

**“Quantitative Reasoning:
It’s Not Just for
Scientists & Economists Anymore”**

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**In today's "world awash in numbers,"
strong quantitative reasoning skills
are required**

- **in virtually all academic fields**
- **in most every profession**
- **and in decision-making in everyday life**
 - **in being an informed citizen**
 - **in making medical decisions**
 - **in making financial decisions**

Lynn Steen's main argument in
"The Case for Quantitative Literacy"
in *Mathematics and Democracy*

How does “QR” differ from “math”?

(Bernie Madison’s “two mathematics”)

Math

- **Math track moves *vertically* to higher levels of abstraction....beauty and elegance ☺**
- **Focus on content and components: algebra, geometry, statistics, calculus**

QR

- **QR reaches out *horizontally*, applying processes of reasoning, deduction, analysis to a wide array of applications in many practical fields**
- **Hands-on use of logic, statistics, and math to solve problems in authentic contexts**
- **“A practical habit of mind” -- Lynn Steen**

QR Competencies for College Students

(MAA's Standards)

- **Reading and understanding quantitative info in graphs, tables, etc.**
- **Interpreting quantitative info and drawing appropriate inferences**
- **Solving problems using logic, math, statistics**
- **Estimating answers and checking for reasonableness**
- **Communicating quantitative info – verbally, graphically, numerically**
- **Recognizing the limitations of mathematical or statistical models**

QR in academic fields at a liberal arts college (beyond obvious subjects such as physics, chemistry, and economics)

Medicine

statistics (assessing clinical trials),
chance (comparing risks), and
calculus (understanding the body's electrical,
biochemical, and cardiovascular systems)

Social Sciences

statistics (analysis of data from surveys & censuses
or from historical or archeological records)

Language Arts

quantitative and logical methods (for linguistics,
ascertaining authorship, computer translation)

Psychology

statistics, computer science, and other aspects of
quantitative literacy (to understand the brain)

Visual Arts

calculus, geometry, and computer algorithms (for use of computer graphics)

Biology

computer mathematics (mapping genomes), statistics (assessing laboratory experiments), probability (studying heredity), and calculus (determining rates of change)

History

analysis of numerical data (government statistics, economic indicators) to provide a context for magnitudes of events and changes over time; verification and dating of artifacts

QR's Importance to Professionals

Lawyers

probability (to establish or refute "reasonable doubt")

Doctors

statistics, risk analysis (to understand and convey info to patients to ensure "informed consent")

Journalists

understanding of risks, rates, samples, surveys, and statistical evidence (to develop an informed and skeptical understanding of current events)

School Administrators

numeracy, arithmetic, networks (scheduling, budgeting, inventory, and planning)

Social Workers

logic, arithmetic (to explain to clients complex state and federal regulations about income and expenses and verify their clients' personal budgets)

Chefs

proportions, scaling, arithmetic (budgeting, menu planning, monitoring nutrition)

Architects

geometry, statistics, probability (for computer graphics, modeling usage, engineering principles)

QR Skills to be a Informed Citizen

- Understand quantitative voter info as relates to school budgets or tax proposals
- Understand how small samples can accurately predict public opinion; how biases can influence results
- Understand student test results in percentages or percentiles and interpret what they mean about school quality
- Understand behavior of weighted averages used in ranking colleges, cities, products, etc.
- Understand that unusual events (such as cancer clusters) can occur by chance alone
- Understand comparative magnitudes of risk and significance of very large and very small numbers

Examples of Analysis of Risks

Paulos's idea of a logarithmic safety index and
Ropeik & Gray's One Year Probabilities

Killed by a shark	1 in 350 million
Die in an earthquake	1 in 11.2 million
Die from a bee sting	1 in 6 million
Be kidnapped	1 in 5 million
Drown in bathtub	1 in 800,000
Attacked by shark	1 in 700,000
Die in bicycle crash	1 in 96,000
Drown in any water	1 in 68,000
Die in car accident	1 in 6,700
Die from flu/pneumonia	1 in 3,025
Die from smoking	1 in 800
Die from cancer	1 in 514
Die from heart disease	1 in 384

QR Skills for Personal Health

- **Calibrate eating and exercise habits in relation to health**
- **Interpret medical statistics and formulate questions about different treatments and their risks**
- **Understand medical dosages in relation to body weight, timing of meds, drug interactions**
- **Weigh costs, benefits, and health risks of advertised drugs**
- **Understand importance of outliers in summaries of medical data**
- **Understand terms and conditions of different health insurance policies**

QR in Personal Fianance

- **Understand effects of compound interest for deposits and loans**
- **Understand the relation of risk to return for investments**
- **Understand the difference between average and marginal tax rates**
- **Be able to calculate income taxes**
- **Understand depreciation and its effect on the value of cars, computer equipment**
- **Understand interactions among factors affecting personal loans incl. mortgages**
- **Understand investment benefits of diversification and averaging**

Tips on Incorporating QR in the Curriculum

- **Create problems in authentic contexts of interest to students**
- **Have students figure out what skills are needed to solve the problems and teach new math skills “just in time”**
- **Give multiple opportunities to work with important concepts – each in an authentic area, e.g., linear versus exponential growth in demographics and later in personal finance**
- **Require students to write about their quantitative analyses**
- **Discuss common mistakes in the media or in your field, e.g., percent change versus percentage point difference**