Scoot Scantrons®, Alphanumeric Clickers are Coming

Tamar L. Goulet and Denis Goulet
Department of Biology, P.O. Box 1848, University of Mississippi, University, MS 38677

Conclusion: Alphanumeric clickers enable assessment of student learning of content and concepts without increasing instructor workload. Answering fill-in-the-blank questions with these clickers raises the difficulty level of questions and more reliably tests student knowledge and understanding versus tests with only multiple-choice questions.

Introduction:

Problem –
Despite advances in pedagogical approaches used in biology courses with a large student enrollment, testing of student knowledge lags behind, potentially restricting student gains from active learning.

Potential solution –
Response systems (clickers) with alphanumeric capabilities enable posing fill-in-the-blank and multiple-choice questions in a machine graded exam. Although employing clickers in classes is commonplace, clickers’ capabilities on exams are underutilized and not assessed.

Methods:

The courses –
BISC 102, Inquiry into Life - Human Biology.
• A non-majors’ introductory biology class.
• Classes of 100-280 students.
BISC 335, Human Reproduction.
• A majors’ biology class.
• Enrollment of 55 students.

Experimental design –
• Questions posed as multiple-choice questions in a one semester were posed as fill-in-the-blank questions in a subsequent semester, allowing a comparison of the same question with different answer formats.
• Control - student responses to identical questions posed in a multiple-choice format were compared between the years.
• The same faculty taught all sections, addressing the potentiality for instructor bias.

Data collected –
• We compared the number of students correctly answering exam questions posed as either multiple-choice or fill-in-the-blank.
• We also compared between cohorts the number of students correctly answering exam questions posed only as multiple-choice.
• The questions were taken from 3 exams and the cumulative final.

Figure 1: Examples of clickers with alphanumeric capabilities. (a) NXT and (b) QWERTY clickers from Turning Technologies ® and (c) iclicker 2 from iclicker ®.

Figure 2: Response of students to eight questions in which the answer required either choosing the correct answer from multiple choices (red bars) or typing in an answer (blue bars). Significant differences (p<0.05), obtained with a chi-square test, between the two answer types are denoted by a (*). The questions appear in the attached table.

Question types possible & examples:
1. Questions requiring a correct sequence, from concept maps to process order
   Place the organs of the human digestive system in the correct order starting from the organ where food enters the body. 1. Esophagus, 2. Large intestine, 3. Oral cavity, 4. Pharynx, 5. Small intestine, 6. Stomach. This question has a total of 6,656 possible answers. Students must know the correct order (341652) to receive the points for this question.

2. Questions requiring a numerical answer
   How many nucleotides make up a codon (type in a number)? Since no answer is provided, there are an infinite number of possible answers. Students need to know the exact number to answer the question correctly.

3. Questions requiring a mathematical calculation leading to a numerical answer
   If adenosine makes up 20% of the bases in a DNA double helix, ___% of the bases are guanine (type in a number). There are 100 possible answers (0-100%).

4. Questions requiring an answer of a word
   Cell division in which two daughter cells are produced is called ____ (type in the word).
   No answer is given for the students to recognize.

5. Questions with potentially multiple correct answers
   Write the number(s) of the respective organ(s) in which amylase is used ___ (list all in ascending order).
   There are 7 possible responses (1; 2; 3; 12; 13; 23; 123).

Results & Discussion:

Results –
• Question format, multiple-choice versus fill-in-the-blank, affected the number of students answering questions correctly.
• When a significant difference arose between course cohorts, the percent of students answering correctly with a fill-in-the-blank answer was significantly less than those answering correctly in the multiple-choice format.
• These significant differences were not due to differences between the cohorts or any negative effect of clicker use during exams. The percent of students answering correctly on multiple-choice questions compared between the cohorts did not differ.

Discussion–
• Fill-in-the-blank questions on exams can better assess student knowledge as opposed to answer recognition, elimination of answers and/or guessing.
• A gain in learning can occur, even in large classes, without increasing the time and effort of grading.
• If students study for clicker exams as they do for short answer exams, then the clicker technology provides a way to increase student knowledge acquisition and understanding while still working within the utility of machine graded exams.

Acknowledgements:
This study was supported by grants from the National Science Foundation: DUE-0942290, DUE-0511654, IOS-0747205

The University of Mississippi

NSF