Quantitative Literacy More Than Ever Before

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#### **Quantitative Literacy**

An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments, and to engage in mathematics in ways that meet the needs of that individual's current and future life as a constructive, concerned, and reflective citizen.

Beyond Crossroads, AMATYC, 2005

#### **Quantitative Literacy**

"...practically no one knows what they're talking about when it comes to numbers in the newspapers. And that's because we're always quoting other people who don't know what they're talking about, like politicians and stockmarket analysts."

Molly Ivins (1944 - 2007)

# Paideia

A healthy democracy requires honorable, virtuous, well educated citizens.

Paideia is the process of educating people to be the the most productive citizens possible.

#### Mathematics for ...

#### College

Core requirements Natural and social sciences courses Pre-service teachers.

#### Careers

Broad cross-disciplinary critical thinking Real world problem solving Explanation and presentation

#### Life

Personal : mortgages, insurance, finance, taxes, gambling

Citizenship : economy, health, environment, voting

### Bloopers!

"According to Lancaster Insurance, five out of four drivers between 17 and 21 have some sort of accident. The figure is correct because some have two accidents."

### Bloopers!

Tornado deaths from 1987 to 1996 dropped 300 percent from the 1940s when 1,176 deaths were attributed to tornadoes, an average of 179 per year.

**Associated Press** 

#### **Percentages in the News**

Teen-age smoking rates are still lower than in the 1970's. But the percentage of 12th graders who smoked daily last year jumped 20% since 1991, to 22 %, according to the most recent edition of the University of Michigan's Monitoring the Future Survey. ... The rate among 10<sup>th</sup> graders jumped 45%, to 18.3%, and the rate for 8th graders is up 44%, to 10.4%.

New York Times

### **Critical Thinking**

#### Ballot Initiative: Amendment to the Colorado Constitution (1992)

Shall there be an amendment to the Colorado constitution to prohibit the state of Colorado and any of its political subdivisions from adopting or enforcing any law or policy which provides that homosexual, lesbian, or bisexual orientation, conduct, or relationships constitutes or entitles a person to claim any minority or protected status, quota preferences, or discrimination?

### Polling!

1936 presidential election

Literary Digest Poll N = 10 million

Alf Landon (R) 57% FDR (D) 43%

Actual results: FDR 62%

"How could the polls get it so wrong?"

Footnote: George Gallup (N = 3000) got it right.

#### It's Not The Mathematics!

American Airlines CEO takes 85% salary cut to avert budget crisis. The cut reduces his salary to \$500,000. What was his original salary?

- a. 1.85 × \$500,000
- b. \$500,000/0.85
- c. 1.15 × \$500,000
- d. \$500,000/0.15

#### Write a sentence:

Old salary -85% of old salary = \$500,000

<u>Not</u>:

Old salary = \$500,000 + 85% of new salary

#### Simplify 1:

100% of old salary – 85% of old salary = \$500,000 <u>Simplify 2</u>:

0.15 × old salary = \$500,000

Solve:

Old Salary = \$500,000/0.15 = \$3.3 M

### **Drug Test Accuracy**

Suppose that 1000 people are given a drug test that is 98% accurate and that 50 of the people actually are drug users. What percentage of the positive tests are false positives (nonusers who test positive)?

- 50 are real users and could be falsely classified as non-users (false negatives)
- 950 are real non-users and could be falsely classified as users (false positives)

### **Drug Test Accuracy**

	Test	Test	Total
	Accurate	Wrong	
Nonusers			
	(true negative)	(false positive)	
Users			
	(true positive)	(false negative)	
Total			1000

### **Drug Test Accuracy**

	Accurate	Error	Total	
Nonusers	931	19	950	
	(true negative)	(false positive)		
Users	49	1	50	
	(true positive)	(false negative)		
Total	980	20	1000	

Percentage of false positives among all positives = 19/68 = 28%

## **Risk and Decisions**

#### Question 1

Option A: I give you \$100.

Option B: Flip a coin.

Heads: I give you \$200. Tails: I give you \$0.

(Amos Tversky and Daniel Kahneman See *The Undoing Project*, Michael Lewis)

## **Risk and Decisions**

Question 2

Option A: You give me \$100.

Option B: Flip a coin.

Heads: You give me \$0. Tails: You give me \$200.

(Amos Tversky and Daniel Kahneman See *The Undoing Project*, Michael Lewis)



- When it comes to gains, we are risk-averse.
- When it comes to losses, we are risk-seeking.

Which sequence is random? (N = 20, H/T = 0.5)

#### ННТНТННТТНТННТТНТНТТ

#### ТТТТННТННННТТННТНТТ

#### Streaks — or Not

**Table 2.1** Probability of Making a Shot Conditioned on the Outcome of Previous Shots for Nine Members of the 76ers

Player	P(x ooo)	P(x oo)	P(x o)	P(x)	P(x x)	P(x xx)	P(x xxx)	r
C. Richardson	.50	.47	.56	.50	.49	.50	.48	02
J. Erving	.52	.51	.51	.52	.53	.52	.48	.02
L. Hollins	.50	.49	.46	.46	.46	.46	.32	.00
M. Cheeks	.77	.60	.60	.56	.55	.54	.59	04
C. Jones	.50	.48	.47	.47	.45	.43	.27	02
A. Toney	.52	.53	.51	.46	.43	.40	.34	08
B. Jones	.61	.58	.58	.54	.53	.47	.53	05
S. Mix	.70	.56	.52	.52	.51	.48	.36	02
D. Dawkins	.88	.73	.71	.62	.57	.58	.51	14
Mean =	.56	.53	.54	.52	.51	.50	.46	04

NOTE: x = a hit; o = a miss. r = the correlation between the outcomes of consecutive shots

Gilovich, Vallone, Tversky, 1985)

#### **Statistical Displays**



#### **Statistical Displays**



## **Periodic Drug Dosing**

You take 100 milligrams of antibiotic every 12 hours.

The half-life of the drug in your blood is 12 hours; that is, every 12 hours, the amount of drug in your blood decreases by 50%.

## **Periodic Drug Dosing**

### **Periodic Drug Dosing**



From *The Wreck of Time*, by Annie Dillard *Harper's*. vol. 296, no. 1772. Jan. 1998. pp. 51-56.

One tenth of the land on earth is tundra. At any time, it is raining on only 5 percent of the planet's surface. Lightning strikes the planet about a hundred times every second. The insects outweigh us. Our chickens outnumber us four to one.

One fifth of us are Muslims. One fifth of us live in China. And every seventh person is a Chinese peasant. Almost one tenth of us live within range of an active volcano. More than 2 percent of us are mentally retarded. We humans drink tea – over a billion cups a day. Among us we speak 10,000 languages.

#### From The Wreck of Time, by Annie Dillard

Every 110 hours a million more humans arrive on the planet than die into the planet. A hundred million of us are children who live on the streets. Over a hundred million of us live in countries where we have no citizenship. Twenty-three million of us are refugees. Sixteen million of us live in Cairo. Nearly a thousand of us a day commit suicide. From The Wreck of Time, by Annie Dillard

HEAD-SPINNING NUMBERS CAUSE MIND TO GO SLACK, the *Hartford Courant* says. But our minds must not go slack. How can we think straight if our minds go slack? We agree that we want to think straight.