FORMAL ASSESSMENT OF A WEB-BASED TOOL DESIGNED TO IMPROVE STUDENT PERFORMANCE IN STATISTICS

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The aim of my talk is to present you the results achieved and the experience gained in designing an implementing e-status (http://ka.upc.es), a web-based tool to improve students' performance in statistics and the formal randomized evaluation of its effects.

This talk is an updated version of the work developed together with my colleagues, presented in ICOTS7[1] (Gonzalez et al., 2006) and the recently published paper in CAEE[2] (Gonzalez and Munoz, 2006). E-status is a tool developed mixing together the main working lines in stats education: "Learning by practicing" and "Problem Solving", to which the feedback knowledge of students' improvement has been added. The tool is complementary to classical learning materials used: practical sessions at the computer lab and lecture-based instruction.

To formally assess the expected improvement in the student's statistical abilities due to e-status, we have prepared two different sets (hereafter A and B) of six practical exercises. Each set has been designed to cover the instrumental abilities involved in a different section of the course.

• **Participants:** all students enrolled in the biostatistics course 2005-06 at the dentistry school of the University of Barcelona (UB) participated in the study (n=121).

• **Intervention:** During the last two weeks of November and all December students could solve the exercises corresponding to set A or B depending on the group they were randomly assigned. The student could work on a particular problem (with new data) as many times as they desire, and their score (by averaging over the repetitions) is updated.

• **Random allocation:** Participants were randomly assigned either to set A or B using random numbers generated with Excel by an independent researcher. Two blocks were defined: lab group, and new/old students.

• **Outcome:** In the practice part of the final exam we have defined three scores (S_A, S_B and S_{both}), each one based on a subset of questions directly related to instrumental abilities covered by exercise set A and not by B (S_A); by set B and not by A (S_B); and by both sets A and B (S_{both}). Differences between scores S_A and S_B in students randomized to receive either intervention A or B were our primary outcome.

• **Statistical model:** Let μ represent the overall mean in the exam; τ_t the fixed effect of e-status intervention t=a, b; π_j the fixed effect of exam questions of part j=A, B; α_i the random effect of student i; and ε_{ij} the random effect of measuring performance of set j=A, B in student i. If we call Y_{tji} to the exam result of set j in student i with intervention t:

$$Y_{tji} = \mu + \tau_t + \pi_j + \alpha_i + \varepsilon_{ij}$$

All the students were included in the analysis, even those not presented to the final exam (the assigned score was 0). The 95% confidence interval for the mean increase in the over 10 score is (0.10, 0.86), that could be understood as a significant evidence ($p<0.05$) of some profit obtained by the students that solved exercises with e-status. Although the numbers analyzed refers only to students that actually used the tool (44 in A and 50 in B), the conclusion was the same, but for active students (those that did make an effort to learn with ICTs).

To conclude, we have shown both, that e-status improves student performance and that it is feasible to employ ethical randomized trials to monitor the effects of single problems in learning.

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[1] Gonzalez, JA., Jover, L., Cobo, E., Munoz, MP. (2006). Formal assessment of an innovative web-based tool designed to improve student performance in statistics. *Proceedings of ICOTS7, Salvador do Bahia.*

[2] Gonzalez, JA., Munoz, MP. (2006). e-status, an automatic web-based problem generator: applications to statistics. *Computer Applications in Engineering Education*. 14(2): 151-159. http://www3.interscience.wiley.com/cgi-bin/jhome/38664.

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