A Study of Instant Hands-on Experiences in Introductory Statistics Class for Undergraduate Students

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Outlines

Introduction

- General statistical training is a required component in many undergraduate programs.
  - STT200 "Statistical Methods" is a required or elective course in most of MSU undergraduate programs.
- Students usually give negative comments on learning experiences in the general statistical class.

  (SIRS, STT200, Fall 2010, 4 sections)
  - Average level of interest is 3.95, "not very interested in".
  - Average level of difficulty is 1.49, "very demanding".
  - Most students don't understand the necessity of statistical training.

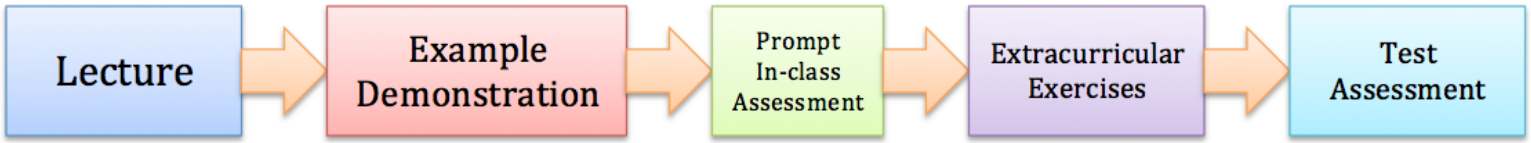
Motivation

- Students' feedbacks on teaching improvement

  "We need more exercises."

  "Slow down the lecture."

- Traditional structure of an introductory statistics class



- Proposed structure by introducing the **Instant Hands-on Experiences**

Project Objectives

1. Investigate students' subjective demands on the instant hands-on experiences.
2. Analyze learning outcome improvement induced by the instant hands-on experiences.
3. Discuss the necessity of the instant hands-on experiences for each topic.
4. Recommend the implementation guidelines to resolve the confliction with intensive lecture time.

Learning Objectives

1. Develop the quantitative thinking, reasoning and analyzing skills.
2. Build up the ability to perform the descriptive statistics analysis, fundamental probability calculation, statistical inference techniques and linear regression methods.
3. Motivate the students to apply the statistical knowledge into the real world problems.

Experiment Design

Control Group

- STT200-106, Summer 2010, 27 students
- Lecture, "iclicker" questions, homework, tests

Treatment Group

- STT200-203, Summer 2011, 23 students
- Lecture, in-class activity, homework, tests

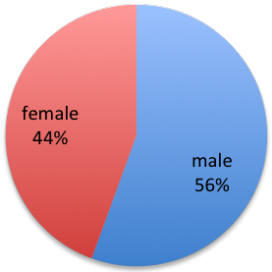
The in-class activities are:

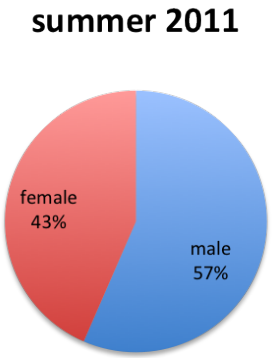
1. closely related to the example demonstrated in class
2. open-book, and discussions are encouraged
3. collected for record, which is not necessary in practice
4. designed as a part of the learning process, instead of the assessment

Experiment Design

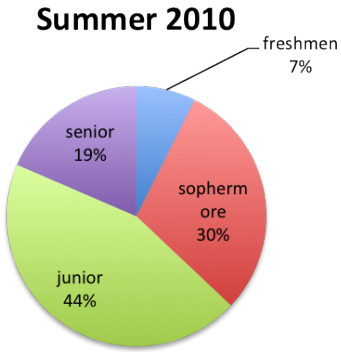
Experiment Unit Comparisons

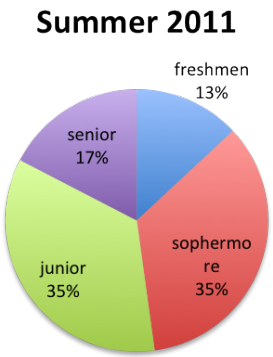
1 Gender





2 Undergraduate Level

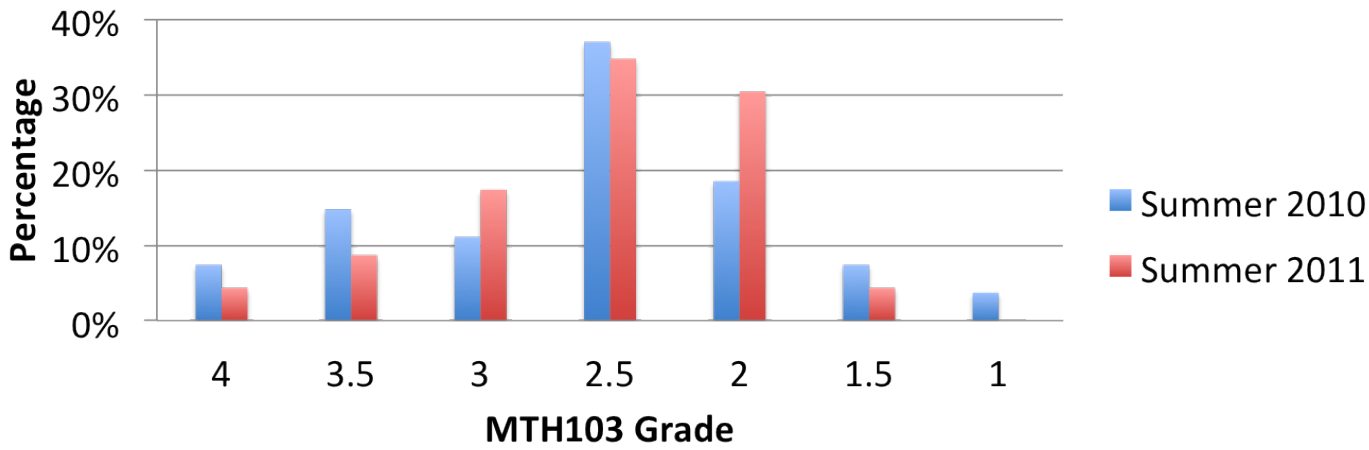




Experiment Design

Experiment Unit Comparisons (Cont'd)

3 Math Background



Chi-square test for homogeneity: p-value=0.0882

Data

1. Anonymous Survey Data
   - A short questionnaire is distributed along with each in-class activity.

Questionnaire

- Q1 How do you feel about the knowledge you just learned in class? (5-very confidence; 1-not confident at all)
- Q2 How much do you want a hands-on activity right away? (5-strongly need it; 1- no need at all)
- Q3 After the hands-on activity, how do you feel about the knowledge now? (5-very confidence; 1-not confident at all)

   - The survey data is used to investigate students' subjective reactions to the in-class activities.

Data

2 Test Scores

- Three midterms and one final, multiple choices questions.
- Questions are classified to different topics covered by each in-class activity.
- Test scores are used to compare the control group and the treatment group in order to analyze the learning outcome improvement.

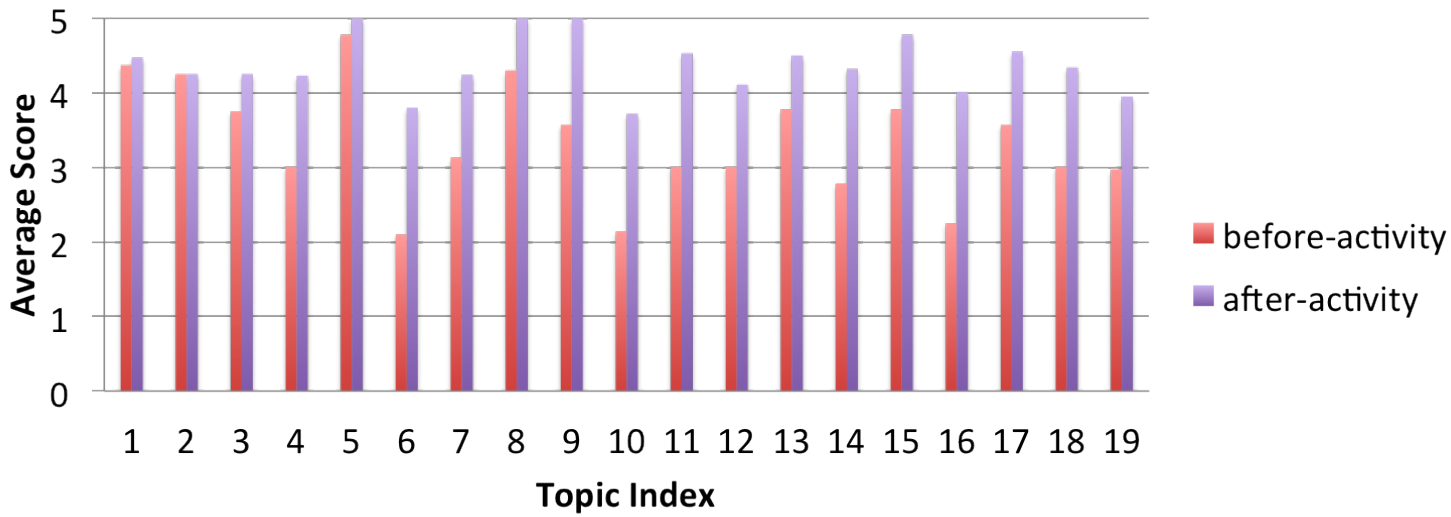
3 SIRS

- To compare the general feedbacks from students between the two groups.

19 Topics

Analysis Results

1 Confidence comparison before/after in-class activity



Top 3 confidence increases are:

16 Hypotheses testing for p

6 Normal proability calculation

10 Tree diagram

Bottom 3 increases are:

2 Histogram

1 Contingency table

5 Distribution comparison

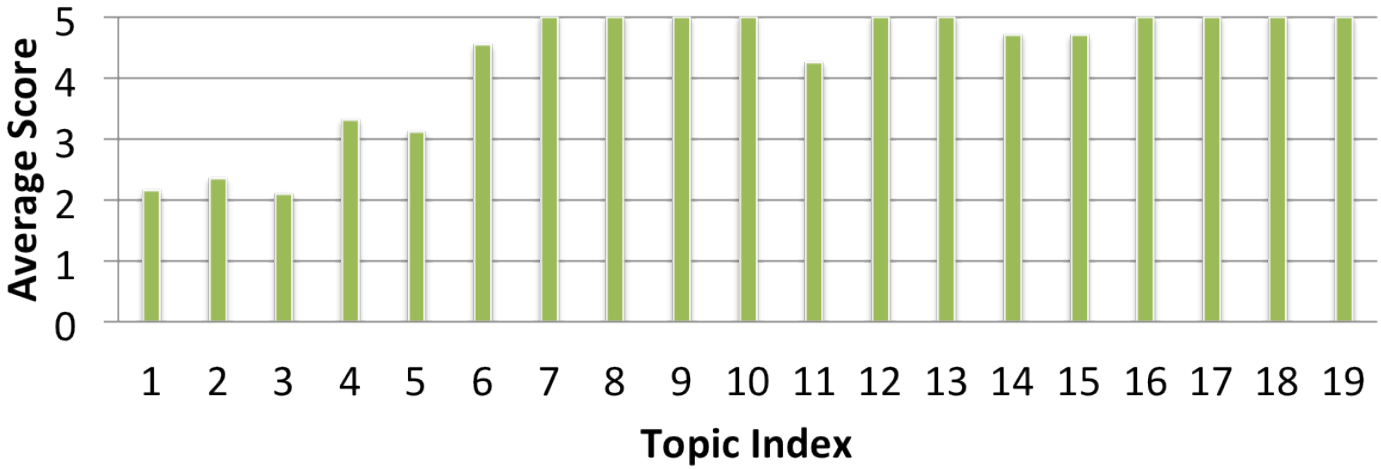
Analysis Results

(Cont'd) We tested the significance of the confidence increase by the signed-rank test.

p-value	Topic
< 0.01	16 Hypotheses testing for p 6 Normal probability calculation 10 Tree diagram 14 Confidence interval for p 11 Random variable
$0.01 \sim 0.05$	9 Disjoint vs. Independent 18 Correlation 4 Boxplot
$0.05 \sim 0.1$	7 Probability rules 12 Sampling distribution for p 15 Confidence interval for mean

Analysis Results

2 Students' feedbacks on necessity



- From the start of Part II (probability), the students' feedback remain close to "strongly need it".

Analysis Results

3 Learning outcome comparison

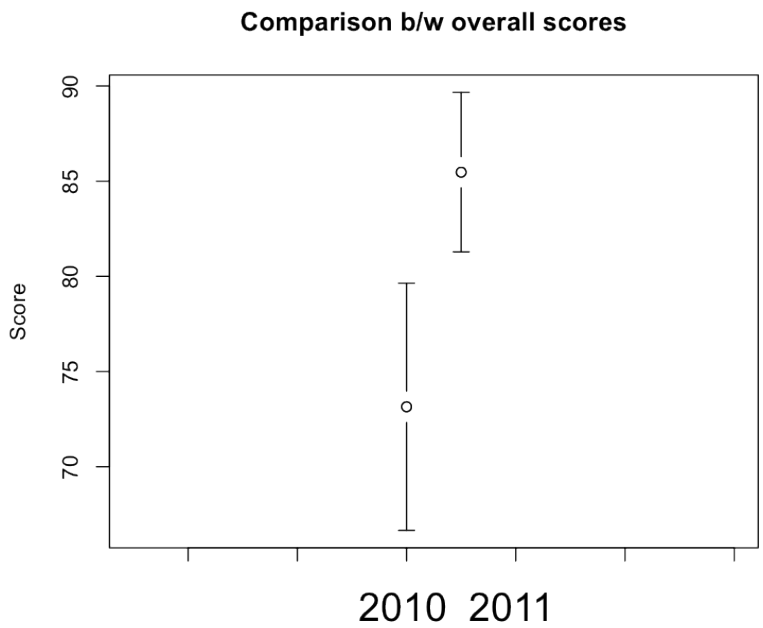
We tested the significance of increment in number of correctly asnwered questions by rank-sum test.

p-value	Topic
< 0.01	All the topics in Part III: Statistical Inference 10 Tree diagram
$0.01 \sim 0.05$	19 Linear regression 9 Normal probability calculation
$0.05 \sim 0.1$	4 Boxplot 8 Venn diagram 9 Disjoint vs. Independent

Analysis Results

(Cont'd) We also compared the overall test performance

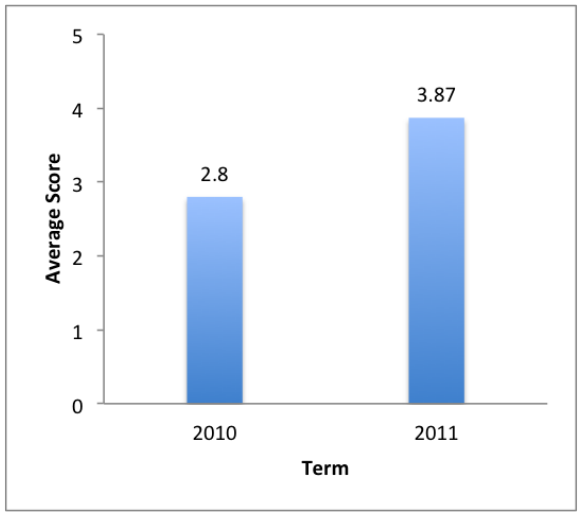
Term	Mean	SD	95% C.I.
2010	73.15	17.3	(66.62, 79.68)
2011	85.47	10.3	(81.26, 89.68)



Analysis Results

4 SIRS analysis

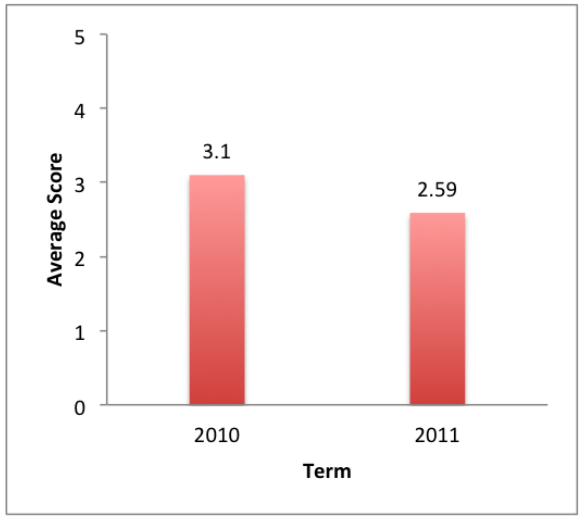
Difficulty level of the course



(1-very demanding; 5- very easy)

p-value= 0.0329 indicates a significant change.

Level of interest



(1-very high; 5- very low)

p-value= 0.4595 indicates an insignificant change.

Analysis Results

(Cont'd) Student's comment:

Wenning was a great teacher! I took his stats class during the summer which meant the class was condensed into a 6 week period, but even with the sped-up course, it was easy to get a 4.0. His teaching method was great because he will explain a concept, give an example right after, and then he would give a daily graded assignment which was similar to the example. He gives you a few minutes to work on it and you are free to ask for help. He will even work with you to get the right answer. Basically its free points towards your grade plus you get lots of practice while you're learning.

Conclusion

Generally speaking, we found that the instand hands-on experiences are very attractive active learning techniques for introductory statistics education, in the sense that

- They can improve the students' learning outcome significantly.
- Students have huge desires on these experiences.

Here are some implementation suggestions:

- Use the activities for all the topics in statistical inference, tree diagram and such topics which have a complicated operation process.
- Follow closely with the example demonstration.
- Join the students' to work on the activies all the time.
- Disassemble the large activity into small parts.

Acknowledgement

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http://grad.msu.edu/fast/