

Operation ARIES!

~~Learning critical thinking about science with~~
intelligent conversational agents in a
game environment

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Operation ARIES!

Defending Science; Defeating Ignorance

Developers



Interdisciplinary team

Keith Millis, Ph.D.

Northern Illinois University, Cognitive psychologist, language comprehension

Diane F. Halpern, Ph.D.

Claremont McKenna College, past president of the American Psychological Association. Internationally known for work on teaching critical thinking

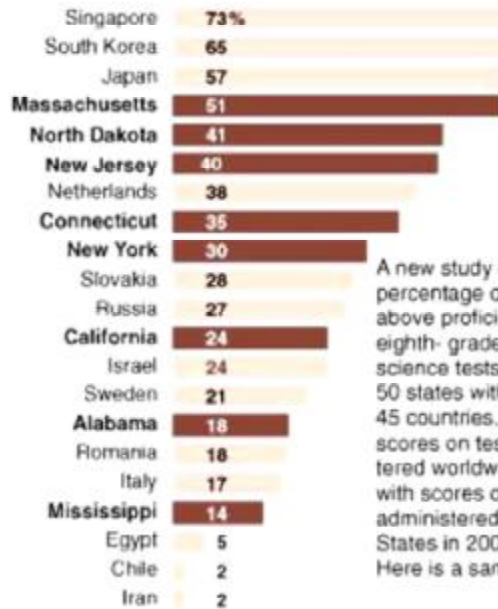
Art Graesser, Ph.D.

University of Memphis, co-director of the Institute for Intelligent Systems at the University of Memphis, expert in discourse technologies

The New York Times

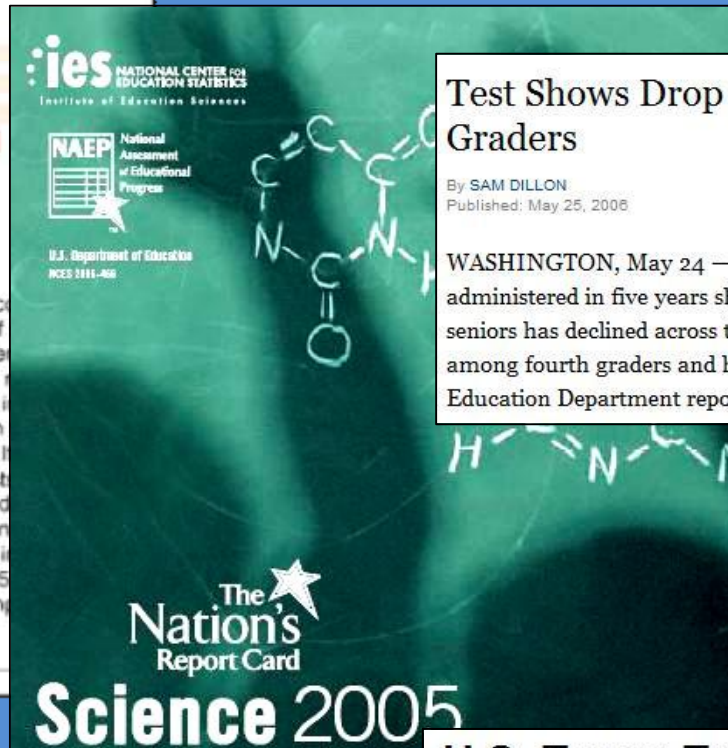
November 14, 2007

States vs. Countries in Math



A new study of percentage of above proficient eighth-grade science tests in 50 states with 45 countries. In scores on tested worldwide with scores on administered in States in 2005. Here is a sam

Source: American Institutes for Research



Test Shows Drop in Science Achievement for 12th Graders

By SAM DILLON
Published: May 25, 2006

WASHINGTON, May 24 — The first nationwide science test administered in five years shows that achievement among high school seniors has declined across the past decade, even as scores in science rose among fourth graders and held steady among eighth graders, the federal Education Department reported on Wednesday.



On Education By U.S. News Staff

[Blog Entry](#)

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Study: U.S. Trails Asian Countries in Math and Science

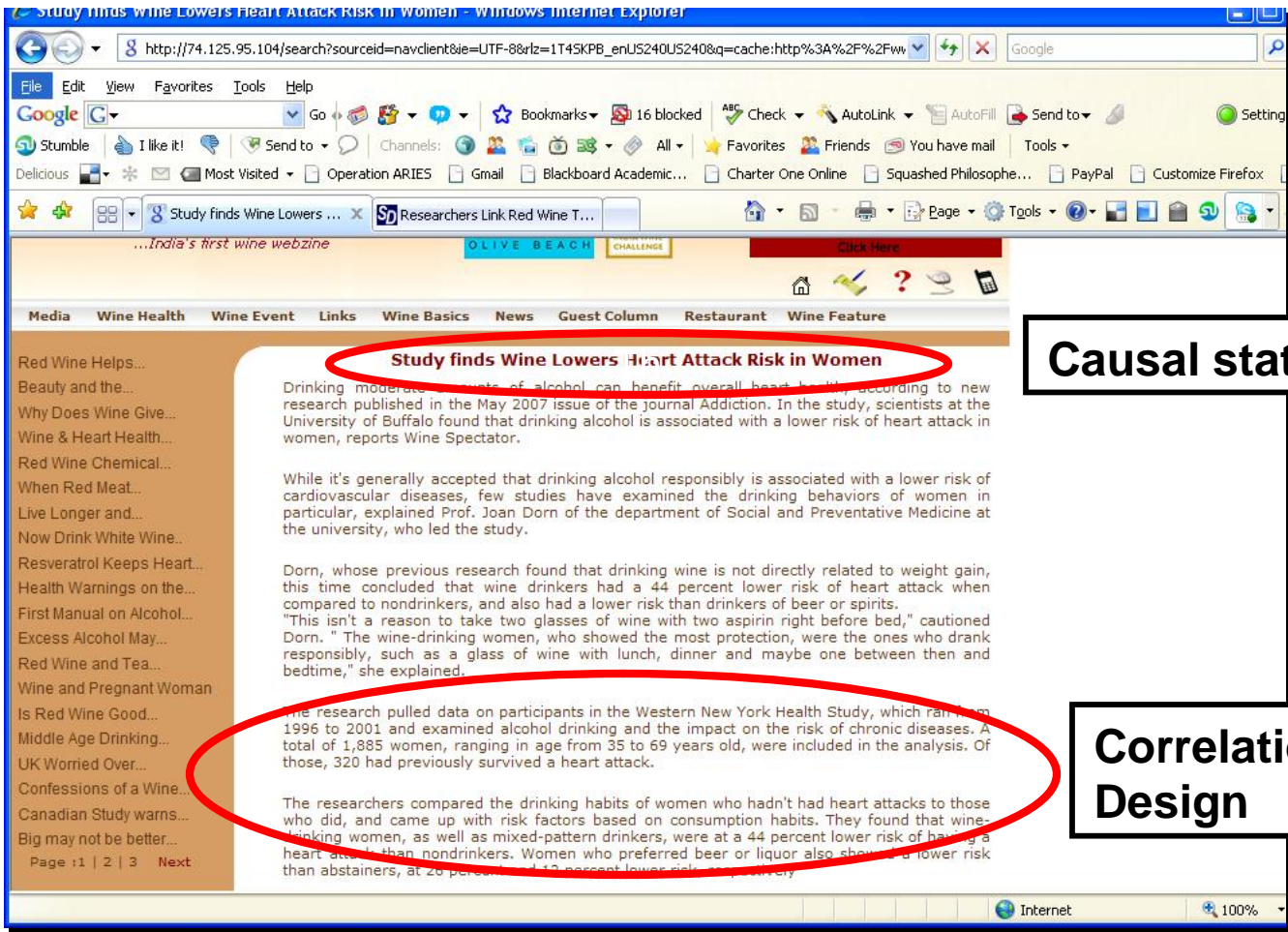
December 09, 2008 05:54 PM ET | Eddy Ramirez | [Permanent Link](#) | [Print](#)

Despite notable progress in mathematics, the United States has failed to raise student achievement in science over the past decade while Singapore and several other Asian countries continue to score higher in both subjects, according to a study released this week that compares math and science test scores of students from dozens of countries.

U.S. Teens Trail Peers Around World on Math-Science Test

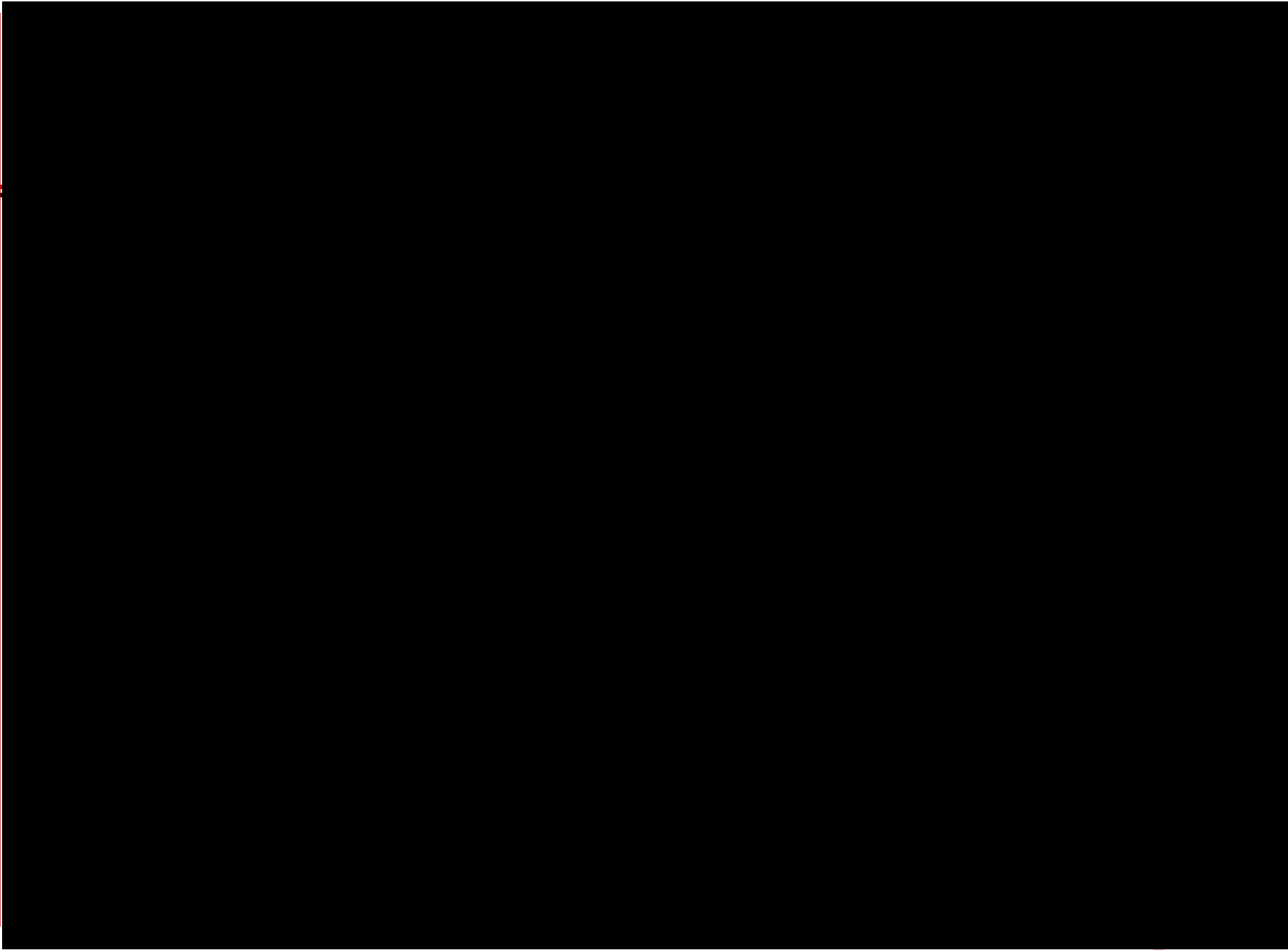
By Maria Glod
Washington Post Staff Writer
Wednesday, December 5, 2007

The disappointing performance of U.S. teenagers in math and science on an international exam, in scores released yesterday, has sparked calls for improvement in public schools to help the country keep pace in the global economy.



Causal statement

Correlational Design



SYSTEMS

or
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Content Covered

- **Critical thinking about scientific inquiry skills**
- **Important concepts shared among psychology, sociology, biology and chemistry**
 - **Developing Research Ideas**
 - **The Independent and Dependent Variables**
 - **Experimental Control**
 - **The Sample**
 - **Experimenter Bias**
 - **Relation of Data to Theory**
 - **(21 concepts altogether – one per chapter)**



Example content

Psychology

Does using cell phones hurt driving?
Is a new cure for autism effective?

Biology

Do chemical and organic pesticides differ on food quality?
Does milk consumption increase bone density?

Chemistry

Does a new product for winter roads prevent water from freezing?
Does eating fish increase blood mercury levels?

Formats

Articles, advertisements, blogs, letters to editors



Learning principles implemented in Operation ARIES!

- Active learning
- Explanatory reasoning
- Immediate feedback
- Dialog interactivity
- Multimedia effects
- Distributed practice
- Multiple examples
- Transfer to real world



The story is told through

Animated agents



Emails, texts,
news updates

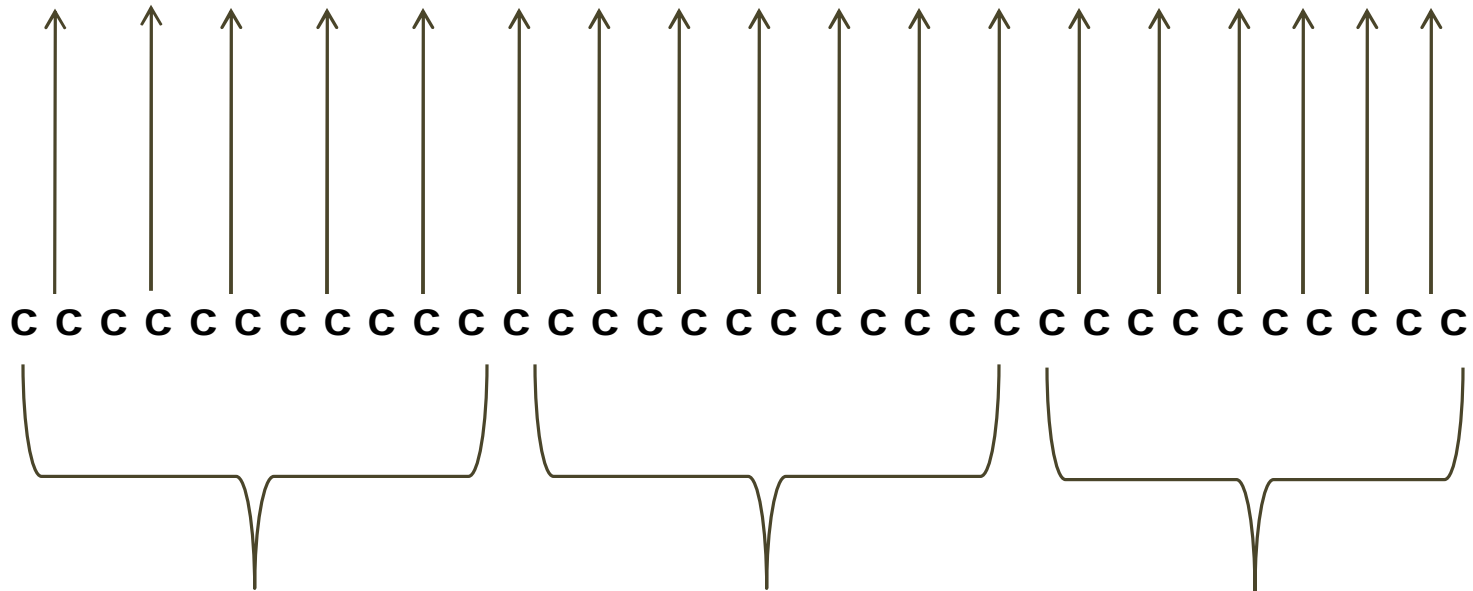


Videos



Story elements are presented across the game

----- Story elements -----



MODULES: Interactive text

Case studies

Interrogation

Module 1: Interactive Text

- Student reads an eBook “The Fuath’s Big Book of Science”
- Provides requisite knowledge for later modules
- Student takes test after each chapter or may test out of reading the chapter



3 Types of “trialogs” – matching prior knowledge with dialog moves

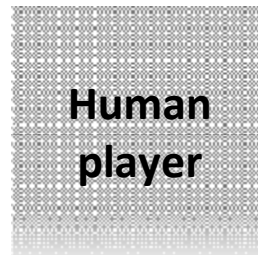
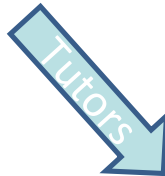
Vicarious: when player shows low knowledge



Human
player

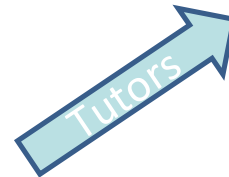
3 Types of “trialogs” – matching prior knowledge with dialog moves

Standard: when player shows intermediate knowledge



3 Types of “dialogues” – matching prior knowledge with dialog moves

Teaching: when player shows high knowledge



Human
player

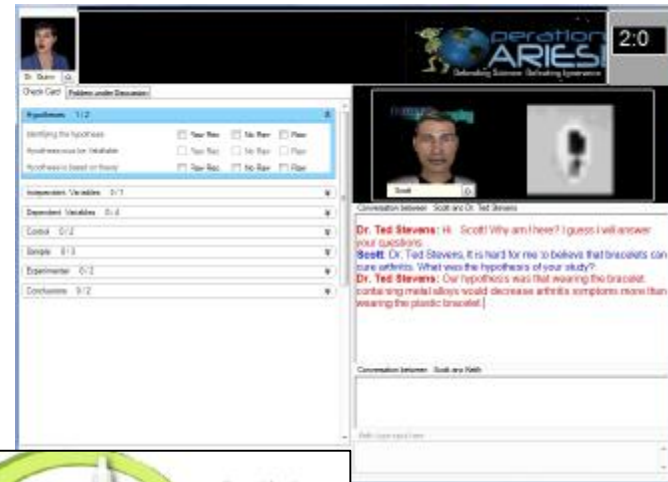
Module 2: Case Studies

- Ø Students apply information from the interactive text
- Ø Evaluate flawed “published” research
- Ø Learn to identify flaws
- Ø Various game-like attributes

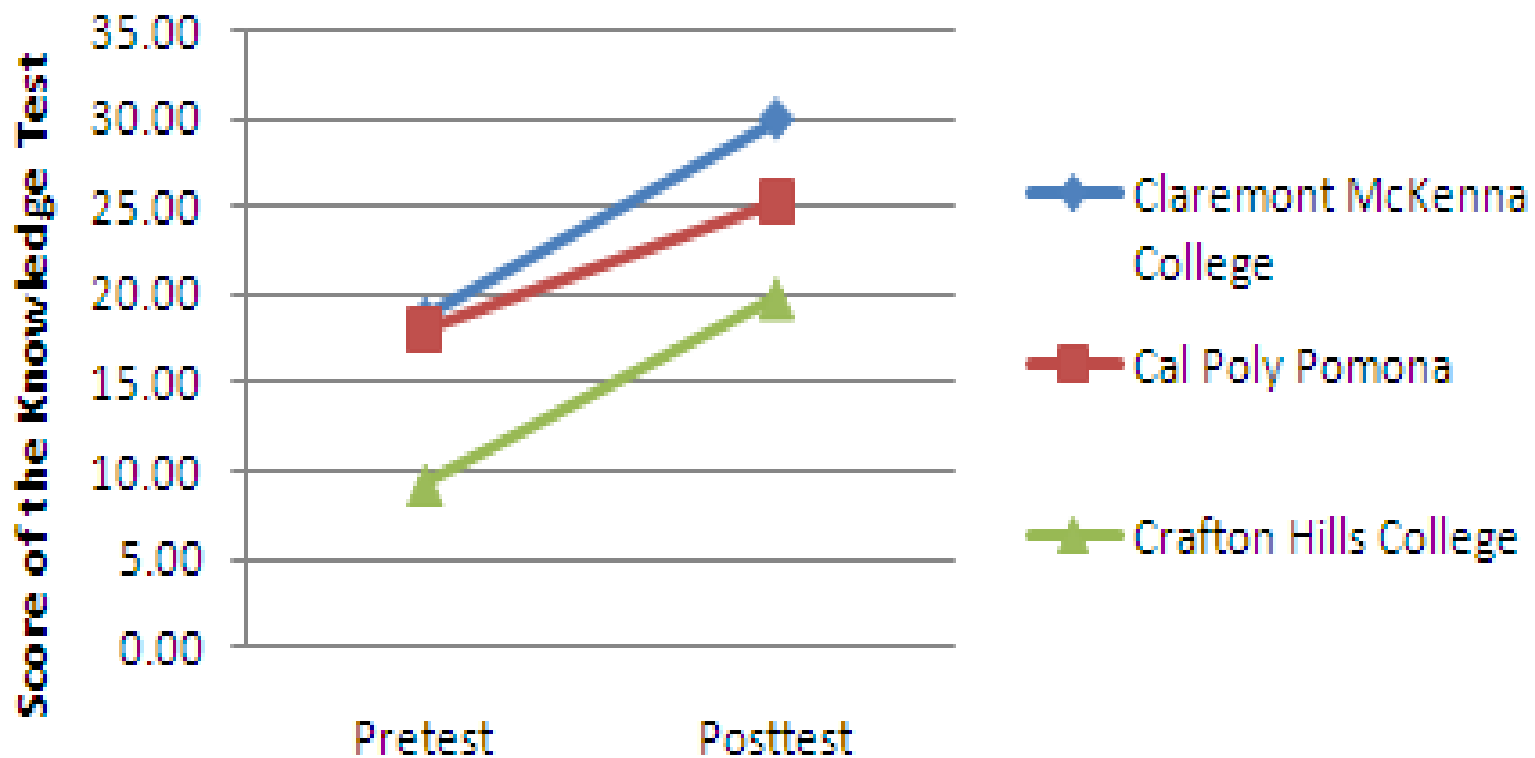


Module 3: Interrogation

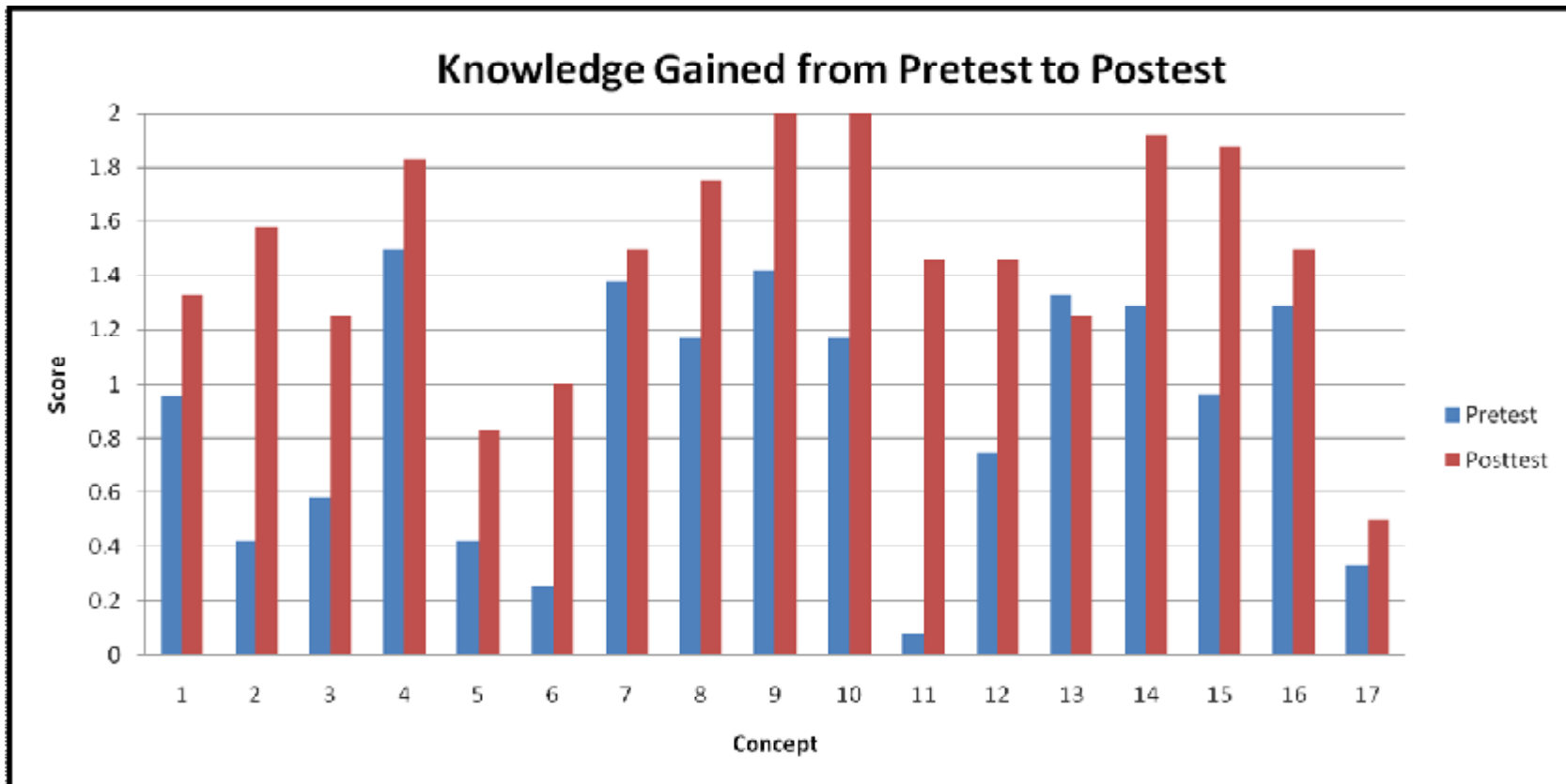
- Ø Students seek out whether research contains flaws
- Ø Research cases are abbreviated (e.g., abstracts, headlines, ads)
- Ø Learn to ask relevant questions about research
- Ø Learn to discriminate flawed from good research



Summative Evaluation on Tests



Interactive Text Data



} **Similar patterns from three different schools**

(Claremont McKenna College, Cal. State Pomona, and Crafton Hills Community College)

Mastery of a Principle/Concept over Time and Tasks

	Pretest Essay	Pretest MC	Training	Posttest Essay	Posttest MC
All-or-none Learning	X00X	X0XXXX0XXX XXX0XXX0XX XX0X0X	X0XX0X1XX1	X1X1	XX1XX1XXXX X11XXXXXX1 XX1XXX
Variable Learning	X10X	X0XXXX0XXX XXX1XXX0XX XX0X0X	X0XX1X1XX0	X1X0	XX1XX0XXXX X11XXXXXX0 XX1XXX
No Learning	X00X	X0XXXX1XXX XXX0XXX0XX XX1X0X	X0XX0X1XX0	X1X0	XX0XX0XXXX X10XXXXXX0 XX1XXX
Refresher Learning	X00X	X0XXXX1XXX XXX1XXX1XX XX1X1X	X1XX1X1XX1	X1X1	XX1XX1XXXX X11XXXXXX1 XX1XXX

Summary of Evaluation Methods

1. **Summative pretest and posttest for overall learning gains.**
2. **Tracking particular principles or concepts over the evolution of testing and training**
3. **Identifying particular flaws with particular cases (signal detection analysis)**
4. **Articulation of language that matches ideal expectations versus misconceptions**
5. **Educational data mining on decisions, response times, study time, and performance**



For more information:

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