

Teaching Quantitative Literacy/ Quantitative Reasoning (QL/QR) Skills: A Numeracy Infusion Course for Higher Education (NICHE)



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The Importance of Numeracy and Quantitative Literacy

- Critical for success in today's technologically-oriented and data-driven world.
- QR/QL is linked to social justice.
- Innumerate persons are prone to being misled by the media and by their own personal experiences.



Approaches to QR Instruction

- MAA (1998) reports that colleges must:
 - treat QL as a necessary goal for graduates,
 - expect every graduate to apply simple mathematical methods to the solution of real-world problems,
 - devise and establish QL programs that consist of a foundation experience as well as a continuation experience, and
 - accept responsibility for overseeing their QL programs through regular assessments.

Research emphasizes the need to infuse QR throughout the curriculum.

The Setting: The City University of New York

- 59% of CUNY students are female.
- 57% are black, Hispanic, or American Indian/Native American.
- Nearly 30% are 25 or older.
- 54% have household incomes of less than \$30,000.
- 44% are first-generation students.
- Many have weak quantitative skills and high levels of math phobia.



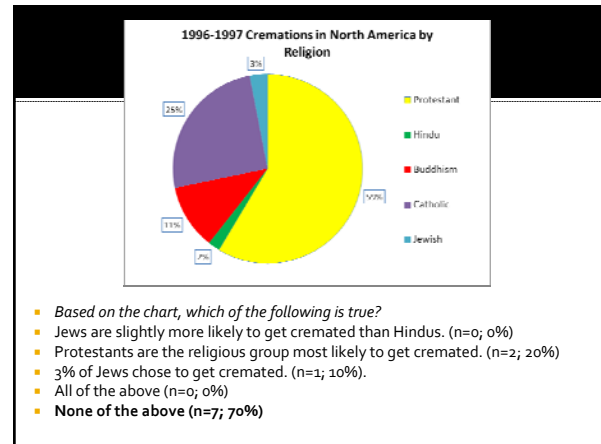
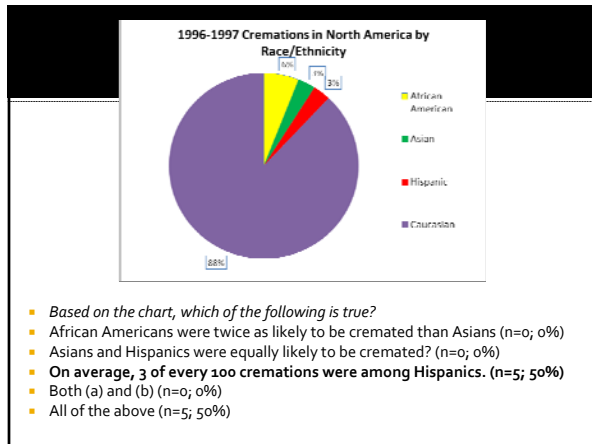
The CUNY QR Alliance

- Brings together together faculty from a wide range of CUNY schools.
- Teaches faculty best practices for responding to the QL needs of CUNY students.
- Gained the support of the National Science Foundation in the fall of 2011.
- Builds upon a QR initiative at Lehman College/CUNY.



Motives for Faculty Participation in the Lehman QR Workshop

- In both years, 100% of participants indicated that an "interest in [the] workshop topic" was a *very important* reason for their participation.
- 100% pointed to a "concern for students."
- Faculty networking, a "convenient time," and financial incentives were also identified as important.



The Lehman QR Program and the Changing Attitudes of Faculty Participants

- First session: 60% of faculty agreed that they had a "good understanding of what Quantitative Reasoning is." End of workshop: 100% agreed.
- September 2011, 80% of participants felt "confident in [their] Quantitative Reasoning skills." End of the year: 100% felt confident.
- From the first session to the last, the percentage of faculty who "place a heavy emphasis on QR in [their] course instruction" rose from 40% to 80%.

Teaching QR: Voices of the Lehman College Faculty

- Pedagogical strategies emphasized as most important for teaching QR:
 - active engagement in data analysis,
 - pairing QR with writing and/or critical reading,
 - the revision of QR assignments,
 - the assessment of QR learning, and
 - the use of computer software such as Excel.

These are the same strategies that faculty plan to use in their teaching.

Written comments show strong emphasis on assessment and infusion throughout the curriculum.

Teaching QR: Voices of the Lehman College Faculty

Most important elements of QR instruction:

- wide and multidisciplinary QR participation
- the blending of QR instruction and writing instruction
- a screening test that assesses students' QR skills
- a QR tutoring center
- regular assessment of student learning
- a standard set of QR learning objectives
- a foundational QR course.

The Future of the NICHE Project

- Key Learning Outcomes:
 - apply QL/QR within a disciplinary context
 - articulate QR learning goals that reflect best practices
 - identify and implement best practices for teaching QR: active learning, collaborative student learning, writing with numerical information, etc.
 - adapt and implement strategies for incorporating QR into course instruction
 - assess the effectiveness of QR initiatives and use the results to improve instruction.

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What is CUNY NICHE?

The Numeracy Infusion Course for Higher Education (NICHE) is a project of the City University of New York (CUNY) Quantitative Reasoning (QR) Alliance to foster the infusion of QR instruction and assessment into undergraduate courses in a broad range of disciplines. NICHE is a predominantly online course that teaches faculty how to (a) apply Quantitative Literacy/Quantitative Reasoning (QL/QR) within a disciplinary context, (b) articulate QR learning goals/objectives that reflect best practices for teaching quantitative literacy, (c) identify and implement best practices for teaching QR: active learning, collaborative student learning, writing with numerical information, etc. (d) adapt and implement strategies for incorporating quantitative reasoning into course instruction, and (e) assess the effectiveness of QR initiatives and use the assessment results to further improve instruction.

The materials presented on this web site serve as a complement to a series of interactive modules that are included in Blackboard that provide instruction to faculty for strategies for teaching QR to students.

The CUNY NICHE QR Alliance
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What is Quantitative Literacy (QL)/Quantitative Reasoning (QR)?

Quantitative Literacy (QL), also called "numeracy" and "quantitative reasoning" (QR), may be defined as "the ability to understand and use numbers and data in everyday life" (Madson 2003:3). QL/QR is not synonymous with mathematics or statistics, however, and it may be viewed more generally as "a practical, robust habit of mind anchored in data, nourished by computers, and employed in every aspect of an alert, informed life" (Stein 2004:4). A collection of different views on QL is provided [here](#).

Some of the key skills that make up QL/QR include reading graphical displays, modeling real-world phenomena, solving practical problems through the use of data, justifying conclusions, and critiquing research designs (Johnson and Kaplan N.Y.). The [Quantitative Literacy Subject](#) of the American Association of Colleges and Universities (AAC&U) highlights some of the essential skills associated with Quantitative Literacy.

Racial Distribution of the United States Population, 2008

Source: 2008 U.S. Census

The Importance of Quantitative Reasoning

Quantitative Reasoning (QR)/Quantitative Literacy (QL) skills are essential for social justice: "Without quantitative undergraduate preparation may be relatively powerless compared with a small number of individuals with specialized knowledge... Inform decision-making, retirement planning, active parenting, and the vast majority of choices we make in our personal, occupational lives can be better served by improved quantitative reasoning skills" (West and associates 2007: 47, 53). Indeed, "the scientifically and mathematically literate are outsiders in a society in which effective participation in public dialogue presumes of basic science and mathematics" (Carnegie and Desrosiers 2002: 20). Paulus (2003) notes that numeracy has social-economic consequences and argues that "numerate people characteristically have a strong tendency to personalize—to be their own spokespersons, or by the media's focus on individuals and drama" (6). He also points to a belief in pseudoscience as a consequence of innumeracy.

While research has shown that many students lack the quantitative skills needed for personal and professional success, it

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Quantitative Reasoning Learning Goals

Many experts in the QR movement have articulated specific learning goals. According to the Mathematical Association of America (1998), "The foremost objective of both liberal and professional types of higher education should be to produce well-educated, enlightened citizens, who can reason cogently, communicate clearly, solve problems, and lead satisfying, productive lives." They further argue that, "A quantitatively literate college graduate should be able to:

1. Interpret mathematical models such as formulas, graphs, tables, and schematics, and draw inferences from them.
2. Represent mathematical information symbolically, visually, numerically, and verbally.
3. Use arithmetical, algebraic, geometric and statistical methods to solve problems.
4. Estimate and check answers to mathematical problems in order to determine reasonableness, identify alternatives, and select optimal results.
5. Recognize that mathematical and statistical methods have limits" (MAA 1998).¹

The Association of American Colleges and Universities has also put forward a rubric ([see tab on Quantitative Reasoning](#)) that a variety of important skills associated with quantitative literacy. These include: (a) ability to explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words), (b) ability to convert relevant information into various mathematical forms (e.g., equations, graphs, diagrams, tables, words), (c) calculations, (d) application/analysis (ability to use judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of its (e) ability to make and evaluate important assumptions in estimation, modeling, and data analysis, (f) expressing quantitative information in support of the argument or purpose of the work [in terms of what evidence is used and how it is formatted, presented, or contextualized].

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Quantitative Reasoning Across the Curriculum

Many scholars have called for a multidisciplinary, active learning approach to QR instruction. (See, for example, Bressoud 2006; Defendbacher, Doan and Salway 2006; Frai and Jordone 2006; Gillard et al. 2010; Gordon and Wren 2006; Haines and Jordan 2006; Hartzler and Leoni 2004; Hilliard et al. 2010; Johnson 2008; Taylor 2006.) As Stein (2008: 19) states, "The success of writing across the curriculum is an inspiration to those who hope QL will follow in these footsteps. Indeed, the National Numeracy Network... is loosely modeled after the National Writing Project, a nationwide system of local coalitions that has provided effective support for writing across the curriculum for over a quarter century."

Kings (2006) stresses the need for collaborative, multidisciplinary QR efforts.¹ Although QR rests on a solid mathematical foundation (Madson 2004: 4-6), it requires more than mathematical or statistical fluency (Madson and Dingman 2010). As Garson (2006: 13) notes, "QL must be everywhere in the curriculum, in all disciplines and all courses... QL is a shared responsibility." Indeed, a multidisciplinary approach is central to many QR initiatives. "Like learning to write well or speaking a foreign language, numeracy is not something mastered in a single course... This quantitative material needs to permeate the curriculum, not only in the sciences but also in the social sciences and, in appropriate cases, in the humanities... (Birk 2005: 134). Similarly, Stein (2004) notes that QR programs should involve faculty from multiple disciplines and the social sciences may be especially well-positioned to take the lead in QR initiatives (Stein 2002). West, Higgins and (2007: 48-49) state that in terms of QL, mathematics "is a tool for greater purposes. Thus, the charge for quantitative literate teachers of all subject areas: "The recognition that QR is the responsibility of all faculty provides the impetus for our current

Video
Kurt Vonnegut on the shapes of stories:

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Best Practices for QR Instruction

Several pedagogical approaches are especially important for teaching QR which are described in more detail on this page including:

1. real world applications and active learning, including constructivist approaches;
2. pairing QR instruction with writing and social reading;
3. using technology, including computers;
4. collaborative instruction and group work;
5. pedagogy that responds to differences in students' culture and learning styles; and
6. scaffolding the learning process with instructor feedback and opportunities for revision.

Of course, these approaches are frequently overlapping.

In her book *Powerful Learning: What We Know About Teaching for Understanding*, Darling-Hammond (2008: 5) argues that "too domains, studies consistently find that highly effective teachers support the process of meaningful learning" by (1) creating and meaningful tasks, (2) engaging students in active learning, (3) drawing connections to students, (4) scaffolding the learning process, (5) assessing student learning continuously, (6) providing clear standards and constant feedback, and (7) embracing strategic and metacognitive thinking. These approaches are also important for teaching quantitative literacy skills.

A video about best practices for teaching QR:

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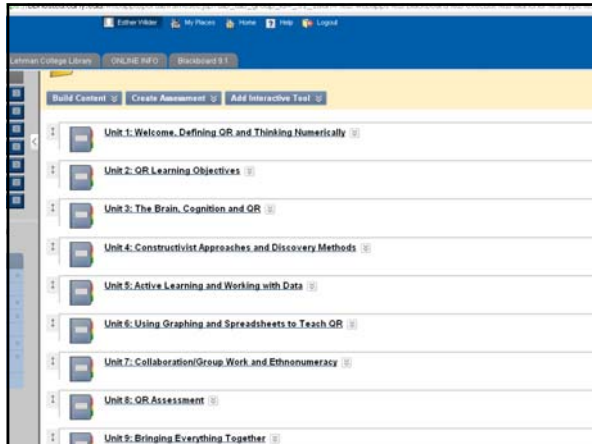
Defining Assessment

As Linda Suskie (2004) notes, there are several core components of the assessment of student learning including:

- Establishing clear, measurable expected outcomes of student learning.
- Ensuring that students have sufficient opportunities to achieve those outcomes,
- Systematically gathering, analyzing, and interpreting evidence to determine how well student learning matches our expectations, &
- Using the resulting information to understand and improve student learning.

Quantitative Reasoning Assessment

An excellent resource for assessing QR is a 2010 edited volume by Bolipood, Hunt and Julie endorsed, *Assessment Methods in Statistical Education: An International Perspective*. Many of the articles in *Numeracy* address QR assessment. Shannon Dingman and Bernard Madson (2010: 8) note that "The major challenge in assessing QR is the central goal of transfer of knowledge and cognitive processes to contexts that are unpredictable and of unbounded risk. As Davies and Mamot (2010: 121) note, in designing/adopting assessment instruments, careful consideration should be given (1) the learning outcomes and the capabilities/skills (implicit or explicit) they imply, (2) methods of assessment that match these outcomes and skills,



Please visit us at our NICHE web site,
<https://serc.carleton.edu/NICHE/>

Thank you!