A Hybrid of Online Assessment and Graded Homework: The Challenges and Impacts on Student Engagement and Learning

Joint Mathematics Meetings – San Diego
Modern Ideas to an Introductory Statistics Course I
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Background / Motivations

• What if we trained airline pilots like we trained teachers? (Laboy-Rush, 2012)
  – Formative Assessment Workshop (2005)
  – CAUSEmos Research Clusters (2007 & 2009)
• Research on Resubmissions/Online HW
  – AKA Mastery learning or standards-competency-based learning
  – Villanova PARLO Study (Posner, 2011)
    • Students attitudes improved more with PARLO
    • “Slower” learners performed equivalently on final exam
  – NSF PARLO Study (2010-2014)
  – Flipped classroom experiment (2013)

Connections to Learning Theory

• Webb’s Depth of Knowledge
• Common themes in successful international mathematics education (Stigler)
  – Time on task / practice
  – Making connections
  – Struggle
• "Applying Cognitive Theory to Statistics Instruction" (Lovett & Greenhouse, 2000)
  – Time on task / practice
  – Knowledge is context-specific and learning must integrate new knowledge with existing beliefs
  – Real-time feedback promotes efficient learning
  – Learning decreases as mental load increases

Efficient Assessment

• All of this is time consuming
  – Grading unlimited resubmissions? No way!
• Leverage the power of technology
  – Using Course Management Systems
• Hybrid Homeworks - online and offline
  – Online homeworks can’t (yet!) encompass all of what we expect of statisticians, yet they are valuable!

Some Research on Online HW

• Williams (TISE, 2012)
  – Research says some find online homework have better outcomes while some find they are similar.
  – Homework delivery system (online vs. traditional) only affects HW grades, not other grades, self-efficacy, or anxiety
• Doorn, Janssen, and O’Brien (IJSoTL, 2010) studied online HW in 14 sections of bus stat
  – students had positive attitudes towards online hw
  – more feedback was desired by the students
  – motivation and success were correlated (causal?)
  – no differences in platforms (limited power)
Homework

• Online – DOK I or II
  – Publishers often provide CMS or modules
  – Define set of problems
  – CMS randomly selects problems for each student from a set of problems selected (or multiple sets)
  – CMS generates some data algorithmically
  – Allows resubmission as many times as they want
  – Provides feedback or solutions to students for each problem (optional)

• Offline – DOK III or IV
  – Open-ended problems

Online Assessments

• Online assessment for inference for one proportion
  – 5 of 20 multiple choice – procedural
    • In 1965, about 44% of the U.S. adult population had never smoked cigarettes. A national health survey of 1205 U.S. adults (presumably selected randomly) during 2006 revealed that 615 had never smoked cigarettes. The P-value of the test of hypotheses is...
  – 2 of 8 multiple choice – conceptual
    • Which of the following will increase the width of a confidence interval?

• Online assessment for inference for one proportion (cont'd)
  – 4 of 7 calculated
    • A manufacturer wants to evaluate whether the product is of good quality. In the first stage of the manufacturing process, she decides to take a random sample of 200 items and reject the entire batch if more than \( p \)% of units are defective. She will conduct a formal hypothesis test to determine whether to reject the batch. She finds that \( x \) units are defective. What is the standard error of \( p \)? (enter your answer to three decimal places)

• Online assessment for inference for one proportion (cont'd)
  – 1 of 4 more challenging problems
    • A confidence interval was created on the proportion of M&Ms in a bag of regular M&Ms that are brown. Eighteen (18) M&Ms were chosen and the confidence interval calculated was (0.093, 0.463). What confidence level was used to create this confidence interval?

Methods & Measures

• Two courses in Statistical Methods...
  – Majors (2012), 2nd course for non-majors (2011)

• Homework
  – Online (Mixed)
  – Offline
    • Mixed (when both online and offline were given)
    • Only Offline (when no online homework was given)
    • Total Offline (combining previous two)

• Final Exam (Z-score)
• Survey of Attitudes Towards Statistics (2012)
• One outlier excluded

Results – Online/Offline

• Correlation between online and offline performance (0.50)
### Results – Predicting Final Exam

<table>
<thead>
<tr>
<th></th>
<th>Online</th>
<th>Offline</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td>5.75**</td>
<td>2.46</td>
<td></td>
</tr>
<tr>
<td>Offline</td>
<td>4.23****</td>
<td>3.56**</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-5.42</td>
<td>-3.66</td>
<td>-5.40</td>
</tr>
<tr>
<td>R-sq</td>
<td>11%</td>
<td>20%</td>
<td>21%</td>
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</tbody>
</table>

**p<0.05, ****p<=0.001

Models including gender, course, and interactions were examined but not included here, since these factors were not significant.

### Results – Attitudes

<table>
<thead>
<tr>
<th>Models</th>
<th>Affect</th>
<th>Cogn Comp</th>
<th>Value</th>
<th>Difficulty</th>
<th>Interest</th>
<th>Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td>6.9*</td>
<td>7.9**</td>
<td>-3.2</td>
<td>3.4</td>
<td>0.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Pre</td>
<td>0.5***</td>
<td>0.4*</td>
<td>0.4*</td>
<td>0.1</td>
<td>0.9**</td>
<td>0.2</td>
</tr>
<tr>
<td>Intercept</td>
<td>-4.0</td>
<td>-4.3</td>
<td>6.1</td>
<td>0.5</td>
<td>1.7</td>
<td>1.3</td>
</tr>
<tr>
<td>R-squared</td>
<td>31%</td>
<td>23%</td>
<td>18%</td>
<td>4%</td>
<td>17%</td>
<td>3%</td>
</tr>
</tbody>
</table>

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</tr>
</thead>
<tbody>
<tr>
<td>Offline</td>
<td>4.1**</td>
<td>2.9</td>
<td>-1.6</td>
<td>0.4</td>
<td>0.3</td>
<td>4.4*</td>
</tr>
<tr>
<td>Pre</td>
<td>0.6***</td>
<td>0.3</td>
<td>0.4*</td>
<td>0.1</td>
<td>0.5**</td>
<td>0.3</td>
</tr>
<tr>
<td>Intercept</td>
<td>-1.6</td>
<td>1.1</td>
<td>4.6</td>
<td>3.5</td>
<td>2.1</td>
<td>0.4</td>
</tr>
<tr>
<td>R-squared</td>
<td>34%</td>
<td>15%</td>
<td>17%</td>
<td>1%</td>
<td>17%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Outcome is post SATS subscale

* p<0.10, ** p<0.05, *** p<0.01

### Results – Open Ended

- “Dr. Posner posted multiple choice questions that were due for homework, which allowed us to submit answers until we got the question right. This took the emphasis of “grades” off of us as students and more on our understanding of the questions and how to answer them properly.”
- “I liked how the HW was split up into two sections.”
- “Sometimes the lengths of the homeworks was excessive.”
- Course Evaluations – “Graded work fairly”: 4.7 / 5 (compared to 4.5 and 4.1 the last two times I taught this class)

### Results - Summary

- Online/Offline are related
  - Good students are good students
- Online score
  - Significant relationship with final exam
  - …but not when controlling for offline
  - Associated with Affect & Cogn Comp
- Offline score
  - Significant relationship with final exam
  - …even when controlling for online
  - Associated with Affect & Effort

### Further Thoughts

- Computerized summary of problems (% correct) was helpful (for Flipped or JITT)
- Monitor student engagement
  - Who did them early
- Only worthwhile when teaching multiple times
- Need a larger and better designed study

### Challenges

- Learning the system
  - Setting tolerance levels for answers
  - Writing open-ended questions
  - Establishing a database of questions
- Differences between book and my teaching
  - Notation: \( \pi \) and \( p \) vs. \( \hat{p} \) and \( p \)-hat
  - \( z \) vs. \( t \) test
- No partial credit
Overall Summary

• Using a hybrid (online/offline) assessment system promotes student learning and allows more time spent on…
  – Improving our pedagogy
  – Getting research papers published
  – Spending time with our family
  – Reading a book…for pleasure
  – Learning the newest tech gadgets
  – Playing Angry Birds Star Wars

References


