Three Approaches to Assessment in the Quantitative Reasoning Classroom

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The University of Massachusetts Boston

- Boston's public urban research university.
- 16,000 undergraduates and graduate students.
- 7 undergraduate colleges.

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Quantitative Reasoning & General Education

Students in liberal arts, social sciences, education take **Math 114Q: Quantitative Reasoning** to meet this requirement.

Course description:

This course covers the basic algebra and technological tools used in the social, physical and life sciences to analyze quantitative information. The emphasis is on real world, open-ended problems that involve reading, writing, calculating, synthesizing, and clearly reporting results. Topics include descriptive statistics, linear, and exponential models. Technology used in the course includes computers (spreadsheets, internet) and graphing calculators.

Text: *Common Sense Mathematics* (www.quantitativereasoning.net)

Focus is on paying attention to the numbers, understanding numbers in context, developing problem solving abilities, relying on common sense and common knowledge.

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Assessment approach #1: student self-reflections

- Online survey asks students to assess their technical/ computer skills and quantitative reasoning abilities.
- Attempts to measure some attitudinal change.
- Administered online with support from the mathematics department.
- At the end of the semester, faculty can log in to view their students' responses and aggregated responses.
- This has been in place since 1999.

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Sample questions

12. As a result of the course my ability to:

	Is about the same	Is Improved	Is much improved
a. Attach documents to email	_____	_____	_____
b. Use Excel to analyze data	_____	_____	_____
c. Use a word processor	_____	_____	_____
d. Use the Internet to obtain information	_____	_____	_____
e. Cut/paste and download data from the Internet	_____	_____	_____
f. Read and understand graphs	_____	_____	_____
g. Draw conclusions from datasets	_____	_____	_____
h Work with formulas	_____	_____	_____
i. Work with very large and very small numbers	_____	_____	_____
j. Use data to construct a convincing argument	_____	_____	_____

13. Do you find that you now read newspaper or magazine articles that contain data, charts or graphs more critically? Yes _____ No _____

14. Check any of the boxes below that apply to you:

	I would be comfortable applying this in another course or in my employment	I have already applied this in another course or on-the-job (if so, specify the course or the kind of job)
a. Evaluating quantitative claims and the evidence presented in their support	_____	_____
b. Using Excel to organize and analyze data	_____	_____
c. Producing reports that use data, charts or graphs to support conclusions or arguments	_____	_____
d. Using technology learned in this class	_____	_____

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Most useful questions

My ability to draw conclusions from datasets is…		
	Fall 2008	**Spring 2013**
Much improved	32%	39%
Improved	48%	40%
About the same	20%	21%
My ability to use data to construct a convincing argument is…		
Much improved	35%	38%
Improved	46%	40%
About the same	19%	23%
Do you find that you now read newspaper or magazine articles that contain data charts or graphs more carefully?		
Yes	49%	57%
No	30%	28%
No opinion	22%	15%

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Assessment of the assessment

Why it's good:

- Student self-assessment;
- Possible to track changes over time;
- Data became more useful when we all began to use the same text.

Why it's not so good:

- Requires support from instructors and tech folk;
- Lots of reasons for variability: different faculty, semester issues, different students;
- Too long – we need to trim questions (we don't use all the data).

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Approach #2: programmatic assessment

Initial model (from 1999):

- Faculty reflections;
- Review of course syllabi and web content;
- Review of portfolios of selected student work (including an end-of-the-semester student self-reflection);
- Holistic assessment of common final exam problems from a sample of student final exams.

Challenges:

- Too much work!
- Feedback loop stretched out too long (danger of no actual feedback);
- Inconsistent information and little basis for comparison over time;
- The assessment focus evolved away from “is this instructor teaching to the learning outcomes” to “as a whole, is the course doing what it should be doing?”.

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New approach (since 2008)

After an assessment of the assessment (through a PKAL/QuIRK workshop), we made some changes:

- Focus on holistic assessment of common final exam questions for a sample of students (6 from each section: 2 strong, 2 average, 2 weak);
- QR faculty do this assessment as part of their end-of-semester debriefing.

Result: faculty are involved in this process and can reflect immediately on trends that they see. This means that we close the assessment loop through the discussions that follow.

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Examples from Fall 2011

Students showed marked improvement in understanding the concepts of exponential growth and decay, performing calculations involving exponential functions, and creating and interpreting exponential models. This can be positively attributed to the holistic grading assessment, which identified this as a previous weakness that faculty addressed in their teaching this year.

Although students demonstrated a conceptual understanding of measures of central tendency, their ability to estimate these values when data are presented in value ranges only showed partial mastery. They also demonstrated only partial mastery in their ability to make coherent arguments supported by mathematical models they had created. Backward percentage calculations remain a challenging concept for most students.

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Examples from fall 2012

Students on the whole demonstrated full or near mastery when identifying and extracting relevant data from complex verbal texts. They also demonstrated full or near mastery when reading and estimating values from time series graphs. Another area of student strength was their use of Excel to perform calculations and create mathematical models, as well as the ability to interpret tables and graphs.

Although students demonstrated a conceptual understanding of measures of central tendency (mean, median, mode), their ability to estimate these values when data are presented in value ranges only showed partial mastery.

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Approach #3: assessing attitudinal change

As the QR course has evolved, faculty now focus on developing problem-solving skills and higher level "habits of mind" in their students. This reflect the shift to the *Common Sense Mathematics* text and approach.

How to assess this? We used a pre- and post-semester student attitudinal survey, based on the Dartmouth College Mathematics Across the Curriculum Survey.

We ask 40 Likert-type questions with responses ranging from "least favorable" to "most favorable".

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Math/QR attitudes survey

Items were to develop scales. All scales had good reliability.

1. Confidence in math ability
   - I usually skip over numbers when I see them in the media
   - I cannot do math without a calculator
   - Learning math makes me nervous
2. Perception of math/QR as applicable to the real world
   - Math helps me understand the world around me
   - Mathematical thinking helps me make intelligent decisions
   - Understanding basic math can help me to be a better informed citizen
   - After I have forgotten all the formulas, I will still be able to use the ideas I learned
3. Ability to achieve concrete goals involving math
   - I am confident in my ability to make a budget/read a loan/read a credit card statement
4. Attitude toward math
   - I enjoy learning new things in math
   - I like exploring problems with real world data

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Evaluation process

With support from an NSF CCLI grant*, we hired a consultant to review at student responses for fall 2011, spring 2012, summer 2012, fall 2012.

- Total of 481 pre-surveys, but only 215 matched up with post-surveys.
- Aggregated the data.
- Analysis looked for significant change from pre- to post-semester.
- Matched cases were analyzed using a within person paired t-test to evaluate changes in students' scores

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Results

- Improvement was seen in all four areas (confidence in math ability, perception of math/QR as applicable to the real world, ability to achieve concrete goals involving math, attitude toward math).
- Significant improvement was seen in:
  - Ability to achieve concrete goals involving math
  - Perception of math as applicable to the real world.
- Comparing mean scores without regard to matching students' pre- and post-semester indicated positive changes in most scales.
- Positive change increased with each semester.

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Conclusions

- If we had additional funding, it would be interesting to survey students several semesters after the course.
- If we had to do this again, we would work with the consultant from the beginning to craft the survey design and to address the issues of pre- and post-semester matching.
- While attitudinal changes were not what we hoped for, the reality may be that achieving attitudinal change in one semester may be unrealistic.

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Questions? Need more info? Contact us!

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