Recent Developments in the Transformation of Statistics Courses

With Highlights on Revisions to STAT 241/251 Labs

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Abstract

We display here a brief summary of the courses being transformed as part of the involvement of the Department of Statistics with the CWSEI and the improved methods used during the past year. Highlighted are the results of approaches used to dispel students' misconceptions and the details of revisions made to computer-based labs. The improvements in student performance and feedback suggest the methods implemented can yield tangible benefits.
## 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 majors and other Science students</td>
</tr>
<tr>
<td><strong>Enrolment</strong></td>
<td>~ 900 per year Multi sections of 150-200</td>
<td>~ 700 per year Single section of 250-300</td>
<td>~ 130 per year Two sections of 60-70</td>
</tr>
<tr>
<td><strong>Offered</strong></td>
<td>Each term</td>
<td>Each term</td>
<td>Term 2</td>
</tr>
</tbody>
</table>
Methods Used

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

• Main aims of the course

• Individual *Learning Outcomes* under each aim

• Aligning course material with the defined Learning Outcomes
  – Lectures
  – Labs
  – Assignments & Exams
Interventions for Misconceptions

• Clicker questions during lectures
  – To alert students to the misconceptions
  – To elicit a discussion

• Assessment questions in exams
  – To target misconceptions
  – To compare pre-post intervention results
Interventions for Misconceptions: Examples

**Sum vs. Multiple of Random Variables**
*(STAT 241/251)*

- Incorrect concept
- Other errors
- Correct concept

**“Everything is Normal”**
*(STAT 200)*

- Incorrect concept
- Correct concept
Formative Assessments

• **Bi-weekly written assignments**
  – Simpler marking schemes to handle the large number of assignments per course

• **Clicker questions**
  – Pop quizzes in course currently without clickers
Student Engagement

• Student collected data and/or examples that pertain to student lives
  – In lectures and assignments

• Clicker questions
  – During lectures

• In-class activities
  – In small informal groups, during lectures
Student Engagement: Example
Student Collected Data (STAT 200 Assignments)

Books in the fifth floor of the UBC Koerner Library

Part I:
• Devise sampling plan
• Collect data
  – Whether book was published before 1980
  – Age of book
  – Number of pages
• Summarize data
  – Summary stats
  – Graphical displays

Part II:
Individual data combined
• Summarize data
• Make inferences
  – True *population proportion* of books published before 1980
  – True *population mean* age of books and number of pages
  – Confidence intervals
Student Engagement: Example Student Collected Data (STAT 200 Assignments)

Books in the fifth floor of the UBC Koerner Library

<table>
<thead>
<tr>
<th>Student</th>
<th>Sample Mean Number of Pages of Books</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>648.7</td>
</tr>
<tr>
<td>2</td>
<td>288.45</td>
</tr>
<tr>
<td>3</td>
<td>283</td>
</tr>
<tr>
<td>4</td>
<td>243.95</td>
</tr>
<tr>
<td>5</td>
<td>275.4</td>
</tr>
<tr>
<td>6</td>
<td>377</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Distribution of the collected sample mean number of pages of the books on the fifth floor of Koerner library](image-url)
Student & TA Feedback

• Mid-course student surveys
  – Provide feedback on lectures & labs

• Weekly Lab TA surveys
  – TAs provide feedback on student and TA difficulties in STAT 241/251 & STAT 200 Labs
    o Identify areas that need improvement
    o Implement possible improvements this term, and make plans for subsequent terms
Cooperative Learning

• In-class group activities
  – Informal, self-selected groups
  – Work is not graded

• Group work in Labs
  – Formal, pre-selected groups
  – Work is graded
Revisions to STAT 241/251 Labs

• **Description**
  – Eight labs, 50 minutes each
  – To give students opportunities to analyze data, as well as to do simulations to better understand statistical concepts
  – Using R
    • a free software for statistical computing and graphics, which is often used for research in statistical methodology
  – Students work in groups
    • About 60 students per lab, with two TAs
## Labs: Motivation for Revisions

<table>
<thead>
<tr>
<th>Student Dissatisfaction (Mid-Course Survey)</th>
<th>Observations by Lab TAs (End of Term Survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of structure</td>
<td>Students were not prepared (although pre-reading materials were made available)</td>
</tr>
<tr>
<td>Difficulties with programming, which overshadowed the objectives of the labs</td>
<td>Lack of engagement &amp; cooperative learning</td>
</tr>
<tr>
<td>Difficulties with working in large groups</td>
<td>Students were not punctual</td>
</tr>
</tbody>
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Labs: Stage 1 Revisions

- Lab Groups
- Pre-Reading Material
- Lab Structure
- Lab Exercises
## Labs: Revisions to Groups

<table>
<thead>
<tr>
<th>Group Selection</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection</td>
<td>Self selected</td>
<td>Pre selected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Based on</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Major</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Gender</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Year in school</td>
</tr>
<tr>
<td>Size</td>
<td>5-6</td>
<td>3-4</td>
</tr>
</tbody>
</table>

# Labs: Revisions to Structure

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group work on lab exercise</td>
<td>Pre-reading quiz</td>
</tr>
<tr>
<td>(Exercise available in advance)</td>
<td>- Four multiple choice questions</td>
</tr>
<tr>
<td></td>
<td>- Two versions</td>
</tr>
<tr>
<td></td>
<td>- Easy to answer (if student has simply read the pre-reading document)</td>
</tr>
<tr>
<td></td>
<td>- Given during the first 5 minutes of the lab</td>
</tr>
<tr>
<td></td>
<td>Brief intro by TAs</td>
</tr>
<tr>
<td></td>
<td>Group work on lab exercise</td>
</tr>
<tr>
<td></td>
<td>(Exercise not available in advance)</td>
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<tr>
<td></td>
<td>Wrap up</td>
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</table>
# Labs: Revisions to Pre-Reading

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pros:</strong>&lt;br&gt; Detailed and possible to <em>stand alone</em></td>
<td>Objectives added to the beginning of the document</td>
</tr>
<tr>
<td><strong>Cons:</strong>&lt;br&gt; More emphasis was given for writing code in R rather than using R for statistical analysis</td>
<td>Content kept the same, but more organized by separating into sections with appropriate headings</td>
</tr>
<tr>
<td>Examples in the first half of the labs were context free</td>
<td>Context rich examples added to pre-reading documents that lack context</td>
</tr>
<tr>
<td>Only some labs included pre-lab exercises</td>
<td>Most labs include pre-lab exercises with R code for problems that require coding</td>
</tr>
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# Labs: Revisions to Exercises

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
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</thead>
<tbody>
<tr>
<td>Exercises in the first half of the labs were context free</td>
<td>Most labs include two versions of the exercises</td>
</tr>
<tr>
<td>Some questions require simply obtaining output using R commands</td>
<td>Questions more aligned with Learning Outcomes</td>
</tr>
<tr>
<td>without analyzing the results</td>
<td>Context rich problems added</td>
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<tr>
<td></td>
<td>Questions encourage meaningful learning</td>
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<tr>
<td></td>
<td>More lab exercises include questions that require use of graphical</td>
</tr>
<tr>
<td></td>
<td>methods</td>
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<tr>
<td></td>
<td>Not simply a repetition of the pre-lab exercises.</td>
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Labs: Student Perceptions
Pre/Post Stage 1 Revisions

Mid-Course Survey:
"The Labs Were Very Useful to Your Learning"

Student Opinion

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Percentage

Before Revisions: After Revisions
Revisions to Labs: Conclusions

• Increased student satisfaction

• TA feedback on labs valuable for improving lab structure and lab material

• Impact on student learning yet to be determined
Acknowledgements

• Eugenia Yu
  – Instructor (STAT 200 & STAT 302)
  – TA Coordinator
• Yew-Wei Lim
  – Instructor (STAT 241/251)
• STAT 241/251 Lab TAs
  – Melissa Lee (Head TA), Yunlong Nie, Yiyang Pan, Dorji Pelzom, Tingting Yu, Gina Yun Zhong
• STAT 200 Lab TAs
  – Hao Luo & Qian Ye (Head TAs), Hao Chen, Zishan Cui, Liying Dai, Andy Leung, James Proudfoot, Tingting Zhao