An improved design for in-class review based on collaborative, two-stage testing

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Abstract

We present the theory and implementation of a review strategy based on testing rather than lecturing. We also show the results of a beginning-of-course review using the format of a two-stage examination, in which students complete a set of questions individually, then again as a group. compared with the typical lecture review: (a) students engage with the review topics much more deeply and more accurately gauge their own preparation; (b) students receive immediate, corrective feedback from their peers and clarify their understanding through discussion during the group stage; and (c) the instructor receives detailed information on students' background understanding that can be used to tailor instruction. These proposed benefits are supported by the improved performance of groups during the second stage and by student opinions collected by survey several days after the review activity. The two-stage review therefore serves to both diagnose and remediate deficiencies in background understanding, leaving students and instructors better prepared for the course.

Why may traditional review fail?

Goal	Barrier
Clarify understanding of previously learned concepts	Students confuse feeling of *familiarity* with actual understanding (Willingham, 2003)
Prime students to connect prior knowledge to the new topics	Students tune out if they think they already understand Students who haven't heard about the topic are unlikely to learn much from such a brief review
Focus students' attention	**The review lectures take up class time and provide little benefit.** Additional time required to re-engage when new material is introduced

How to improve review effectiveness?

Results from Cognitive Psychology:

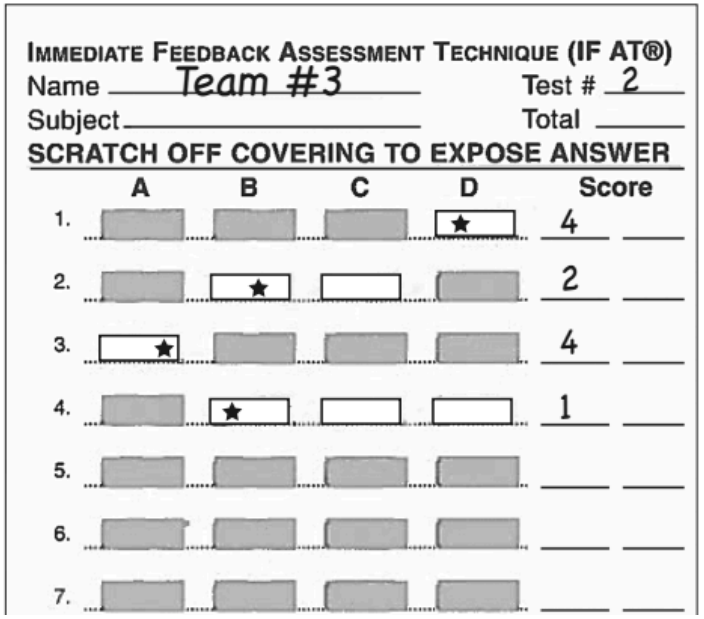
- **Testing** benefits retention, self-evaluation, and learning
  - (Bjork, 1994; Karpicke & Roediger, 2008; Roediger & Karpicke, 2006)
- **Collaborative strategies** provide students with immediate, corrective feedback
  - Peer Instruction (Crouch & Mazur, 2001)
  - Two-stage exams (Cortright, Collins, Rodenbaugh, & DiCarlo, 2003)
- Students remember the answer chosen by their group in during collaborative testing (Gilley & Clarkston, 2014)

Two-stage review strategy

Stage	Student benefits	Instructor benefits
1. Individual stage Students answer questions on Scantron form	Engage deeply with questions Opportunity to gauge their own preparation	Results can be used to tailor future instruction Opportunity to communicate pre-requisite expectations
2. Group stage Students answer the same questions in groups of 4-5	Group discussion provides immediate, corrective feedback & clarification Groups receive feed-back from IF-AT card	Group results reveal stickiness of misconceptions, areas of greatest concern

Developing a two-stage review activity

1. Identify the topics and key concepts from pre-requisite courses
2. Develop a set of multiple-choice questions
   - Target "quiz" level rather than "final exam" level
3. Prepare question sheets, Scantron forms, and **IF-AT cards**


IMMEDIATE FEEDBACK ASSESSMENT TECHNIQUE (IF AT®)
Name Team #3 Test # 2
Subject Total
SCRATCH OFF COVERING TO EXPOSE ANSWER

	A	B	C	D	Score	
1.				★	4	
2.		★			2	
3.	★				4	
4.		★			1	
5.						
6.						
7.						

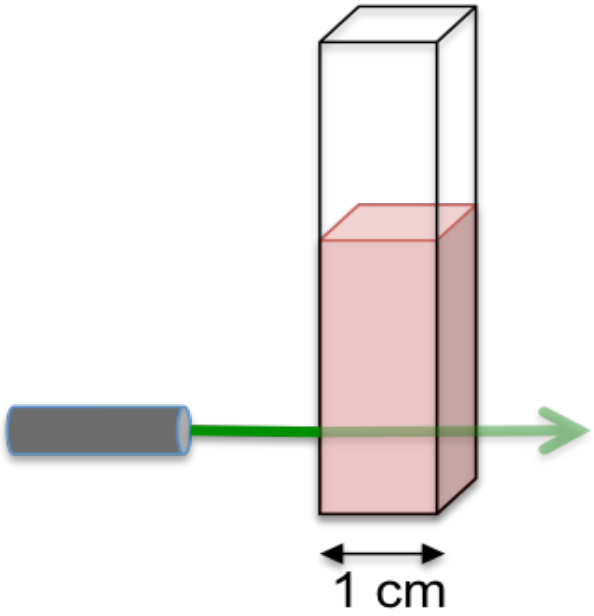
Immediate Feedback Assessment Technique (IF-AT cards)

- Multiple-choice form covered in scratch-away layer
- Groups scratch selected answer, reveal a star if correct
- If incorrect, groups try again

Example question: Analytical Chemistry

Q7. You shine a green laser pointer through a 1-cm glass cuvette containing 4 mL of cranberry juice, and observe that the beam that comes out the other side.

Which of the following changes would increase the <u>percent</u> of light that passes through the cuvette?

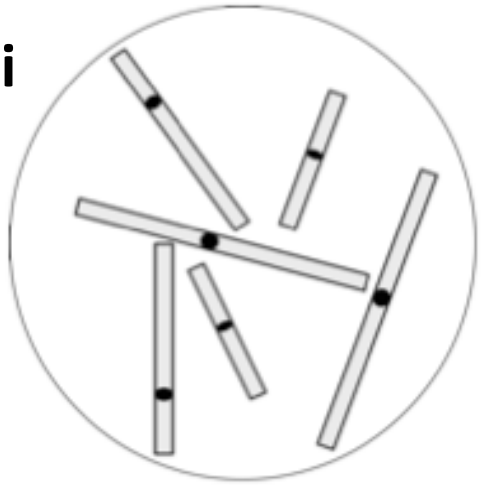


A. Adding 2 mL of water
B. Increasing the width of the cuvette from 1 cm to 2 cm
C. Increasing the intensity of the laser pointer by 10%
D. More than one of the above
E. None of the above

Example question: Genetics

One or more of the cells represented below are diploid. Which one is it/which ones are they?

i



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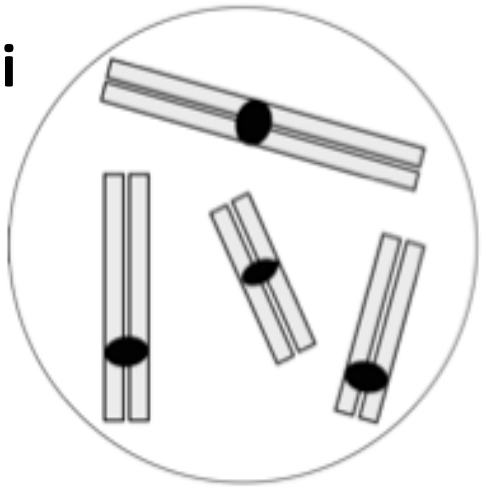

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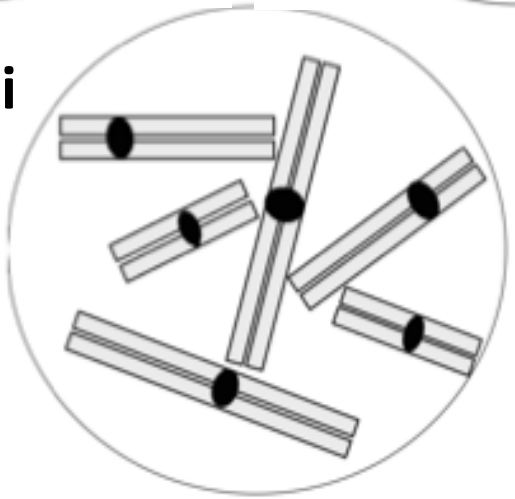


A. i only
B. ii only
C. iii only
D. i and ii
E. i and iii

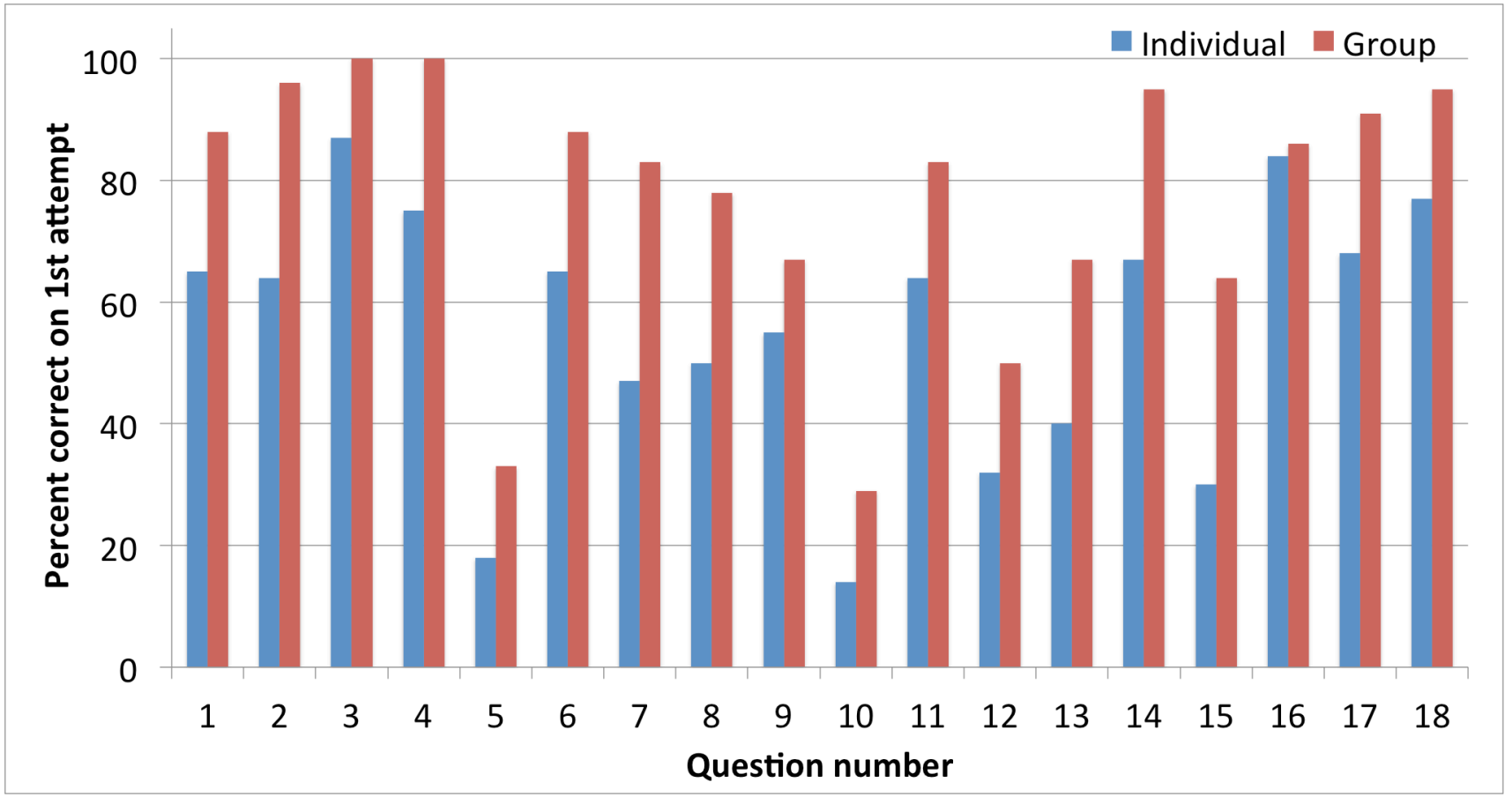
Individual stage: 45% correct
Group stage: 85% correct

The first day of class

- Students form groups of 4-5 during a 5-minute break
  - Groups may be assigned or self-selected
  - Assigned groups helpful for mixing cohorts or maximizing heterogeneity within groups
- Activity introduced as an opportunity for students to assess their background understanding
- Emphasize that it is NOT graded, but results will be used to tailor instruction

- **Individual review**: Scantron sheets, 15 min
- **Group review**: same questions, "Immediate Feedback Assessment Technology" (IF AT) cards, 15 min

Two stage review results: Analytical Chemistry



Individual and group scores the two-stage review. Group scores were calculated as the percentage of groups choosing the correct response on their first answer attempt (first scratch on the IF-AT card).

Review results provide information on student's strengths and weaknesses

3 major categories of questions:

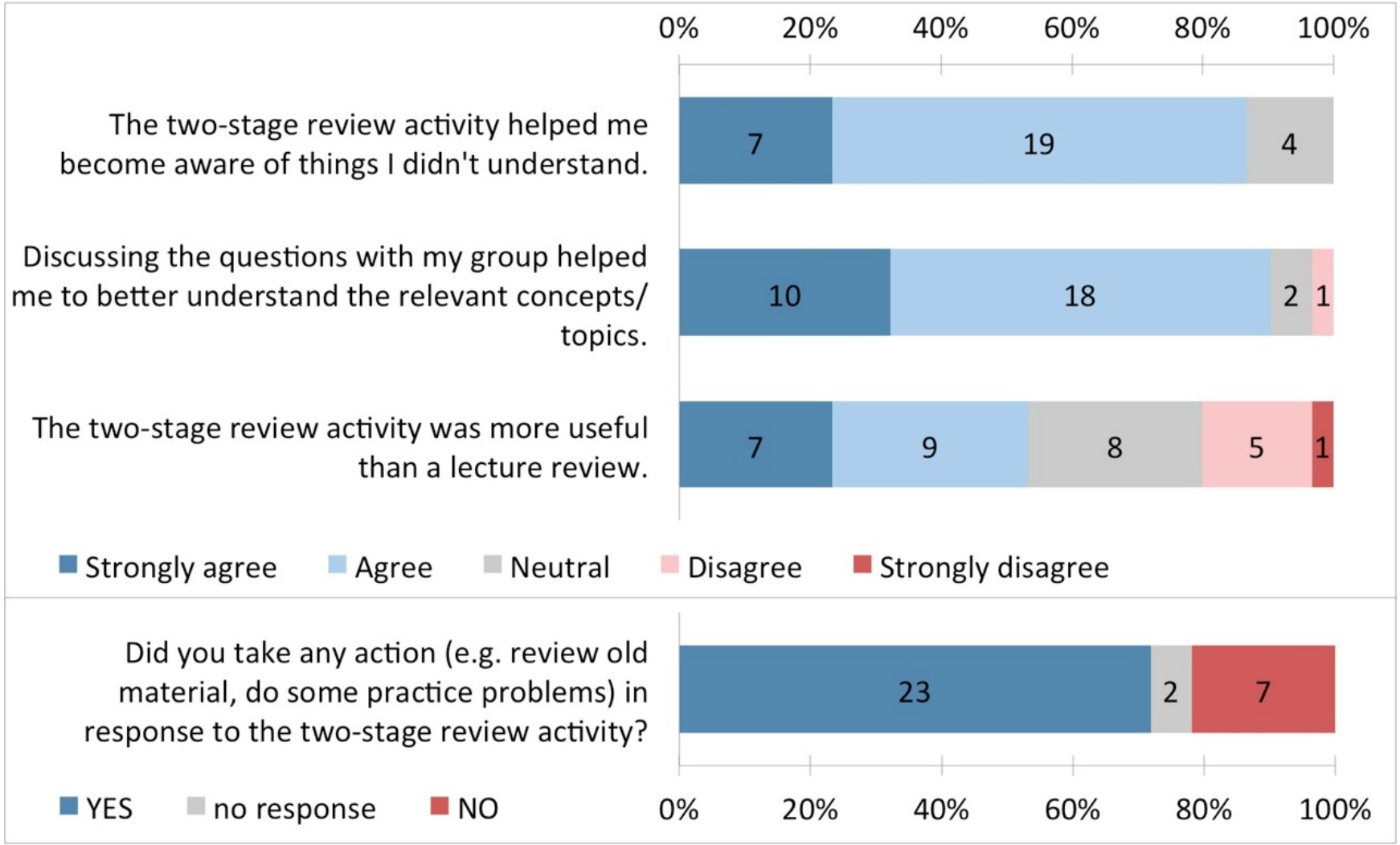
Category	Action required	Examples
Majority of individuals & groups correct	No further review required	Q1-4, 14, 17, 18
Majority of individuals incorrect, majority of groups correct	Flag for additional review or provide study resources	Q7-9, 13, 15
Majority of individuals & groups incorrect	Major target for future instruction to correct misconceptions	Q5, 10, 12

Example of a persistent misconception

Q10. Which feature of the absorption spectrum of an unknown dye could be used to definitively identify the molecular structure of the dye?

	Individual	Group
A. The height of the absorption peak	4%	1%
B. The area of the absorption peak	21%	8%
C. The wavelength of maximum absorption	63%	57%
D. The number of absorption peaks in the UV-visible spectrum	38%	19%
E. None of the above	**29%**	**14%**

Student perspective



*Responses from **genetics students** to an online survey completed 4 days post-review (32 of 50 students responding)*

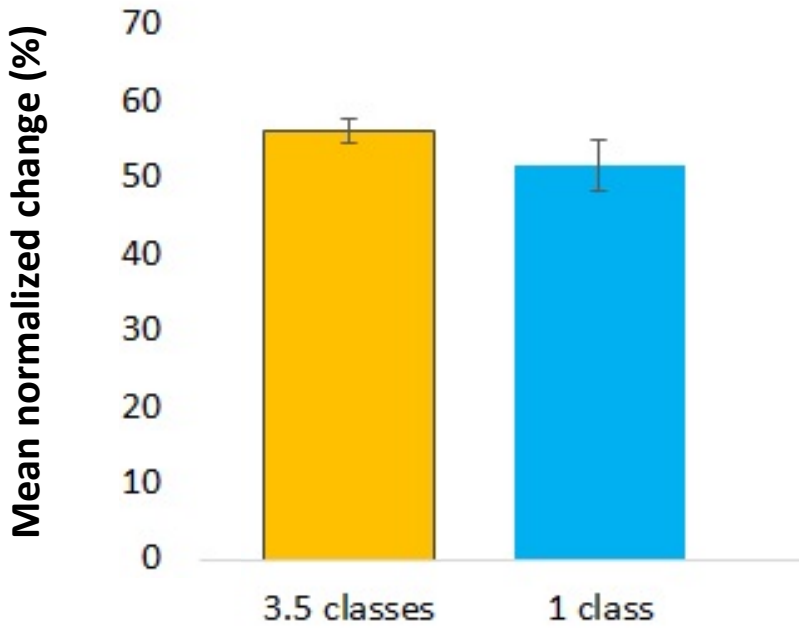
Student perspective

What did you like most about the two-stage review activity?	N
Discussing/working with group	20
Gauge ability/feedback/ review	11
Clarify/improve/correct understanding	5
Scratch cards	4
Doing individual stage first	3

" I liked that the activity was put under test conditions at first, to realize how much I personally know. Then the group portion allowed me to understand the material better by talking in groups and teaching and learning the material to our group members. "

Instructor perspective

- Results of two-stage review allowed the genetics course to **save two full class periods** previously spent on review.
- Student performance on test questions related to this topic (based on pre- and post-tests) were not negatively



Number of 50-minute classes spent on mitosis/meiosis

- Instructors who have used this method in other courses have been universally enthusiastic.

Summary of benefits

Using two-stage review allows instructors to:

- Capture a snapshot of students' understanding of key concepts that could be used to tailor lectures and activities
- Provide students with immediate feedback on their level of preparation
- Remediate deficiencies in students' understanding through peer discussion
- Communicate clear expectations for students' background understanding
- Engage students in active class from the first day

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