Online Supplements: A Tool for Confident Learning in Advanced Probability Theory

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Course context

- **Course Title:** BIOS7361- Advanced Concepts in Probability and Real Analysis
- Required for PhD students in the biostatistics department, available to all students
- Generally small class sizes, < 6 students
- **Goal of course:** understand probability in a more formalized framework
  - E.g.- "Random variables are functions on a sample space for which inverse images of Borel sets are events" vs. "Random variables are functions mapping elements from a sample space to the real line"
- **Concepts covered:**
  - Random variables
  - Independence
  - Expectations
  - Limit theorems
  - Markov chains

Problem to be solved

- **Problem:** course has a reputation for being difficult
- Students were invited to reflect on expectations of the course prior to taking it:
  - “I expect the material in the course will be quite difficult, based on discussion with fellow students who have taken the course.”
  - “…I anticipate that the material will be reasonably difficult…”
  - “I imagine that the material will be difficult with a fair amount of work (10+ hours of homework)”
  - “I know that the material in the course won’t be familiar, or come easily to me.”
- **Goal:** use online supplemental material before course starts to assist with theoretical mindset transition
  - Theoretical mindset will be required throughout the course
Approach

- Online supplement consists of:
  - Proof toolkit
  - Random walks section
  - Lim sup/lim inf section

- Types of resources
  - General descriptions of concepts
  - Guided practice problems
  - Video tutorials with in-video questions
  - R code illustrating examples

Assessment

- Qualitative data
  - Transcribed interviews of Fall 2016 students (controls), and Fall 2017 students (exposure)

- Quantitative data
  - Likert-based evaluations of online supplement
  - Coding of transcribed interviews for key concepts and course reflections

- Coding scheme validated by two external coders
Results

- None of the students felt supplementary material did not help learning.
- Students used module for an average of 5.5 hours.
- All students agreed the three main supplementary components (proof toolkit, random walks section, lim inf/lim sup section) were very helpful to their learning.
- 3 out of 4 students agreed that the online supplement was at least moderately helpful with understanding real analysis.
- All students agreed that the online supplement was at least moderately helpful with becoming more familiar with proofs.
- Validation of coding scheme: there was a TO FILL (TO FILL) agreement between two individual validators.
- Course may benefit from additional supplementary material, beyond what was included in this investigation’s online supplement.
- Future investigations may benefit from assessments that contribute to course grade to encourage more interaction with supplement.
- General consensus that course proceeds quickly, and homework deadlines should change.