The Benefits and Pitfalls of Learning with Classroom Clickers: A Large-Scale, Multidisciplinary, Empirical Study

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ABSTRACT

The purpose of this study was to conduct a highly controlled study of the effect of factual and conceptual clicker questions in live college classrooms, across multiple disciplines, on mastery of targeted factual and conceptual exam questions. The biology course, which emphasized memorization more than conceptual understanding, found clicker questions enhanced performance on factual exam questions. Clicker questions of either type did not enhance performance on conceptual exam questions. In the physics course, which emphasized conceptual understanding and problem solving more than memorization, clicker questions did not enhance performance on either type of exam question. The use of factual clicker questions actually lowered performance on either type of exam question.

INTRODUCTION

Subjects: The research participants were college students enrolled in freshman- and sophomore-year courses in biology (n=850) and physics (n=1999) over 4 semesters. They were not majors in these disciplines and were taking the courses to fill requirements for their respective majors.

Materials and Design: The experiment compared performance on targeted factual and conceptual exam questions in each of 4 conditions: (1) factual clicker questions; (2) conceptual clicker questions; (3) enhanced control; (4) simple control. In the enhanced control condition the instructor indicated the information was important and would be on the test. A team of PhDs in each field evaluated the quality of all the materials and established validity of the IVs. Validity and inter-rater reliability were established for all materials. A total of 24 target items were used in the biology analysis and 31 in physics.

METHOD CONT.

In all classes, students who answered fewer than 75% of the in-class clicker questions were removed from the analysis, as they were not sufficiently exposed to the treatment conditions to be part of the study. Students that answered fewer than two exam questions in a condition were also removed from the analysis, as there were insufficient data in those cases to find a condition mean. After data were edited in this way, a total of 439 subjects remained in the biology course and 134 in the physics course analyses, respectively.

RESULTS

Repeated measures ANOVAs (with Greenhouse-Geisser corrections) in the biology class showed a significant effect of treatment condition on the factual exam questions, F(3, 399) = 1.58, p < .05, but a significant effect on the conceptual exam questions (with a Greenhouse-Geisser correction), F(2, 34) = 10.34, p < .01, partial η2 = .07. A series of paired t-tests revealed that performance reductions in the factual clicker and enhanced control conditions were the sources of the significant effect.

Secondary analyses using subject variables revealed a significant 3-way interaction in the regression between prior knowledge (PK), clicker condition and exam type, t(2138) = 2.50, p = .01. As Figure 3 shows, students performed worse in the factual clicker and enhanced control conditions. The effect was strongest for those with PK (i.e., true beginners). The effect of those conditions on conceptual exam performance stems in the main analysis appears to stem largely from the low PK group.

CONCLUSIONS

The present study demonstrates that clickers can be of benefit for learners when applied to courses focused on fact-based learning. In courses that are directed primarily at conceptual understanding of the domain, clicker use not only had no beneficial effect, but actually impeded learning in some circumstances. Specifically, questions that focused students’ attention on surface features of the material distracted low PK students from attending to a more conceptual understanding. Certainly, some previous research has shown that clickers can be effective for promoting conceptual understanding of material, but this has generally been demonstrated when clicker use has been combined with certain types of peer interaction and activities in class (e.g., think-pair-share activities, Crouch & Mazur, 2001; Mazur, 1997, 2009).

REFERENCES


