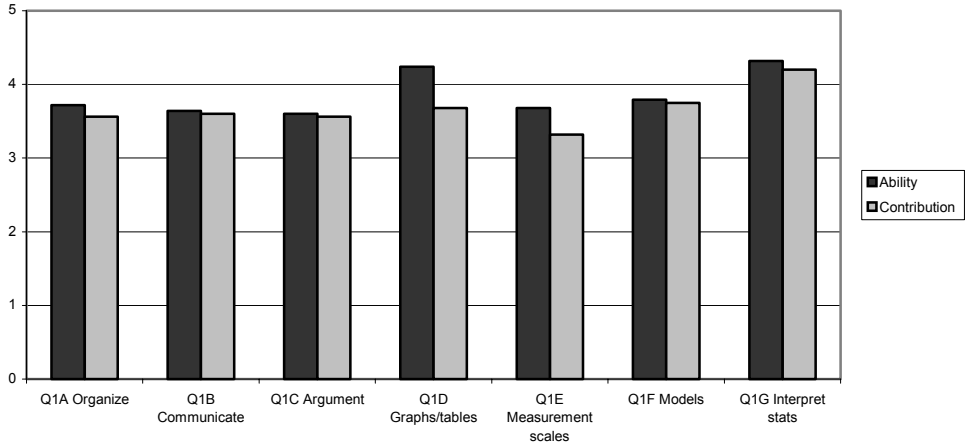
6. If you had the opportunity to take another course that uses quantitative reasoning, would you be likely to do so? Why or why not?

QR Assessment Results:
QR Courses

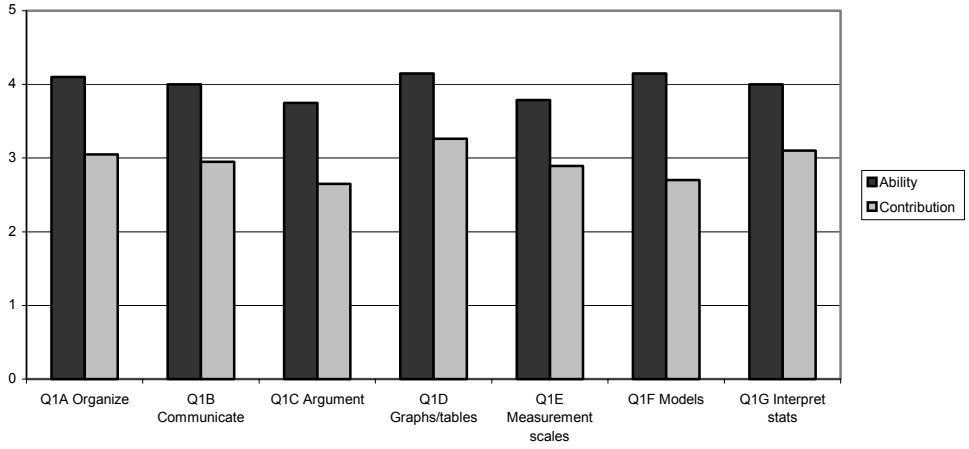
QR Course 1



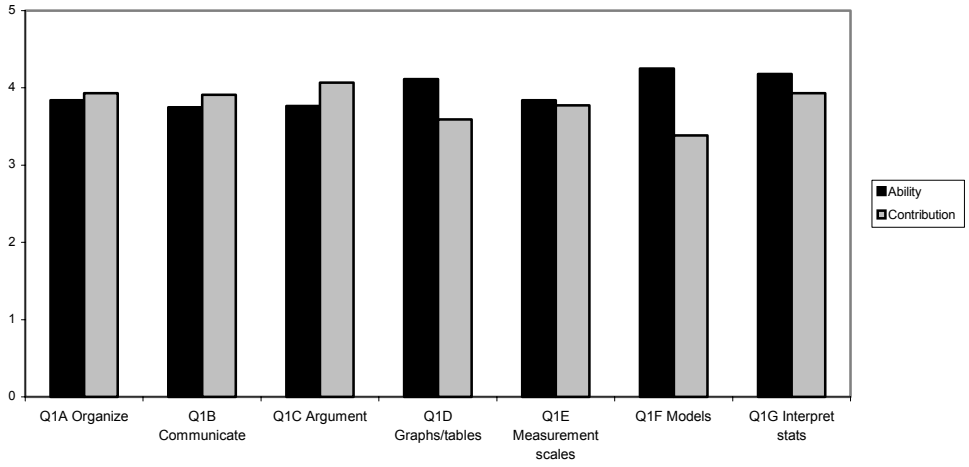
QR Course 2



QR Course 3

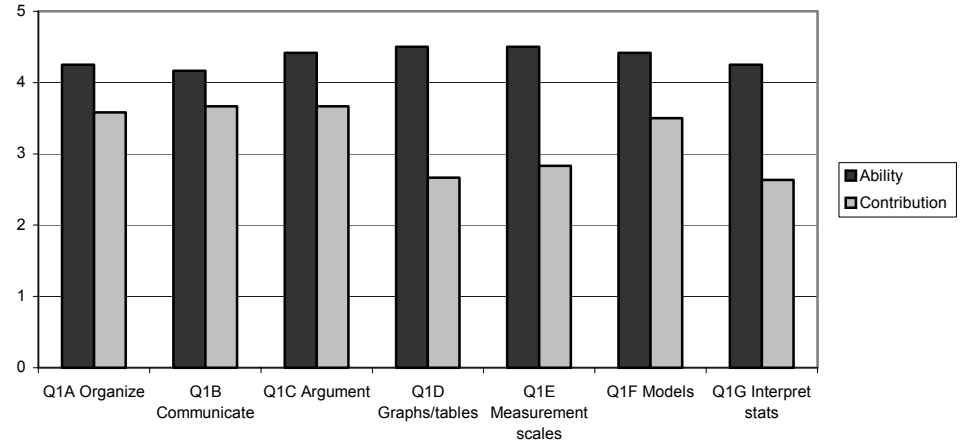


QR Course 4

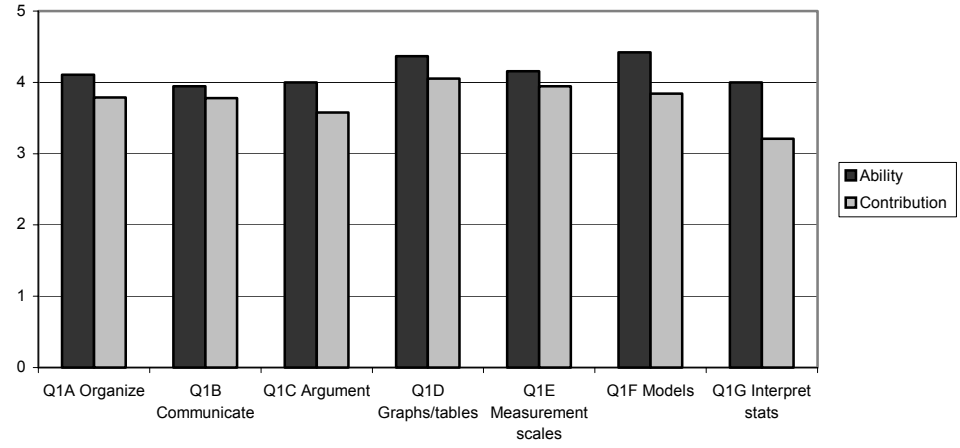


QR Assessment Results: Math/Science Courses with QR Credit

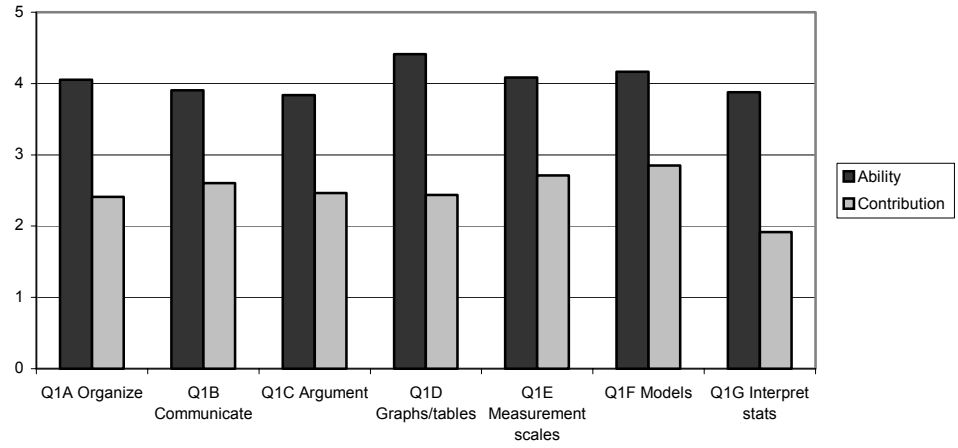
Math/Sci Course 1



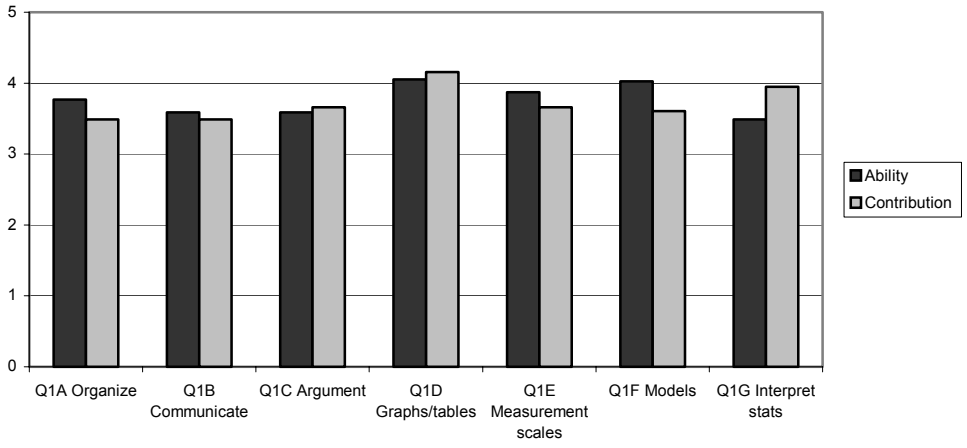
Math/Sci Course 2



Math/Sci Course 3



Math/Sci Course 4 (no QR credit)



Thoughts on Self-Reported Assessment

- Strengths
  - Produces "quantifiable" perceived gains in understanding and competencies.
  - Sensible results
- Weaknesses
  - Perceived and actual competencies may differ greatly.

Enter the Reaccreditation Team

- The institution has "inadequately addressed" assessment.
- The team recommended using
  - "more direct methods for measuring student educational outcomes"
  - "reporting on progress about how these more direct student educational outcome measures have led to improvements in the departmental and general curricula."

Current Status:QR Assessment

- The Assessment committee is rethinking strategies for assessment of general education.
- Ongoing assessment of QR should emphasize learning outcomes.
- Consider developing pre/post tests for specific courses or course clusters?

Current Status of QR

- The QR Committee meets on an *ad hoc* basis
  - Focused on assessment activities
- Limited awareness of QR
  - Not all faculty aware of QR goals
  - Some new faculty unaware their classes earned QR credit.