Clickers in the Wild: A Campus-Wide Study of Student Response Systems (SRSs)

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Background

Science, technology, engineering, and math (STEM) majors face high rates of attrition. How can instructors improve persistence? SRSs (e.g., clickers) are being implemented across STEM undergraduate courses as a means to improve the learning experience for students. We take a naturalistic approach to study the potential of clicker implementation to impact four relevant domains: (1) student engagement, (2) student achievement, (3) gender inequality in STEM, and (4) innovative instructional practices.

Research Questions

- Does SRS use in large, introductory STEM courses positively impact student achievement (i.e., course grade, progression, and grade in subsequent course)?
- What instructional pedagogies are already at play, and are these practices optimal implementations of SRSs?

Method

Results are taken from a larger study of promising instructional practices in entry-level STEM lecture courses with average enrollment over 270. Institutional data and an observation protocol were used to study SRS use, which occurred in 15/43 lower division STEM courses (6/23 in Fall 2013; 9/20 in Winter 2014).

Measuring Student Achievement:

- *Grade in Observed Course*
- *Course Progression (Persistence)*
- *Grade in Subsequent Course*

Observing Instruction:

- *Simple PRotocol for Observing Undergraduate Teaching (SPROUT)*
- *Instructor Interviews*

Results

	Grade in Observed Course	Progression to Next Course
Exposure to SRS	0.150***	-0.230***
Interaction of Clickers and Females	0.045**	0.310***

$^{**}p < 0.01$. $^{***}p < 0.001$.

SRS use most positively impacts student achievement for women in STEM.

Engagement: "…[T]hat [clicker] attention grabber is what I was after. They stop, they pause, they take it in, and they understand the explanation. Then I'll ask another question and it'll flip. Now 80% get it right. "

(Introductory Biology)

Peer-Peer Interaction: "…sometimes there's a discrepancy, so I tell them, 'there are two possible answers, find someone near you who gave the other answer and convince them that they are wrong' and I give them 2-3 minutes to talk about it and then we re-do the question. "

(Introductory Chemistry)

Feedback: "I want [students] to care but I should give [them] a reason to care, so we should work together on this and generally that comes in the form of feedback—constant feedback—so I use clickers. I tell them, 'I'm not going to grade you on whether you were correct or not, but here's this question, work through the problem, or think about the idea.'"

(Introductory Chemistry)

Problem Solving: "Spend five minutes working with two or three students around you and figure out why marathon runners sometimes collapse at the finish line after drinking a large amount of water, then choose your answer."

(Introductory Biology)

Demographic Data

43 Courses Observed	Biological Sciences, Inorganic and Organic Chemistry, Physics, Mathematics, Engineering, and Computer Science
Gender	52% Females and 48% Males
Ethnicity	49% Asian, 20% Hispanic, 13% White, 1.5% Black, 16.5% All Other (Including non-residents); 38% low-income; 55% first generation
Previous Academics	High School Grade Point Average, Mean Score on All STEM AP Exams Taken, SAT Math and Verbal Scores, Declared STEM Major

Discussion

- SRS implementation positively impacts current course grade with additional benefits for women
- SRS implementation increases the likelihood that women will persist
- SRS implementation showed no impact on grade in the next course
- Some instructors already use SRSs as a means of implementing: engagement, interaction, feedback, and problem solving.

Because SRSs provide non-threatening, anonymous, and immediate feedback, these findings provide a tangible reason for instructors to implement SRSs in introductory STEM courses.

Broader Impacts

By demonstrating the efficacy of SRS implementation and illustrating the ways in which this technology is presently used by some instructors, this study supports use of SRSs to mitigate attrition and underrepresentation of certain groups in STEM classrooms. Study of SRSs is particularly important given that this is an easily implemented change to traditional pedagogies.

Future Analyses

The present study was limited to two terms at a single research university. Larger populations are needed to better assess SRS implementation. Future studies at other research universities will address questions of reliability and validity. Longitudinal (i.e., progression to next course) data will further validate that SRS implementation reduces attrition in STEM majors. Future analyses will be conducted on discipline-specific effects and their interactions with demographic groups, and instructional differences.

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