

## **METHODS OF LEARNING IN STATISTICAL EDUCATION: DESIGN AND ANALYSIS OF A RANDOMIZED TRIAL**

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### **Abstract**

**Background:** Recent psychological and technological advances suggest that active learning may enhance understanding and retention of statistical principles. A randomized trial was designed to evaluate the addition of innovative instructional methods within didactic biostatistics courses for public health professionals.

**Aims:** The primary objectives were to evaluate and compare the addition of two active learning methods (cooperative and internet) on students' performance; assess their impact on performance after adjusting for differences in students' learning style; and examine the influence of learning style on trial participation.

**Methods:** Consenting students enrolled in a graduate introductory biostatistics course were randomized to cooperative learning, internet learning, or control after completing a pretest survey. The cooperative learning group participated in eight small group active learning sessions on key statistical concepts, while the internet learning group accessed interactive mini-applications on the same concepts. Controls received no intervention. Students completed evaluations after each session and a post-test survey. Study outcome was performance quantified by examination scores. Intervention effects were analyzed by generalized linear models using intent-to-treat analysis and marginal structural models accounting for reported participation.

**Results:** Of 376 enrolled students, 265 (70%) consented to randomization; 69, 100, and 96 students were randomized to the cooperative, internet, and control groups, respectively. Intent-to-treat analysis showed no differences between study groups;

however, 51% of students in the intervention groups had dropped out after the second session. After accounting for reported participation, expected examination scores were 2.6 points higher (of 100 points) after completing one cooperative learning session (95% CI: 0.3, 4.9) and 2.4 points higher after one internet learning session (95% CI: 0.0, 4.7), versus nonparticipants or controls, adjusting for other performance predictors. Students who preferred learning by reflective observation and active experimentation experienced improved performance through internet learning (5.9 points, 95% CI: 1.2, 10.6) and cooperative learning (2.9 points, 95% CI: 0.6, 5.2), respectively. Learning style did not influence study participation.

**Conclusions:** No performance differences by group were observed by intent-to-treat analysis. Participation in active learning appears to improve student performance in an introductory biostatistics course and provides opportunities for enhancing understanding beyond that attained in traditional didactic classrooms.