

Structuring Interactions for Large-Scale Synchronous Peer Learning

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Motivation

- In physical classrooms, structured student interaction in small groups (a form of **peer learning**) promotes learning
- In large online classes like MOOCs, there is risk of isolation
- **Goal:** Design and evaluate a software system to bring peer learning to online classes



QUIZ 1-1: METHOD CALLS (1 point possible)

In the Ruby expression `a.foo`, which calls method `foo` on receiver `a` affects whether the call succeeds?

- `a` responds to the `foo` method.
- `a`'s class, or one of its superclasses or included modules, implements that handles the `foo` method.
- `a` is an instance of a class, rather than the class itself.
- `a` has the correct type.

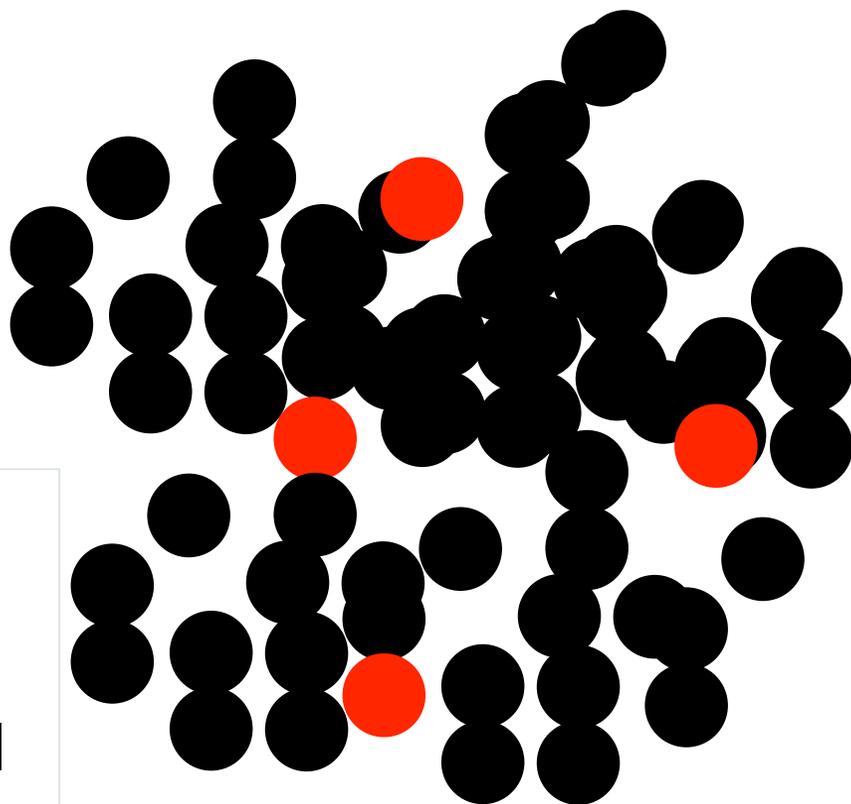
Background: Peer learning: core ideas

- Students learn better by explaining to others (Johnson 1991)
- Extended group work should be structured (Millis 2012)
- Must promote both:
 - Positive interdependence: reward depends on success of group
 - Individual accountability: reward depends on doing your part
- Group makeup
 - Best if heterogeneous
 - Groups can change frequently
- Benefits supported by extensive research literature

Background: Interaction among students in MOOCs

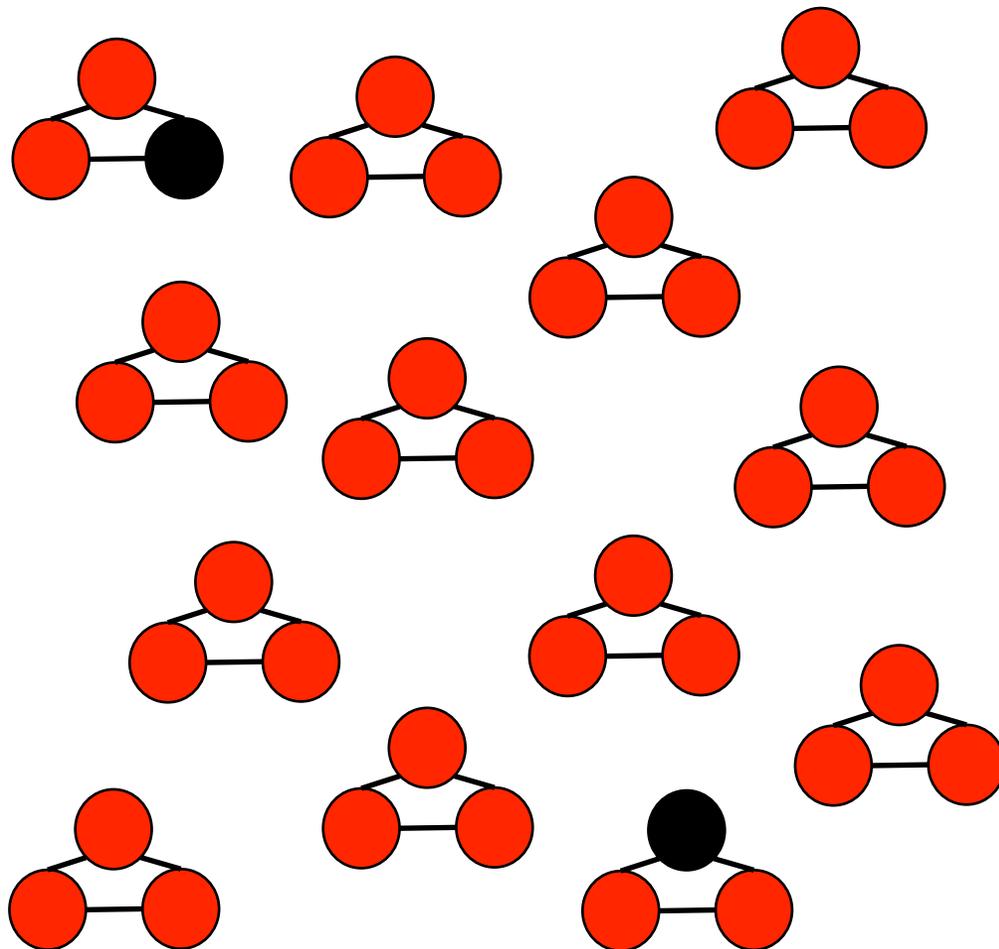
- Formal long-term project groups: NovoEd (effective but requires fundamentally restructuring course)
- Discussion forums: essential, but low participation (Mak et al 2010)
- Informal groups: social media, local meetups
- Peer grading: asynchronous, anonymous evaluation of other students (Kulkarni et al, TOCHI 2014)
- Synchronous group discussions (Kulkarni et al, L@S 2015)

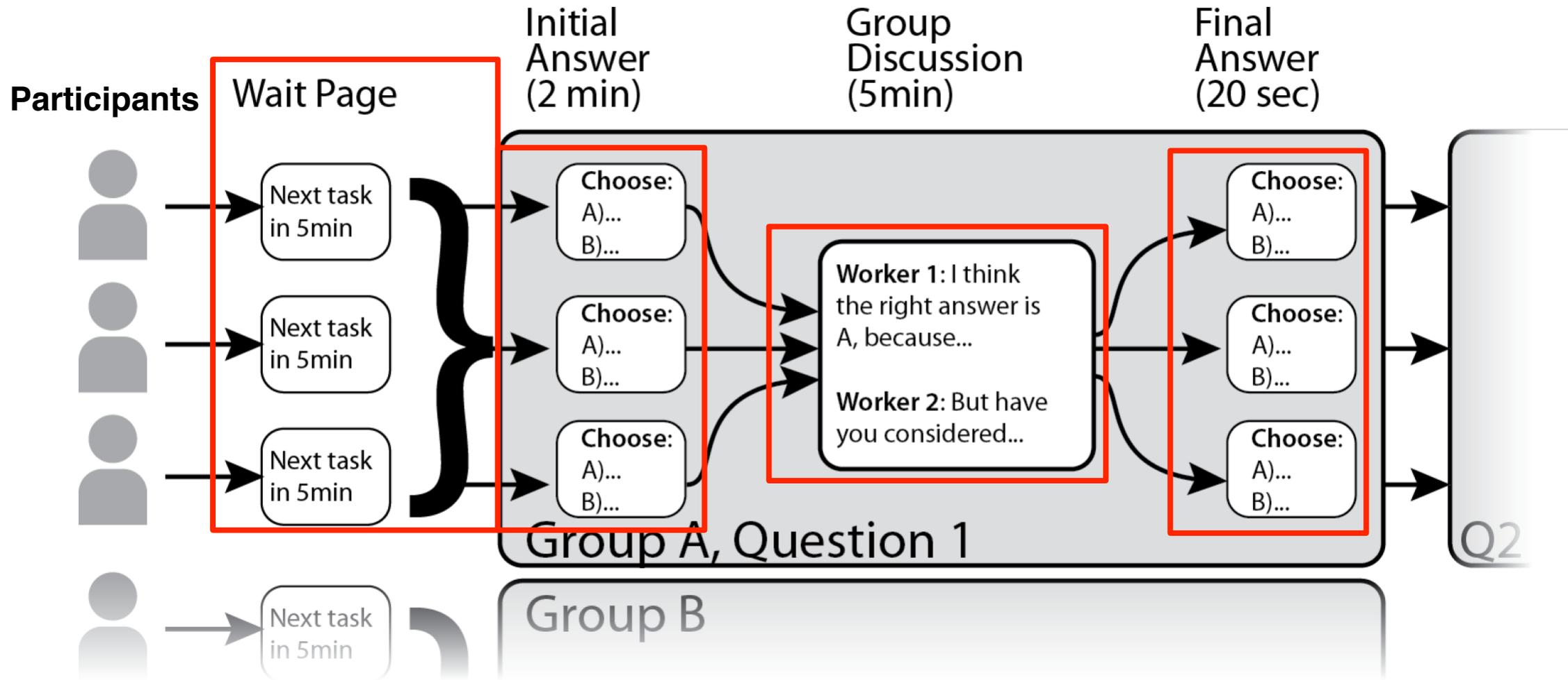
Discussion forum / Large lecture



Participation
can be higher
with smaller
groups (Voelpel
et al 2008)

Small group discussion





Experimental questions

- Is discussing questions in groups helpful in this setting?
 - Varying: Some participants placed in groups, others work alone
 - Measuring: % correct final responses
- Will discussion be substantive (in-depth, on-topic)?
 - Measuring: manual coding of chat transcripts
- Positive interdependence: should participants receive a reward if everyone in their group gives correct answer?
 - Varying: Some groups are offered such a bonus, others are not
 - Measuring: % changed answers going from incorrect → correct

Example question (GMAT critical reasoning practice question)

With the decline of predators, such as wolves and coyotes, that used to keep the deer population within certain limits, deer have increased in numbers until they cannot feed themselves in the forest alone but must forage on open rangeland in competition with cattle. Thus, in areas where forest borders on rangeland, deer hunting is an essential activity.

This argument would be most seriously weakened if it could be shown that

- A. deer hunters are not concerned about the prosperity of ranchers
- B. wolves and coyotes do not prey upon deer only
- C. deer and cattle do not eat the same plants
- D. deer hunting is popular even in areas where the forest does not border rangeland
- E. the deer population may someday be hunted out of existence

Participants

- Paid workers on Mechanical Turk take on role of students
- Allows rapid iteration on design

amazon mechanicalturk

Question

With the decline of predators, such as wolves and coyotes, that used to keep the deer population within certain limits, deer have increased in numbers until they cannot feed themselves in the forest alone but must forage on open rangeland in competition with cattle. Thus, in areas where forest borders on rangeland, deer hunting is an essential activity.

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Choose one of A to E. Please scroll down if your screen does not display all choices.

Possible Answers

A

deer hunters are not concerned about the prosperity of ranchers

B

wolves and coyotes do not prey upon deer only

deer and cattle do not eat the same plants

D

deer hunting is popular even in areas where the forest does not border rangeland

E

the deer population may someday be hunted out of existence

Discuss this question until the timer runs out. You may change your answer choice during the discussion.

Discussion

Student 3: I chose C because it seemed to clash with the statement "deer hunting is an essential activity" more than other statements

Student 1: I don't think the popularity of deer hunting is the issue.

Student 3: Right, it's whether it's essential. If the deer and cattle don't eat the same plants, then deer hunting isn't essential to preserve the rangeland for the cattle.

Student 1: That's how I see it.

Me: Actually, I did not understand the question until now. Whoops.

Me: I actually do believe it's C.

Student 3: Awesome!

Me: That was easy!

Student 3: We all agree so let's hope for the bonus :)

Student List

Student

1 **C**

Flag This Student

Student

2 **D**

Flag This Student

Student

3 **C**

Flag This Student

Send

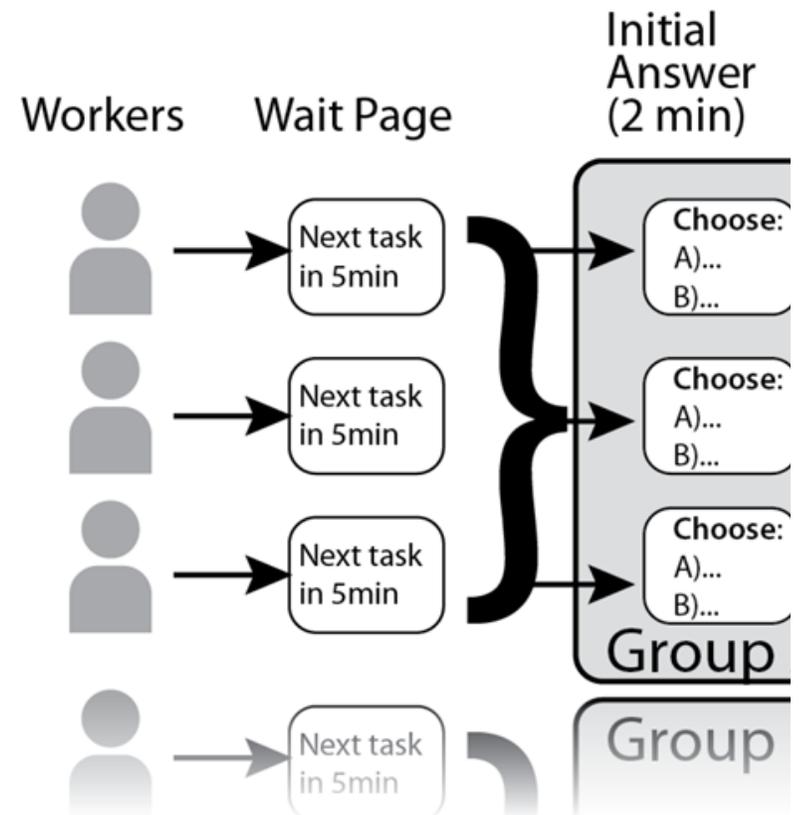
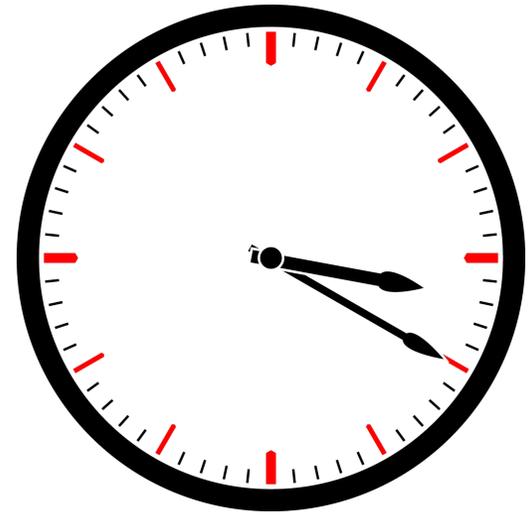
Your first choice was **D**
Your final choice is **C**

Timer
03 : 10

Quit Discussion

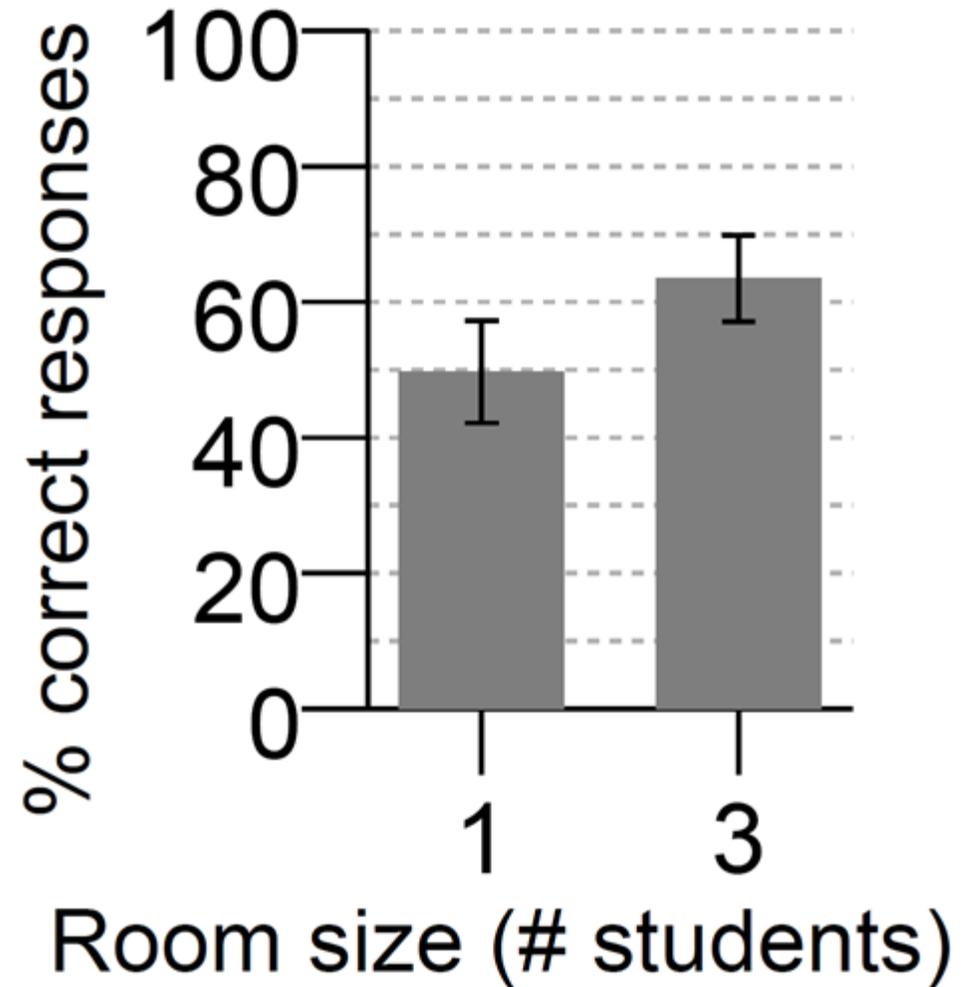
Group formation

- Tasks begin at fixed times (e.g. every 5 minutes)
 - Can adjust to suit arrival rate
- When task begins, all waiting workers are placed in groups of 3 arbitrarily
 - Group remains same throughout task



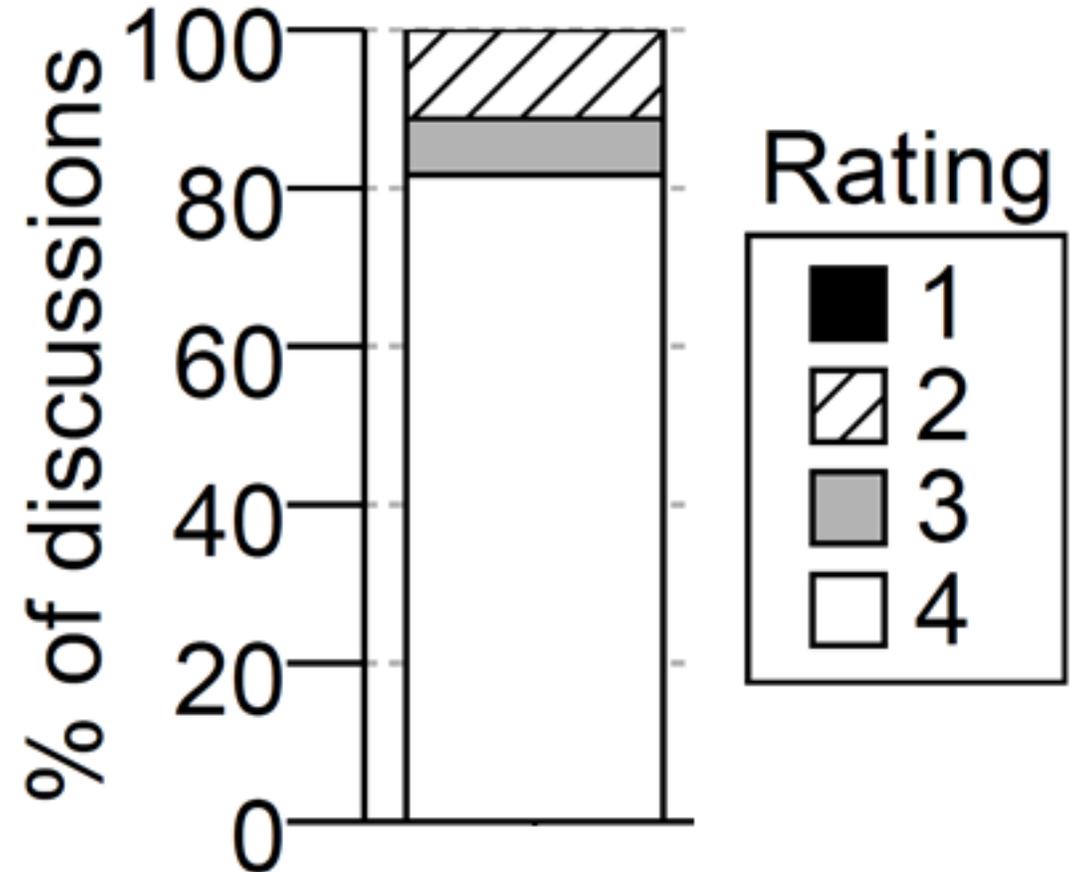
Results: Discussion is helpful

- Higher % of correct final responses for workers in groups (Fisher's test, $p < 0.01$)



Results: Discussion is substantive

- Rating scale:
 1. No relevant discussion
 2. Stated own answer
 3. Justified own answer
 4. Debated answer
- Most discussions were substantive (3 or 4)
- Inter-rater reliability:
Spearman's $\rho = 0.65$



Results: Bonus incentive is helpful

- About same % of workers changed answers in each condition (30% vs 33%)
- But a larger % of those changes were from incorrect to correct in the condition with the bonus incentive
 - 22% vs 11% (significant, Fisher's test, $p < 0.03$)

Experiment 2: Introducing instruction

- Motivation: so far, participants had to solve a new type of problem without any instruction
- Question: If we introduce minimal instruction for this type of critical reasoning problem, how will it affect outcomes?
 - Vary: Some groups receive instruction, some don't
 - Measure: % correct final answer

Experiment 2: Mini-lesson

- Teach workers a method for doing the problem
 1. Identify hidden assumptions in the provided argument
 2. Choose response that depends on those invalid assumptions
- Step workers through the method as a group

Mini-lesson: 212 words

In this task you'll learn a critical reasoning skill commonly called identifying hidden assumptions. Read the following carefully.

[...]

Example question

With the decline of predators, such as wolves and coyotes, that used to keep the deer population within certain limits, deer have increased in numbers until they cannot feed themselves in the forest alone but must forage on open rangeland in competition with cattle. Thus, in areas where forest borders on rangeland, deer hunting is an essential activity.

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Students individually write down unstated assumptions:

Student 1: deer eat the same food as cattle

Student 2: Deer are in competition with cattle for food and the only solution is to kill the deer. The assumption being there is a decline of predators, disregarding the biggest predators of all, humans.

Student 3: The assumption is that there are too many deer, and they do not have enough food in the forest. They have to feed on the ranges.

Discussion of assumptions:

Student 1: hi do we know that deer eat the same food as cattle

Student 2: It is assumed they would graze on grass

Student 2: But I don't believe there is a shortage of predators as long as we are around

Student 3: It is assumed that they eat grass just like the cattle

Student 2: Jinx

Student 1: it is also assumed wolves and coyotes are the only predators

Student 2: We are master justifiers for our actions. M

Student 3: That is true

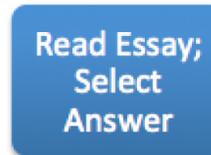
Student 2: Animal populations are not like people the breeding stops when there is nothing to eat

Experiment 2: Flows

DISCUSS QUESTION (E1)



MINIMAL (E2)



MINI-LESSON (E2)

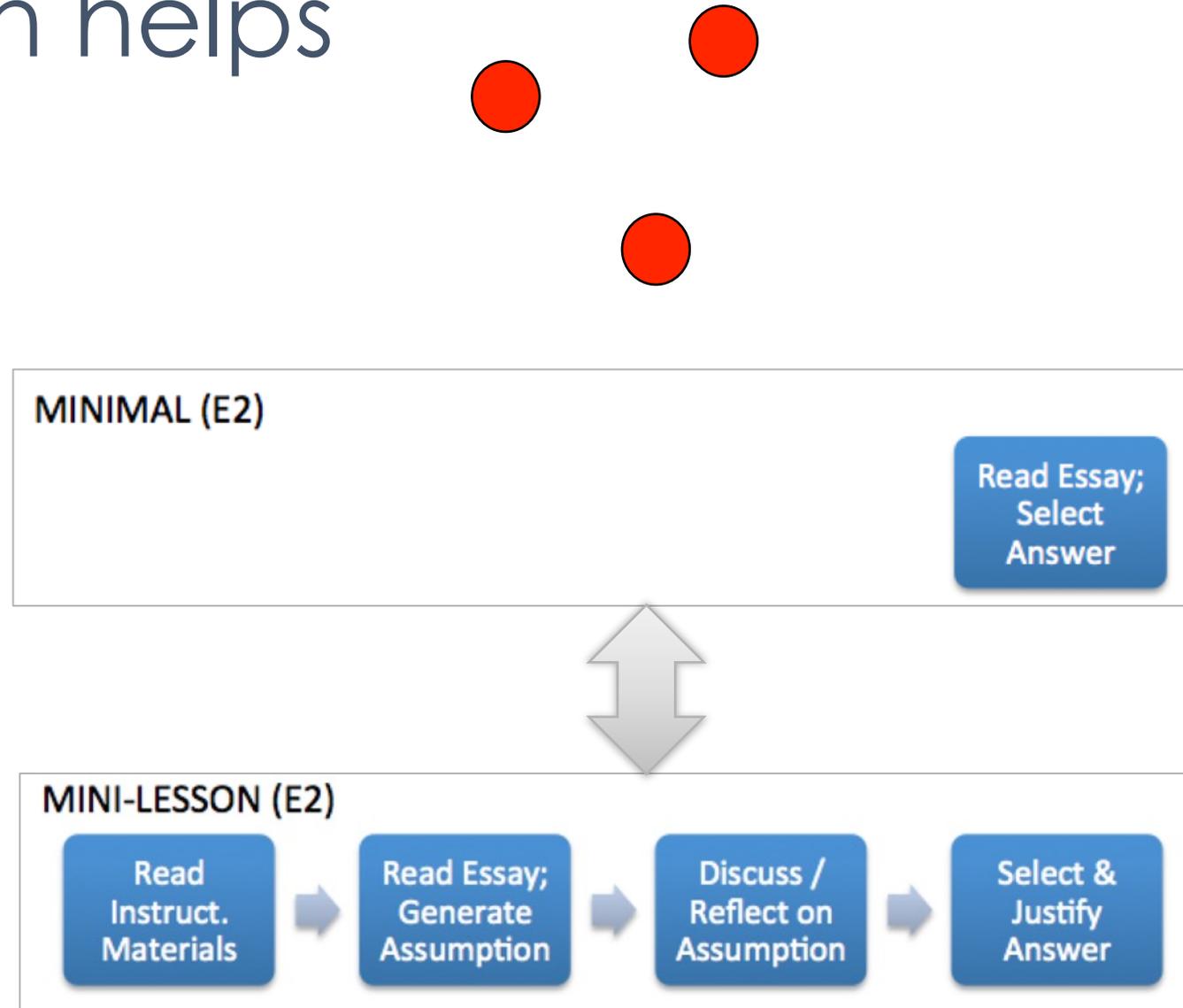


MINI-LESSON + DISCUSS QUESTION (E2)



Results: Mini-lesson helps

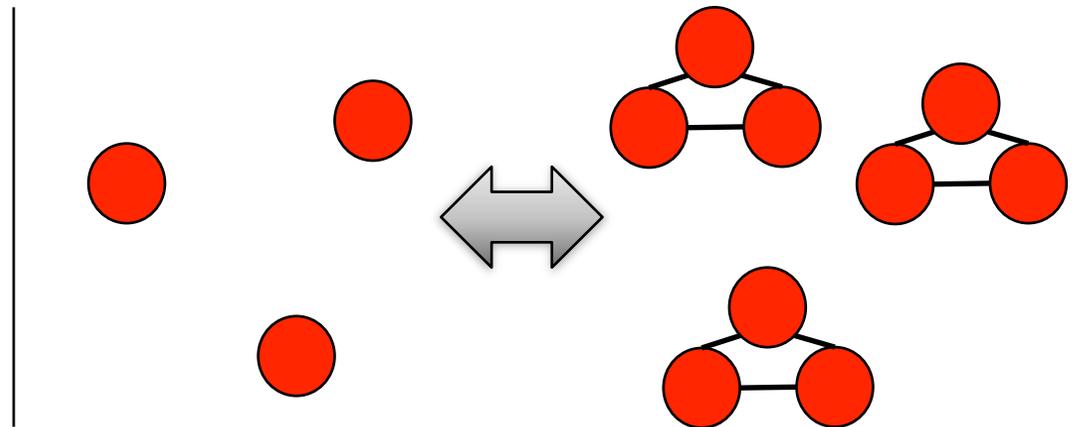
- Solo workers who viewed mini-lesson 7 to 17 times more likely to give correct response on first try
 - 11% correct → 58% correct
- Unsurprising (instruction improves performance)
- Acts as baseline (improvement from mini-lesson vs. from discussion)



Results: Discussion not shown to produce more correct responses

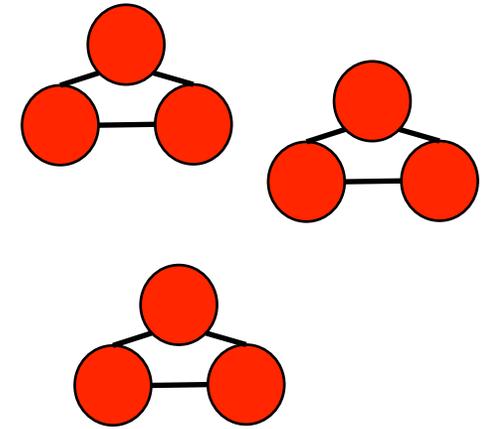
- Workers who participated in groups and viewed the mini-lesson got about same percentage of answers correct as solo workers who just viewed the mini-lesson
 - 59.1% vs 58.6% correct on first question
 - 54% vs 56% correct on second question

MINI-LESSON (E2)

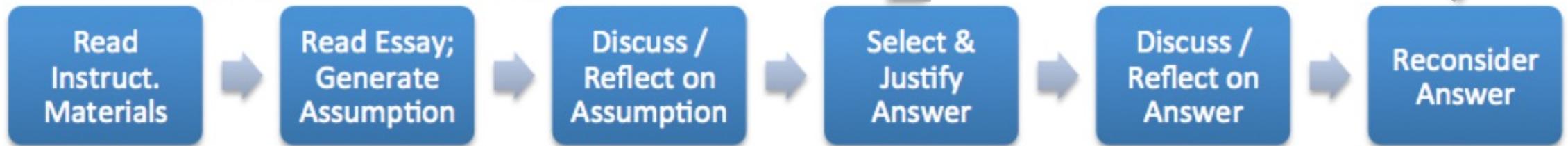


Results: Revised answers improved

- In the longest flow, workers discussed their answers and then revised them, producing improvement
 - 61% correct before discussion → 74% after (Fisher's, $p < 0.002$)
 - 1.2 to 2.6 times more likely to be correct after discussion

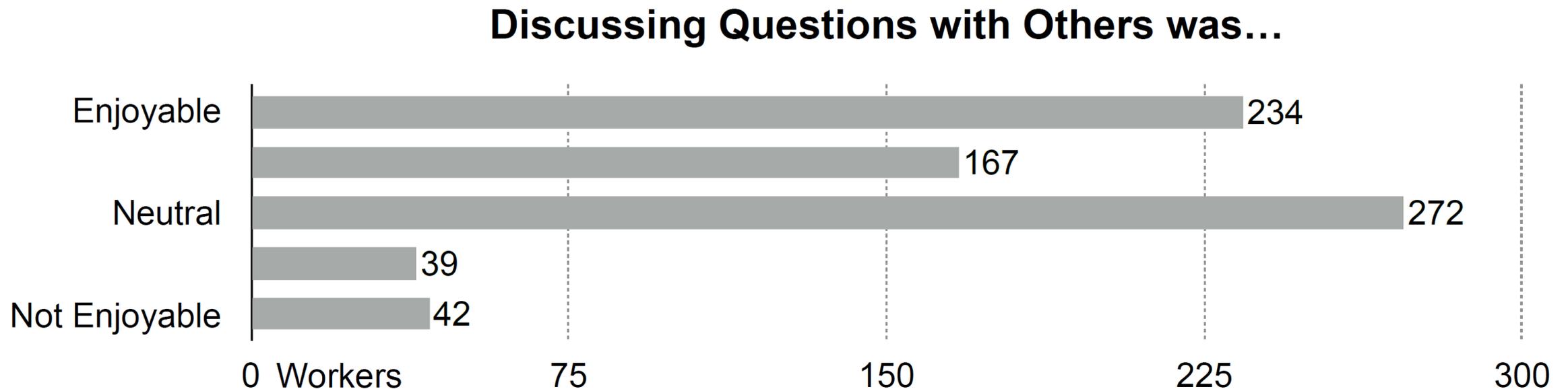


MINI-LESSON + DISCUSS QUESTION (E2)



Results: Subjective impressions

- Most workers rated as enjoyable, and left positive feedback
- Similar results when deployed in real online course (53% rated enjoyable)



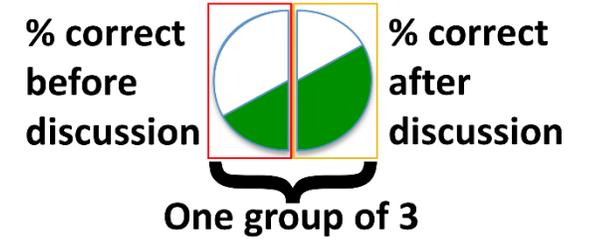
Pilot with real students

- Deployed in intro engineering course at University of Queensland with online component and >1000 students
- Used as part of weekly mandatory summative assessment
- High-quality discussions, and 53% rated task as enjoyable
- Compared to global MOOC: students are collocated and more committed to the course, making high participation easier to achieve

Discussion: Applicability to MOOCs

- Will the same approach work in real MOOCs?
- Turk workers and MOOC students have:
 - Similar levels of geographic dispersal and isolation
 - Comparable demographics (e.g. about 50-70% have Bachelor's degrees)
 - Different motivations and community sizes
- Small pilots in MOOCs (~20 people)
 - Limited participation, but positive reception from participants

Discussion: Group formation



- Data shows groups with at least one correct student much more likely to reach correct answer
- Suggests: dynamically base groups on initial answers

Num initial choice correct	Num final choice correct			
	0	1	2	3
0				
1				
2				
3				

Discussion: Implications for Crowd Work

- Discussion can improve results for tasks that involve problem solving and is more engaging for workers
 - Supports previous crowdwork findings (Zhu et al, CSCW 2014)
- Mini-lessons: brief training during task may improve results and enable new tasks
- Other ideas for improving crowd work may be inspired by learning research

Conclusions

- Peer learning can be done in online courses, can be integrated with instructional material, and is promising
- Students enjoy real-time group activities
- Encouraging positive interdependence is helpful
- The online setting offers new opportunities for structuring group activities
- Questions?