

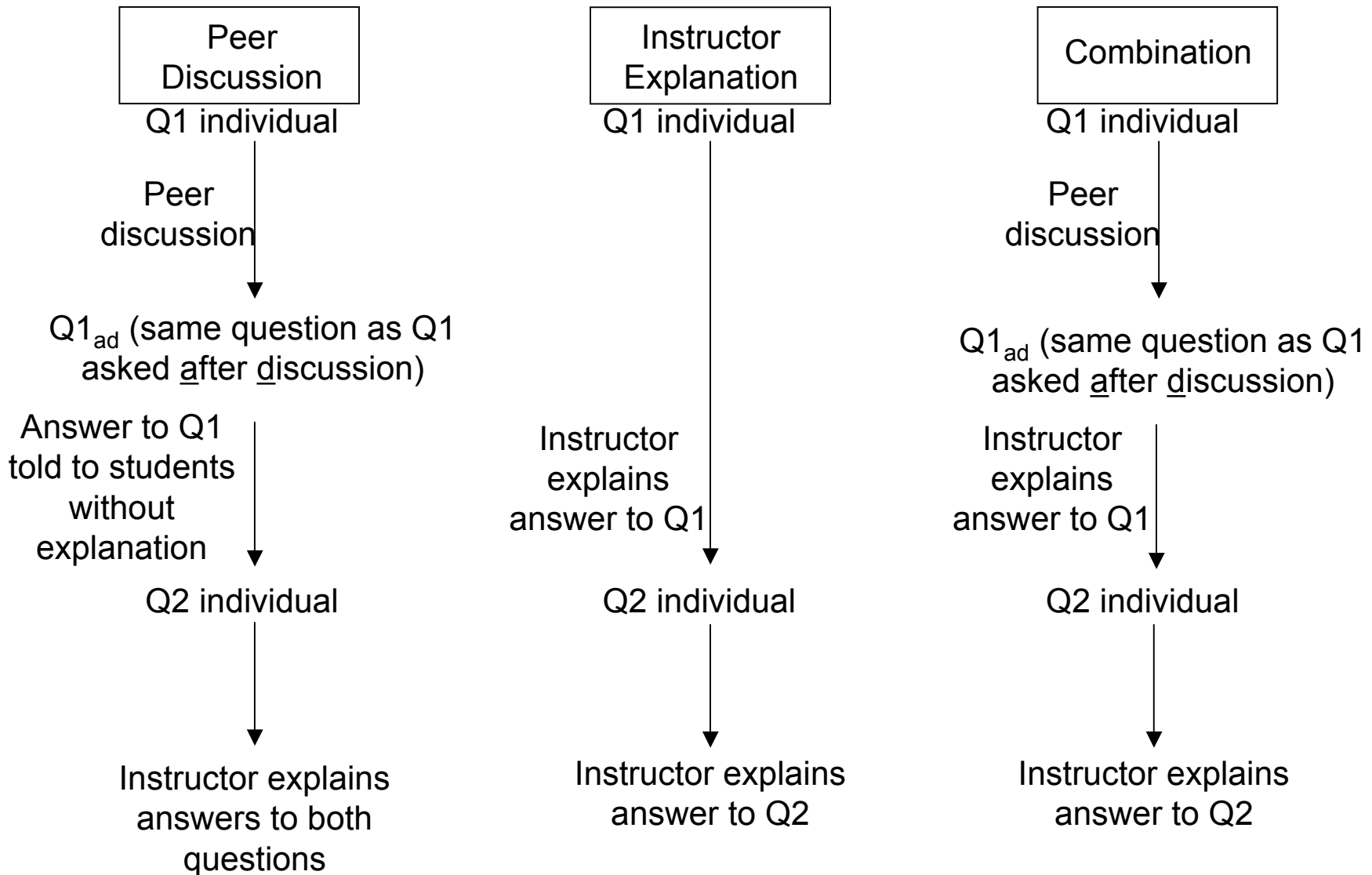
A Combination of Peer Discussion and Instructor Explanation Provides the Most Effective Way for Students to Learn from In-class Concept Questions

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Which is the most effective way for students to learn from in-class concept questions?



Study performed in the Fall 2008 Principles of Genetics course

The combination method results in the largest learning gain from Q1 to Q2

Table 1: After using peer discussion, instructor explanation, or a combination of both, the percentage of students who correctly answer a similar question (Q2) as individuals increases.

Method for discussing Q1	Q1*	Q1 _{ad} *	Q2*	Learning Gain Q1 to Q1 _{ad} †	Learning Gain Q1 to Q2†	Students (n)	Questions (n)
Peer discussion	50% (2)	74% (2)	72% (2)	48% (4)	45% (4)	161	6
Instructor explanation	45% (2)	N/A	76% (2)	N/A	56% (4)	163	5
Combination	50% (2)	70% (2)	88% (2)	41% (4)	76% (3)	152	5

*Performance results on Q1, Q1_{ad}, and Q2 were averaged for each individual before computing the averages shown. The SEM is in parentheses.

†Q1 to Q1_{ad}, and Q1 to Q2 normalized learning gains [(post-pre)/(100-pre)] were calculated based on class averages. The binomial distribution SEM is in parentheses.

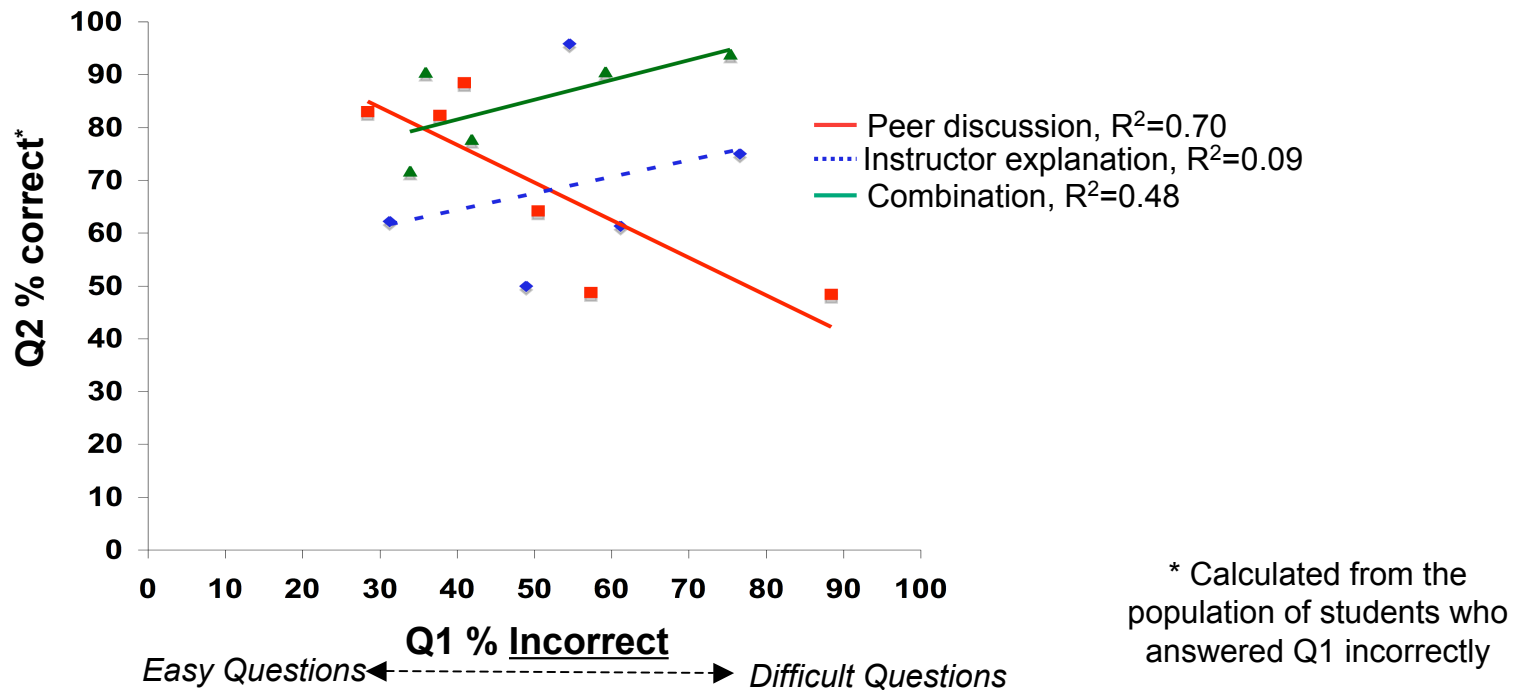
The combination method helps students who answer Q1 incorrectly learn the most

Table 2. Breakdown of mean Q2 student responses for each method used to discuss Q1. Binomial distribution SEM is shown in parentheses.

	Peer discussion	Instructor explanation	Combination
Of students who answered Q1 correctly, the percentage who answered Q2 correctly	80% (2)	83% (2)	92% (1)
Of students who answered Q1 incorrectly, the percentage who answered Q2 correctly	69% (2)	69% (2)	85% (2)

For difficult questions, students who answer Q1 incorrectly benefit the most from the combination method

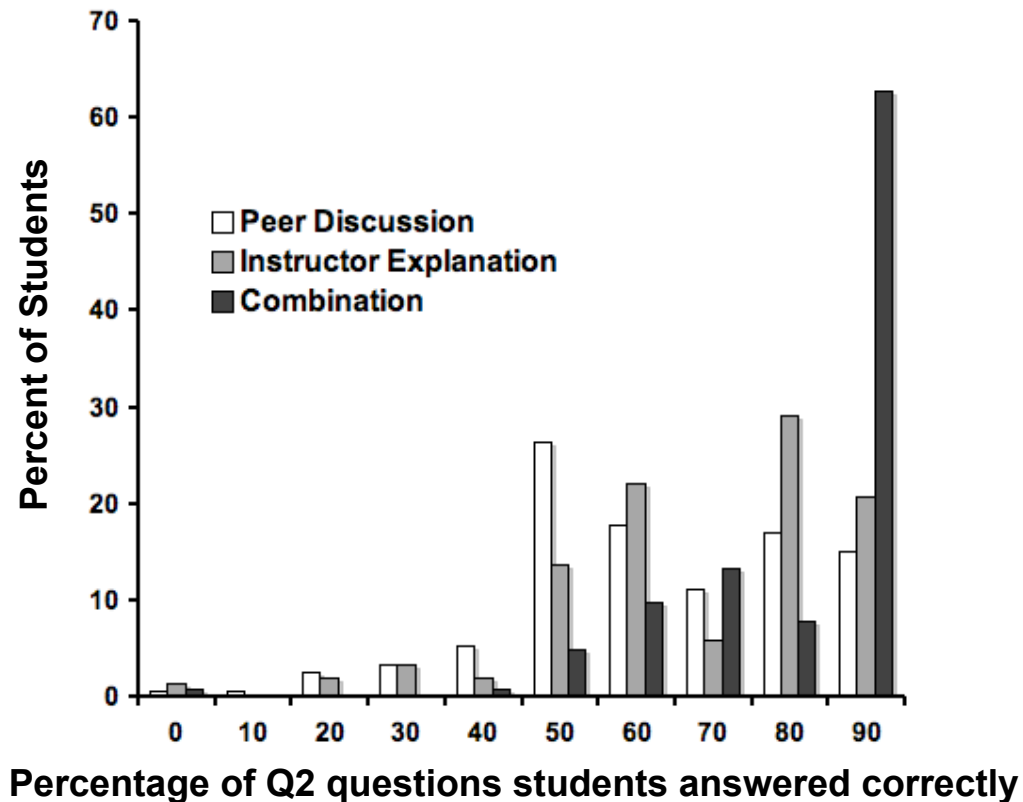
Figure 1. Correlation between Q1 percent incorrect and Q2 percent correct for those students who answered Q1 incorrectly.



- On easy questions, peer discussion alone may be sufficient to help students who answer Q1 incorrectly.
- On difficult questions, the combination method is more beneficial.
- Cannot draw conclusions about instructor explanation alone, because of the low R^2 value for the trend line.

Overall, the combination method is the most effective at helping students learn

Figure 2. The percentage of students who answered Q2 correctly, regardless of how they performed on Q1.



- Pairwise Chi-square comparisons revealed no significant difference peer discussion and instructor explanation.
- There is a significant difference between peer discussion and the combination method ($p < 0.001$, $\chi^2 = 76.6$, $df = 4$) and instructor explanation and the combination method ($p < 0.001$, $\chi^2 = 47.0$, $df = 4$).

Hypothesis: the combination method is effective because peer discussion engages students and prepares them to listen to the instructor explanation

On an end-of-term survey, 64% of the class agreed with this statement (n=122 responses):

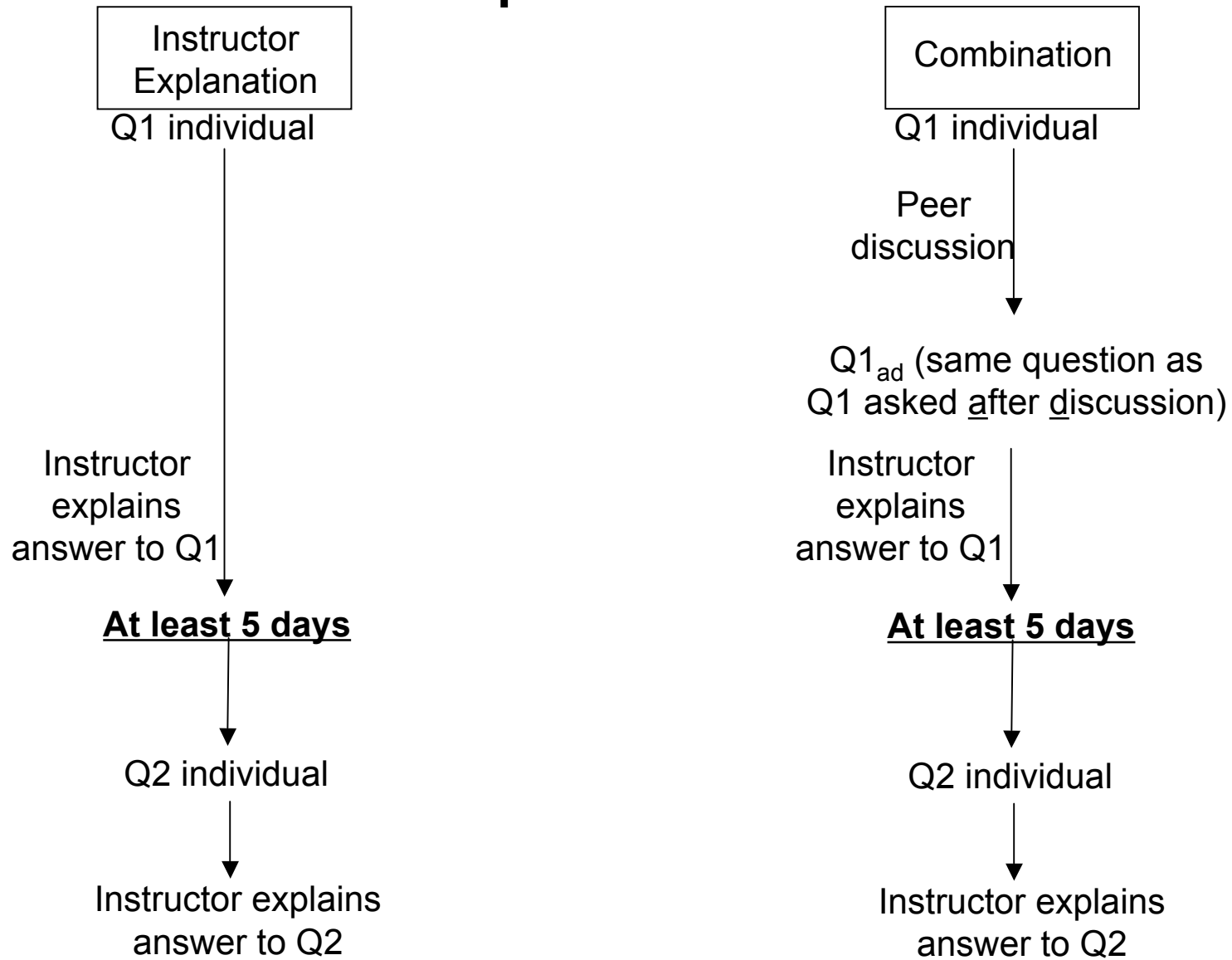
Having a discussion with my neighbors prepares me to listen to instructor's explanation.

Excerpts of student explanations include:

-Sometimes it is easier to understand the problem solving approach introduced by your peers rather than the one introduced by your professor.

- It gets me thinking about the topic before [the instructor's] lecture, rather than just passively listening to what he has to say, I am already engaged.

How much do students retain from in-class concept questions?



Study performed in the Spring 2009 Molecular Biology course

Retention: The combination method results in the largest learning gain from Q1 to Q2 (questions separated by 5+ days)

Table 3: After using instructor explanation or the combination method, the percentage of students who correctly answer a similar question (Q2) as individuals increases.

Method for discussing Q1	Q1*	Q1 _{ad} *	Q2*	Learning Gain Q1 to Q1 _{ad} †	Learning Gain Q1 to Q2†	Students (n)	Questions (n)
Instructor explanation	38% (2)	N/A	58% (2)	N/A	32% (4)	167	7
Combination	32% (2)	64% (2)	65% (2)	46% (3)	48% (3)	165	8

*Performance results on Q1, Q1_{ad}, and Q2 were averaged for each individual before computing the averages shown. The SEM is in parentheses.

†Q1 to Q1_{ad}, and Q1 to Q2 normalized learning gains $[(\text{post-pre}) / (100 - \text{pre})]$ were calculated based on class averages. The binomial distribution SEM is in parentheses.

Retention: Data collected using the combination method provide insight into student behavior

Table 4. Breakdown of mean Q2 student responses based on student performance on Q1_{ad}.

Behavior	Question Performance	Mean Percent
Retained Concept	Q1 _{ad} and Q2 correct	43%
Learned Concept	Q1 _{ad} incorrect, but Q2 correct	22%
Forgot Concept	Q1 _{ad} correct, but Q2 incorrect	20%
Never Learned Concept	Q1 _{ad} and Q2 incorrect	15%

-The majority of the students (65%) either retain or learn the concept over the 5+ day period

Conclusions

-Using a combination of peer discussion followed by instructor explanation is the most effective way to promote learning during in-class concept questions.

-A combination approach is also more effective than instructor explanation alone for encouraging retention.

-When the combination method is used, the majority of students will either retain or learn the concept. We will investigate which factors promote retention and learning with a follow up study in the fall.

Bottom line:

When using in-class concept questions, first allow your students to discuss the question and then provide an instructor explanation.