Student behavior, attitudes, and learning using in-class questions with "clickers" vs. a show of hands in a large introductory geology course

Andrea Bair, Jennifer Stempien, and David Budd
Department of Geological Sciences, University of Colorado - Boulder, UCB 399, Boulder, CO 80309-399, Andrea.Bair@colorado.edu

Introduction

"Clickers" have become popular instructional tools promoting interactive engagement of students in large lecture courses. Studies examing the efficacy of pedagogy paired with technology to improve student conceptual learning, engagement, and enjoyment have primarily focused on comparisons between traditional (non-interactive) lecture courses and highly interactive courses utilizing clicker technology (e.g., student learning and attitudes comparing and contrasting clickers vs. traditional lecturing or vs. socratic questioning).

Use of clickers and teaching techniques promoting interactive engagement in geology courses at the University of Colorado-Boulder began relatively recently, and like other geology faculty, faculty have struggled with weighing "negative" aspects of clicker use (such as increased instructional time, monetary cost to students, logistical and techonological challenges, and data management issues - see "Special Session at 2004 Annual Meeting of the Geological Society of America: Electronic Student Response Technology" abstracts at: http://gsa.confex.com/gsa/2004AM/finalprogram/session_12862.htm, and a summary at: serc.carleton.edu/resources/14033.html) with "positive" aspects of increased student engagement and learning reported widely in science education literature.
Thus, some faculty wondered, "Is it necessary (or advisable) to use clicker technology to facilitate interaction in a large lecture course? Can students gain the same "positive" aspects reported for learning with clicker questions without the technology – by voting by a show of hands?

We investigated student behavior, attitudes, and learning in two sections of introductory geology in which most course elements were the same (instructor, classroom, lecture content, assessments, and in-class questions); one section used clickers to vote, and students voted via a show of hands in the other section.

Implementation and methods

Course logistics

The two sections of introductory physical geology were team-taught by two instructors, such that instructors traded off lecturing and giving assessments to both sections four times during the semster. Each instructor used identical lecture notes, homeworks, and exams, and the sections were held one after the other in the same lecture classroom (student number ~160 in each section). The non-clicker section met directly after the clicker section.

When asking in-class questions (using clickers or show of hands), instructors asked students to discuss the question with neighbors before answering approximately half the time; the other half of the time students were either not directed to discuss or asked to answer without discussion (as judged by ~5 classroom observations by two observers). When teaching the non-clicker section, instructors asked, "How many people think the answer is A?" or a similar question, and wrote out their estimated number of students responding , and then followed the same format with additional answers. Clicker questions were graded for participation only; the non-clicker section students' attendence was monitored for several class meetings throughout the semester, for which they received equivalent attendence credit. The clicker section used HITT clickers, for which the classroom was wired.

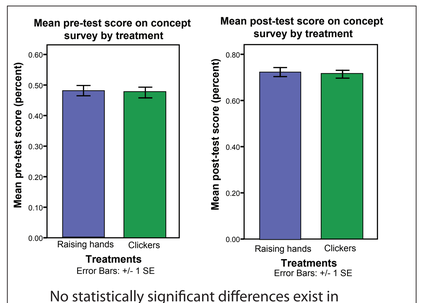
Evaluation methods

Student learning: We administered a 20-question multiple choice concept survey at the beginning and end of the semester. 17 questions were scored, 13 of which are from the Geoscience Concept Inventory, and four questions were designed and are in the process of being validated by the Science Education Initiative in Geological Sciences at CU.

Student attitudes, behavior, and opinions: We interviewed ~5 students from each section on aspects of their clicker or in-class question experience, and our preliminary analysis of interviews was used to develop post-semester student survey questions (six multiple choice questions and one open-ended question). We augmented student-reported data with classroom observation of ~5 class sessions per section with two observers.

Student learning

Differential treatments did not seem to impact student learning as measured by our pre- and post- concept survey results.

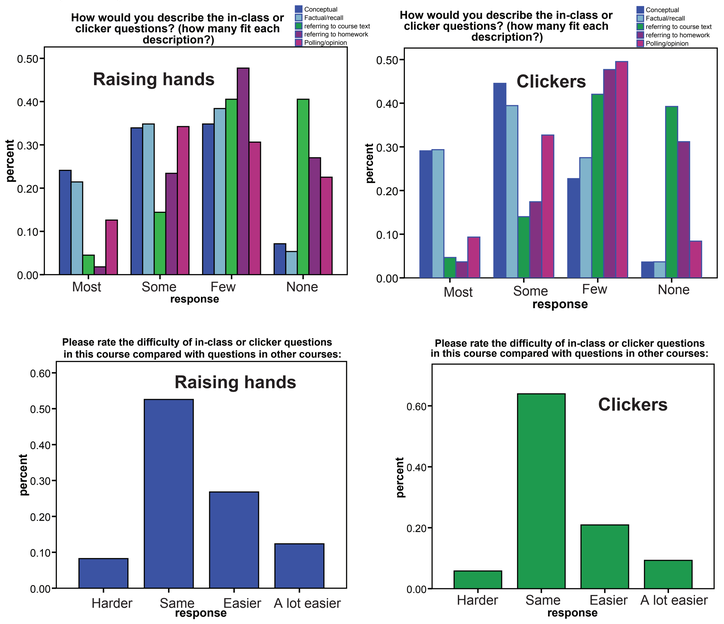


No statistically significant differences exist in pretest or posttest scores between treatments.

Student attitudes, behavior, and opinions

Nature and difficulty of in-class MC questions

Students in both sections characterized questions similarly; observers characterized the questions very similarly to students.

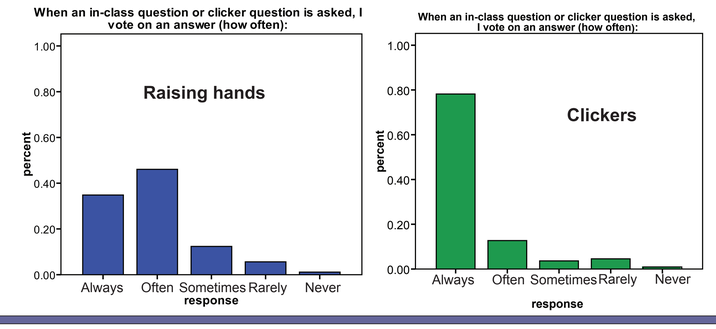


Participation and behavior

Both observers and students reported a large difference in student participation, with students in the clicker section nearly always participating, but many more students not participating in the non-clicker section. Student interviewees, observers, and students in the open-ended survey question noted that many students looked at neighbors' and the class majority answer before raising hands, and avoided voting if they were uncertain of the answer.

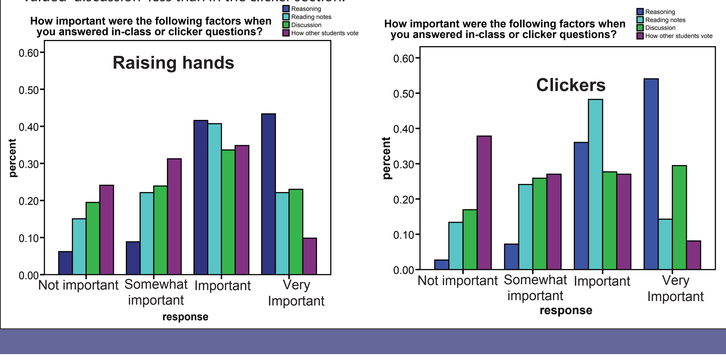
Student quote: "Voting was done by raised hands, so people rarely voted different than the majority. I didn't have a problem really, but I'm sure it played a part for some others."

Other students, particularly those familiar with clicker use in other courses, noted that:
"Clickers would have been nice because then people would be forced to answer and the voting results could lead to better discussions",
apparently recognizing that students had little incentive to vote compared with participation clicker points, and that important elements of pedagogic value were not possible in the non-clickerclass (at least in the way it was implemented here).

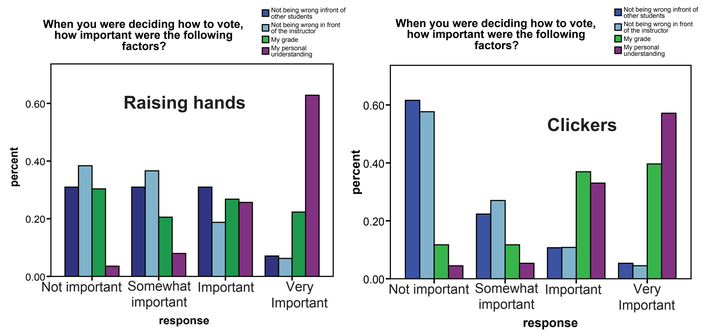


Motivation and values

Although students in both sections identified "reasoning" and "reading" notes as more important when they answered questions, students in the non-section valued "how other students vote" more highly, and valued "discussion" less than in the clicker section.



In student interviews and survey responses, students indicated that anxiety of appearing "wrong" in front of the instructor and fellow students was a significant factoring preventing them from voting honestly and in at least some cases, from voting at all. This is consistent with class observations, where students who expressed uncertainty about the correct answer were observed to hesitate and vote with the class majority, even if they had expressed that they thought a different answer might be correct.
Survey results indicate that while "personal understanding" was students' self-reported strongest motivating factor, "not being wrong in front of the instructor" and "not being wrong in front of other students" was much more important for the non-clicker section. As noted earlier, students in the non-clicker section were not motivated by "my grade" in the non-clicker section, as they received no credit for participating.



Use for learning

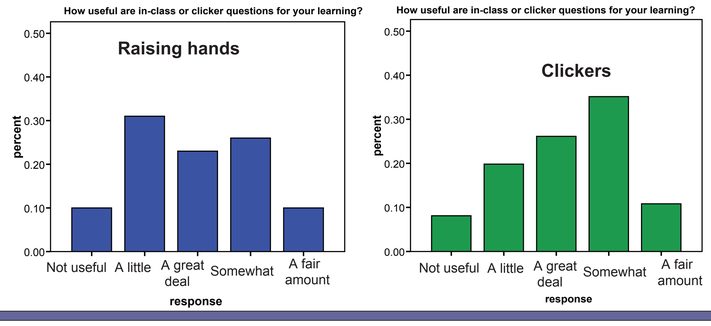
Students in the clicker section felt that the questions (with clickers) was more useful for their learning than did students in the non-clicker section, despite the fact that identical questions were used. This was expressed in interviews and on the open-ended survey questions as well.

"A clicker question is much more useful than just an in-class raise-your-hand question"

Again, some students noted WHY clicker use is preferable, referring the the pedagogic value of feedback to students and to instructors about student understanding:

"i think it would be better to use clickers instead of hand raising so it would be more obvious if all the students understood the topic"

At least some students in the clicker section also recognized pedagogic value of clickers:
"I thought that clickers were helpful. It made it easier for the teacher to see how many people actually understood what we were talking about without embarrassing anyone and picking on them."



Conclusions

Our analysis supports the idea that the anonymity (or near anonymity) afforded by clickers allows the critical feedback cycle between students and faculty about student understanding to take place.

Without feeling they could (and should) answer questions honestly, students did not participate at a high rate, or did not vote honestly.

Without honest student voting at a high level of participation, both students and faculty then had a difficult time judging student understanding.

Student learning appears not to be affected by "raising hands" rather than using clickers (at least as both were implemented here), but student attitudes and perceived value of in-class questions were negatively impacted.

References - available on request.

Acknowledgements
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