

**Curricular Sudoku: Quantitative Reasoning as an Educational Imperative  
Across the Curriculum**

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		3			7		
	2		4	6	8		
1			5				9
	9					1	
		8	4	2			
	7					9	
6			2				8
	5		3	1	7		
		4			6		

## **10 Foundational QR Questions**

### ***I. What do the numbers show?***

What do the numbers mean?

Where are the numbers?

Is there numerical evidence to support a claim?

What were the exact figures?

How can seeking and analyzing numbers illuminate important phenomena?

How plausible is a possibility in light of back of the envelope calculations?

### ***II. How representative is that?***

What's the central tendency?

*"For instance is no proof."*

Mean, Mode, and Median.

Interrogating averages:

Are there extreme scores?

Are there meaningful subgroups?

Who's in the denominator?

What's the variability (standard deviation)?

What are the odds of that? What's the base rate?

### ***III. Compared to what?***

What's the implicit or explicit frame of reference?

What's the unit of measurement?

Per what?

What's the order of magnitude?

Interrogating a graph:

What's the Y-axis? Is it zero-based?

Does it K.I.S.S., or is it filled with ChartJunk?

### ***IV. Is the outcome statistically significant?***

Is the outcome unlikely to have come about by chance?

*"Chance is lumpy."*

Criterion of sufficient rarity due to chance:  $p < .05$

What does statistical significance mean, and what doesn't it mean?

### ***V. What's the effect size?***

How can we take the measure of how substantial an outcome is?

How large is the mean difference? How large is the association?

Standardized mean difference ( $d$ ):  $d = (\mu_1 - \mu_2) / \sigma$

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**VI. Are the results those of a single study or of a literature?**

What's the source of the numbers: PFA, peer-reviewed, or what?  
Who is sponsoring the research?

How can we take the measure of what a literature shows?  
The importance of *meta-analysis* in the contemporary world of QR.

**VII. What's the research design (correlational or experimental)?**

Design matters: Experimental vs. correlational design.  
*How well does the design support a causal claim?*

Experimental Design:

Randomized Controlled Trials (RCT): Research trials in which participants are randomly assigned to the conditions of the study.

Double blind trials: RCTs in which neither the researcher nor the patient know the treatment condition.

Correlational Design: Measuring existing variation and evaluating co-occurrences, possibly controlling for other variables.

Interrogating associations (correlations):

Are there extreme pairs of scores (outliers)?

Are there meaningful subgroups?

Is the range of scores in a variable restricted?

Is the relationship non-linear?

**VIII. How was the variable operationalized?**

What meaning and degree of precision does the measurement procedure justify?

What elements and procedure result in the assignment of a score to a variable?

What exactly was asked?

What's the scale of measurement?

How might we know if the measurement procedure is a good one?

Reliability = Repeated applications of the procedure result in consistent scores.

Validity  $\approx$  Evidence supports the use to which the measure is being put.

Is the measure being manipulated or "gamed"? The iatrogenic effects of measurement.

**IX. Who's in the measurement sample?**

What domain is being evaluated? Who's in? Who's not?

Is the sample from that domain representative, meaningful, and/or sufficient?

Is the sample random?

Are two or more samples being compared equivalent?

**X. Controlling for what?**

What other variables might be influencing the findings?

Were these assessed or otherwise controlled for in the research design?

What don't we know, and how can we acknowledge uncertainties?