

Assessing Quantitative Reasoning in Student Writing: A QuIRKy Experience

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New England Educational Assessment Network

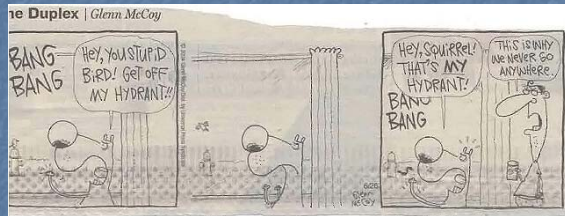
With support from the US Department of Education's Fund for the Improvement of Post-Secondary Education, the National Science Foundation, and the WM Keck Foundation.

What is QuIRK?

Carleton College's Quantitative Inquiry,
Reasoning, and Knowledge (QuIRK)
initiative.

serc.carleton.edu/quirk

What is QR?



What is QR?

"The power and habit of mind to search
out quantitative information, critique it,
reflect upon it, and apply it in their public,
personal and professional lives. "

—National Numeracy Network
vision statement

What is QR?

*The habit of mind to consider the power
and limitations of numerical evidence in
real-life problems.*

What is QR?

Four facets of QR:

- 1) QR requires a *basic skill set*

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- 1) QR requires a *basic skill set*
- 2) QR demands *application in context*

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"Deploying numbers skillfully is as important to communication as deploying verbs."

-Max Frankel, *The New York Times Magazine*

What is QR?

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"Numbers [are] the principal language of public argument."

-BBC Program *More or Less*

What is QR?

Four facets of QR:

- 1) QR requires a *basic skill set*
- 2) QR demands *application in context*
- 3) QR involves *communication*
- 4) QR is a *habit of mind*

"[QR] is not a discipline but a way of thinking...."

-Lynn Steen
Achieving Quantitative Literacy

What is QR?

Weasel-Words Rip My Flesh! Spotting a bogus trend story on Page One of today's *New York Times*.

By Jack Shafer
Posted Tuesday, Sept. 20, 2005, at 6:38 PM ET

How many "many's" are too many for one news story?


Like its fellow weasel-words *some, few, often, seems, likely, more* -many serves writers who haven't found the data to support their argument. A light splash of weasel-words in a news story is acceptable if only because journalism is not an exact science and deadlines must be observed. But when a reporter pours a whole jug of weasel-words into a piece, as Louise Story does on Page One of today's (Sept. 20) *New York Times* in "Many Women at Elite Colleges Set Career Path to Motherhood," she needlessly exposes one of the trade's best-kept secrets for all to see. She deserves a week in the stockades.

What is QR?

"The Senate on Thursday narrowly approved a sweeping five-year plan to trim a variety of federal benefit programs and to allow drilling for oil and natural gas in a wilderness area of Alaska.... the most ambitious effort to curb federal spending in eight years It will... reduce the deficit and save roughly \$35-billion over the next five years "

New York Times, 11/4/05

What is QR?

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How to Beat the Big Energy Chill

This winter's soaring heating bills will be a painful reminder that we're living in an age of expensive energy. But there's an upside: the business case for renewable sources of energy is warming up quickly.

NEWSWEEK
Updated: 2:30 PM ET Oct 16, 2007

Gina and Ron Martin's home in Mentor, Ohio, is just plain big. It has six bedrooms, five and a half bathrooms, a cavernous basement, a spacious patio and a pool in the backyard. But the last thing the self-employed housing contractors suspected when they bought their dream house in 2004 was just how big the heating bills were going to be. Last winter their utility bills averaged \$400 a month. Although the price of heating oil has inched down in the past two weeks, the Martins are anticipating bills of \$700 a month this winter. They expect the price of energy to keep rising--and many experts agree with them. Once their three teenage kids leave for college, the couple plans to downsize. "We loved this house, now we hate this house," Gina says. "We are a hardworking middle-class family that is freaking out about a gas bill. Something is very wrong with that picture."

What is QR?



Friday, Jan. 12, 2007

Is the Autism Epidemic a Myth?

By Claudia Wallis

Epidemic is a powerful word. It generates bold headlines, congressional hearings, research dollars and dramatic, high-stakes hunts for culprits. It's a word that has lately been attached to autism. How else to account for the fact that a disorder that before 1990 was reported to affect just 4.7 out of every 10,000 American children now strikes 60 per 10,000, according to many estimates--the equivalent of 1 in 166 kids?

What is QR?

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Consumer Tools & More

Dec 30, 2007 1:15 pm US/Central Digg | Facebook | E-mail | Print

Report: Indians Denied Home Loans More Often

What is QR?

"...sophisticated reasoning with elementary mathematics more than elementary reasoning with sophisticated mathematics."

-Lynn Steen
Achieving Quantitative Literacy

Implications for Assessment

Four facets of QR:

- 1) QR requires a *basic skill set*
- 2) QR demands *application in context*
- 3) QR involves *communication*
- 4) QR is a *habit of mind*

Implications for Assessment

"[QR] is largely absent from our current systems of assessment and accountability."

-NCED (2001)

Implications for Assessment

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Implications for Assessment

Application in context:

"Standardized conditions are decontextualized by design"

-Grant Wiggins

"Get Real!": Assessing for Quantitative Literacy "

Implications for Assessment

Communication:

While traditional assessment tools effectively measure comprehension, the ability to read others' QR exposition does not guarantee the ability to engage in the creation of QR arguments.

Implications for Assessment

Habit of mind:

"As in book literacy, evidence of students' ability to play the messy game of the [QR] discipline depends on seeing whether they can handle tasks *without specific cues, prompts, or simplifying scaffolds* from the teacher-coach or test designer."

-Grant Wiggins

"Get Real!": Assessing for Quantitative Literacy"

Implications for Assessment

"[OR] requires creativity in assessment, since neither course grades nor test scores provide a reliable surrogate."

-Lynn Steen
Achieving Quantitative Literacy

Evolving Assessment Tools: JMU' Quantitative Reasoning Test

- Web-based
- Multiple-choice items
- 24 operational items
- Scores correlate positively with grades in and exposure to relevant courses
- Contact: Donna Sundre

Evolving Assessment Tools: Collegiate Learning Assessment

"Life is not like a multiple choice test."

Example Performance Task:

Analyze various possible causes of several recent airplane accidents so that your employer can evaluate recent decision to buy a plane for sales staff.

Evolving Assessment Tools: Collegiate Learning Assessment

Available information:

- 1: Newspaper articles about the accident
- 2: Federal Accident Report on in-flight breakups in single engine planes
- 3: Your company's internal email
- 4: Charts on SwiftAir's performance characteristics
- 5: Amateur Pilot article comparing SwiftAir 235 to similar planes
- 6: Pictures and description of SwiftAir Models 180 and 235

Evolving Assessment Tools: Collegiate Learning Assessment

357 institutions in 46 states have tested more than 70,000 students with the CLA

Contact: cla@cae.org

Evolving Assessment Tools: The QuIRK Rubric

"The interdisciplinary and contextual nature of [OR] cries out for a cross cutting approach."

-Lynn Steen
Achieving Quantitative Literacy

"We want to regularly assess student work with numbers and numerical ideas *in the field...*"

-Grant Wiggins
"Get Real!: Assessing for Quantitative Literacy"

Evolving Assessment Tools: The QuIRK Rubric

QuIRK's idea:

Measure QR in the natural context of papers written in courses across the curriculum—papers written for "authentic" purposes.

Evolving Assessment Tools: The QuIRK Rubric

Sophomore Writing Portfolio

3-5 papers plus reflective essay written in 2 of the 4 college divisions

- observation
- analysis
- interpretation
- documented sources
- thesis-driven argument

Evolving Assessment Tools: The QuIRK Rubric

Writing requirement assessment:
30 faculty members, 3 days, 450 portfolios

QR assessment:

6-8 faculty members, 3 days, random sample of portfolios, 1 paper each drawn from analysis, interpretation, or observation categories

Evolving Assessment Tools: The QuIRK Rubric

1. Does the assignment explicitly demand QR?

Quantitative Reasoning in Student Writing Rating Sheet

I Identification Student I.D.#: _____ Essay: 1 2 3 4 5

Department: _____ Category: **Observation** Analysis Interpretation

II Does the assignment explicitly call for the use of QR in the paper?

___ YES ___ NO ___ NO ASSIGNMENT PRESENT

Evolving Assessment Tools: The QuIRK Rubric

2. Did the student's response to the assignment head in a QR-relevant direction? If so, to what extent did the student actually use QR?

III Is QR potentially relevant to this paper? [rate potential contents of paper, not the assignment]

___ NO or incidentally only ___ YES, but peripherally only ___ YES, centrally

IV Does the paper, in fact, employ quantitative reasoning? [See "Employ QR Criteria", Note: This is not a rating of the quality of the QR shown; it is an assessment of the degree to which QR is present.]

___ rating of 0-4, where 0 = not at all and 4 = extensively.

Evolving Assessment Tools: The QuIRK Rubric

The importance of the periphery:

"Even for works that are not inherently quantitative, one or two numeric facts can help convey the importance or context of your topic."

-Jane Miller
The Chicago Guide to Writing About Numbers

Evolving Assessment Tools: The QuIRK Rubric

3. How and where did QR appear?

V. Did the paper:

- Discuss others' quantitative findings.
- Report an analysis of existing data (a secondary data analysis).
- Report on the collection and analysis of new data.
- Employ modeling.

VI. Where is the paper's quantitative information located? TEXT TABLE FIGURE

VII. In what form was quantitative information presented? (Indicate if this information was presented (a) without citing specific support, (b) with support described in words, or (c) with support citing numbers)

- average (mean) standard deviation (variability) significance test
- percentage time or date or age length of time
- rate count or amount index or other measure

Evolving Assessment Tools: The QuIRK Rubric

4. Spotlight on several recurring problems:

VIII. Problematic characteristics of the QR present in the paper: [check all that apply]

- Uses ambiguous words rather than numbers.
- Fails to describe own or others' data collection methods.
- Doesn't evaluate source or methods credibility and limitations.
- Inadequate scholarship on the origins of quantitative information cited.
- Makes an unwarranted claim about the causal meaning of findings.
- Presents numbers without comparisons that might give them meaning.
- Presents numbers but doesn't weave them into a coherent argument.

Evolving Assessment Tools: The QuIRK Rubric

5. How would you rate the overall quality of QR used in the paper

IX. OVERALL ASSESSMENT of QR actually employed in paper:
Rate each of the following using 0-4, where 0 = poor and 4 = exemplary, review attached criteria

- Implements Competently Interprets Soudly Communicates Clearly

Evolving Assessment Tools: The QuIRK Rubric

Example of QR-irrelevant paper:
"The Maiden who Needs No Saving"—an analysis of Keat's treatment of helplessness and power in "La Belle Dame Sans Merci"

Evolving Assessment Tools: The QuIRK Rubric

Example of ineffective peripheral QR paper:
"Denmark: A Modern Social Democracy"

Thesis: Denmark is an effective model for social democracy in Europe

Evolving Assessment Tools: The QuIRK Rubric

"Danish policy has, over the years, favored welfare-state politics over the liberal model of Great Britain...."

"Although traditionally agrarian...industrial policies central to furthering their technology industry."

Evolving Assessment Tools: The QuIRK Rubric

"world-class standard of living," "high labor costs," "high taxation," "drastic changes" by right wingers in 1980s, "inflation brought under control," "economy...fundamentally strong," "since 1992...export performance slipped considerably"

Evolving Assessment Tools: The QuIRK Rubric

Top 10 GDP per capita in \$US, 2005

Luxembourg	\$79,851	Ireland	\$48,524
Norway	\$63,918	Denmark	<u>\$47,769</u>
Iceland	\$53,290	United States	\$41,890
Qatar	\$52,240	Sweden	\$39,637
Switzerland	\$49,351	Netherlands	\$38,248

And Denmark reports the least income inequality of all countries measured by the UN.

Evolving Assessment Tools: The QuIRK Rubric

Example of effective peripheral QR paper:
"Democracy in India"

Thesis: Because India is exceptional in creating democracy despite the lack of typical preconditions, it is a useful example for us to identify true preconditions.

Evolving Assessment Tools: The QuIRK Rubric

"In the over five decades since the establishment of democracy, there have been 12 parliamentary elections."

"All political offices are contested, peaceful transfers of power between rival parties have taken place seven times...."

Evolving Assessment Tools: The QuIRK Rubric

Example of ineffective centrally QR paper:
"Day Care and Development"

Topic: Literature review of effects of day care participation on child development

Evolving Assessment Tools: The QuIRK Rubric

"With rising inflation..., many families are forced" to make tough child care choices.

"Nonparental child-care is on the rise as more and more mothers choose to work...."

Evolving Assessment Tools: The QuIRK Rubric

Alternative:

"The effects of day care on child development are increasingly important as labor force participation among married women with children, ages 25-34, increased from 28% in 1960 to 68% in 2005. In fact, the number of working women with children nearly tripled in that time from 8.1 million to 26.2 million."

Evolving Assessment Tools: The QuIRK Rubric

Even when quantitative evidence is used, student doesn't appreciate the real power of the actual numbers:

Ex: "The amount of time that children spent in day-care was positively correlated with reports of how many friends they had."

Evolving Assessment Tools: The QuIRK Rubric

Example of effective centrally QR paper:

"Speech Production in Reference: Testing the Principle of Least Collaborative Effort"

Topic: Literature review on the empirical support for competing theories of determinants of discursive language.

Evolving Assessment Tools: The QuIRK Rubric

"Subjects were 6 undergraduate students divided into 3 pairs of two students."

"The average word count for trial 1 was 37 [per picture], 16 for trial 2, 7 for trial 3, 4 for trial 4, and 3 for both trial 5 and 6....a statistically significant ($p < .001$) relationship.....Once mutual understanding was achieved the first time, the effort taken to collaborate was reduced to the minimum necessary."

Evolving Assessment Tools: The QuIRK Rubric

Clear success as formative tool:

- "...numeracy is not something mastered in a single course.... Thus quantitative material needs to permeate the curriculum, ... so that students have opportunities to practice their skills and see how useful they can be in understanding a wide range of problems."

-Derek Bok (2006)

- "...authentic and enduring learning...can rarely succeed one course at a time."

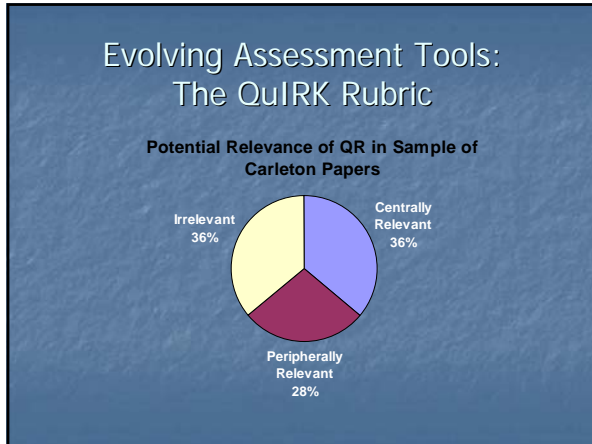
-Lee Shulman (1997)

Evolving Assessment Tools: The QuIRK Rubric

"If [QR] remains the responsibility solely of mathematics departments—especially if it is caged into a single course such as 'Math for Liberal Arts'—students will continue to see [QR] as something that happens only in the mathematics classroom."

-Lynn Steen

Achieving Quantitative Literacy



Evolving Assessment Tools: The QuIRK Rubric

	Potential Relevance	
	Central	Peripheral
Did use	66%	12%
Did not use	34%	88%

Evolving Assessment Tools: The QuIRK Rubric

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	Central	Peripheral
Did use	66%	12%
Did not use	34%	88%

Evolving Assessment Tools: The QuIRK Rubric

QuIRK-related course revisions:

Art History, Biology, Chemistry, Cinema and Media Studies (2), Economics (6), Educational Studies, English (5), Environmental Studies, Geology (2), History (3), Linguistics, Mathematics and Computer Science, Music, Philosophy and Cognitive Studies, Physics, Political Science (9), Psychology (2), Russian Studies, and Sociology (3).

Evolving Assessment Tools: The QuIRK Rubric

QuIRK-related course revisions:

Art History, Biology, Chemistry, **Cinema and Media Studies (2)**, Economics (6), **Educational Studies**, **English (5)**, **Environmental Studies**, Geology (2), **History (3)**, **Linguistics**, Mathematics and Computer Science, **Music**, **Philosophy and Cognitive Studies**, Physics, Political Science (9), Psychology (2), **Russian Studies**, and Sociology (3).

Evolving Assessment Tools: The QuIRK Rubric

Summative assessment?

- Certainly not of students, but we hope of our program
- Currently being evaluated

Evolving Assessment Tools: The QuIRK Rubric

Adaptability to other institutions FAQ:

- Do we need a writing portfolio to do this?

Evolving Assessment Tools: The QuIRK Rubric

Adaptability to other institutions FAQ:

- Do we need a writing portfolio to do this?
- Do we need a large team of faculty?

Evolving Assessment Tools: The QuIRK Rubric

Adaptability to other institutions FAQ:

- Do we need a writing portfolio to do this?
- Do we need a large team of faculty?
- Do those involved need extensive experience with quantitative methods?

Evolving Assessment Tools: The QuIRK Rubric

Adaptability to other institutions FAQ:

- NSF grant supporting revision with help from Yale, St. Olaf, Morehouse, Wellesley, Iowa State, and Seattle Central Community College
- Feasibility studies to be done at last four

More Information on QuIRK

Serc.carleton.edu/quirk

PKAL conference "Quantifying Quantitative Reasoning in Undergraduate Education: Alternative Strategies for the Assessment of Quantitative Reasoning" October 10-12, 2008

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