Presenting Clicker Questions with an Open- Versus Closed-Response Format

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INTRODUCTION

Active learning in the classroom has been shown to increase student learning and decrease student failure rates (6). However, the effect of active learning is lower in large classrooms (6), probably because this type of learning environment can be difficult to create in today's large lecture classrooms. As a method of introducing active learning, course response systems (clickers) have become increasingly popular in large lecture halls. Clickers have been used to keep students' attention, to increase student interaction, as a tool for formative assessment, and as a measure of attendance (4). Research indicates that students have high levels of satisfaction with the clickers (5) and that they can increase test scores (7). However, the method in which the questions are asked and the amount of discussion that ensues can greatly impact the actual active learning that occurs (8). In the present study, the instructor attempted to use clickers in a way that would allow students to engage in the biology content, constructing answers to questions, and at the same time produce feedback that could be used in a large classroom setting (>200 students per section). The purpose of the study was to determine whether students were more successful on clicker questions if they first constructed an answer compared with choosing from a list of options on a multiple choice question.

PROCEDURE

Clicker questions

The clicker questions used for comparison were designed to stimulate students' thinking about the material. Clicker questions were used routinely in the course, with one to five presented each day, and were scored as extra credit. The questions were primarily taken from the McGraw-Hill supplemental materials supplied with the text (3), but some were designed by the course instructor. The clicker questions used for comparison were all Bloom's taxonomy level of comprehend (Level 2) or application (Level 3) (1, 2). The rest of the clicker questions, not used for this comparison, were used to quickly check student understanding of material (Bloom's Level 1).

The clicker questions were presented in one of two formats: open or closed. In both formats, the instructor prompt was simply “turn and talk to your neighbor.” In the open format, the question was projected with no answers visible on the PowerPoint slide. After student discussion, the students were provided with the next slide containing the question and possible answer choices presented in a multiple choice format. Then they chose an answer using their clickers. In the closed format, the slide contained both the question and the possible answer choices in a multiple choice format. After discussion, the students chose an answer using their clickers. In both formats, after presenting the results, the instructor discussed the correct answer.

Comparison of student learning

Three hundred ninety-four students who completed the course agreed to participate in this study. They were enrolled in two sections of an Introductory Cellular and Molecular Biology course designed for science majors at a mid-sized doctoral research university. Each section of the course was taught by the same instructor (first author) for 50 minutes three times a week; one section met mid-morning and the other section met in the early afternoon of the same day. Most students took the course as a requirement for their major.

To control for possible differences between sections, the question format varied between sections. Each day a random number generator was used to assign either open or closed format questions to each section. Each section was asked the same clicker questions each day, with only a variation in the question format. This allowed a direct comparison of student scores on the same question in both an open and closed format using an independent t-test of the proportion of correct answers in the open versus closed format (the proportion correct allowed for missing data due to absence). All of the Bloom's level 2 and 3 questions asked throughout the course that were presented as indicated above during
both sections were used for comparison, resulting in a total of 39 questions analyzed (19 questions in one format and 20 in the other, balanced between sections).

When comparing all students (Fig. 1) there was no significant difference between the proportion of correct answers for the open and closed formats (open: M = 63.0%, closed: M = 61.0%, t = 1.724, p = 0.085). However, when comparing the students’ final grades in the course (Fig. 1), there was a significant difference for students with a C grade (open: M = 62.5%, closed: M = 58.3%, t = 2.005, p = 0.046).

CONCLUSION

The data indicated that, overall, students do not perform significantly differently in the two clicker question formats, although there is a trend for higher performance on open format questions (Fig. 1). It is possible that the students often talked with students of similar grade, since the discussion was simply a seating proximity discussion, not assigned groups. However, there is a significant increase in final grades for students with a C grade who had the open format. The open format is helping the middle performing students, those students we are often trying to reach, to learn more during the class period.

Additionally, the instructor noted that when potential answers were available for students, the discussion was often limited to one student simply telling the others the correct answer. In effect, the discussion was merely “the answer is B.” When no answers were available, students had longer and more in-depth discussions. Those students who felt confident of their answer had to take the time to explain it to their peers. Justifying an explanation is also a skill we want our students to learn, and this small change in format of clicker questions is possibly increasing this process for the students. The types of discussion engaged in by the students’ was not explored in this study and should be the focus of further research.

For faculty members using clickers in their courses, this study indicates that the way in which the question is asked can have an impact on the average students’ success as well as the overall discussion. When the question is first presented in an open-response format, students are more likely to have longer discussions about the question and students with a C grade are more likely to answer the question correctly. For the faculty member, this technique requires no more time or effort than the typical clicker question, as it only requires one additional PowerPoint slide without visible answers.

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REFERENCES


FIGURE 1. Comparison of open- versus closed-format clicker questions. Percentage of questions answered correctly in the open versus closed format, for all students and by final course grade. The n for each group is: A = 44, B = 128, C = 114, D = 58, F = 50. The group for which the difference is significant is the students with a C grade (t = 2.005, p = 0.045).