

Comparing Active Learning and Traditional Lecture Introductory Statistics Classes at Montana State University (Fall 2013)

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- Fall 2013 - Two versions of STAT 216 (introductory statistics) are offered at MSU
 - Traditional - Lecture environment covering classical topics from [De Veaux *et al.* 2012]
 - Technology Enhanced Active Learning (TEAL) - Active learning environment with a simulation based curriculum.
- Both courses have common learning objectives.
 - Aim to leave students with a basic understanding of statistical inference and thinking.

Similarities

- Understanding random events
- Inferential techniques for:
 - Means
 - Proportions
 - Differences between means & proportions
- Hypothesis testing framework:
 - 1 Simulate or derive the null sampling distribution
 - 2 Evaluate strength of evidence by comparing an observed result or a test statistic to a null distribution
 - 3 Interpret p-value
 - 4 Communicate results
- Confidence intervals and the idea of “confidence”
- Influence data collection and treatment application has on inference → Scope of inference

- **Pedagogical Style**

TEAL: Group activities based on CATALST
[Garfield & DelMas, 2008-2012]

New Unit 3 - includes z and t tests.

Traditional: Lecture [De Veaux *et al.* 2012]

- **Instructor**: 1 for Traditional 2 for TEAL

- **Technology**

TEAL: Web Apps and StatKey [Lock, Robin, 2013] (not TinkerPlotsTM)

Traditional: Pearson MyStatLab MC online HW's

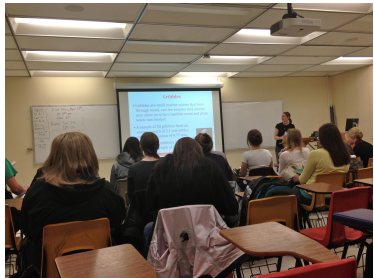
- **Assessment**: TEAL HW is written and Traditional is online MC

- **First introduction to sampling distributions and statistical inference**

$\approx 3^{rd} - 4^{th}$ week in TEAL vs. $\approx 9^{th}$ week in Traditional (15 weeks total)

Classroom Differences

TEAL Classroom (left) and Traditional Classroom (right)



* All students pictured gave written consent.

Goal

Assess and compare content knowledge between TEAL and Traditional STAT 216 in Fall 2013.

Confounding

- Activities/lecture, order of topics, length and schedule of course meeting times, etc.

Complications

- This was an observational study (Students were not randomly assigned to treatments)
- Our treatment is comprised of a more than one factor - # of instructors, classroom type, and curriculum.

Instrument

- Ask common questions on both STAT 216 finals and compare results.

Exam Questions

- The course had a common final exam time and the 8 questions were asked in the same order on all exams.
- [Garfield & DelMas, 2008-2012] developed the MOST exam - designed to ask questions that could be answered by students in both classes at the University of Minnesota.
- We used the MOST exam questions to create 8 multiple choice questions for our students.

Question Categories

- Scope of inference
- Power
- Variability
- Interpretation of CI
- Understanding of hypothesis tests
- Interpretation of p-values

Example Exam Questions

Example: Power

Which of the following will decrease the probability of both a Type I and Type II error simultaneously?

- a. Increase the sample size
- b. Increase the power of the test
- c. Increase the significance level of the test
- d. All of the above

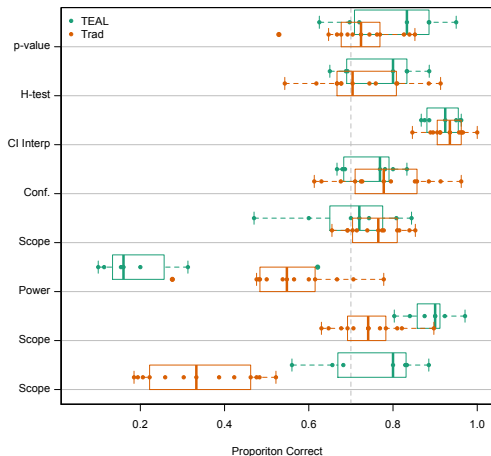
Example: Scope of Inference

Researchers surveyed 1,215 randomly selected adults in the United States. They found strong evidence against the null hypothesis and concluded that people in the high income category recycled more than those in the low income category. Can the researchers conclude that earning more money causes more recycling among U.S. adults?

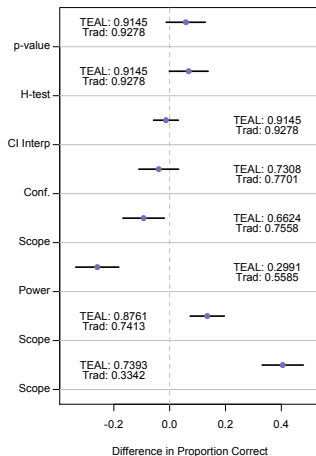
- a. No, the study design does not allow causation to be inferred.
- b. No, the sample size is too small to allow causation to be inferred.
- c. Yes, the statistically significant result allows causation to be inferred.
- d. Yes, there is strong evidence that income causes people to care more about the environment.

Results

Proportion Correct in Each Section



95% CI's: Differences in Proportion Correct (TEAL - Trad)



Sample Size: TEAL - 268

Trad - 452

of Sections: TEAL - 8

Trad - 13 \approx 35 students per section

Results

- All students did well on questions about confidence, CI's, hypothesis tests and p-values.
- Students from both TEAL and Traditional classes struggled with the question on power
- With the exception of one question, TEAL students did better on scope of inference questions than Traditional students.

What we Learned

- Hit scope of inference harder in the Traditional classrooms.
- Improve activities and lectures about power
- Keep doing these types of studies and making similar comparisons
- We piloted some sections using [Lock⁵, 2012] (Spring 2014) - similar ordering of topics as TEAL.

References



Richard D. De Veaux & Paul F. Velleman & David E. Bock (2012)

Stats: Data and Models 3rd Edition

Addison-Wesley: Pearson Education Inc.



Robert DelMas & Joan Garfield (2008-2012)

CATALST: Change Agents for Teaching and Learning Statistics.

The University of Minnesota, <http://www.tc.umn.edu/~catalst/>



Robin Lock (2013)

"StatKey - Online Tools for Teaching Bootstrap Intervals and Randomization Tests"

St. Lawrence University,

<https://www.causeweb.org/webinar/activity/2013-08/>



Lock, Robin and Lock, Patti Frazer and Morgan, Kari Lock and Lock, Eric F. and Lock, Dennis F. (2012)

Statistics. Unlocking the Power of Data.

Wiley

Questions?

Thank you for listening, please ask questions in the discussion below!