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Exploring the Universe Together: Cooperative Quizzes With and Without a Classroom Performance System in Astronomy 101

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Abstract

Our University of Alabama introductory astronomy course has large enrollments, with the usual problems of low attendance and students putting off studying until just before major exams--with predictable consequences. We tried one strategy--cooperatively answering quiz questions-- during our May 2002 interim term. Classes were long: three hours a day over three weeks. Before midclass break, we presented a multiple-choice open-book-and-notes quiz to be answered after the break. Quizzes could increase grades without excessively diluting the importance of closed- book major exams. The interim 2002 final exam average was 80%, much better than the 2001 class average of 57%. During a regular semester, handing out and taking up papers would take up much time during the more frequent classes. It’s also more interesting if students vote for different answers together, then see the correct answer. We obtained funds for a Classroom Performance System (CPS) consisting of two computer receiver units, a hub, and 128 TV remote-style response pads. We used the CPS during interim 2003. Ease of giving quizzes and grading permitted two shorter quizzes a day. Improvement was maintained, with a slight 3% increase. In addition, students graded the "cooperative quiz" 2002 and 2003 courses higher than the 2001 course. We also used the CPS for public astronomy events and introductory physics courses.

1. THE PROBLEM AND A TRIAL SOLUTION

To solve attendance and procrastination problems in our introductory astronomy course at the University of Alabama, we (Byrd, faculty; Werneth, graduate student; and Coleman, undergraduate student) tried a strategy to actively involve students: cooperatively answering quizzes. The idea of eliciting understanding via a series of questions dates as far back as 400 B.C. by Socrates, as reported by Plato in the Meno dialogue. We tried this solution during our three-week May 2002 interim term. The interim classes of three hours a day make midclass breaks essential! Before breaks, we presented a short multiple-choice open-book-and-note quiz answered after the break. We wanted the daily quizzes to positively motivate, increasing course grades without excessively diluting the importance of the closed-book major exams. Correct answers to the quizzes could help the student's final course grade, counting up to 1/6 of the average. However, wrong answers did not hurt. Perfect performance on daily quizzes could change a 70% course average to 75%, with smaller changes for higher averages. A course grade above 100% was not possible. Missed questions on the regular closed-book noncooperative major exams did reduce the students' grades, providing motivation to understand the daily quizzes.

2. EXAM RESULTS AND STUDENT OPINIONS

Comparing the 2002 interim closed-book noncooperative final exams with interim 2001, the average was 80%, much better than the 2001 class average of 57%. There is very low probability that this difference happened randomly. These final exams were not handed back to the students, so we actually gave the same exams to both groups. This, along with the same interim term and no other changes, improved the strength of our conclusions. The 2002 students appeared to interact with one another more in class than previously. Attendance was over 90%. The 2002 cooperative quiz students did not do better simply because they had seen typical multiple-choice questions before the major exams; a sample exam was handed out to the May 2001 students before each major exam.

We evaluated students' opinions via our teacher/course evaluation. Students assigned a grade for the course, from A = 5 to F = 1. For the 2001 interim class, which did not have daily quizzes, the average grade was 3.80. For the 2002 class for which paper-and-pencil daily quizzes were introduced, the average was 4.33, a statistically significant difference. Students graded the daily quiz course as a better course! The grade given to the teacher was statistically the same for both.

3. NEED FOR GREATER CONVENIENCE

During a regular semester, handing out and taking up papers takes up much time for the more frequent and larger classes. In addition, it is more interesting if the students vote for different answers together ("Is that your final answer?"), then see the correct answer. To increase convenience, a grant was obtained to purchase a Classroom Performance System (CPS) from Einstruction, Inc. The CPS consists of a computer receiver, software for creating quizzes, and 128 wireless response pads that look like TV remotes.

We used the system during interim 2003. The ease of giving quizzes and grading permitted more frequent shorter quizzes. We gave a short five-question quiz before the midclass break, with another at class end, for a total of 27 quizzes (almost one a day for a regular-semester Tuesday and Thursday class). Questions can be given during the lecture. The example questions given below are simple, but often, such questions are missed, even right after the material has been covered. The CPS quizzes enable the instructor to quickly identify and discuss misunderstood material.

1. Which arrangement is correct in increasing order of size, left to right?
A. planet, star, galaxy
B. star, planet, galaxy
C. galaxy, star, planet

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2. Most humans live inside which one of the following?
A. star
B. planet
C. galaxy

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3. Our solar system is composed of billions of
A. stars
B. planets
C. stars and planets
D. none of the above

We have also used the CPS for introductory physics during summer 2003, as well as for astronomical events such as the recent Mars opposition. Kids of all ages like to check their understanding with a few questions. For physics, we have even written derivations as a series of multiple-choice questions similar to the Meno example as part of a lecture. We can do this even in introductory astronomy (e.g., steps in obtaining distances of astronomical objects). We also created a Web site where students could interactively review questions before the major closed-book exams. (See http://bama.ua.edu/~byrd/quizzes.html. To try, use ID 123456789 and Section 000.) Our entire set of daily quizzes in CPS format is available from Einstruction for use in their system. If interested, you can ask us for information.

4. CPS TRIAL RESULTS

Improvement was maintained--with an increase from 80% to 83%--for the CPS section. Slightly more (7%) students stayed in the class rather than dropping. The co-operative paper and pencil quizzes gave improvement that was simply retained and made more convenient by the CPS! The average grade given to the CPS course was 4.19, still a statistically significant improvement over 3.80, and about the same as the paper-and-pencil daily quiz section. Again, the students gave the teacher about the same grade as in the section with no daily quizzes.

5. HARDWARE AND COST

We attached the CPS pads to the classroom desks using metallic ball pen chains common in banks. We removed each pen from its chain. The chain’s adhesive base was attached to the CPS pad. A shortened, snipped chain base was attached under the table to make the connector less accessible, and to connect the two. There will be some attrition: the chain can only be a reminder not to remove the pads. Over five terms, we lost four pads. For storage out of sight, we used fuzzy tabs of velcro on the backs of the CPS units, and hook tabs underneath each desk. We put hook velcro tabs at the top front for storage "in sight."

The cost for 128 pads, sensors, and a hub for a PC was $8,600. Per student, the $70 per pad would be divided by the number of students in different sections using each pad over the total number of terms. Our cost for each student per semester has thus become a few dollars. There is a bookstore option that treats the pads like resellable college texts. For the bookstore option, the student buys the unit, registers it via the Web at a net cost of about $20, and sells it back to the bookstore at the end of the semester. If the student uses the bookstore unit in several classes, the cost is reduced. Use of the manufacturer's Web site permits identification of each student at each class so that assigned seating is not necessary. The direct cost to the school is less in this case, but as the price of convenience, students would pay more than our prorated cost.

6. CLASSROOM OPERATION

Casual use, in which the students' responses are strictly for diagnostic purposes, is easy to implement because there is no assigned seating, and the students do not get credit for attending or answering. To give the individual students credit for answering questions, we took roll at the first class and obtained the unit numbers for each student's seat, making it clear that any seating changes would require notification of the teacher. We have used this procedure with classes of 40 and 60 students, with good results. One faculty member at our department tried it with a class of 120 students, and had difficulties with students sitting in the wrong seats during weekly 10-question quizzes. This may be a "collective" issue for larger classes, or for weekly longer quizzes.

To help solve seating problems, we projected and posted a list of the assigned seats at each class, instructing students to sit in their assigned seats. We used the pads in almost every class to make them routine. We refined the list during the first few classes, making unilateral assignments for no-shows. "Dummy" students were placed on the list for all unassigned CPS units so that data for any student who wandered to an unassigned seat would not be lost. As a sensor gets data for each pad, its number lights up on the screen. Students were responsible for immediately reporting if their answers were not being recorded. We posted quiz reports under anonymous ID codes with the requirement that the student must immediately report problems.

We used a teacher-managed quiz mode in which the questions are answered sequentially by all of the students together. In our experience, these should be short, with no more than five questions to avoid tedium. In the student-managed method, the pad numbers were all displayed on the screen, with boxes below each, displaying the number of the question that the student was answering. Students could scroll through an exam, answer or skip questions, then come back to skipped questions. Larger numbers of questions could be asked in this mode, but the questions would have to be available in paper form or projected on a screen. Some students could finish early, others late. For our major closed-book exams, we used bubble scan sheets and randomized assigned seating to emphasize that these were serious and different from the in-class cooperative exams. Each time a quiz was given, a report was generated in the CPS software. We transformed this report to a TXT file, then to an Excel file. We alphabetized the result and copied the grade column into an Excel grade book for the class. There is a grade book in more recent CPS software.

7. CONCLUSIONS

We found that simple, nonpunitive cooperative quizzes are a successful strategy for teaching introductory astronomy. Our students not only learned more but also enjoyed the course more. The CPS system is not a panacea, but a convenient way to implement the successful interactive, cooperative daily quiz strategy. Its instant feedback enables the instructor to quickly identify facts or concepts that the students do not understand.

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