Evidence-Based Pedagogy Goes to College: Infusing the Science of Learning into the Curriculum

Victor A. Benassi
University of New Hampshire
Professor of Psychology
Faculty Director, Center for Excellence in Teaching and Learning
vab@unh.edu

Workshop Co-Presenters

Michael J. Lee, Administrative Director, Center for Excellence in Teaching and Learning, Affiliate Associate Professor of College Teaching

Catherine Overson, MA and PhD Candidate, Department of Psychology

Sam Pazicni, Assistant Professor of Chemistry

Elizabeth M. Reilly, Student Learning Outcomes Assessment Coordinator, Center for Excellence in Teaching and Learning

Barbara P. White, Director of General Education Program and Associate Professor of Occupational Therapy, University of New Hampshire, Durham

Acknowledgements

- This work is made possible by a grant from the Davis Educational Foundation. The Foundation was established by Stanton and Elisabeth Davis after Mr. Davis's retirement as chairman of Shaw’s Supermarkets, Inc.
- This work is also made possible by support by the University of New Hampshire Office of the Provost and Vice President for Academic Affairs.

Background on Cognitive Toolbox Project

- Different way of working with faculty on:

  Course Design

  Instructional Implementation

  Student Learning Outcomes Assessment

One View of Human Memory

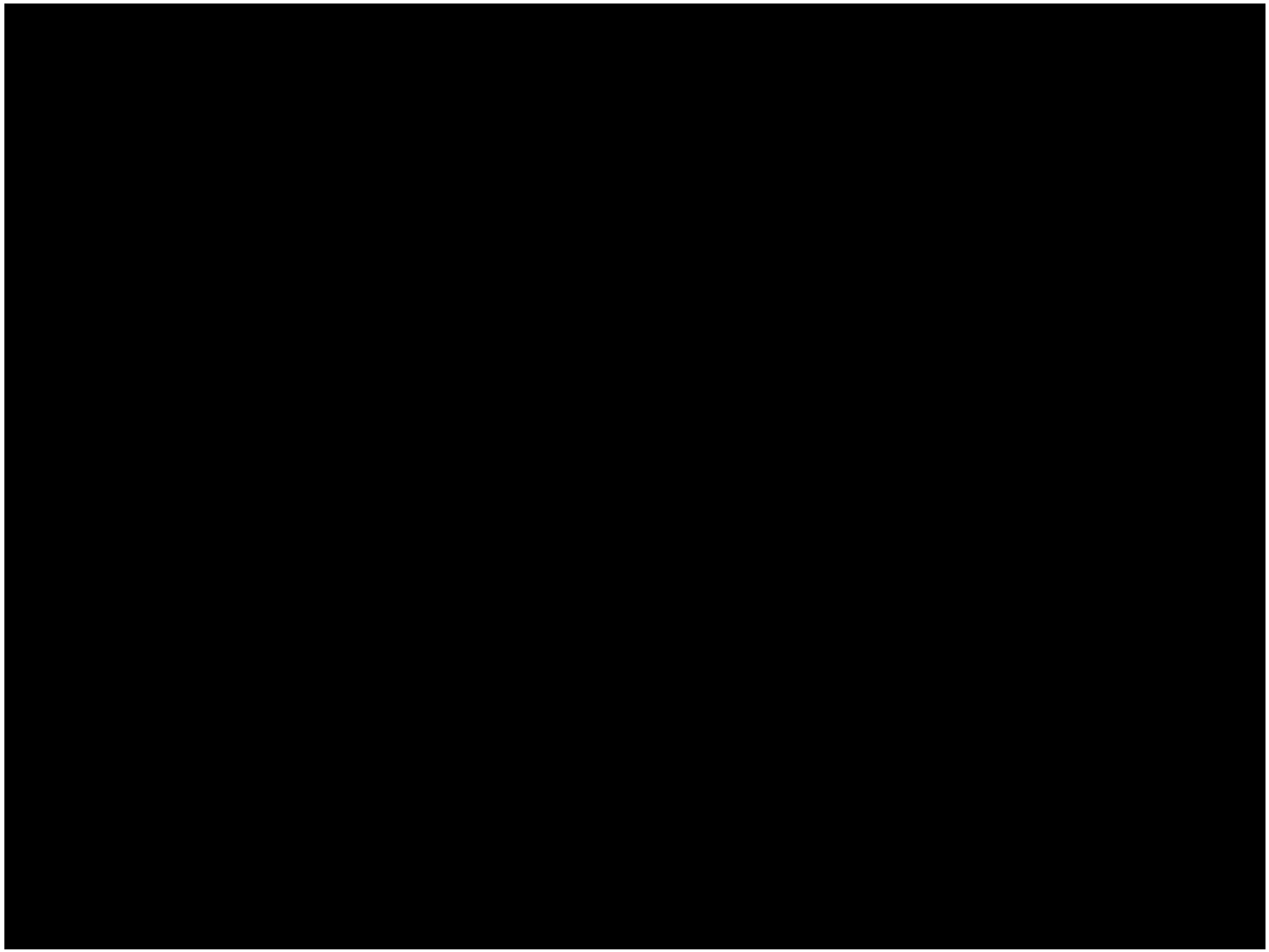
“ . . . one of the ubiquitous problems we face is the fragility of what is learned. ***It's like dry ice. It just evaporates at room temperature and is gone.*** Students seldom remember much of what they've read or heard beyond their last high-stakes exam on the material.”

Lee Shulman, “Professing the Liberal Arts” (1997)

Another View of Human Memory

Father Guido Sarducci's "Five Minute University"

http://www.youtube.com/watch?v=kO8x8eoU3L4



The Problem

"Despite all the gains made in understanding what happens when people learn, the truth is that most professors have gained relatively little from cognitive psychology."

Diane Halpern, 2002, *New Directions for Higher Education*, pp. 41-43.

Four Questions

Q: What is known about the learning, maintenance, and transfer of academic material at the college/university level?

A: A lot.

Q: How long have we known it?

A: For quite some time, but especially during the past couple decades.

Q: What has been done to apply what we know?

A: Not a lot.

Q: What can we do?

A: A lot, for not a lot of extra work.

A University of Memphis Department of Psychology website lists 25 principles related to what we know about human learning

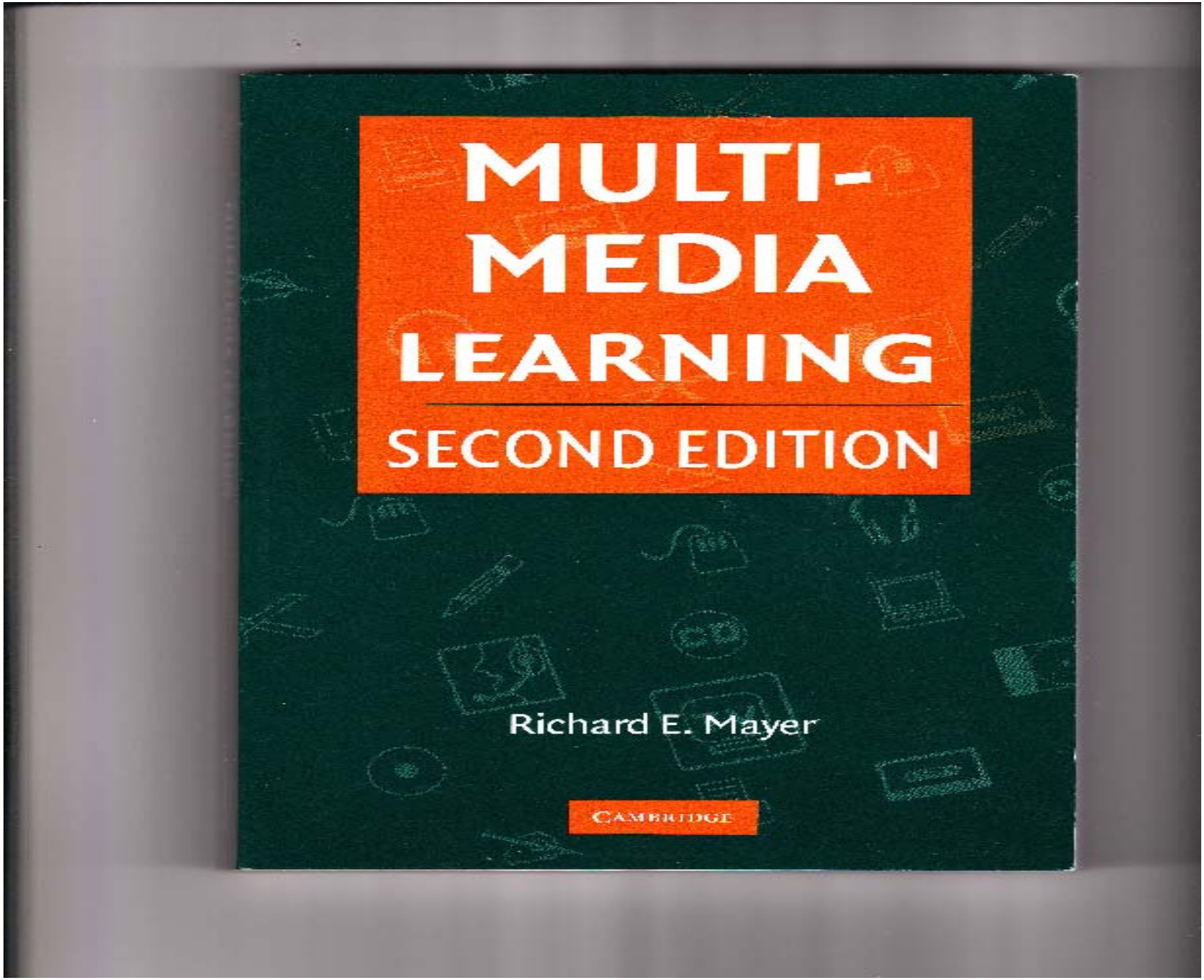
http://www.psyc.memphis.edu/learning/whatweknow/index.shtml

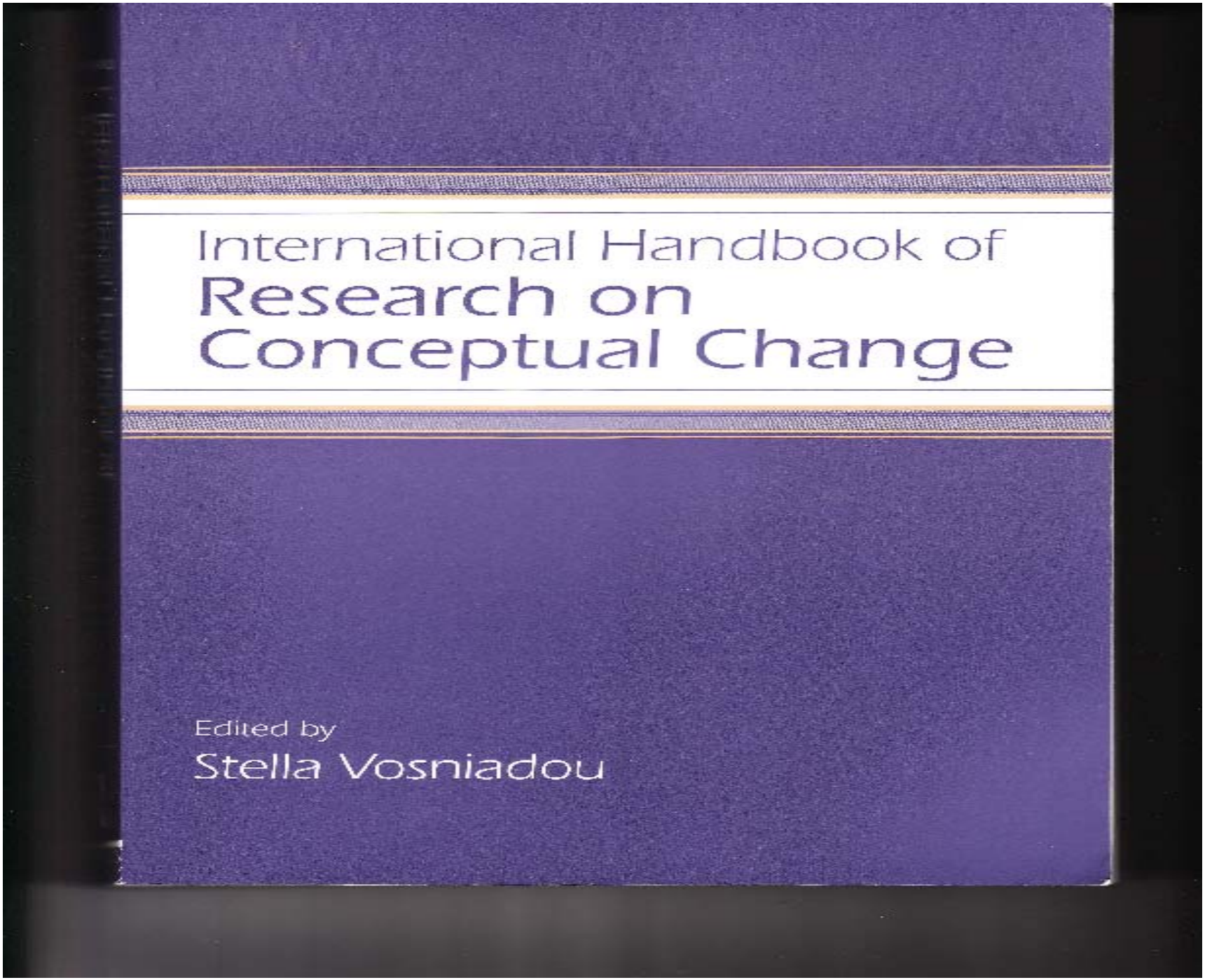
NEW DIRECTIONS FOR TEACHING AND LEARNING

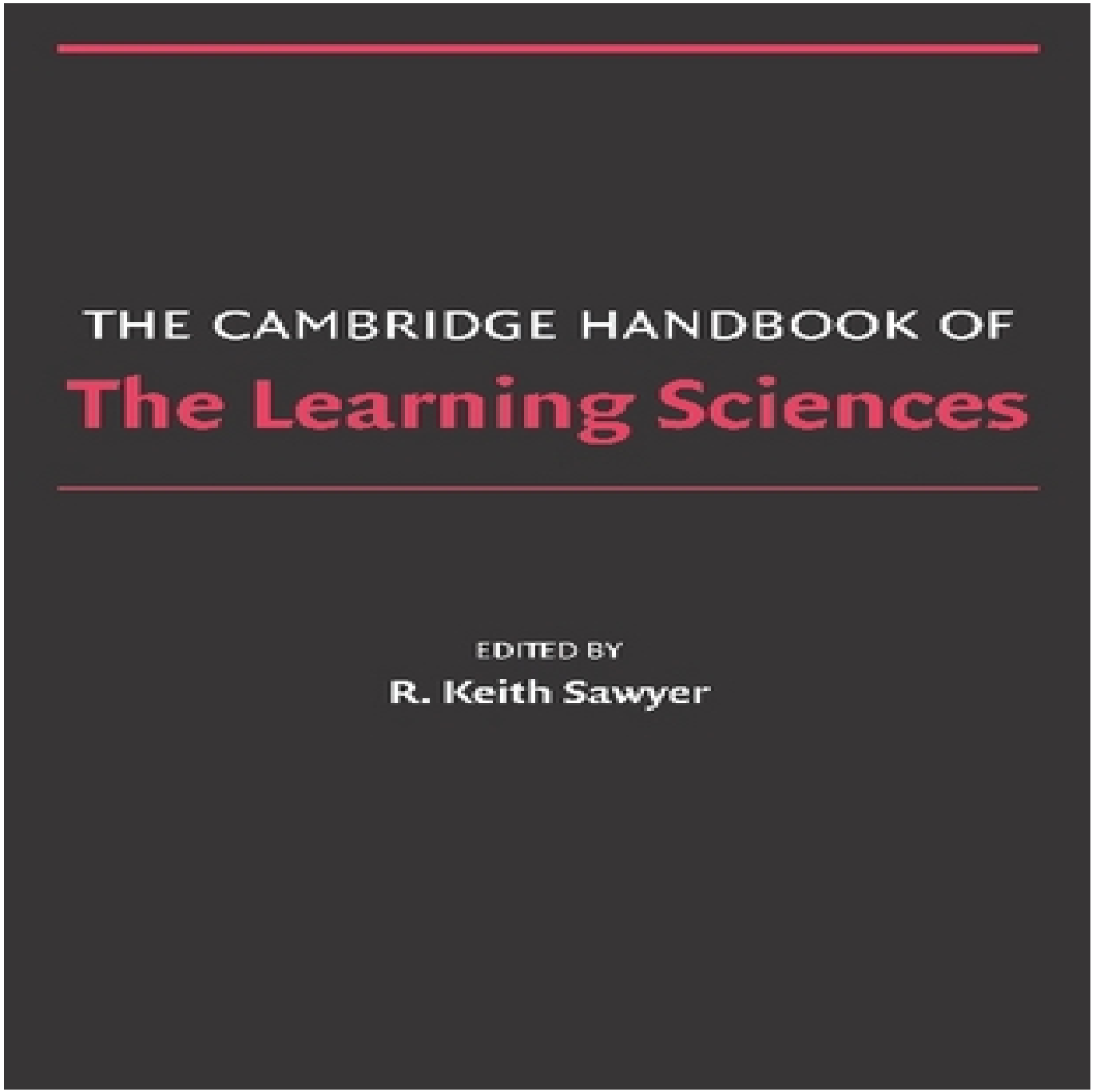
Applying the Science of Learning to University Teaching and Beyond

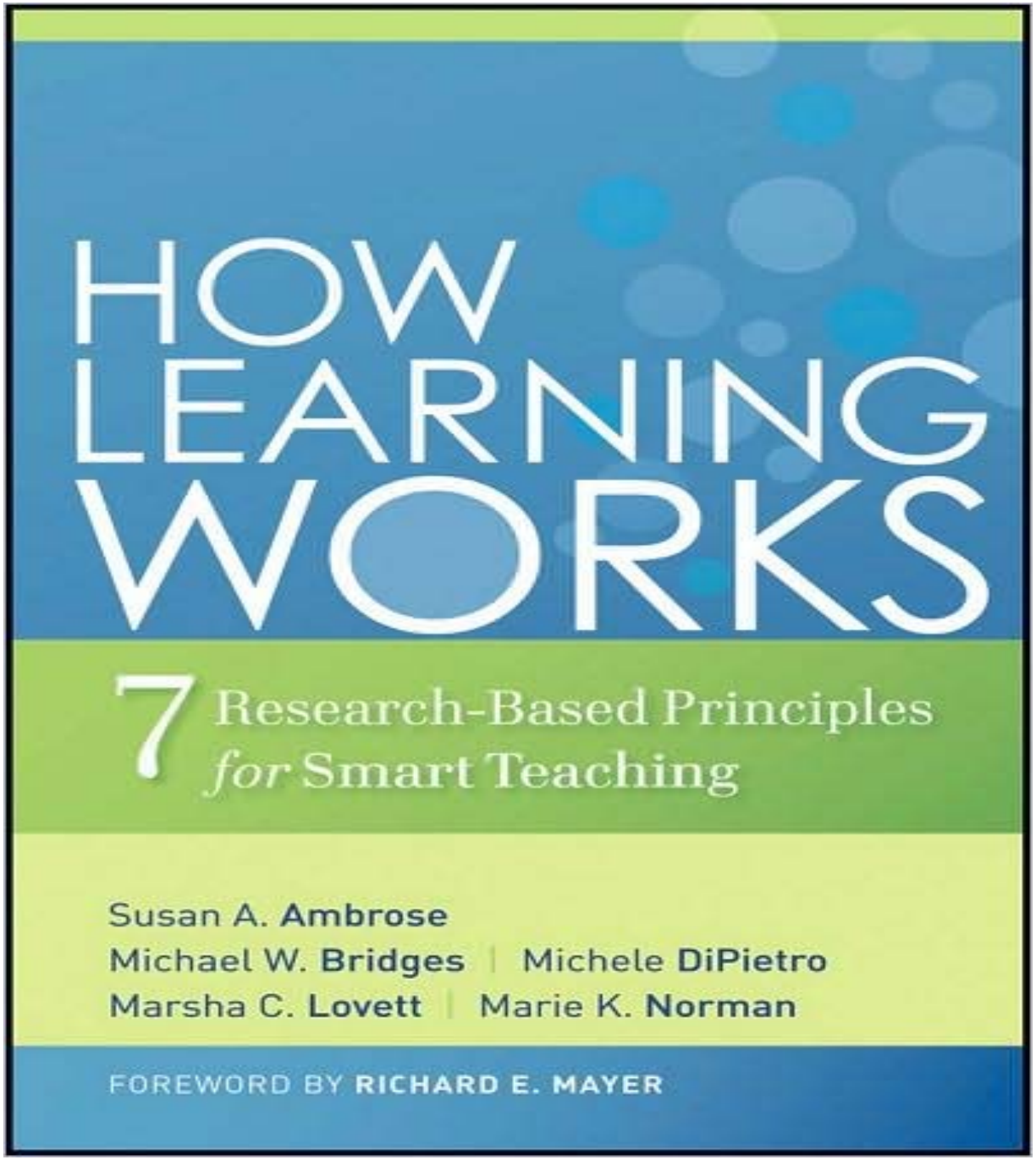
Diane F. Halpern, Milton D. Hakel
EDITORS

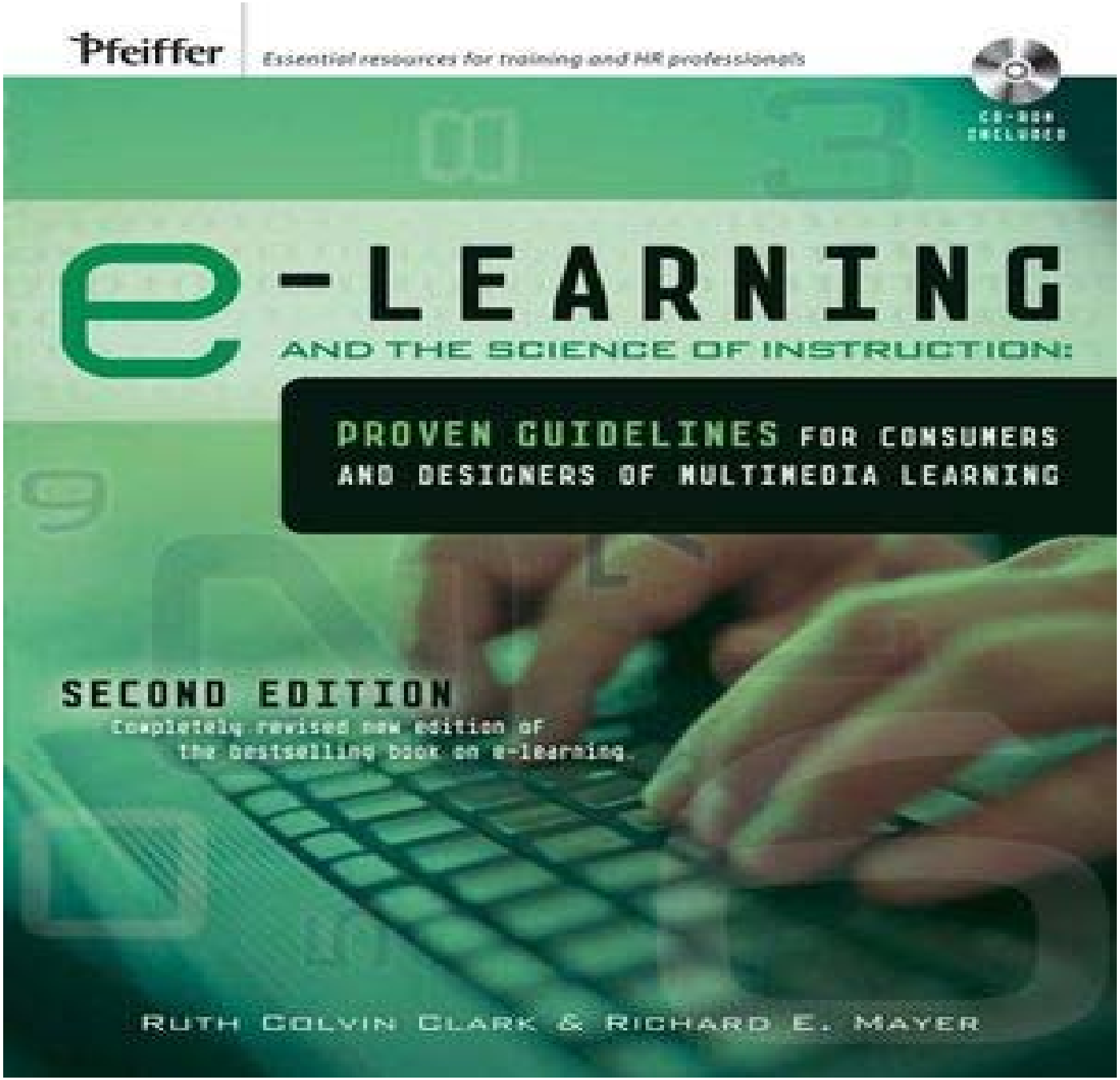
NUMBER 89, SPRING 2002
JOSSEY-BASS


MULTI-
MEDIA
LEARNING
SECOND EDITION
Richard E. Mayer
CAMBRIDGE


International Handbook of
Research on
Conceptual Change
Edited by
Stella Vosniadou


THE CAMBRIDGE HANDBOOK OF
The Learning Sciences
EDITED BY
R. Keith Sawyer


HOW LEARNING WORKS
7 Research-Based Principles for Smart Teaching
Susan A. Ambrose
Michael W. Bridges | Michele DiPietro
Marsha C. Lovett | Marie K. Norman
FOREWORD BY RICHARD E. MAYER


Pfeiffer
Essential resources for training and HR professionals
CD-ROM INCLUDED
e-LEARNING
AND THE SCIENCE OF INSTRUCTION:
PROVEN GUIDELINES FOR CONSUMERS AND DESIGNERS OF MULTIMEDIA LEARNING
SECOND EDITION
Completely revised new edition of the bestselling book on e-learning.
RUTH COLVIN CLARK & RICHARD E. MAYER

Overview of Workshop

- **Describe some principles of learning and cognition.**
- **Present examples of work done as part of UNH's Cognitive Toolbox project.**
- **Workshop participants will develop interventions and assessment protocols for several course-related learning issues.**
- **Final discussion and wrap up.**

Tutorial on Cognitive Principles Applicable to Everyday Use in College and University Courses

- **Desirable Difficulties**
- **Generation and Retrieval Practice**
- **Elaboration and Self Explanation**
- **Transfer Appropriate Training**
- **Distributed Practice**
- **Background (e.g., Prior Knowledge, Reading Skill)**
- **Expertise Reversal Effect (example, worked solutions)**
- **Coherence Principle (Seductive and Irrelevant Details)**
- **Knowing and remembering are not the same**
- **Plus many others**

UNH Cognitive Toolbox Project

- **We have worked to date with faculty in more than 50 courses.**
- **Examples of courses: epidemiology; human reproduction; first-year English, statistics, chemistry; biology; health care financial management; science and practice of strength training; geographic information systems; community psychology; genetics; soils; stress; chemistry for engineers; human occupation.**
- **Today, I'll present a few representative examples of results we have obtained.**

Our Basic Approach

- Invite faculty to participate.
- Identify learning issues.
- Design interventions.
- Assist instructors in implementing interventions.
- Develop and conduct assessments.
- Provide feedback.

Retrieval Practice and Testing Effect

Students' beliefs about benefits of GENERATION versus STUDY

Suppose that you are reading a textbook chapter in preparation for a closed-book exam on the chapter that will be given the next day in class. Your instructor has told you the exam will consist of multiple-choice, fill-in-the-blank, and short-answer questions. Your goal is to do as well as you can on the exam.

After Karpicke, Butler, & Roediger (2009)

- **We asked students how they would prepare for the exam.**
- **Sample: from University of New Hampshire, from colleges and universities across the United States, and from universities in the UK, New Zealand, Singapore, and Turkey.**
- **What Follows are representative results.**

Go back and re-read either the entire chapter or certain parts of the chapter

78%

Try to recall as much material as you can from the chapter with the book closed (without the possibility that you could restudy the material after you completed the recall task)

22%

Go back and re-read either the entire chapter or certain parts of the chapter

47%

Try to recall as much material as you can from the chapter with the book closed (<u>with</u> the possibility that you could restudy the material after you completed the recall task)

53%

In-Class Quizzing Promotes Long-term Learning and Retention.

- **Course: Introductory Psychology.**
- **Most class periods, students received a short in-class quiz.**
- **Some items were study trials—given question, with answer provided. (Study)**
- **Some items were quiz trials—given question and asked to provide answer. (Retrieval Practice, Generation)**

Exam Details

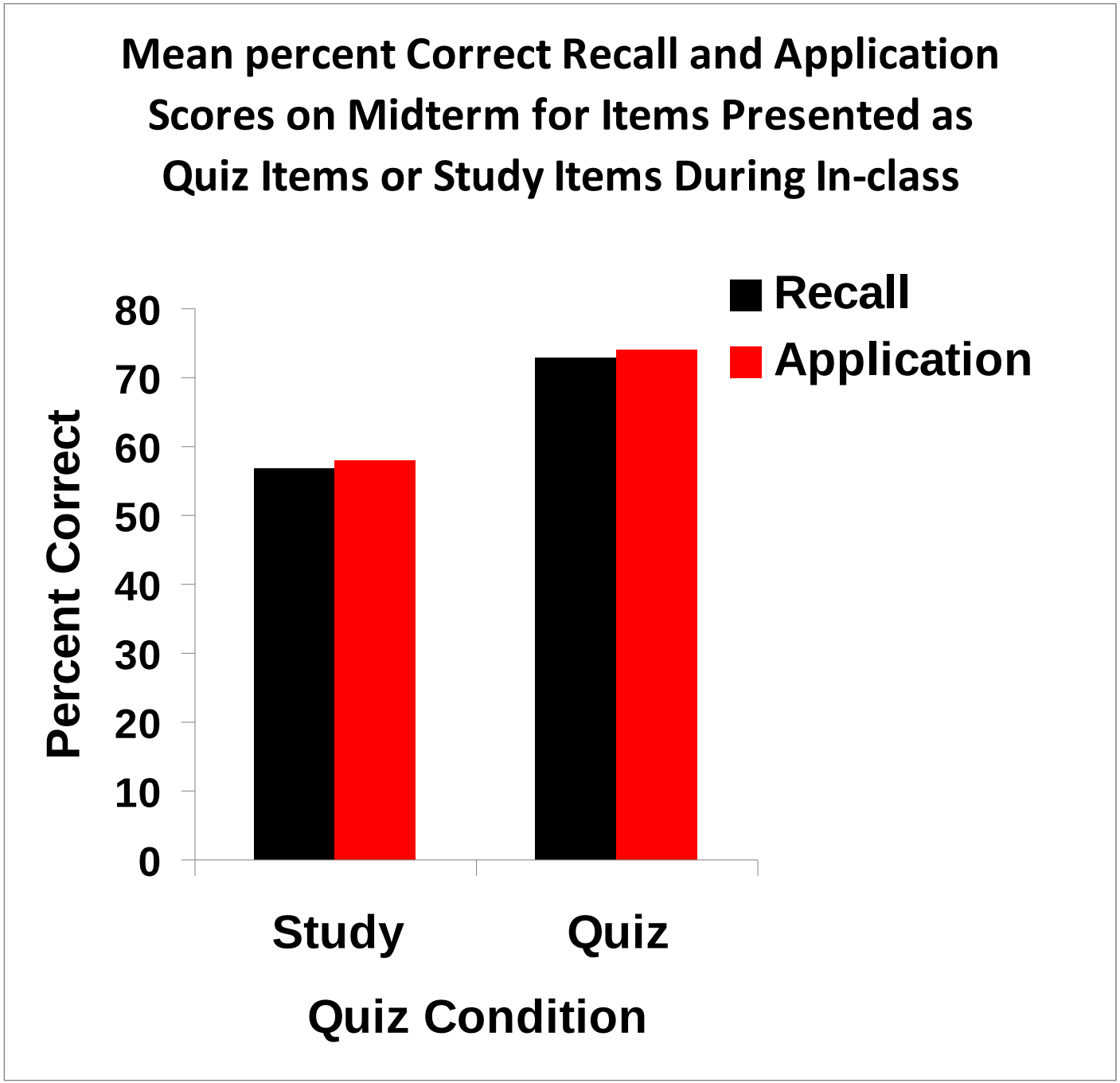
- **Midterm Exam**

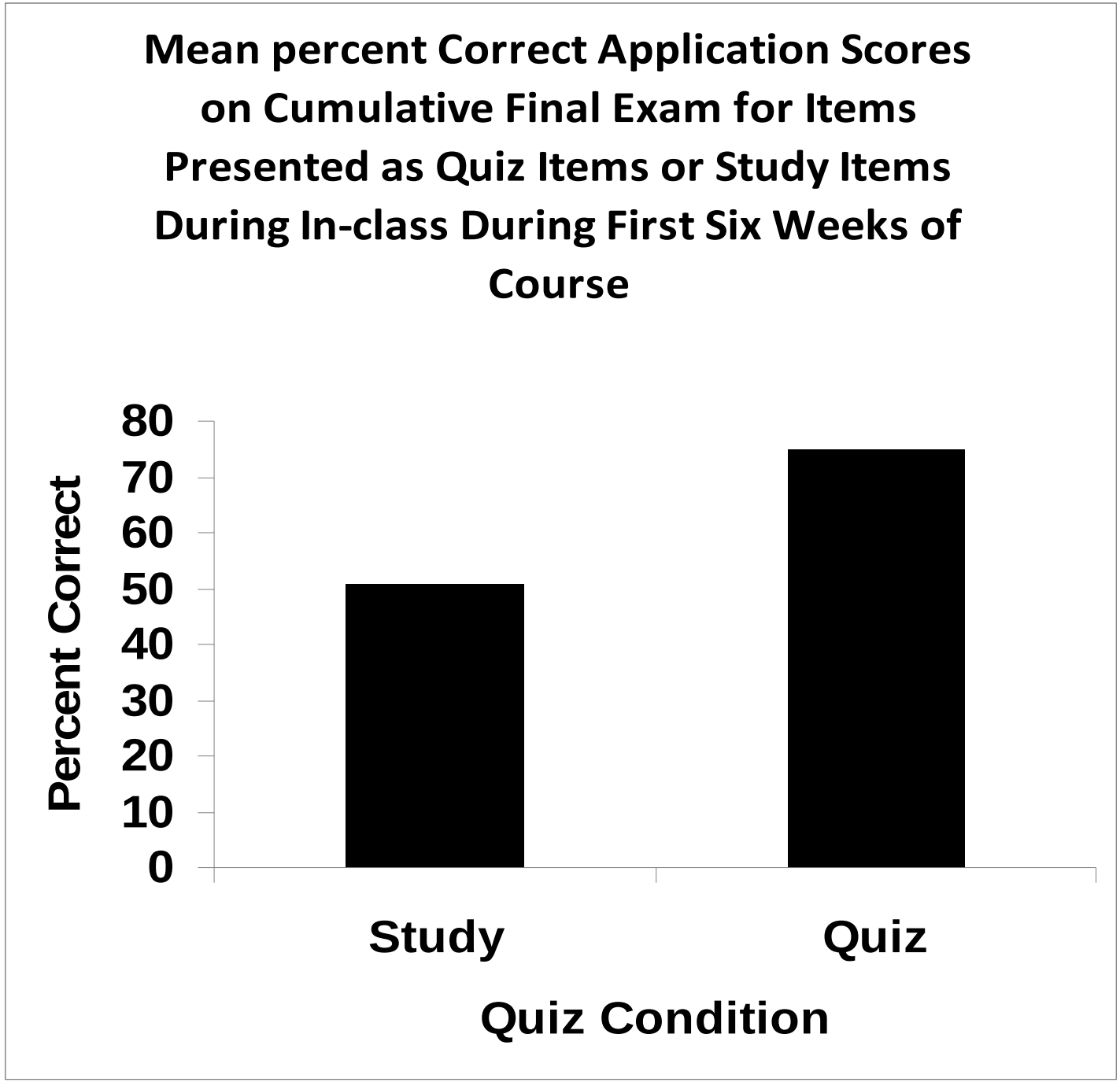
  - recall and multiple choice application items

  - presented as study trials or quiz trials during preceding classes.

- **Cumulative Final Exam**

  - items that appeared on the midterm and also presented as quiz trials or study trials on quiz days.

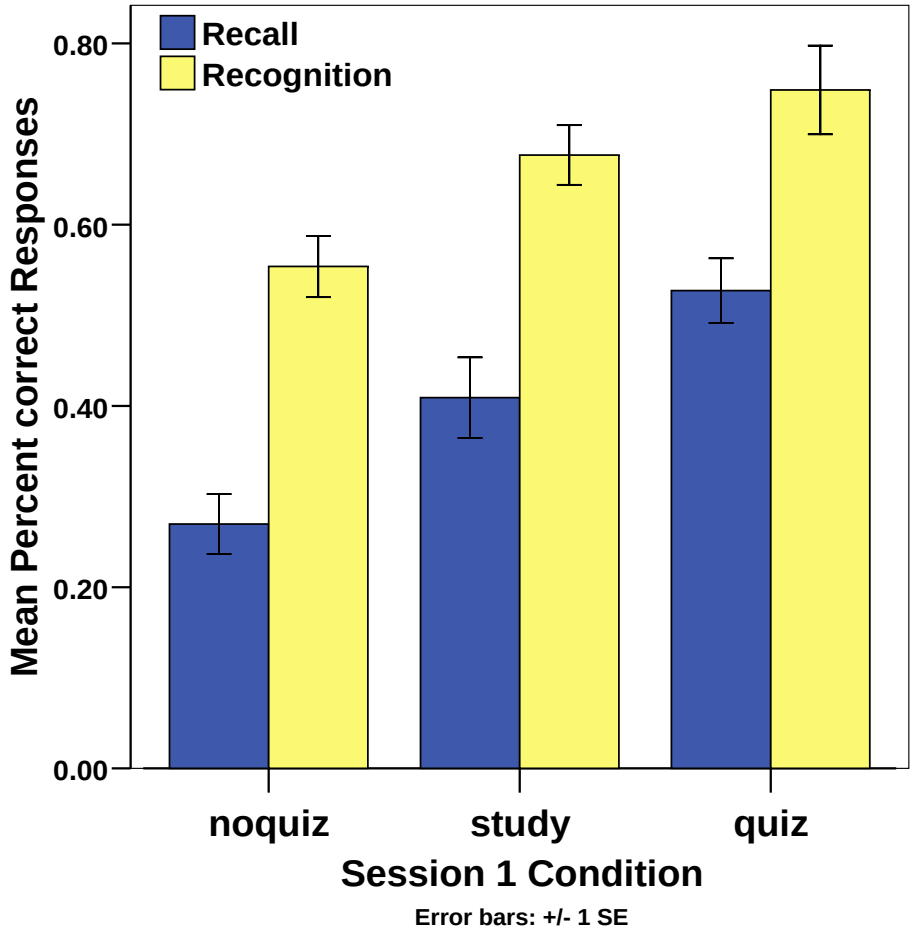

Mean percent Correct Recall and Application Scores on Midterm for Items Presented as Quiz Items or Study Items During In-class
Recall
Application
Percent Correct
80
70
60
50
40
30
20
10
0
Study
Quiz
Quiz Condition


Mean percent Correct Application Scores on Cumulative Final Exam for Items Presented as Quiz Items or Study Items During In-class During First Six Weeks of Course
Percent Correct
80
70
60
50
40
30
20
10
0
Study
Quiz
Quiz Condition

Taking a quiz after watching a video promotes learning and retention of material covered in video.

- **Students watched 20-minute video on judgment and decision making.**
- **No note taking permitted or notes provided.**
- **After delay, students either studied a quiz (with answers), took a recall quiz, or completed an unrelated task.**
- **No feedback provided after quiz completed.**
- **Dismissed, returned in two days.**
- **Final test on material covered in video—recall and multiple choice items.**

Delayed Final Test Performance after Watching a Video and Then Studying a Quiz (with answers), Taking a Quiz, or Completing an Unrelated Task.



Online Quizzing Leads to Better Exam Performance for Material That Was Quizzed.

- **Course: Science and Nature of Human Stress.**
- **Large enrollment (circa 150)**
- **Weekly lecture and lab sessions**
- **Weekly online quizzes leading up to in-class midterm exam.**

Study Trial Condition

- **For some items,**

  - students read a statement that included the correct answer

  - then, answered a multiple choice question that appeared immediately after.

- **For example,**

  “The rain in Spain falls mainly in the plain,” followed by a multiple choice question with “plain” as one of the alternatives.

Quiz Trial Condition

- **For other items,**

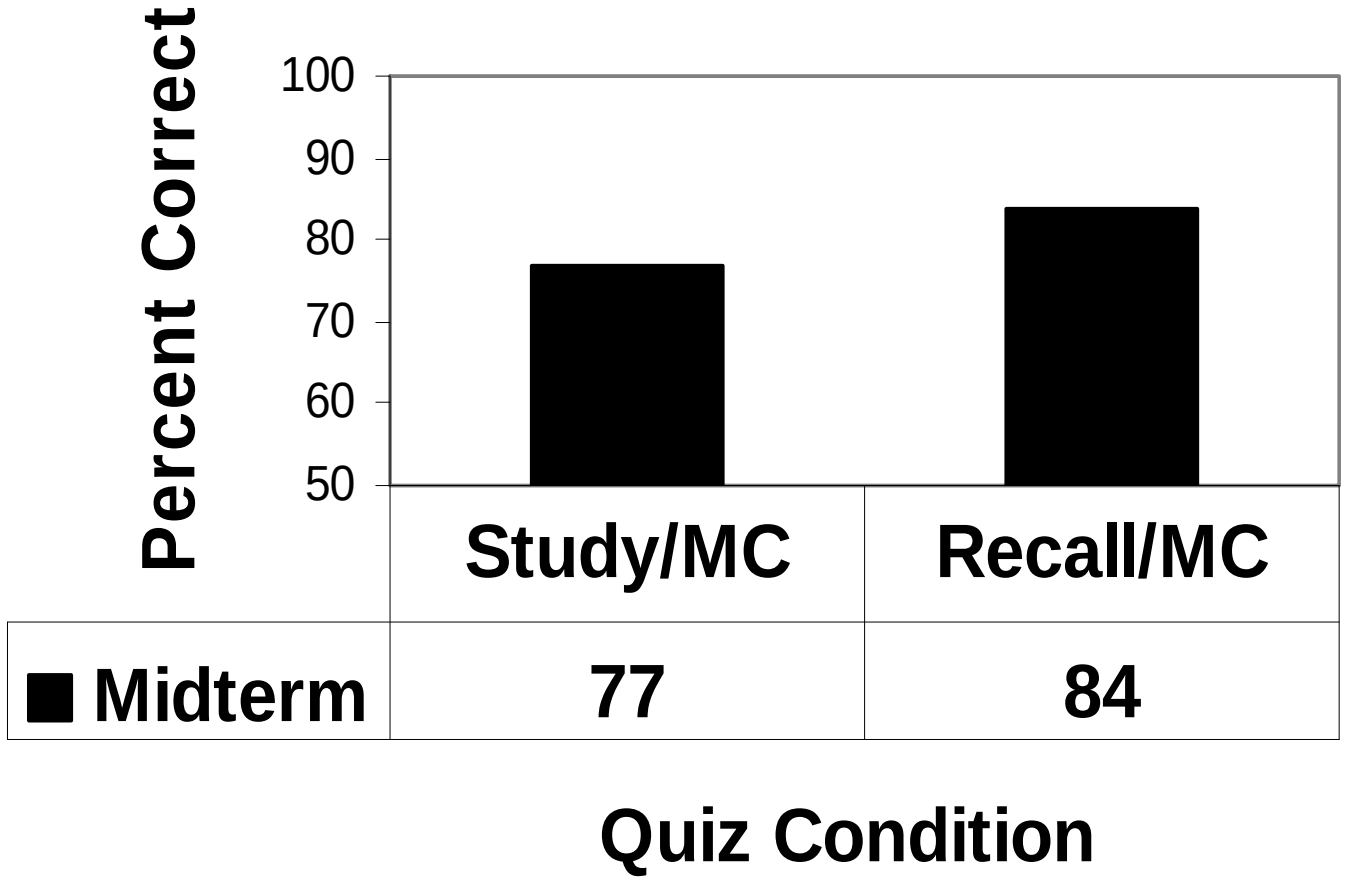
  - students read a statement and tried to recall the answer.

  - then they immediately were asked a multiple choice question for which they were to select the best answer.

- **For example**

  “Where does the rain in Spain mainly fall? _____,” followed by a multiple choice question with “plain” as one of the alternatives.

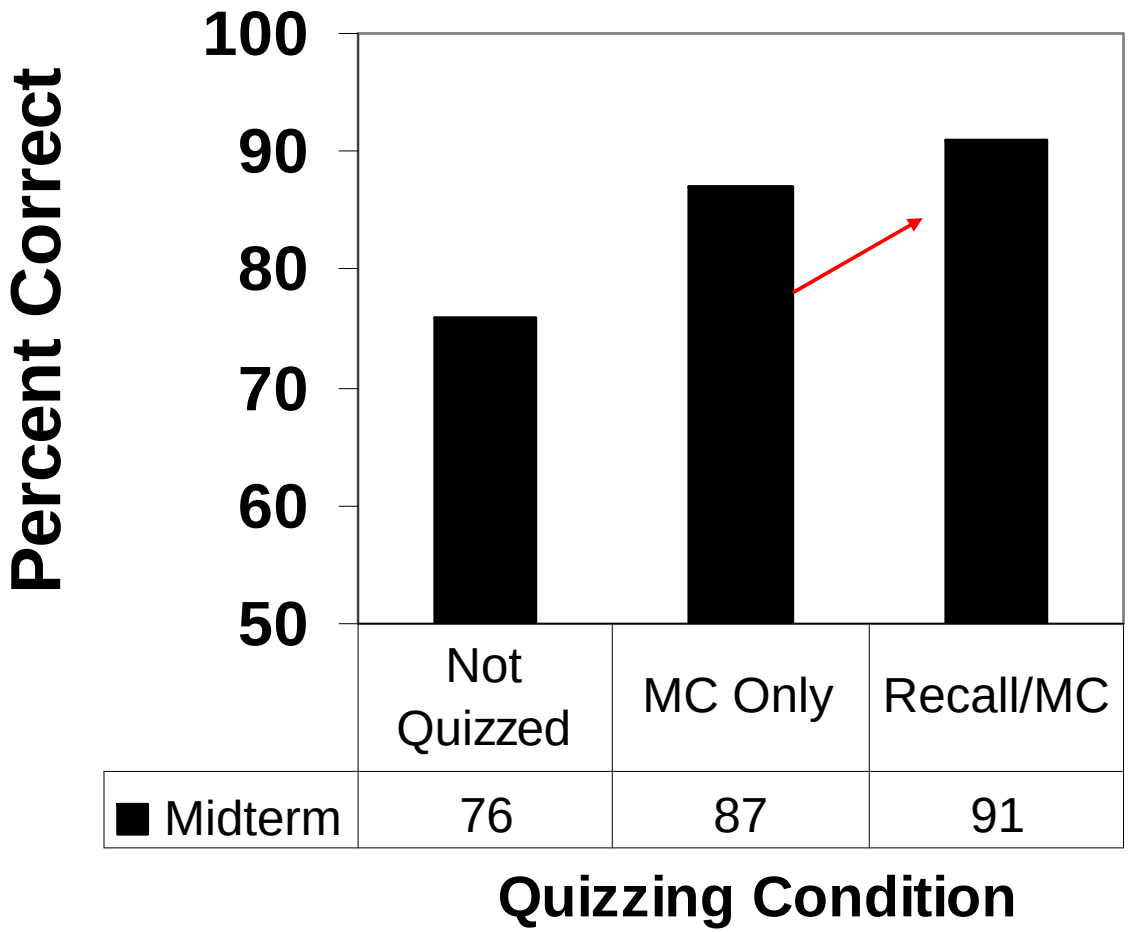
Percent Correct on Midterm for Items "studied, then MC" Versus Items "Recalled, then MC."



Follow up

- **New section of Stress course.**
- **Showed that recall, followed by multiple choice questions, leads to better exam performance than multiple choice quizzing alone.**
- **Generation Effect in action.**

Percent Correct on Midterm Exam for Items "Not Quizzed," "Quizzed by MC," or "Quizzed by Recall, then MC."



Elaboration and Transfer-Appropriate Processing in an Upper-Level Occupational Therapy Course.

- **Writing intensive course.**
- **Enrollment = 35**
- **Prior to writing a formal paper that asked students to describe the key issues raised in a set of research articles as well as the relation among the articles,**

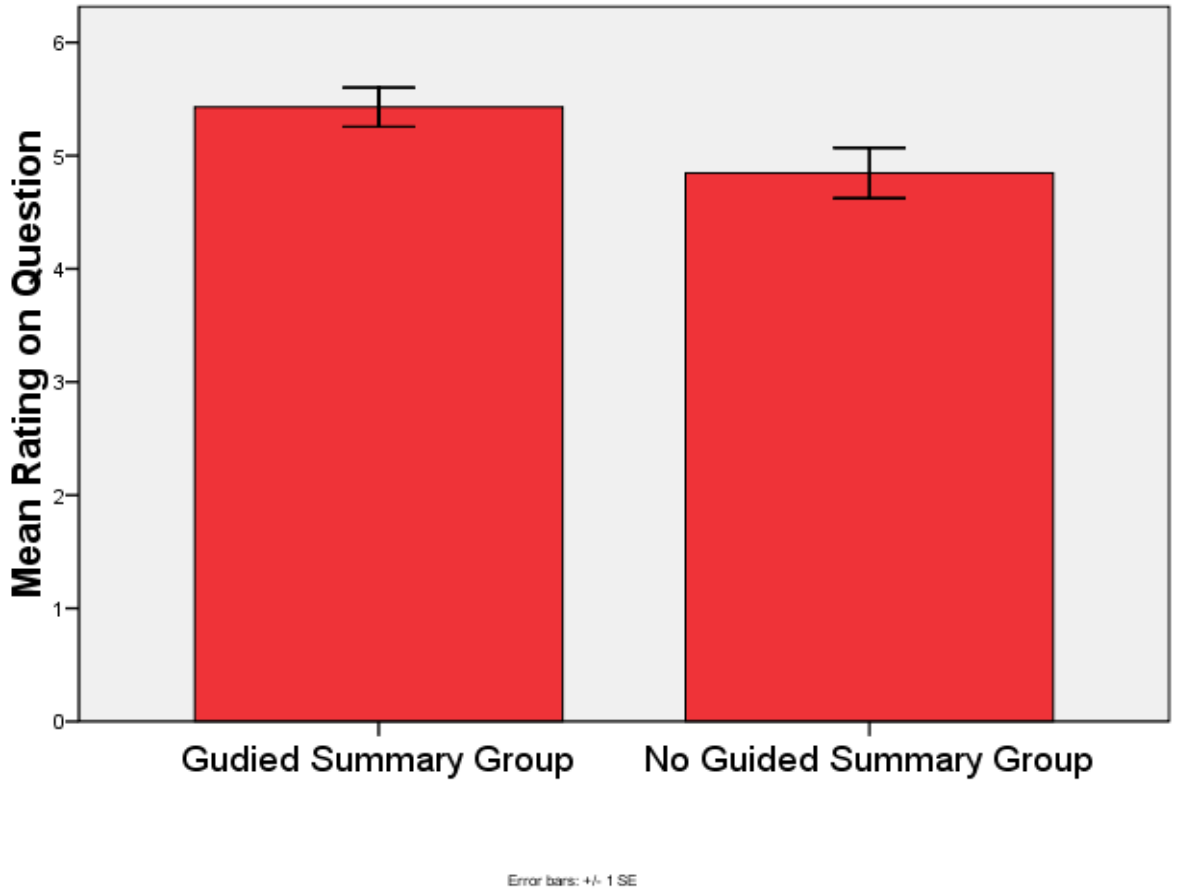
  half of class (random) responded to a set of "guiding" questions for each of the assigned articles.

Results

- **Instructor gave a higher mean grade to the response papers written by the students who had prepared responses to the guided summary questions than to the students who had not.**

- **We also had a trained rater read and rate the response papers without any prior knowledge of the project or that some students had written responses to guided summary questions before preparing their response papers.**

How well did the student integrate information that was provided in the two assigned articles?



Distributed Versus Massed Practice: Cramming

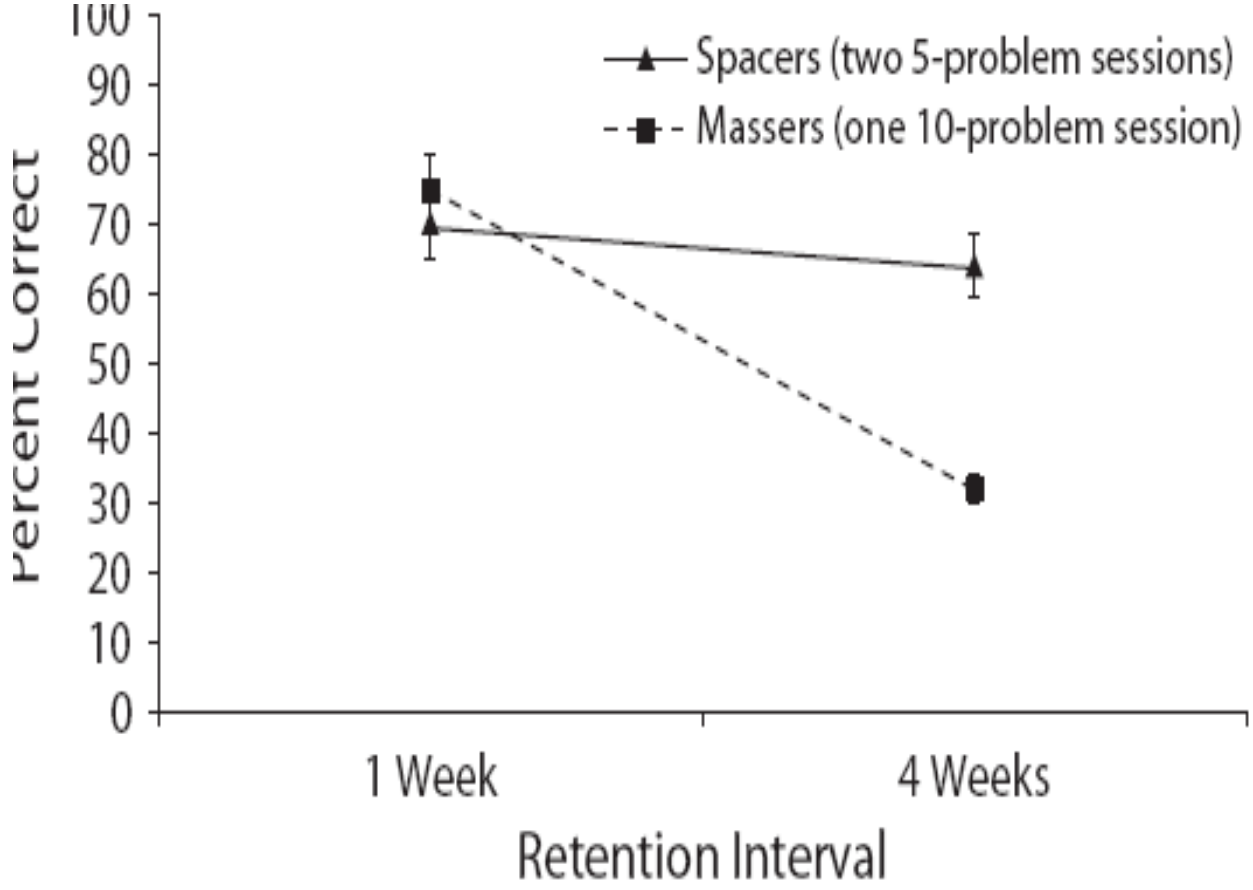
Is this how to do it?

It Depends.

Solving
Math
Problems

Solving Mathematics Problems: Effects of Distributed Versus Massed Practice at 1 Week and 4 Week Testing Intervals

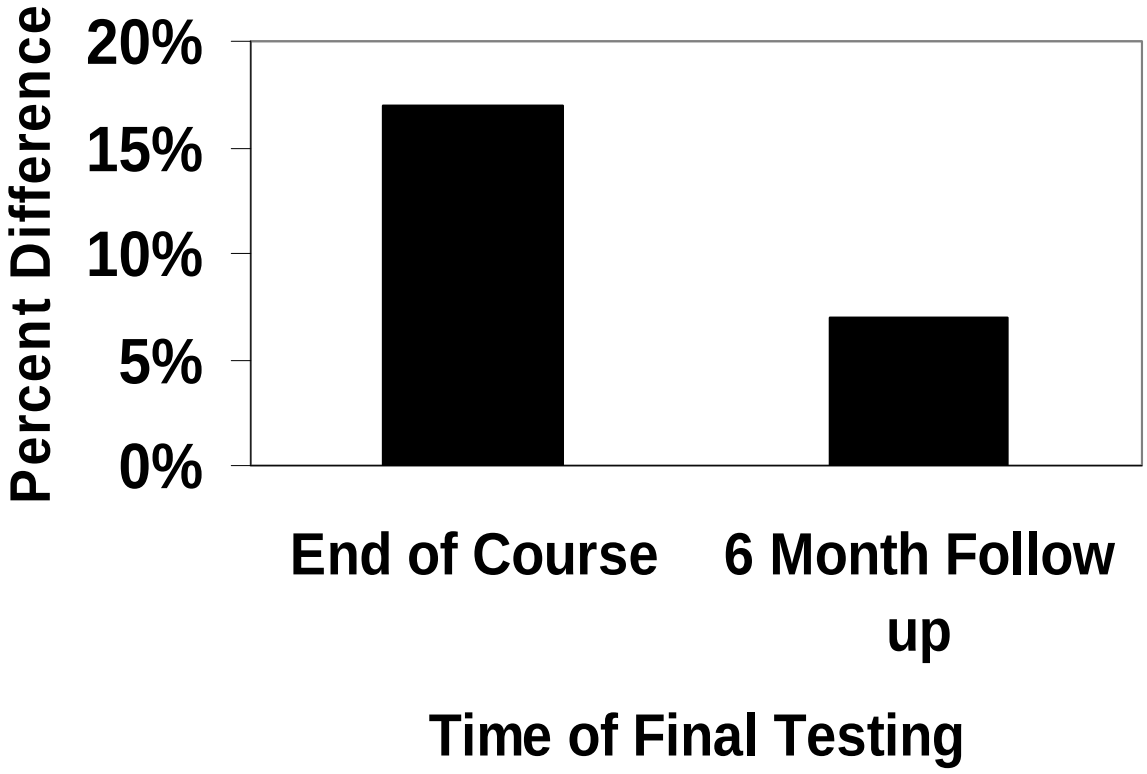
(Pashler, et al., 2007).



Benefits of Spacing and Multiple Testing in Statistics Course

- **Course: Introductory Statistics**
- **Learning issue**
- **Proposed solution**
- **Evaluating impact of solution**

Percent Difference on Final Assesment Between Students Who Did Versus Did Not Complete Interleaved Statistics Modules

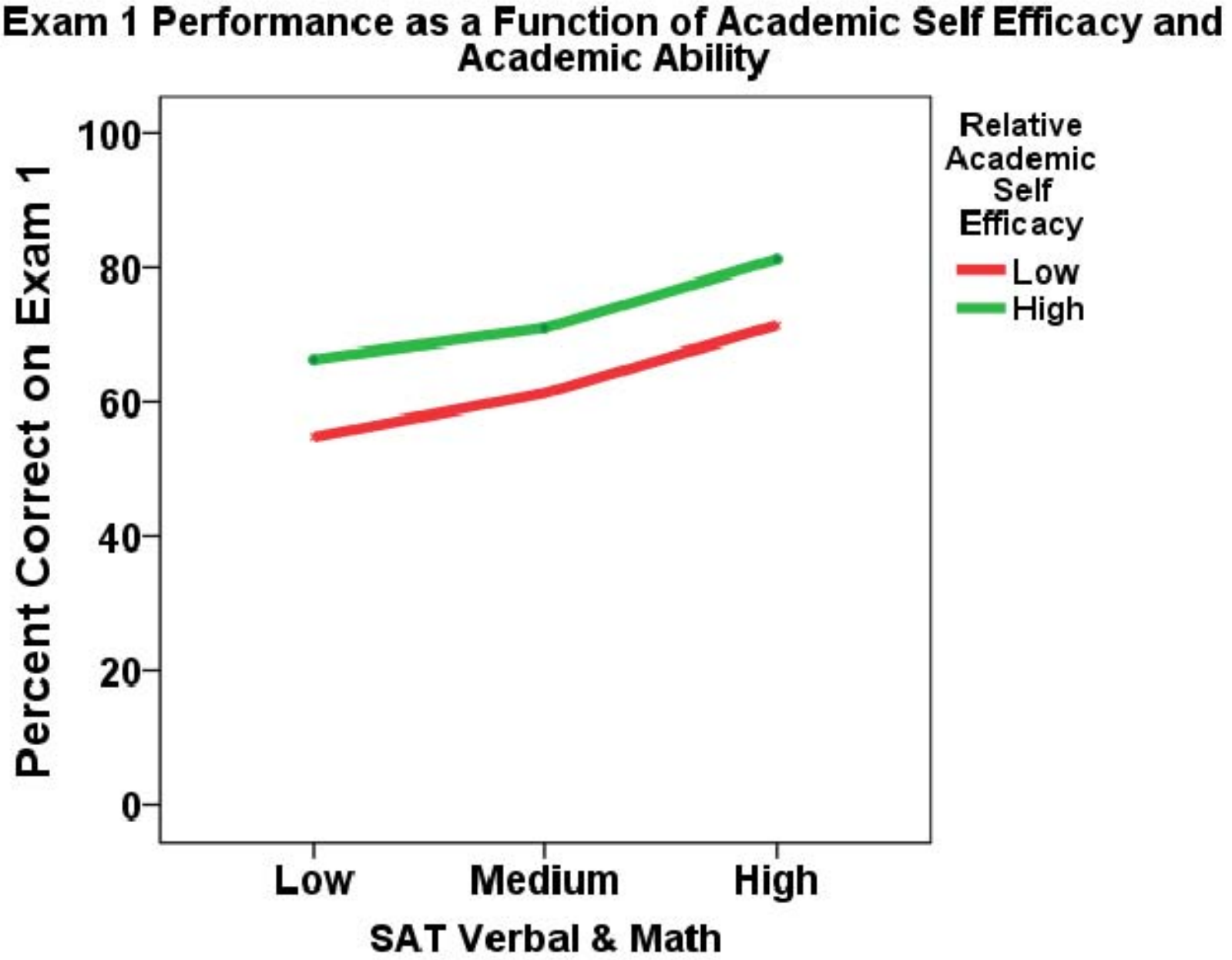


Individual Differences

- Academic self efficacy
- Reading skill
- Illusions of competence

Academic Self Efficacy

- **“Self efficacy is the belief in one’s ability to organize and execute the courses of action required to manage prospective situations” (Bandura, 1995).**
- **Self efficacy is domain specific.**
- **Students who report high academic self efficacy at the beginning of a course should perform better on a major exam than those who report low self efficacy—at all levels of academic ability.**


Exam 1 Performance as a Function of Academic Self Efficacy and Academic Ability
Percent Correct on Exam 1
100
80
60
40
20
0
Low
Medium
High
SAT Verbal & Math
Relative Academic Self Efficacy
Low
High

Reading Skill

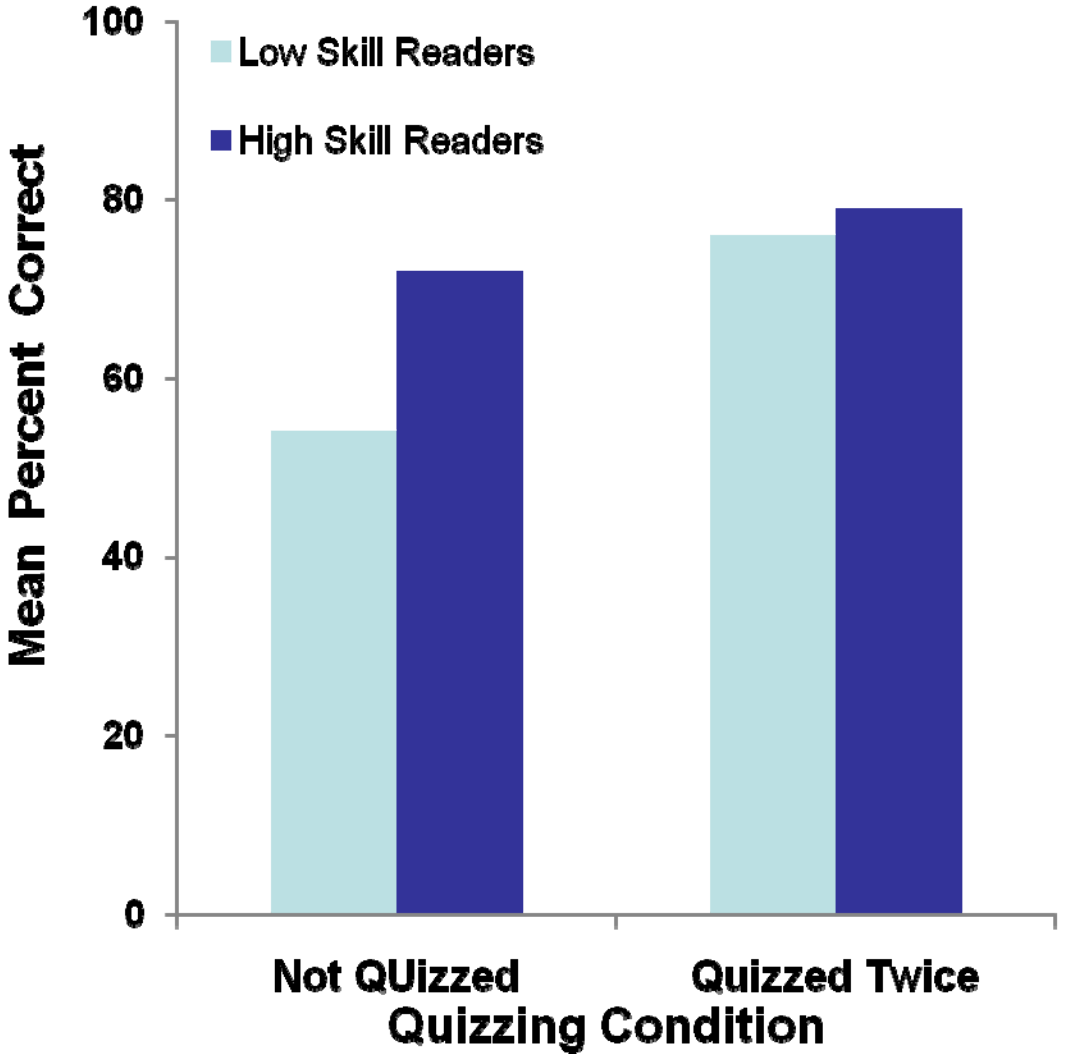
Low skill readers often benefit more from teacher-provided instructional aids than good readers:

- **outlines**
- **notes**
- **adjunct questions provided with assigned readings.**

Multiple Quizzing May Reduce Negative Effect of Poor Reading skill on Exam Performance

- **Poor reading skills can have a negative effect on students' learning, especially in heavy reading, difficult material courses.**
- **Can we reduce this negative effect?**

Midterm exam performance for low skill and high skill readers for content not quizzed or quizzed twice on weekly online quizzes.



Illusions of Competence

- **Poor performing students tend to overestimate how well they have done on an exam—usually by a lot.**
- **High performing students tend to underestimate how well they have done on an exam.**
- **Double curse on low skill students (Dunning).**

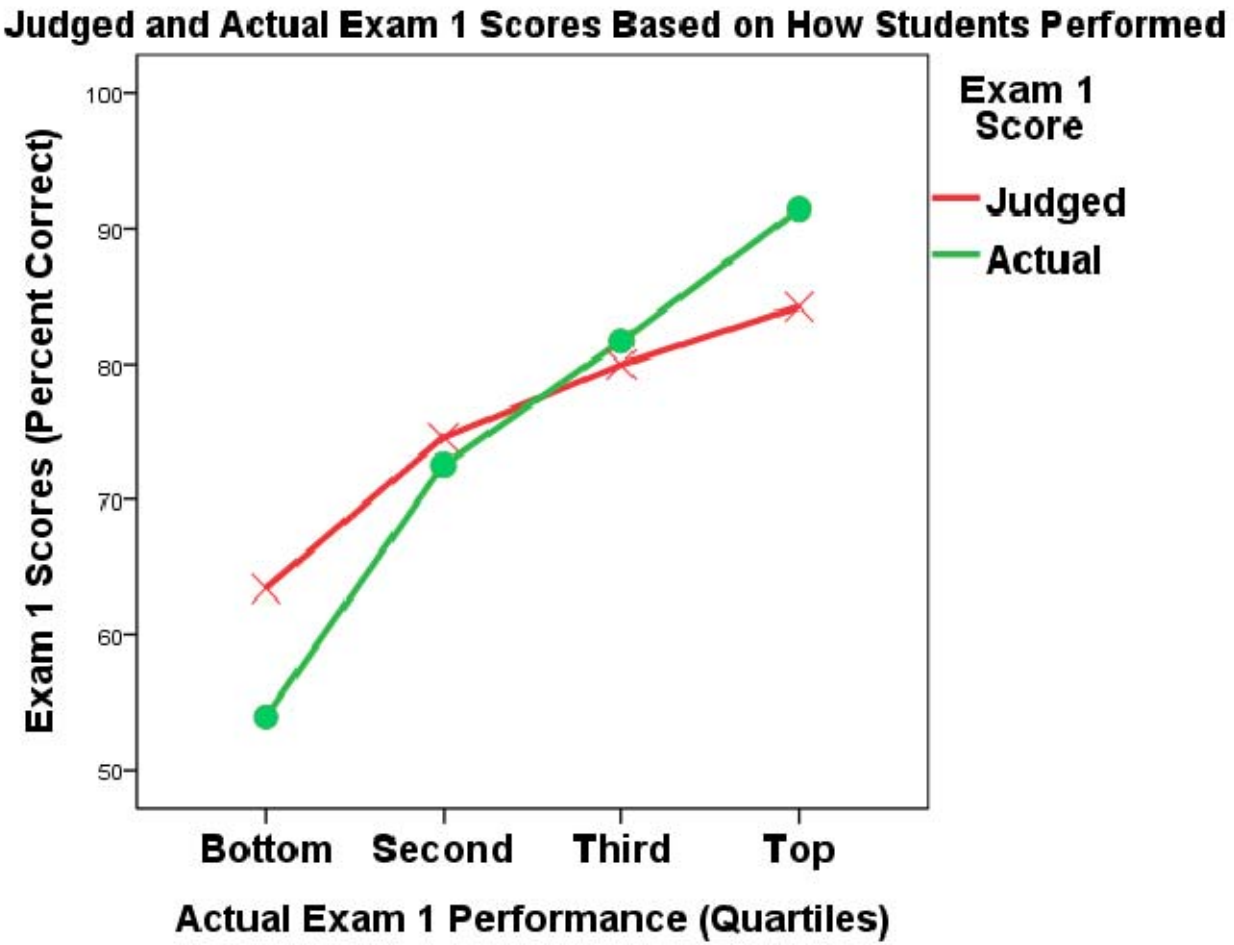
Biology 1 for Science Majors

Course: Large enrollment Biology 1 for Science Majors.

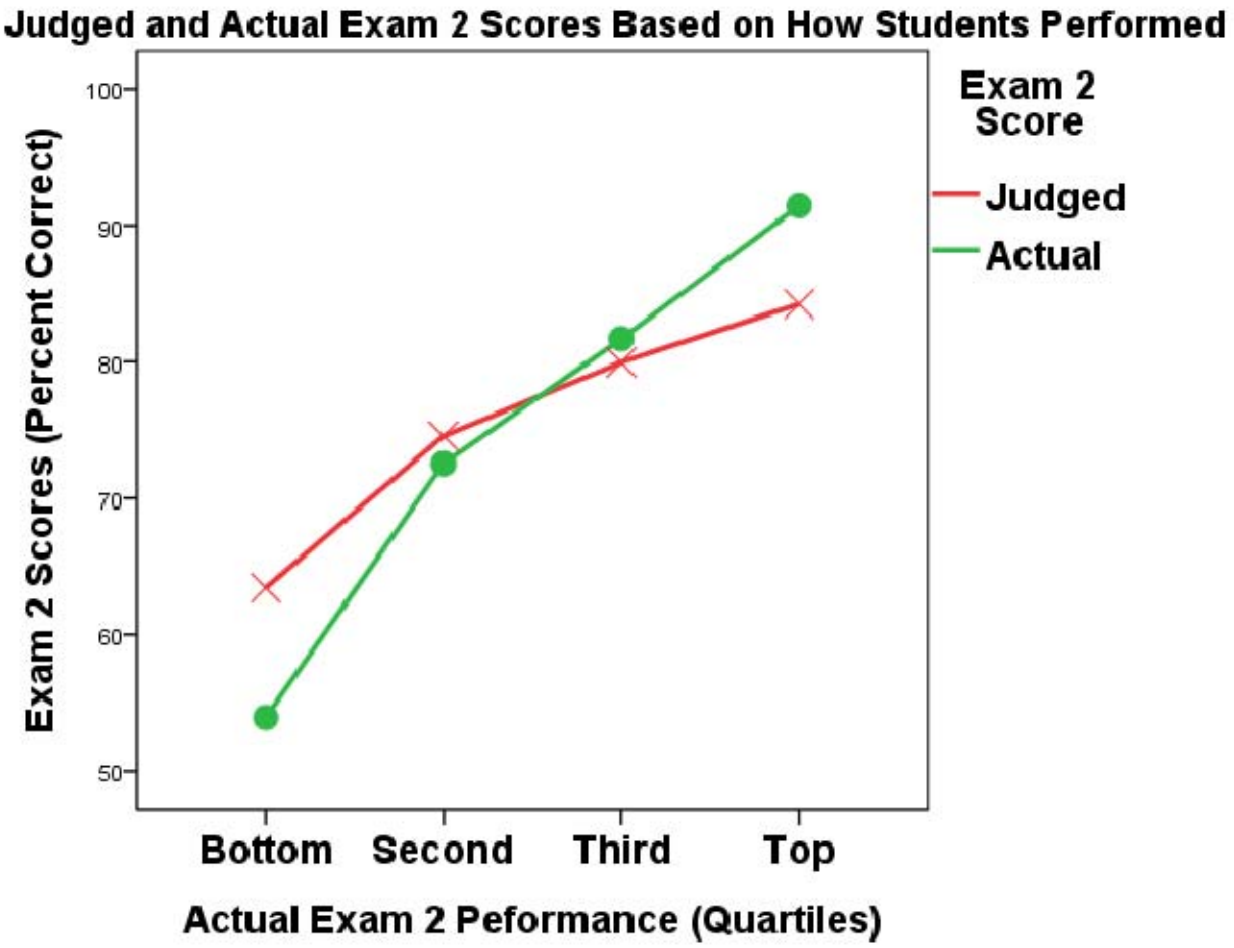
Exam: After completing exam, but before receiving exam-related feedback, students are asked to estimate their score on the exam (0 – 100 scale).

Results that follow have been replicated in more than 10 other UNH courses.

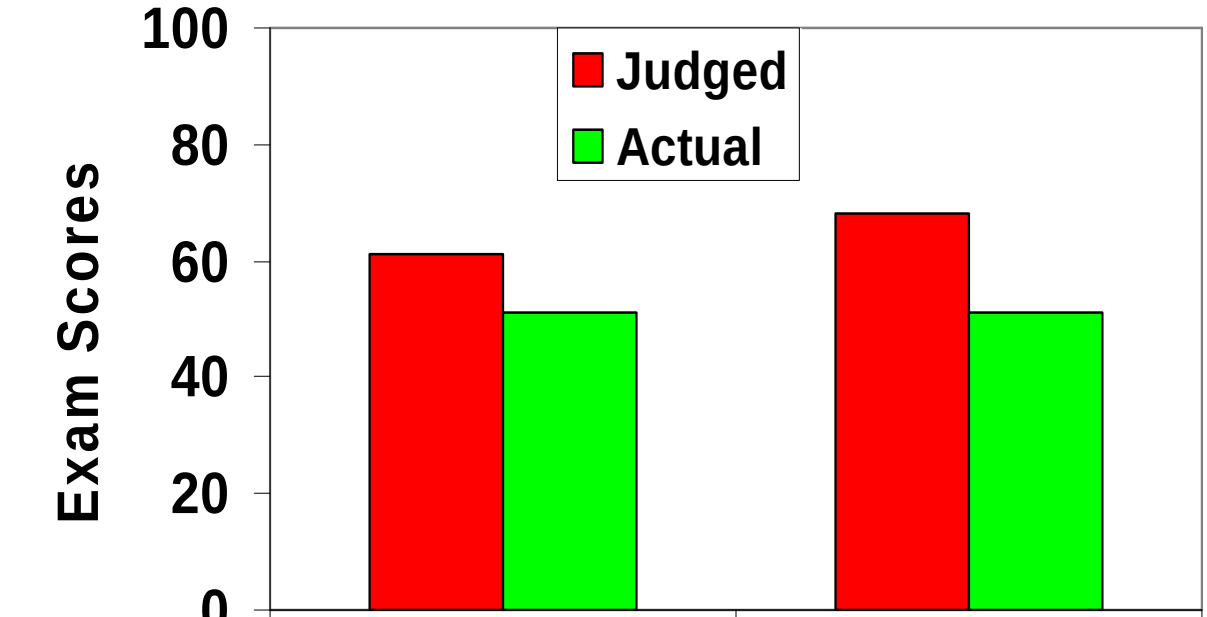
Illusions of Competence: Biology 1 For Science Majors (Exam 1)



Illusions of Competence: Biology 1 For Science Majors (Exam 2)



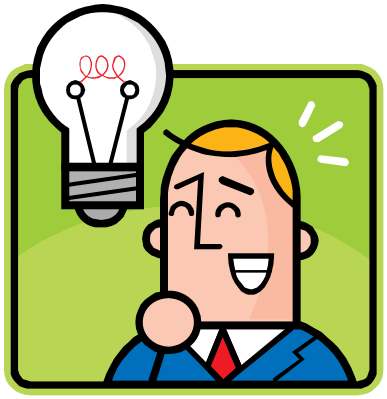
Judged and Actual Peformance for Students Who Failed Biology Exam 1 and Exam 2

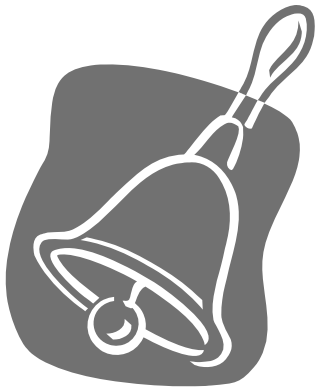


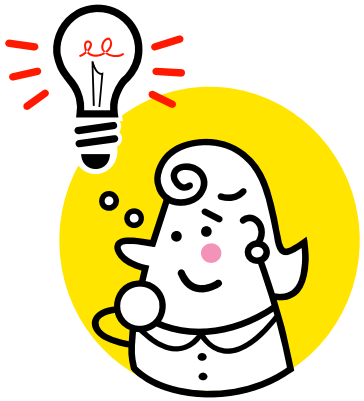
	Exam1	Exam2
Judged	61	68
Actual	51	51

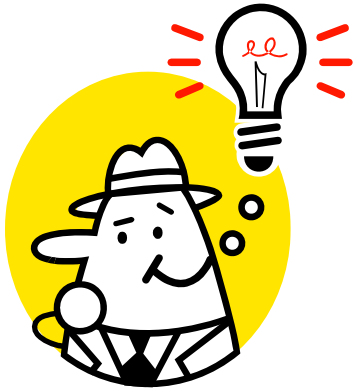
Audience Participation

- **Four Learning Issues.**
- **Develop a plan for an intervention and an assessment of student learning.**
- **Discuss as a group before moving to next issue.**









Thank You.

Proportion of artists selected correctly on the multiple-choice tests in two experiments as a function of presentation condition and test block. (Kornell & Bjork, 2008)