An Internet-based System of Homework for Precalculus

Profs. Edward Grossman & Stanley Ocken, Mathematics With Prof. Irvin Schonfeld, Statistical Consultant, The City College

The Goal

• The goal of the study was to rigorously test whether providing online homework using the Maple TA system would significantly improve outcomes in the precalculus course (Math 19500). The primary measure of success was the score on a uniformly administered and graded final exam.

The Design

- 14 day session classes half randomly assigned to online homework, half traditional.
- Background data obtained for each student to control for possibly significant covariates:
 - Admit status & Prior Math grades at CCNY
 - HS GPA
 - CCNY GPA
 - NY State Math Regents Exams
 - Math & Verbal SAT
 - COMPASS Scores
 - Ethnicity, Financial Aid Status
- Pre & Post Algebra Diagnostic for all Students

Preliminary Work

- Maple TA problem data base created about 550 problems duplicating in randomized form problems from the text.
- Problems (about 20%) included interactive graphics – Flash modules for evaluating student generated graphics responses.
- Diagnostic test extracted from the Maple TA-MAA placement test suite. Pre-tested for validity on 100 students in spring and summer 2010.

Basic Statistical Analysis

- In composite measures (ethnicity, financial aid status, pre-test diagnostic scores and background math achievement) there were no statistical differences between the experimental and control groups.
- To model individual achievement we used Hierarchical Linear Modeling to account for students being treated in groups (classes).
 - Most significant covariates of final exam score (accounting for 25% of the variance) were the pre-test diagnostic score and the COMPASS College Algebra score.

Statistical Conclusions

- Controlling for pre-test diagnostic and COMPASS College Algebra score, there was <u>no</u> <u>statistically significant difference</u> in final exam score between the groups.
- On the course letter grade, which includes a 60% component not under uniform control, the control group scored about 1/3-letter grade higher than the experimental group. This difference was marginally statistically significant.

Observations I

- Performance of both groups on the final exam was very poor (consistent with past results): Maple TA average 61.5 (n = 187), Controls average 63.7 (n = 206).
- Homework participation in Maple TA sections was poor average problem completion rate was 40%.
- Doing homework leads to success students in Maple TA sections completing 60% or more of the homework had an 82% pass rate, compared to a 22% pass rate for students completing less than 40% of homework.
- BUT...only 25% of the students in the Maple TA sections successfully completed 60% or more of the homework!

Observations II

- Improving student homework completion is key to success in course.
- Many students did not like the system because it challenged them (wrong answer), without showing them their mistakes. At this level, students showed little ability to self-analyze their work for errors. In fact, the opposite occurred. Students repeatedly claimed that their incorrect answers were right and the system was wrong.

Observations III

- "If you build it, they will come." does not apply to math learning tools.
- We are tweaking the system to provide students with more feedback (showing them the answer to a similar problem), but only occasionally with worked details. Too much help shortcuts learning.
- Instructors will intervene more forcefully at the beginning to counteract negative interactions when student attitudes towards the system are malleable.