Using Video Analysis to Classify Student Discussions During Peer Instruction


Laura Tucker


Rachel Scherr


Eric Mazur

Research questions. To what extent do students interact during Peer Instruction, and when they do interact, what kinds of conversations do they have?

Background. Peer Instruction[1] is a commonly-used interactive lecture pedagogy used in physics classrooms.[2] It centers on students discussing and answering conceptual questions called ConcepTests. Students answer individually, discuss with their peers, then answer the question again individually. Large correct answer gains occur after peer disucssion, as illustrated in fig. 1's polls. Yet little is known about student peer discussions in the Peer Instruction classroom environment. What kinds of conversations do students have, and to what extent do students participate in peer discussions?

Data. We recorded an extensive, unprecedented amount of audio and video data from an introductory physics courses at a major research university. In our first recorded course, introductory electromagnetism taught by a Peer Instruction expert, we had a 97% participation rate: 89 of the 92 terminal students participated in the study.

With the goal of capturing every student conversation over the entire semester, we equipped the classroom with six small, wall-mounted cameras and 48 miniature microphones -- about the size of a marble -- scattered among the seats of a lecture hall (fig. 2). We recorded all lectures after the course enrollment was finalized: twenty 80-minute lectures totaling 160 hours of video footage and 1277 hours of audio recording. This footage contains 87 peer discussion segments of Peer Instruction.

Analysis. Our full analysis has many dimensions -- from manual human coding, to social network analysis, to automatic group and gesture recognition using custom-developed computer vision technology. Our manual analysis has two components. First, for large-scale efforts, trained coders watch a video segment once for each student. For each five-second time interval, coders classify if the student discusses, whether the discussion is on- or off-topic, the student's discussion partners, and additional notes (sample output in fig. 3). We then count the amount of time each student spends in each interaction type during the discussion period.

The second component of manual analysis is conversation classification. Conversations neatly fall into two categories: "check-in" conversations and "disciplinary engagement." Check-in conversations occur when students exchange initial answers but do not discuss beyond their initial reasoning. We use the term "disciplinary engagement" when students have on-topic conversations that do extend beyond their initial reasoning exchange.

Perhaps the most exciting part of our interdisciplinary research is our collaboration with Todd Zickler's computer vision group at Harvard to do automatic analysis of individual and group activity based on visual cues,[3] and then pair this data with learning outcomes in order to evaluate existing interactive teaching methods and propose new ones.

1 Mazur, E. *Peer Instruction: A User's Manual*, Prentice Hall, 1997.
2 Dancy, M. & Henderson, C. .*American Journal of Physics*, 2010.
3 Li, R & Zickler, T. *Computer Vision and Pattern Recognition (CVPR)*, 2012.

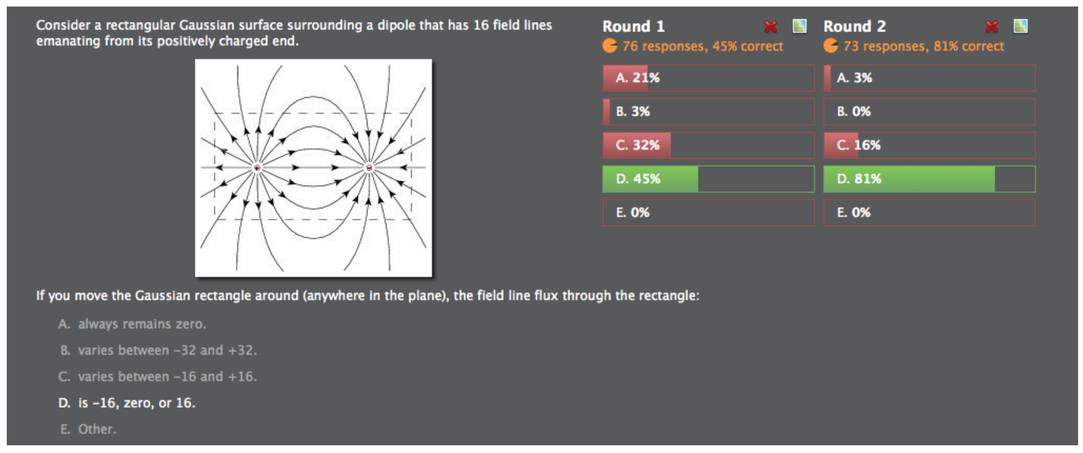

Figure 1. In Peer Instruction, large gains occur between the first and second polls. Student discussions, which occur between the polls, likely explan these gains. Our work supports this assertion with new data.

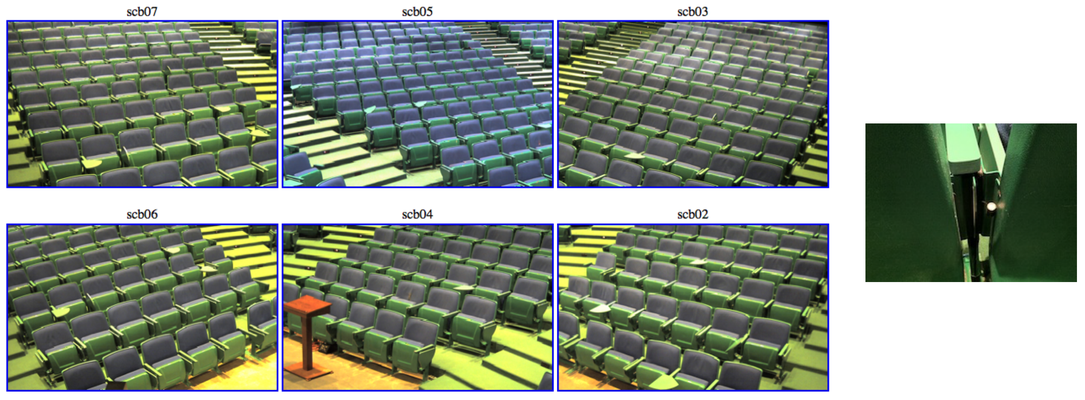

Figure 2. Our Lens to Learning recording system is comprehensive and discreet. Its six cameras and 48 miniature microphones scattered throughout the classroom capture conversations from every student. We also have a system installed in a classroom designed for project-based learning.

Time	Discussion type	ON/OFF-topic	Partners	Notes
0:01:00	N			
0:01:05	N			Looks around, but
0:01:10	N			
0:01:15	PEER	ON	D104,D105	She attempts to ask
0:01:20	PEER	ON	D104,D105	Pays attention to their
0:01:25	PEER	ON	D104,D105	Difficult to tell if she's still
0:01:30	PEER	ON	D104,D105	
0:01:35	PEER	ON	D104,D105	
0:01:40	PEER	ON	D104,D105	
0:01:45	PEER	ON	D104,D105	
0:01:50	PEER	ON	D104,D105	
0:01:55	PEER	ON	D104,D105	
0:02:00	PEER	ON	D104,D105	
0:02:05	PEER	ON	D104,D105	
0:02:10	PEER	ON	D104,D105	
0:02:15	PEER	ON	D104,D105	
0:02:20	PEER	ON	D104,D105	
0:02:25	N			
0:02:30	N			
0:02:35	N			
0:02:40	N			

Figure 3. Output from trained coders' analysis of a single student's behavior during a Peer Instruction discussion segment. For each five-second time interval, coders note the type of discussion in which the student participates, whether the discussion is on- or off-topic, the student's discussion partners, and additional notes about the interaction. This data is then compiled to gain information about class-wide behavior and individual student behavior throughout the term.

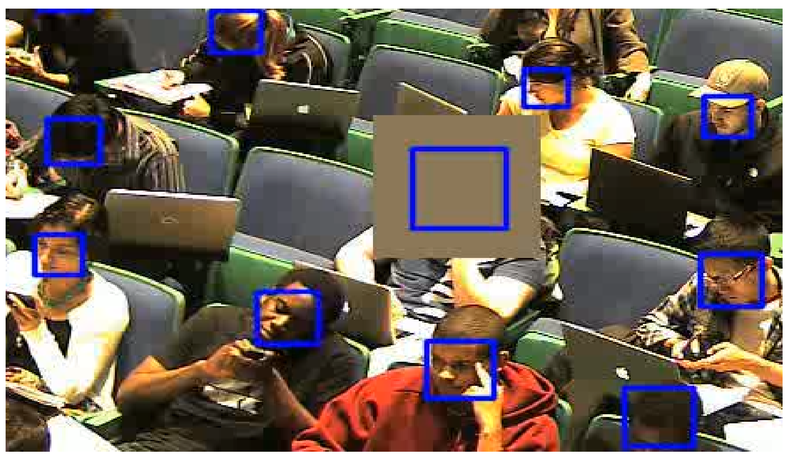

Figure 4. Using advanced computer vision tools[3], the technology localizes each student in the video, extracts computational descriptors of her activities, and uses these descriptors to enable systematic analysis at a large scale that would otherwise be impossible. Using this technology, we are creating computational models for group discussions in large classrooms, and we validate these models against observational studies of the same video by experts in education.