

**“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

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

# **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**