

*The Science of Learning and  
Implications for E-Learning  
Systems*

**Dr. Joel M. Smith**

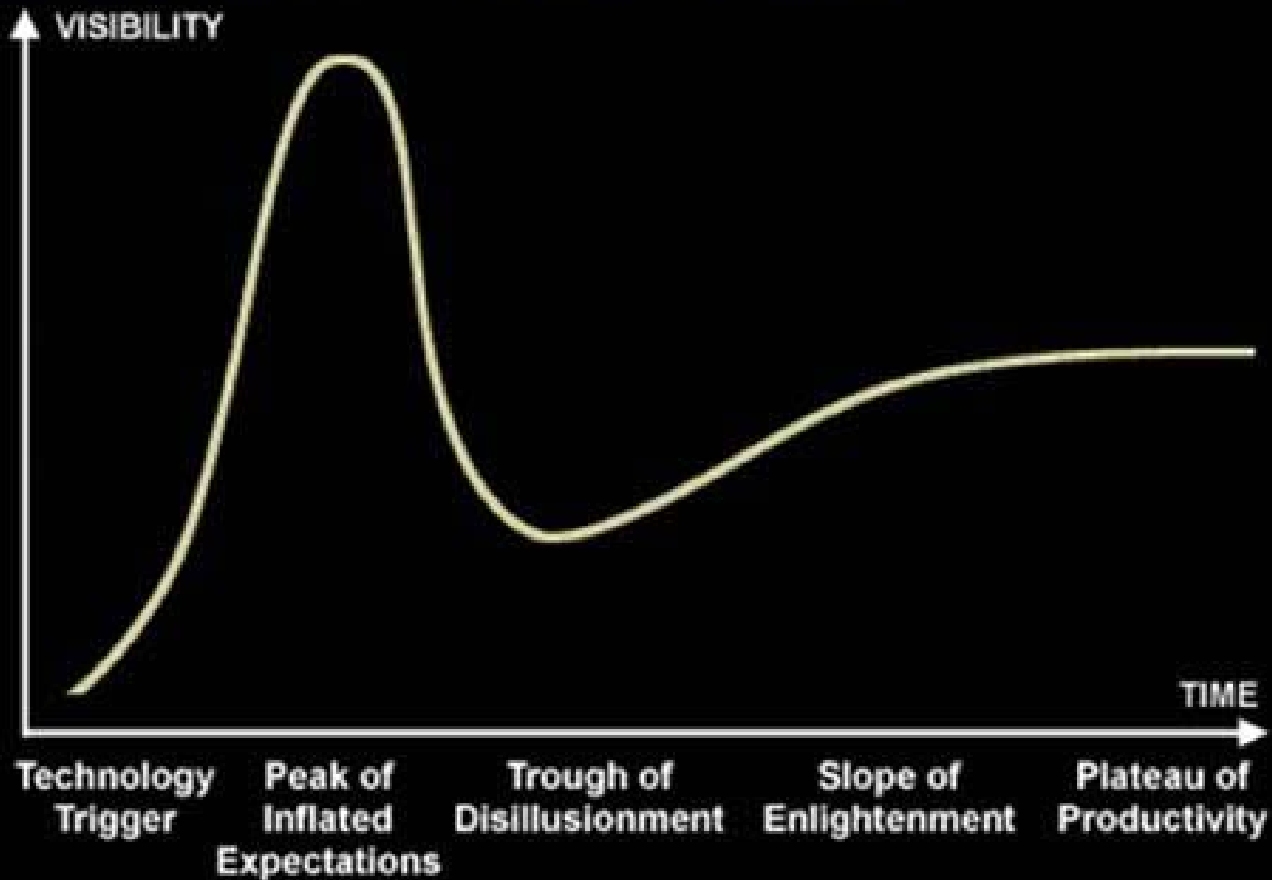
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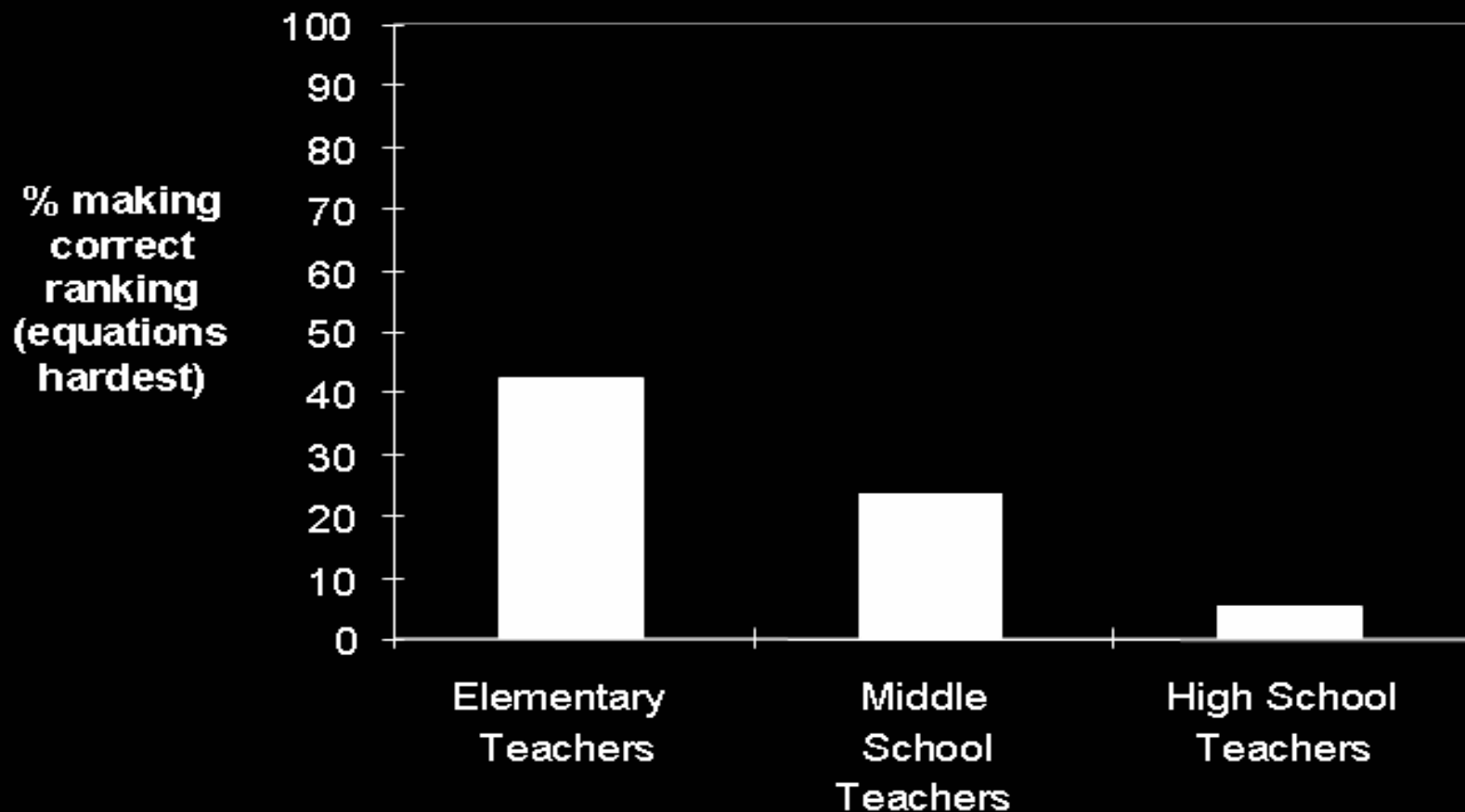
# Hype About eLearning

## Hype Cycle of Emerging Technology



Ref: Gartner Group

# A Surprising Source of the “Trough of Disillusionment”: The Expert’s Blindspot



Ref. Nathan, M.J. &  
Koedinger, K.R. (2000)

# Another Source of the "Trough of Disillusionment" – No Evidence the Interventions Work

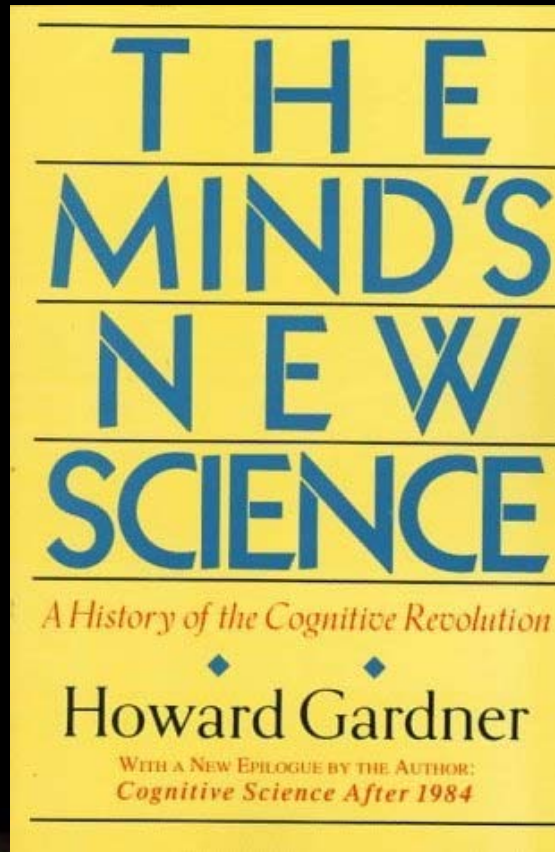
What Works Clearinghouse:

“Only 5 of the more than 40 middle school math interventions known to be available for adoption have any studies of their effectiveness that meet the WWC evidence standards.”

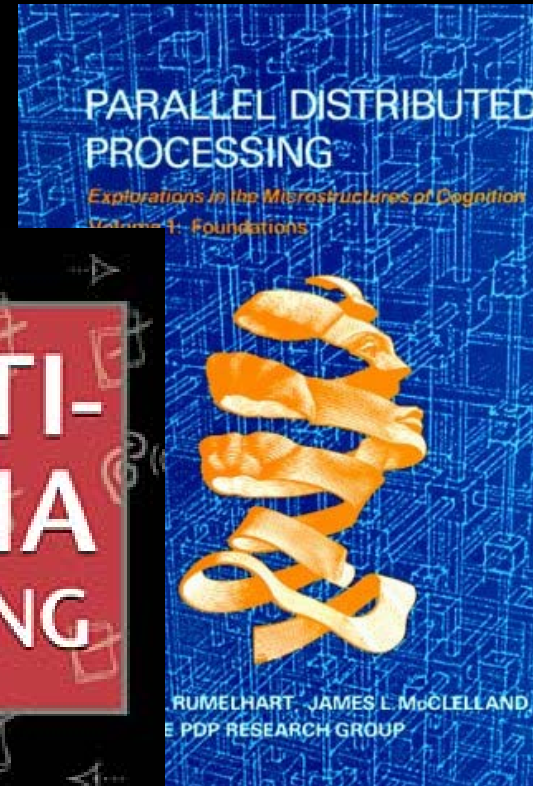
<http://www.whatworks.ed.gov/>

# Getting to a “Plateau of Productivity”

Taking a Scientific Approach to eLearning

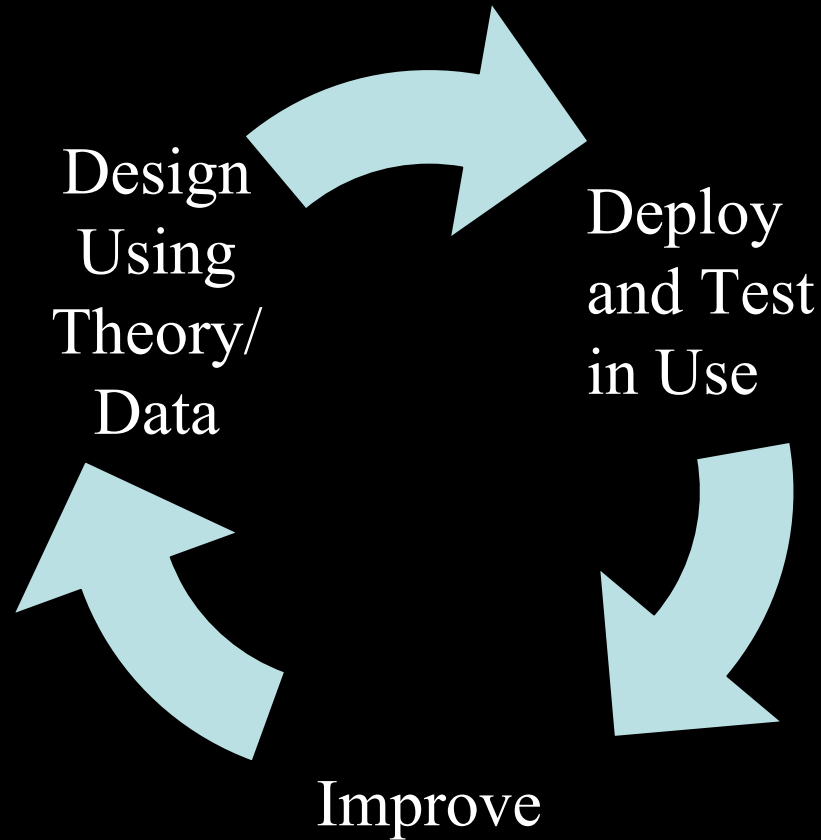


Richard E. Mayer



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# Requires a Scientific Approach: Use-Based Design



# Formative Evaluation for eLearning Interventions – An Example

**Laptop Program Hype**

**VS.**

**Laptop Program Reality**

# eLearning Can Be Transformative

https://oli.web.cmu.edu - Creating a buffer solution - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

1. (5 pts) You have three bottles, one filled with 1M NaAc (Sodium Acetate), one filled with 1M HAc (Acetic Acid), and one filled with distilled water. You need to create a buffer solution that has a pH of 4.75 such that when 1ml of 10M HCl is added to 100ml of your buffer, the resulting pH is 3.75 ( $\pm 0.1$ ). What concentrations of HAc and NaAc do you need to create the buffer solution?

Iridium Chemistry Lab -- Buffer Creation Problem

File Edit Tools View Help

Stockroom Explorer...

- Iridium Solutions
  - H<sub>2</sub>O
  - 1M NaOH
  - 10M NaOH
  - 1M NaCH<sub>3</sub>COO
  - 10M HCl
  - 1M HCl
  - 1M CH<sub>3</sub>COOH
  - Problem Description

Workbench 1

The workbench contains several items: a 25mL Pipet, a 10M HCl flask, a 1M CH<sub>3</sub>COOH flask, a 10M NaOH flask, a 250mL beaker on a scale showing 240.291g TARE, and another 1M CH<sub>3</sub>COOH flask. A pH Meter is also present, showing a reading of 7.0.

Solution Info...

Name:  
Volume:

Aqueous  Solid  Gas

1 Molar Acetic Acid

Transfer amount (mL): 40 Pour from 1M CH<sub>3</sub>COOH to 250mL Beaker

Applet iridium.vlab.VLApplet started

oli.web.cmu.edu

# eLearning Can Be Transformative

StatTutorv2.0.9 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address <http://ko.mac.cc.cmu.edu/stattutor/StatTutorv2.0.9.html> Go Links

**STAT TUTOR**

WORK PLAN

- ▶ Understand the Problem
- ▶ Reflect on Question
- ▼ Analyze Data
  - ✓ Plan Analyses
  - ✓ Exploratory Analysis
    - Determine displays and measures
    - Conduct analysis
    - Report results
    - More Formal Analyses
- ▶ Draw Conclusions
- ▶ Summarize

Cheat

Instructor Controls

Author Mode  on  off

Problem Questions Variables Save Print

1. What are the drinking habits of students at this university? In particular, what is the typical number of drinks a student has during a week? Do the data suggest that drinking is a problem in this university?

2. One of the statistics professors at this university uses the honor system when giving exams. If there were cheating going on during her exams, would the professor be likely to know about it?

**Determine Displays and Measures (Question One)**

Hint

In order to visually explore the number of alcoholic beverages that students drink per week (which you classified as a **quantitative** variable), a meaningful display is:

- Side-by-side boxplots
- Scatterplot
- Two-way table
- Piechart
- Histogram

A meaningful numerical summary to supplement the above display is

select one

Using this display and numerical summary, I will

select one

Done Internet 12:07 AM

# But...Show Us the Data!

| EXAM  | Descriptive Statistics | Traditional | Online |
|---|------------------------|-------------|--------|
| <b>First Midterm</b><br><i>(EDA + Producing Data)</i> | Sample size            | 201         | 20     |
|   | Mean                   | 90.17       | 88.75  |
|   | Standard Deviation     | 8.59        | 6.23   |
| <b>Second Midterm</b><br><i>(Probability)</i>         | Sample size            | 202         | 20     |
|   | Mean                   | 81.62       | 81.45  |
|   | Standard Deviation     | 14.25       | 13.82  |
| <b>Third Midterm</b><br><i>(All of inference)</i>     | Sample size            | 201         | 20     |
|   | Mean                   | 85.87       | 85.10  |
|   | Standard Deviation     | 11.91       | 16.80  |
| <b>FINAL</b><br><i>(comprehensive)</i>                | Sample size            | 204         | 20     |
|   | Mean                   | 83.54       | 84.79  |
|   | Standard Deviation     | 11.06       | 12.23  |

Ref: Marsha Lovett

# What Do We Do?

Establish a *research and evaluation organization* in every educational system that evaluates eLearning interventions.

# Time to Get Past the Hype

Accepting what “*looks like* it should work” will leave us in the eLearning “trough of disillusionment.”

# Let's Transform Education

Use scientific knowledge and techniques to get to the “plateau of productivity” and use technology to make our educational systems more effective!