An Overview of the Transformation of Statistics Courses via CWSEI

With Highlights on Interactive Engagement in STAT 300, STAT 302 and STAT 305

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Abstract

The transformation of undergraduate courses in Statistics began in 2007 and is ongoing. The recent impact on five current courses is summarised here. Highlights include moves to activity-based learning, clickers questions, group work, regular online homeworks, and weekly TA feedback. Data on student perceptions of certain innovations and student shifts in attitudes to Statistics are also described.
# Courses Being Transformed

<table>
<thead>
<tr>
<th></th>
<th>STAT 200</th>
<th>STAT 241/251</th>
<th>STAT 302</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title</strong></td>
<td>Elementary Stats for Applications</td>
<td>Intro Probability &amp; Statistics</td>
<td>Intro to Probability</td>
</tr>
<tr>
<td><strong>Description &amp; Audience</strong></td>
<td>Intro course for Science students</td>
<td>Intro course for Comp Sci. &amp; Applied Sci. students</td>
<td>Core course for Stat specialists, elective for other students</td>
</tr>
<tr>
<td><strong>Enrolment</strong></td>
<td>~ 1000 per year Multi sections of 150-350</td>
<td>~ 700 per year Single section of 250-350</td>
<td>~ 130 per year Two sections of 60-70</td>
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<tr>
<td><strong>Offered</strong></td>
<td>Each term</td>
<td>Each term</td>
<td>Each Term</td>
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## Courses Newly Transformed

<table>
<thead>
<tr>
<th></th>
<th>STAT 300</th>
<th>STAT 305</th>
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<tbody>
<tr>
<td><strong>Title</strong></td>
<td>Intermediate Stats for Applications</td>
<td>Intro to Statistical Inference</td>
</tr>
<tr>
<td><strong>Description &amp; Audience</strong></td>
<td>Intermediate course for Science students</td>
<td>Core course for Stat specialists, elective for other students</td>
</tr>
<tr>
<td><strong>Enrolment</strong></td>
<td>~ 100 per year</td>
<td>~ 120 per year</td>
</tr>
<tr>
<td></td>
<td>Single section of ~100</td>
<td>Single section of ~120</td>
</tr>
<tr>
<td><strong>Offered</strong></td>
<td>Term 1</td>
<td>Term 2</td>
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Methods Continued to be Used

- Learning Outcomes
- Interventions for Misconceptions
- Formative Assessments
- Student & TA Feedback
- Student Engagement
- Cooperative Learning

New Methods Being Used

- Student Engagement & Cooperative Learning in Each Lecture
- Weekly Formative Assessments & Faster Feedback
- Post Course Knowledge Retention Survey
- Weekly TA Feedback
Student Engagement & Cooperative Learning in Each Lecture

• Instructor pre-selected groups, based on
  – major
  – year in program
  – gender and
  – other factors deemed important for group diversity

• Assigned seating
  – To enable group work during lectures & labs
    – See Resource Package for Example(s)
Activity-Based & Cooperative Learning in Each Lecture …

• Activity worksheets
  – Scaffolded to guide students
    – See Resource Package for Examples

• Clicker questions to probe understanding
  – See Resource Package for Example(s)
  – Individual attempt
    • To monitor individual progress
    • To ensure accountability
  – Group attempt (when needed)
    • To provide opportunities to discuss difficulties
In-class Group Activities: Student Perceptions

"In-class activities were very helpful to my learning"

<table>
<thead>
<tr>
<th>Feedback Level</th>
<th>STAT 300</th>
<th>STAT 302</th>
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</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>35%</td>
<td>45%</td>
</tr>
<tr>
<td>Agree</td>
<td>40%</td>
<td>55%</td>
</tr>
<tr>
<td>Neutral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Don't know</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In-class Group Activities: Student Perceptions …

• STAT 305:
  – At first I had a lot of growing pains with the activity-based lectures, but after sampling the style up until the first quiz, I must admit I love this system. Wish more lectures were like this!!

  – "The interactive hands-on approach to learning is really helping me understand the concepts and makes them 'stick' in my mind".

• STAT 302
  – "I think that the in-class activities are REALLY helpful (it's fun too!) It really makes me think and not waste the class time just copying down the notes. LOVE it :)."
Weekly Formative Assessments & Faster Feedback

Weekly online assignments (via WeBWorK)

– Open-source online homework system
  • free to students, unlike resources accompanying textbooks
– Student engagement with course material weekly
– Students obtain instant feedback
– Frees TA time from grading to more productive tasks
  • such as assisting instructors with in-class activities
Weekly Online Assignments: Student Perceptions

"Online assignments were very helpful to my learning"

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Don't know

STAT 241/251
STAT 200 (Sec 1)
STAT 200 (Sec 2)
Weekly Online Assignments: Student Perceptions

- Having the allowance of multiple attempts gives me instant feedback and letting me look through my train of thought to figure out what I did wrong and how to get the right answer … very helpful in learning the material.

- Although having weekly homework can seem like a lot of work, WeBWorK ensures that I am somewhat caught up with the class.

- I like the fact that WeBWorK questions are not so lengthy in terms of its number of questions. I could finish every WeBWorK assignment on time and it was a great review for the week's lectures.

- Questions were reflective of material taught in lecture; allowed us to practice skills and reinforce learning
Weekly Formative Assessments & Faster Feedback …

• Two day turn around time for written assignments in STAT 200 (Elementary Statistics for Applications)
  – Assignments collected on Friday, marked over the weekend and returned on Monday
    • ~550 students in Term 1
    • ~350 students in Term 2
Post Course Knowledge Retention Surveys

• STAT 200 (Conducted in 2006-2007)
  – Students interviewed several months after taking the course
  – Reported avg. time spent studying outside class: 3-4 hrs.
  – Mean final grade of participants: 80%
  – Performance on retention interviews: very poor, with many key concepts retained by less than 7 of the 29
  – Sample was obviously atypical – average grades on STAT 200 are much lower 80%
  – Could be presumed that
    • most students studied less than this sample, or
    • at least would have retained less post-course.
Post Course Knowledge Retention Surveys …

• STAT 200 Results:
  – In line with research
    • Cramming leads to poor long-term retention.
  – Suggests need for
    • Interactive engagement during the lectures,
    • Frequent formative assessments and
    • Timely feedback

• STAT 302 & STAT 305 Surveys:
  • On-going 2012/2013
TA Feedback

• Weekly surveys during the first implementation
  – See Resource Package for Example(s)

• Mid-course surveys during the subsequent implementations
  – See Resource Package for Example(s)
Weekly TA Lab Feedback …

• Goals
  – Identify current problems TAs may be facing
  – Identify current problems the students may be facing
  – Keep a record of student difficulties, to share with future Lab TAs as they prepare for labs
  – Share ideas on running labs smoothly among current Lab TAs
Weekly TA Lab Feedback …

• Three-fold benefit:

Provides
  – instructor with detailed information on student difficulties
  – TAs with an opportunity to reflect on their teaching
  – Instructor with an opportunity to
    • Give feedback to TAs and
    • Modify activities for future use where necessary
SLASS: Statistics Attitude Survey

- Developed and trialed in 2007 for STAT 200, validated via student interviews.
- 49 parcelled into five sets: Conceptual Understanding, Effort, Problem Solving, Real World Application, Study Skills.
- Student responses compared with expert-like responses, pre and post course.
- Pre/post % favourable aggregated over each of the five parcels. Within-student differences taken.
- Robust multivariate method applied – analogous to univariate sign test.
Attitude Survey Results Comparison

• For Spring 2008, significant shift pre to post, mostly in the wrong direction.
• For Fall 2012, a greater shift observed, but mostly in the “expert-like” direction.
• Table below indicates direction and magnitude of shifts for each category.

<table>
<thead>
<tr>
<th></th>
<th>CU</th>
<th>E</th>
<th>PS</th>
<th>RW</th>
<th>SK</th>
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<tbody>
<tr>
<td>2008</td>
<td>0.30</td>
<td>-0.10</td>
<td>-0.06</td>
<td>-0.03</td>
<td>-0.94</td>
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<tr>
<td>2012</td>
<td>0.96</td>
<td>-0.15</td>
<td>0.49</td>
<td>0.02</td>
<td>-0.41</td>
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</tbody>
</table>
Acknowledgements

• Prof. Will Welch
  – Instructor of STAT 305

• Prof. Paul Gustafson & Dr. Bruce Dunham
  – Co-instructors of STAT 300

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  – Instructor of STAT 200 & STAT 302
  – TA Coordinator

• Mr. Yew-Wei Lim
  – Instructor of STAT 241/251
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  – Hao (Nelson) Chen, David Lee & Camila Maria Casquilho Resende

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• STAT 241/251 Lab TA Team
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• STAT 200 Lab TA Team
  – Jonathan Baik, Yumian Hu, Wooyong Lee & Hao (Allan) Luo