

Personalizing Small Group Discussions for Learning@Scale

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Joint work with Bjoern Hartman and Armando Fox



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)

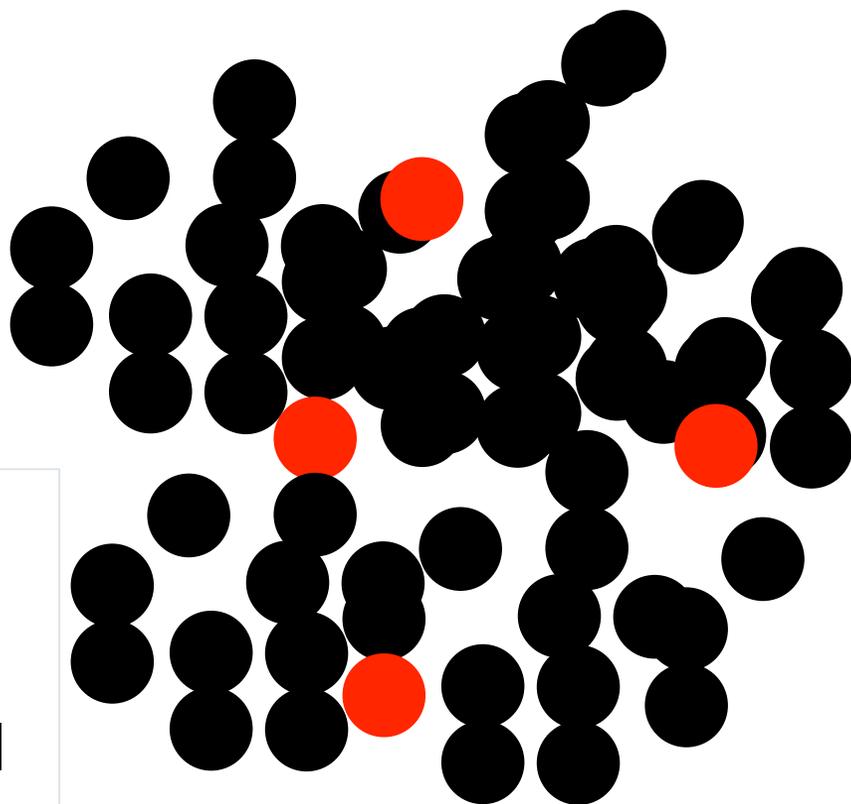
In the Ruby expression `a.foo`, which calls method `foo` on receiver `a` affects whether the call succeeds?

- `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

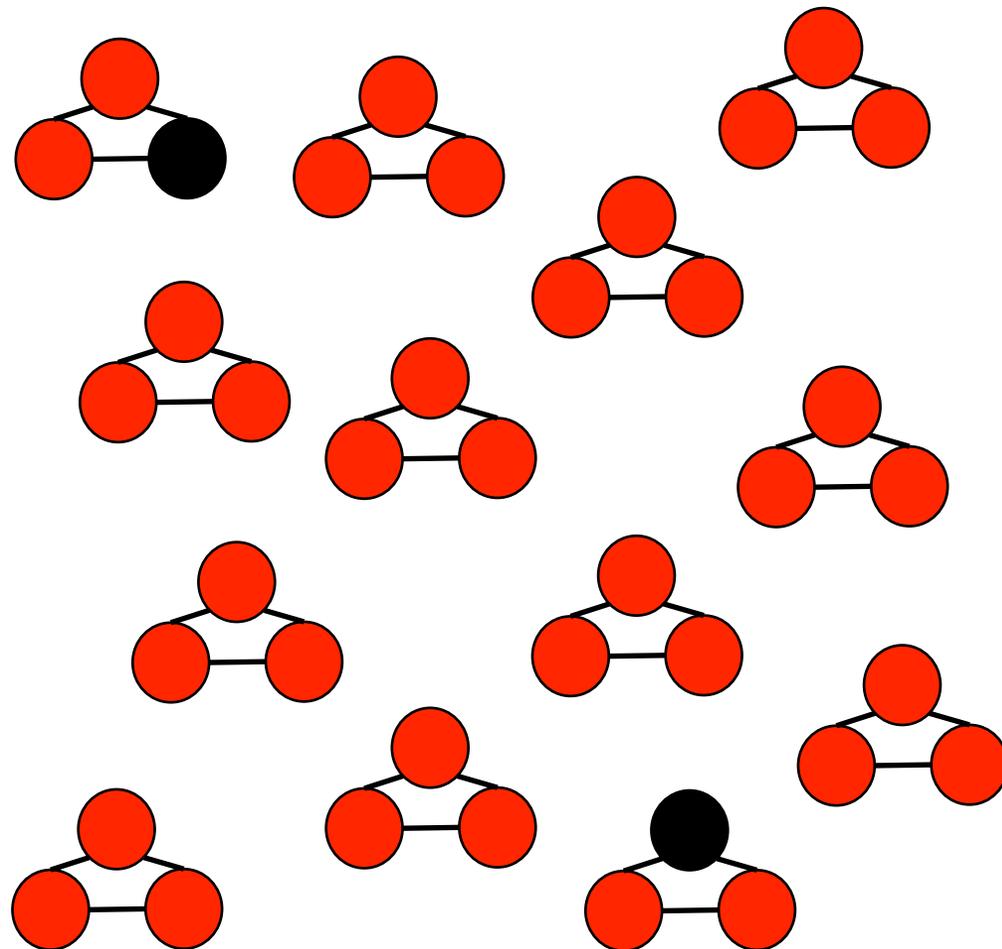
Discussion forum / Large lecture



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

UC Berkeley

Small group discussion



Study: 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

Participants

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



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

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

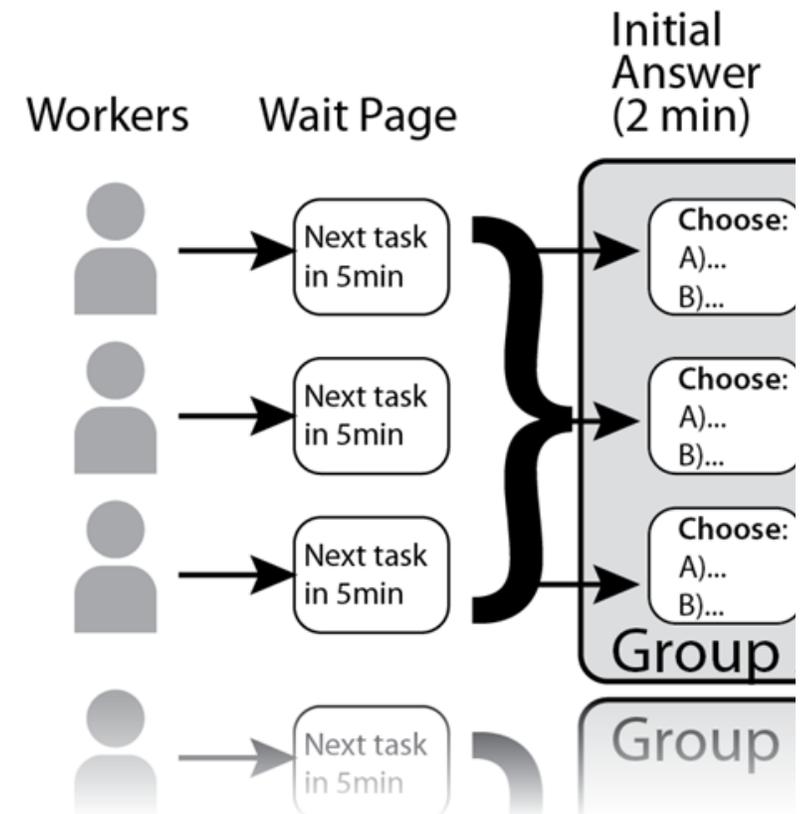
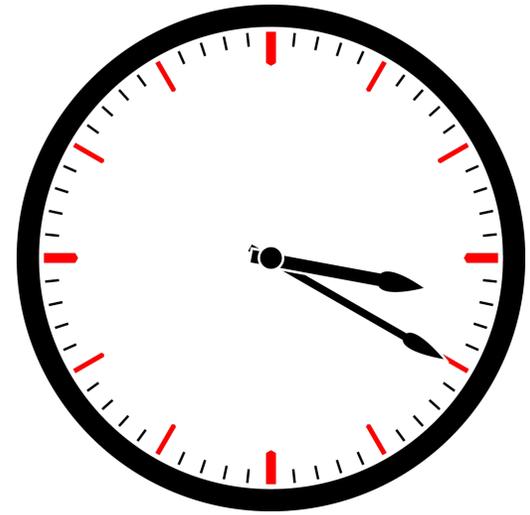
Your first choice was **D**
Your final choice is **C**

Timer
03 : 10

Quit Discussion

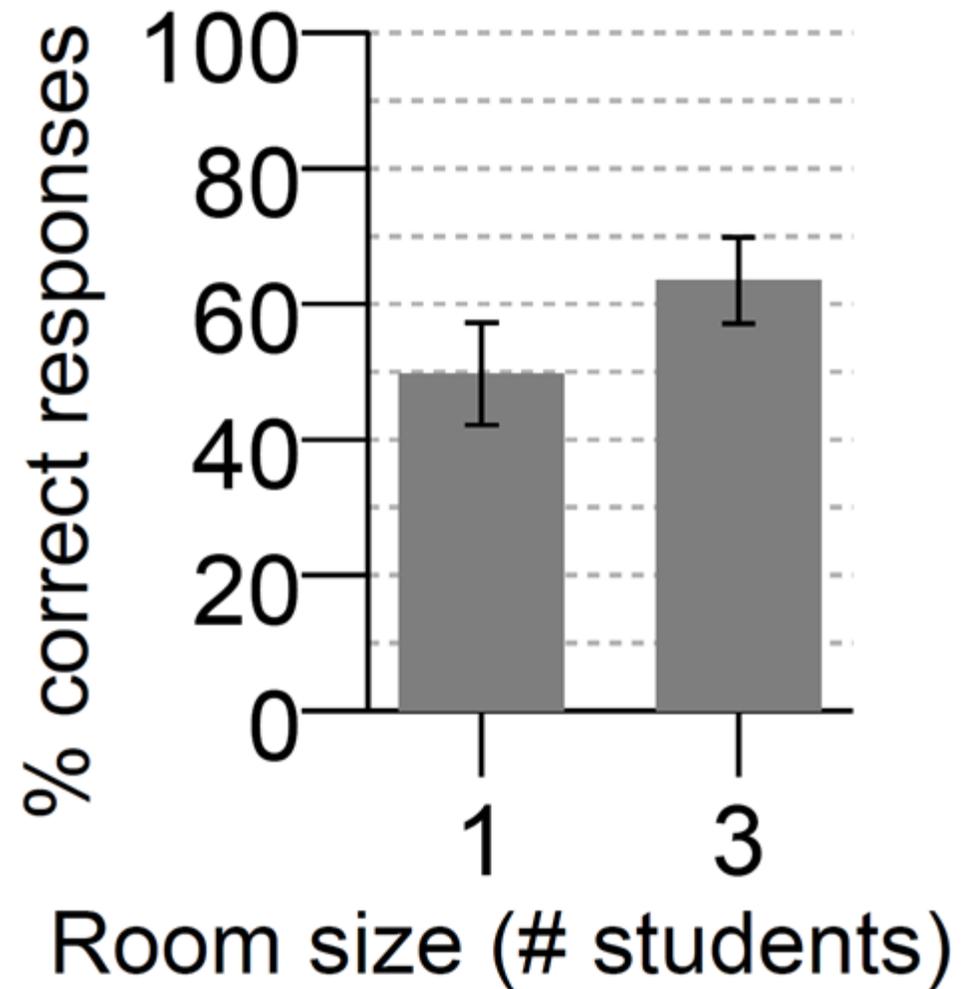
Group formation

- 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



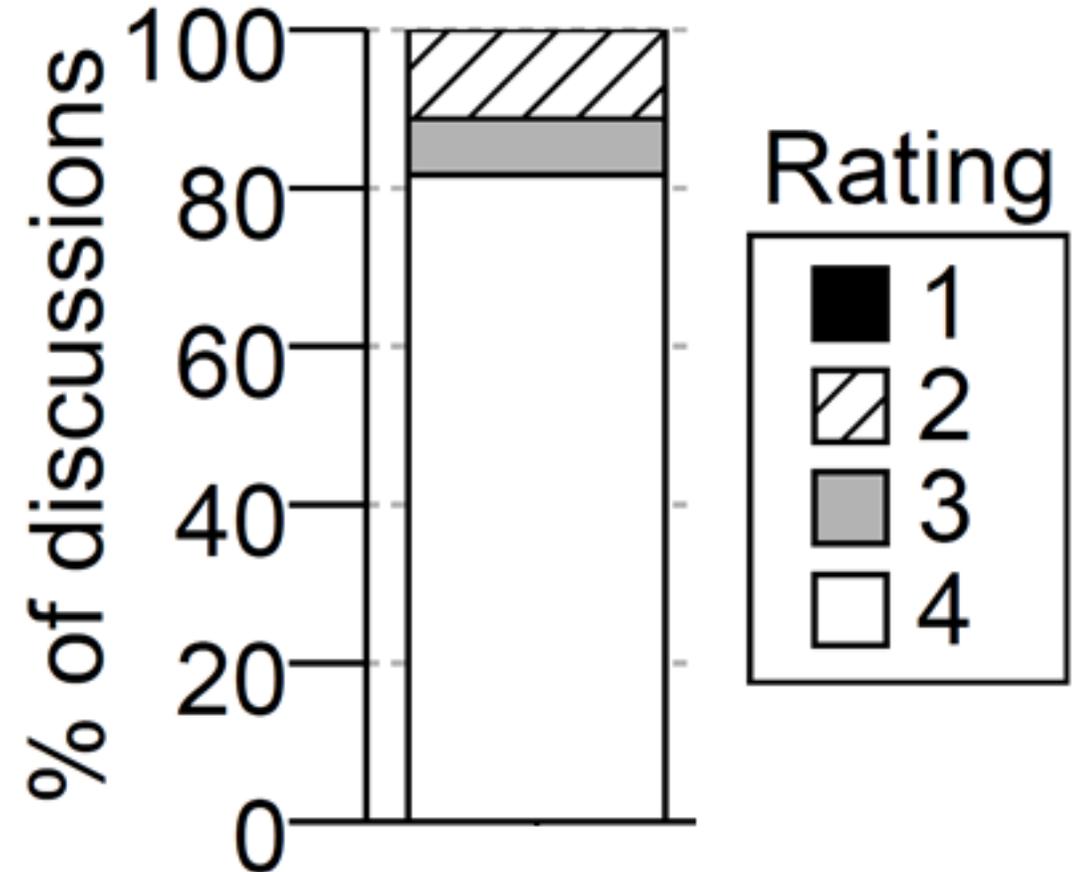
Results: Discussion is helpful

- 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 increases correct answers

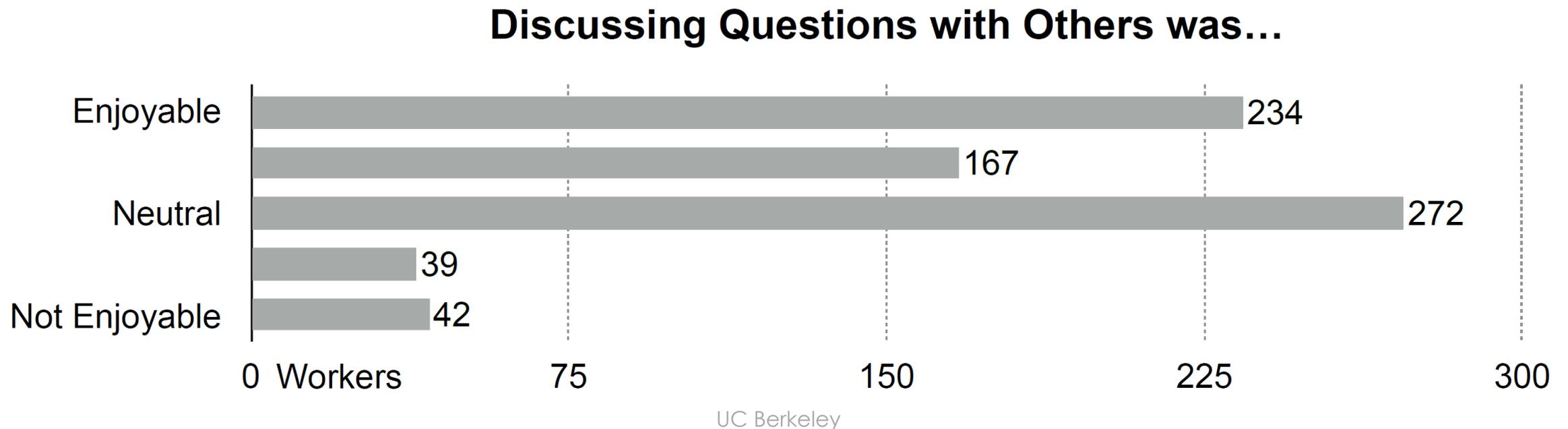
- About same % of workers changed answers in each condition (30% vs 33%)
- But a larger % of those changes were from incorrect to correct in the condition with the bonus incentive
 - 22% vs 11% (significant, Fisher's test, $p < 0.03$)

Sample Discussion

- Student 2: I think E is the right answer
- Student 1: Hi, I think E is right, too
- Student 3: Hi! This seems to be a nurture vs nature question.
- Student 3: Can scent be learned, or only at birth?
- Student 2: Yeah, but answer A supports the author's conclusion
- Student 1: I felt that about A too
- Student 2: But the question was, which statement would weaken the author's conclusion
- Student 3: So I choose A, showing that scent can be learned at not only AT BIRTH.
- Student 2: That's why I think E is right
- Student 3: Are you real, or fake?
- Student 2: real

Results: Subjective impressions

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



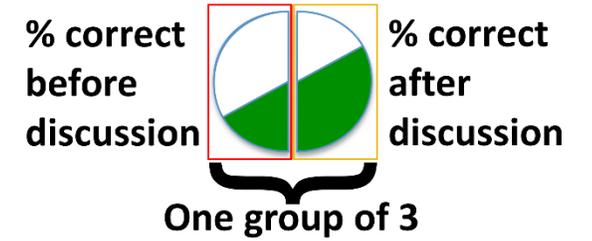
Pilot with real students

- 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
- They plan to repeat with more assignments.

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.

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

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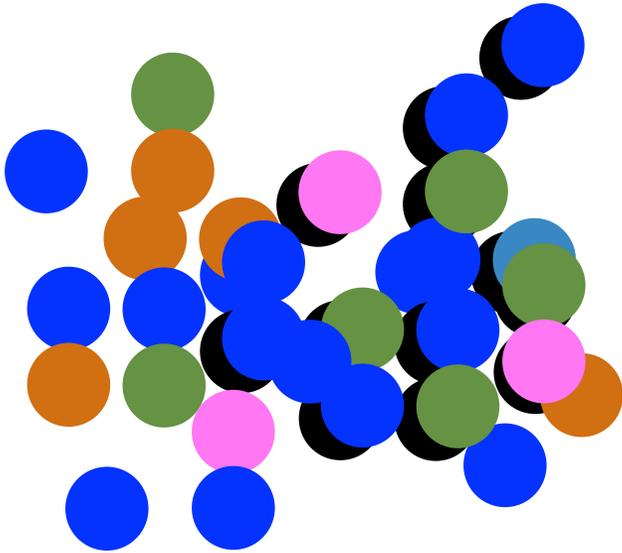
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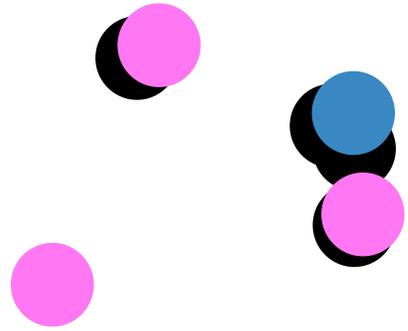
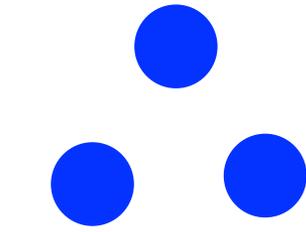
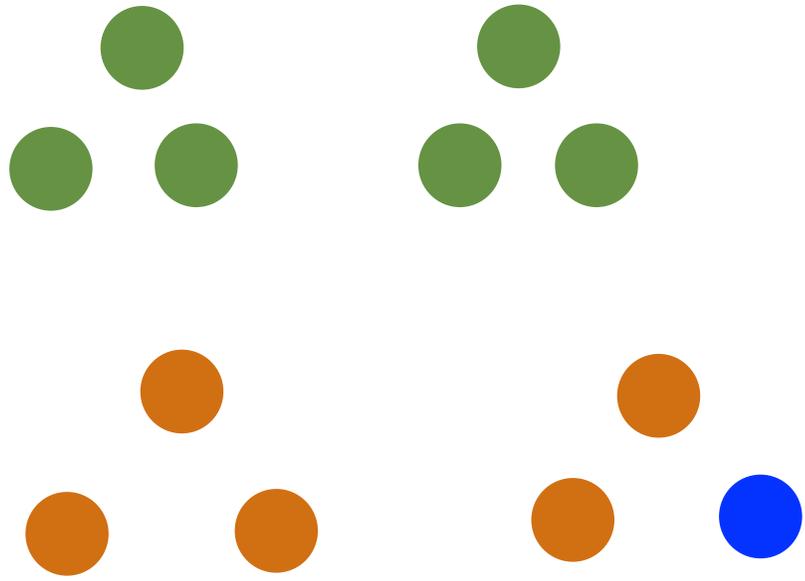
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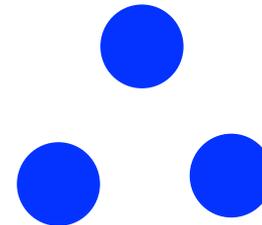
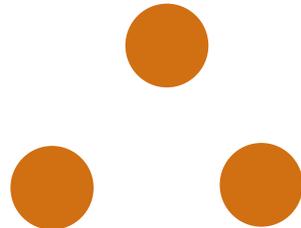
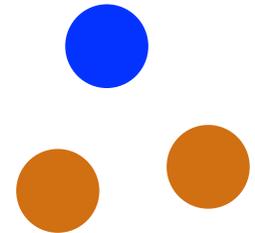
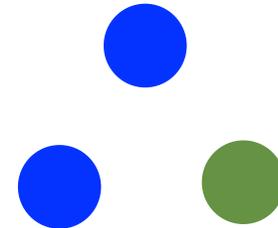
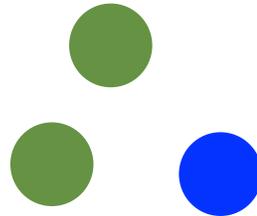
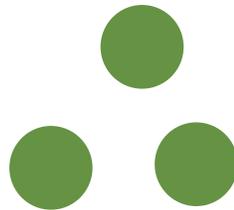
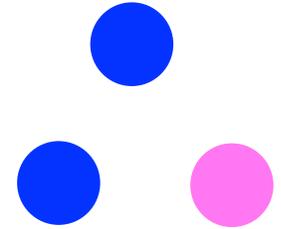
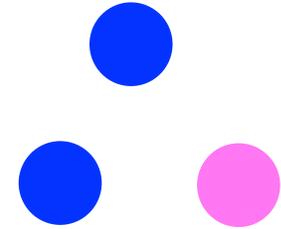
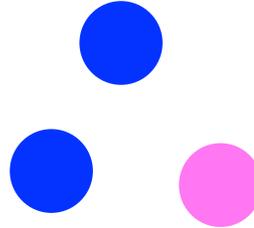
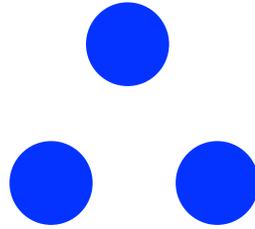
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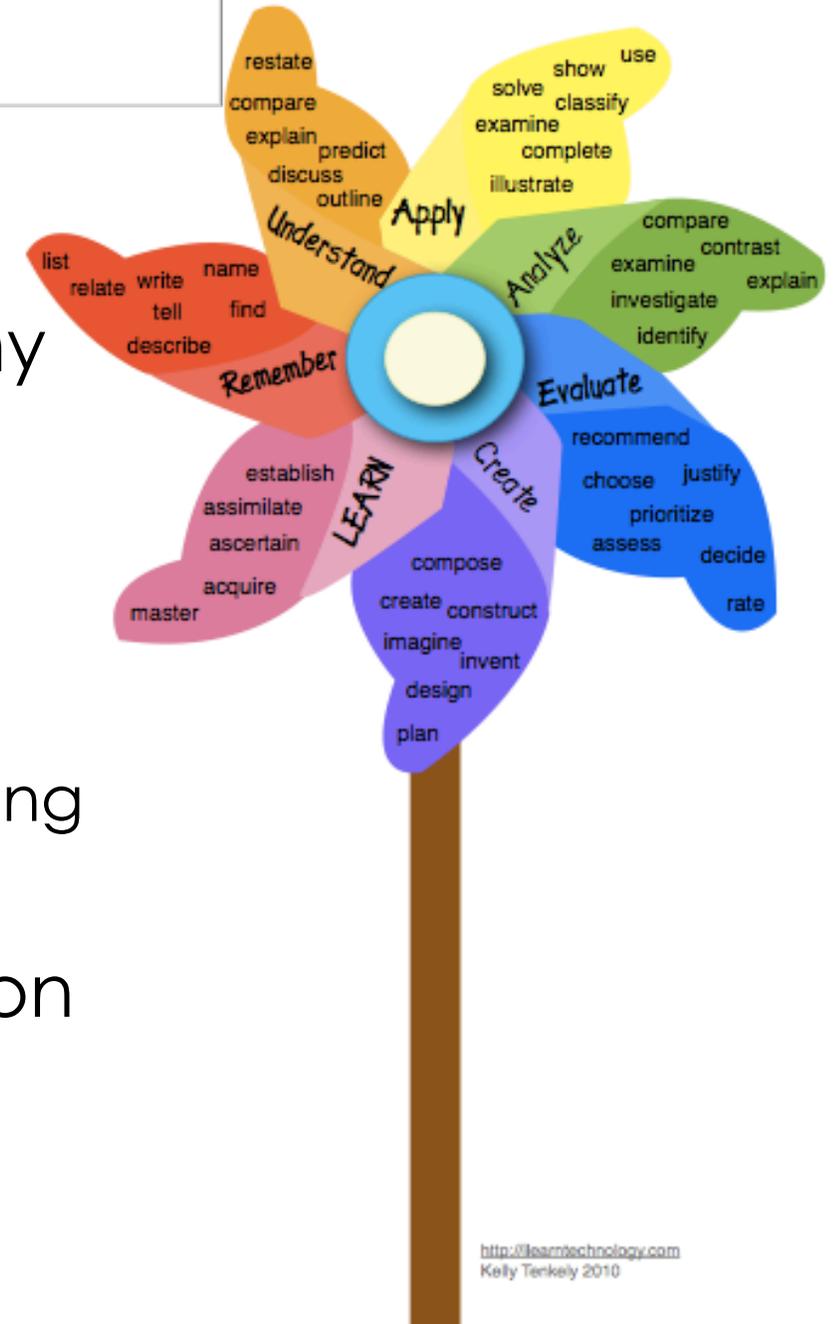
Idea: Dynamically (Re)Group Students

- Based on Misconceptions (initial answers)
 - Give a hint as to why “B” was wrong, and/or
 - Include a short remedial reading, and then discuss, and/or
 - Include one student who understands the concept (?)
 - For students who then choose another incorrect answer ...
 - Assign to another group to discuss it further!

This is only possible online.

Lots of NLP Work To Do!

- Assess what level in the Bloom taxonomy the discussion is at
- Automatically detect levels of understanding
 - To assign TAs to discussions
 - To re-group students based on understanding
 - To create new quiz questions on the fly
- Discourse analysis to shape the discussion



Other Research in Synchronous Interaction among students in MOOCs

- Formal long-term project groups: NovoEd (effective but requires fundamentally restructuring course)
- Informal groups: social media, local meetups
- Peer grading: asynchronous, anonymous evaluation of other students (Kulkarni et al, TOCHI 2014)
 - Integrating machine grading with peer feedback
- Synchronous group discussions with video increases interactions positively (Kulkarni et al, L@S 2015)

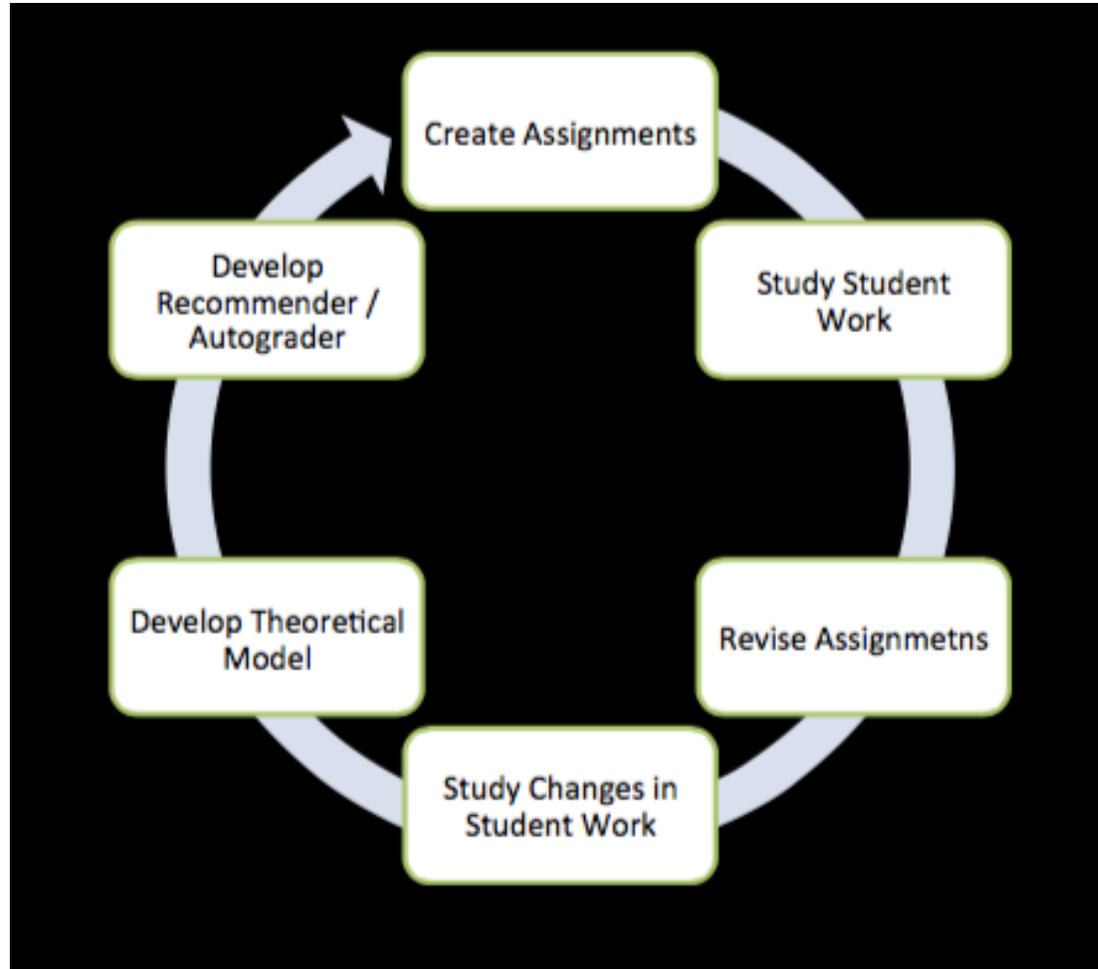
How to use this?

- Integrate with mastery learning exercises and games
- Analyze discussions; automatically classify Bloom levels
- Analyze questions to see which are really revealing misconceptions.
- Make online learning (and doing practice) more fun!

Teach What We Don't Know How To Do

“MOOCs in Progress”

How to Teach What We Don't Know How To Do Yet



How to Teach What We Don't Know How To Do Yet

**EXPLORATORY DATA
ANALYSIS**

**PROGRAM
DEBUGGING**

**WRITING
TUTOR**

