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Instructional Redesign Portfolio

Section I: Instructional Context and Pedagogical Approach

Learning context. I implemented an Instructional (re)design for my undergraduate course PSYC2220H: Introduction for Data Analysis for honors students. This face-to-face course is taught in a computer laboratory within the Psychology Building (PS22). While it is a small enrollment lecture course for honors students, there are comparable sections with the course number PSYC2220 for non-honors students. This course has prerequisite courses (PSYC 1100 or 1100H and Stat 1450, Math 1130, 1148, 1149, 1150, 1151, 1152 or Math Placement Level M or higher), and serves as a prerequisite to PSYC 3221. This course is required for psychology majors. I have taught this course <u>once</u>.

Area of interest. A challenge to this <u>required course</u> is students' disinterest due to several reasons: (a) math anxiety and difficulty of probability as a concept; (b) learning script-based statistical software; and (c) perceived inaccessibility and irrelevance of the course content to their daily lives.

Goals. To make the content more relevant to students, I am interested in teaching students how to recognize that statistical information is present everywhere and how *statistical thinking* can help to evaluate this information to make informed decisions. In this vein, there are two *significant* goals of the course. First, is to teach students how to be perceptive consumers of statistics. Second, as recommended in the *American Psychological Association Guidelines for the Undergraduate Psychology Major* (August, 2013), the course will also introduce students to how statistics is used in scientific inquiry. The redesign focuses on the two goals above.

Learning outcomes. The learning outcomes specific to the two goals listed above are listed below.

<u>Goal</u>: Students will be able to appreciate the relevance of statistics in everyday life.
- <u>Outcome 1</u>: Students will be able to recognize when statistics underlies everyday information.
- <u>Outcome 2</u>: Students will be able to evaluate the quality of statistical information in such everyday information and potentially tracing the information back to a scientific source.
- <u>Outcome 3</u>: Students will be able to apply their knowledge of statistics with confidence to make decisions about everyday information.
- <u>Outcome 4</u>: Students will be able to acknowledge the advantage of statistical thinking in everyday life.

Evaluation. I plan to assess these learning outcomes in as follows:
- <u>Outcome 1</u>: Have students make reasoned arguments based on statistics of real data relevant to everyday life (e.g., UC Berkeley lawsuit involving sex discrimination in graduate school admissions; smoking status and mortality), and correctly recognizing that interpretations attached to statistics are often external to the data.
- <u>Outcome 2</u>: Have students appreciate the following equation that summarizes the role of statistics in summarizing data: DATA = MODEL + ERROR

  From this equation, students should recognize the limits of statistics by being able to list the underlying assumptions of the model and evaluate whether these assumptions have been violated in the context of scientific studies and everyday information. Next, students should state a personal opinion (e.g., decision to act or not act) about the everyday information.

Outcome 3: Have students rate their confidence in using statistics in the beginning of the course, and then later after an assignment on statistics in everyday information. Students will be given these data on change in confidence using statistics.

Outcome 4: Have students reflect on their personal growth in confidence in using statistics regarding everyday information.

The second goal of teaching students to use statistics in scientific inquiry was somewhat achieved in the course prior to redesign, and relevant course components developed to attain these outcomes (e.g., exams, data analysis requirements) are maintained in the redesign.

Past strategies. In the previous version of the course, I have done the work of seeking everyday information built on statistics in a section called “Statistics in Your Life!” Examples used were:

- A poll about increasing percentages of Flat Earthers among millennials.
- Gender discrimination by tennis umpires in the wake of Serena’s William’s loss of the 2018 US Open Final to Naomi Osaka.
- Polling information on Trump’s performance as president.

I presented the data and graphics and offered opportunities for students to discuss the claim made. From experience, students’ participation was minimal. Here, students were not actively seeking everyday information with statistics embedded in them. I encouraged students to seek such information by giving bonus points for voluntarily providing examples.

Evidence-based strategies. The learning outcomes in the redesigned course now encourage the students to think about how this information is relevant to them by making them actively seek, consider and evaluate the decision, form a personal opinion, and reflect on this information. Necessary for student success is providing more opportunities for active learning (Brame, 2016; Freeman et al., 2014). The form of active-learning that I plan to make use of is in-class activities analyzing empirical data with script-based software, R.

Evidence in support of the importance of understanding statistics for responsible citizenship is recognized by The New York Times in their section called The Learning Network (https://www.nytimes.com/section/learning). In particular, there is a monthly feature called What’s Going On in This Graph? (https://www.nytimes.com/column/whats-going-on-in-this-graph), which I have used in some class lectures.

Additionally, the American Statistical Association has expended resources to provide case studies on statistics in action. See https://community.amstat.org/stats101/home. Here, real word problems are presented, with leads students to see how statistics can be applied to everyday life.

References

Brame, C. (2016). Active learning. Vanderbilt University Center for Teaching. Retrieved [June 8, 2019] from https://cft.vanderbilt.edu/active-learning/.

Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., & Wenderoth, M.P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America*, 111 (23) 8410-8415. doi:10.1073/pnas.1319030111.

Section II: Development and Planning

Pathway. I selected the pathway of obtaining a University Institute for Teaching and Learning (UITL) endorsement of *Course Design in Higher Education* through attending a workshop organized by the University Center for the Advancement of Teaching (UCAT) course design institute. I have recently received the UITL endorsement “Course Design: Institute Pathway.”

I selected this pathway because it provided a comprehensive treatment and highly structured approach to redesigning a course using the backwards design approach. When I first prepared for teaching PSYC 2220H for the first time (Fall 2018), redesigning a course backwards was recommended to me in a one-on-one consultation with Sarah Holt from UCAT in Summer 2018. I was, however, unable to implement this approach for my course in Fall 2018 because of time constraints.

Applying the principles of backwards design to redesign PSYC 2220H for Fall 2019 has helped me focus on curating content required to help students realize course goals and align these goals with learning outcomes that can be systematically evaluated. This pathway has been extremely effective in helping me reduce extraneous information, which can quickly become overwhelming to students. I had designed my course according to recommendations on what works for introductory statistics courses (e.g., see https://www.apadivisions.org/division-5/publications/score/2018/04/active-learning).

Additionally, the workshop was well designed in that it also highlighted additional resources which could be helpful to incorporate into a course.

Additional resources. I have made use of *different technologies* offered through the Office of Distance Education and eLearning (ODEE) to promote active learning in the course. For instance, I use CarmenCanvas to have students complete weekly low stakes multiple-choice questions (MCQs) that provide immediate feedback to prepare for class during the week. I have also moved my content from PollEverywhere to TopHat to track students’ participation during class to encourage active learning. Often, I use TopHat to help students review concepts covered in lecture before moving onto a learning activity.

In addition, I have designed in-class activities focused on having students use R to analyze empirical data in a step-by-step manner as a group. The purposes of in-class group activities are to have students practice applying statistics right after being introduced to concepts with the script-based software R. Groups also facilitate peer learning. Importantly, having students struggle with R code in class allows me to provide immediate help and feedback. Initially, these activities were presented in OneNote. But, because of server issues with Microsoft, I now make use of Google Drive for group activities.

On top of in-class activities, I have a Google Document for students to take collaborative notes that I review at the end of each week. Within the collaborative notes, students have an opportunity to list the muddiest concept in class for the day. I typically provide feedback on topics they missed out or find unclear with additional examples and resources.

I have also made use of support services offered by UITL to obtain feedback on my integrated course plan as well as specific in-class activities and assessments of learning outcomes. This plan was developed at the Course Design Institute (CDI), and further refined with a one-on-one consultation with Laurie Maynell. Additionally, I also made use of UITL's services to obtain student feedback at two time points. The first time point involved developing a survey to solicit student feedback on how the first part of the course went, and whether adjustments should be made. The second time point occurred in the middle of the term, after the most difficult portion of the class, to solicit feedback on students' evaluation of their learning. When final grades were posted, students were also encouraged to fill out an exit survey that had them reflect on the extent to which they achieved the course goals. Students were also asked to reflect on their personal growth in confidence using statistical thinking to evaluate everyday information (cf. Outcome 4).

Section III: Instructional Redesign Implementation

Process of Implementation. The first step I took was to revisit student feedback afforded to me from the course Student Evaluation of Instruction (SEI) ratings and comments as well as student feedback solicited from a midterm interview conducted by UCAT in 2018. Here, I considered aspects of the course that were not serving the students well. The second step was to consult with senior faculty who observed my class to provide a written evaluation of my teaching as part of my tenure evaluation. In these discussions, we identified certain aspects of the course that I can change to improve student learning. A similar consultation occurred when I met with my mentoring committee to discuss the next steps I need to take to be successful for tenure. The third step was to participate in the CDI workshop on backwards design and work on a course plan that aligned course goals with learning outcomes content, and class activities as well as assignments and exams. The fourth step was to prepare course material (student activities, assignments, weekly practice multiple choice questions; MCQs) learn about new classroom technologies (TopHat, OneNote, Carmen, Google Docs, and web applications), and seek feedback from UITL during an individual consultation on specific aspects of the course. These steps were conducted during Spring 2019, Summer 2019, and Autumn 2019.

Implemented changes. The specific changes I implemented to redesign the course are:

- Better align low-stakes MCQs to primary content, allowing students to revisit questions to study for exams. These questions were completed during the week when concepts are introduced. Based on student feedback solicited in Autumn 2019, I modified MCQs to better reflect the style of questions in the class exams.

- Reduce lecture material and content on slides to focus on key concepts. Instead of breadth of material (that tended to be overwhelming), I focused on depth of mastery. Students were informed to supplement these key concepts with textbook readings. On average, my slide deck was reduced from 40 – 50 slides to less than 20 slides for each session.

- With reduced lecture time, more student activities were conducted during class time (i.e., flipped classroom setting). These activities included highly structured data analysis activities using R. Additionally, emphasis was placed on the interpretation of statistics in everyday information and scientific reports.

- The majority of Individual homework assignments were redesigned to be capstones to all the in-class activities conducted over the course of 3 to 4 weeks. For example, the first 3 weeks of in-class activities were spent on summarizing data with graphics and numbers, and learning how statistical summaries are interpreted. At the end of the third week, students analyzed data with Simpson's paradox in groups, where two opposing positions are supported by the data depending on what statistics are presented. Students then participated in a class debate where groups took opposing positions and arguments are evaluated on clarity, organization, use of argument, use of rebuttal, and style. Individual homework assignments then required students to summarize both positions in their topic of debate and provide a personal opinion on the issue. (Outcomes 1, 2 and 3.)

  The second homework was designed to illuminate observed data from an unobserved statistical model as well as illustrate a random process. Each group was provided a toy that embodied a random process (e.g., Dungeons and Dragon die or a Magic 8 Ball). Groups were then directed to theoretically derive a distribution of responses for this random process. Then, students had to collect data (e.g., throwing the die, turning the ball) and summarize it. Next, they had to evaluate how far their data fell away from their theoretical predictions and write individual reports to summarize the experiment. (Outcome 1 and 3)

  The third homework required students to work in groups to translate a scientific article or book chapter on a psychological phenomenon to a lay audience. Groups worked together to identify aspects of study design (e.g., population, sampling design, type of analysis etc.) and write a summary of these findings to a layperson (e.g., their grandparent). In this homework, students were assigned peers to provide feedback on their summaries. After peer comments have been incorporated into their final summaries, these were submitted for instructor feedback. (Outcomes 1, 2, and 4)

  The last and final homework focused on data analysis using R. Students participated in an in-class experiment based on the Coke vs. Pepsi Challenge and were later tasked to analyze data to answer specific questions. To encourage student engagement, students provided feedback on variables of interest (e.g., accuracy in identifying cola in the blind taste test, confidence in their accuracy, how often students drank cola, etc.) Each group was assigned a general research question (e.g., extent of liking cola and accuracy in identifying colas in a blind taste test), and each student was assigned two unique variables to analyze to answer specific research questions consistent with their group assigned general question. Here, students need to make use of R to describe, analyze, and evaluate statistical assumptions. The homework submission consistent of a group-based introduction, individual scientific reports of their results, and a group-based conclusion and discussion that reflected their opinion about the overall pattern of results (Outcomes 1, 2, and 3).

  In summary, in-class group activities, in-class individual activities, and homework sets encouraged students to identify, evaluate, and make decisions about everyday information with statistical sources. Additionally, these course components were also employed to reinforce the goal of teaching how to apply statistics in scientific research. Students had to also reflect on their statistical thinking and growth of confidence in using statistics in everyday life.

- To facilitate student participation, I made use of TopHat for students to review concepts, check their learning of new ideas, and to prepare them to think about issues before a class discussion.

- I also made use of concept maps to guide students to study for exams and better understand, organize, and review the underlying structure of the content.

These changes required a disciplined commitment to preparing course material ahead of time, and necessitated careful alignment of components according to goals and learning outcomes. The success of the course also required the seamless integration of technology, which was sometimes a challenge. However, it is anticipated that once the course is designed well, such upfront preparation will be reduced and worthwhile in terms of return of investment in terms of time. Educational technology used are: CarmenCanvas, TopHat, R (statistical programming language), and Google Drive.

A teaching assistant supported the course in terms of grading weekly in-class activities, generating MCQs, and checking the fidelity of exam questions. The teaching assistant also was tasked with seeking out real world data examples for in-class activities, and examples for class discussions on "Statistics In Your Life!" The teaching assistant also supported the course in being a secondary contact person by offering office hours.

Section IV: Assessment

Student response. At the end of Exam 1 (week 7), students were assessed on their confidence in using statistics. 25% of students reported being not confident at all with using statistics before the course statistics; 20% of students reported being somewhat unconfident and 20% reported being neither unconfident or confident. 35% reported being somewhat or very confident. After Exam 1, 0% reported feeling not confident at all. 25% reported feeling somewhat unconfident or neither confident or unconfident. 75% of students felt somewhat or very confident. ☺

Below are some comments from students about how their thinking about the relevance of statistics in their lives have changed.

- I'm starting to recognize the presences of statistics in many different kinds of observations, not even relating to actual experiments.
- I think I find statistics way more relevant and now I can approach statistical data with a much more prepared mindset.
- This class helped me realize the extent of statistics and therefore research impacts people's daily lives through things like healthcare, social structures, and products.
- I am realizing that most news I read uses statistics and how to know when to actually believe those claims.

At the end of the course, students were encouraged to provide anonymous feedback when their final grades are posted. Here, they were asked to evaluate their achievement of the course goals and personal growth in terms of confidence in using statistical thinking in everyday life.

Only one student responded to the survey. With regard to the goal of being able to understand how statistics work, including its limitations (Course Goal A; Outcome 2), the student indicated that the course prepared them *well enough*. In terms of how well the course prepared the student to evaluate scientific claims based on statistics (Course Goal B), the student indicated that the course prepared them *excellently*. For the goal of preparing students to think statistically and see how statistics is the dominant language of science (Course Goal C), the course prepared the student *excellently*. The course prepared the student *well enough* to achieve the goal of using statistical software to conduct basic statistical analysis (Course Goal D). The course is considered to have *excellently* prepared the student to appreciate the relevance of statistics in everyday life (Course Goal E; Outcomes 1, 2, 3, and 4).

In terms of self-ratings of personal growth, the student indicated that they have grown *tremendously* as a consumer of statistical information from this course (Goal 1 of redesign). The student also indicated that they have grown *a lot* as a user of statistics from the course (Goal 2 of redesign). Finally, this student indicated that they are *somewhat confident* in making use of statistical information for everyday life after the course.

Group Activities. Students have consistently been able to complete group activities that require using R to analyze data. Although minor mistakes continue to be made in final submissions, in-class feedback from the instructor and written feedback in their shared Google Docs have worked to improve their grade. On average, students' in-class group activities are scored at 97.3% (*SD* = 2.4%). There was no group activity component before the redesign to make comparisons.

Homework. Students have also shown mastery in their individual homework submissions. Homework has mainly focused on interpreting and evaluating statistical results. Here, students have provided their personal opinions about the results. Because the course is structured such that students receive feedback on their work before submission, the average grade is 93.1% (*SD* = 1.8%). Prior to the redesign, students in the course exhibited a lot of variability in their homework grade (*M* = 90.8%, *SD* = 7.0%).

Exams. As to be expected, there was more variability in exam scores across the students. Exams were designed to evaluate individual mastery of statistical concepts. On average, students scored 92.0% (*SD* = 8.2%) on the exams after the redesign. Performance on the exams was similar to before the redesign (*M* = 82.7%, *SD* = 7.8%). These exams are comparable in terms of form and content covered.

Conclusions. The course redesign seems to have aided students in learning script-based statistical software (i.e., R). The group activities allowed them to practice using R in class twice a week, addressing their discomfort and anxiety in using software. The quality of Homework 4, which is a report of their independent and individual analysis of class data using R, was impressive as reflected by their grades (see Appendix for more information).

By using in-class group activities to provide structure and scaffolding to individual homework submissions increased the quality of student work. It is assumed that this cascading structure (e.g., using in-class group activities to work on portions of homework to do with data analysis using R in a cumulative manner) helped students overcome potential math anxiety and discomfort in using statistical software. Compared to the previous class, there seems to be less student anxiety in using R.

Students' appreciation of statistics in their lives is enhanced by developing class slides that present current news reports based on statistics (e.g., polling data on whether Trump should be impeached.

Awarding bonus points to students who submit misleading graphics, with an explanation of what is problematic, shows that students have learned how to critically evaluate the verity of information presented in graphics.

By redesigning homework, and making use of rubrics to emphasize the value of statistics in everyday information, students had better a appreciation of statistics in everyday life relative to scientific inquiry. For instance, Homework 1 required students to articulate a personal opinion about a controversial topic where the data support two opposing positions (i.e., a case of Simpson's paradox). This appreciation is reflected in student comments collected after Exam 1.

Course redesign did not seem to adequately address the issue of making concepts of probability more accessible to students. Homework 2, which made use of toys with random processes, did not seem to help students make strong conceptual connections between data and probability. Timing is likely to have limited the effectiveness of Homework 2 as a teaching tool. Instead of using Homework 2 to introduce concepts of probability, Homework 2 could be better used as a capstone where students apply concepts of probability after learning it in earlier sessions.

Section V: Reflection

View of Teaching. I was taught statistics the traditional way, where concepts were presented in lectures and students had individual homework to complete on a bi-weekly basis. This set up is boring and does not prepare a student well in terms of learning how to analyze data with statistical software. By incorporating the application of R in the classroom via group-based active learning exercises, students are taught how to analyze data on the first day of class. The early introduction of software sets an expectation and seems to reduce student anxiety about using statistical software. I also realize that expectation management of a potentially intimidating course on statistics and data analysis is highly important to temper student anxiety and frustrations. Students seem to require much handholding when it comes to learning statistical software.

The IR process helped me to focus on course goals and develop teaching material to meet those course goals. With a focus on learning outcomes, the process streamlined course preparation by reducing the amount of material I usually develop for a course. The focus on learning objectives that are mapped onto course goals encouraged the development of grading rubrics. Such rubrics were extremely helpful to stay on target by emphasizing what was important to students. Additionally, the grading rubrics were very useful to maintaining homogeneity in grading done by course assistants.

What I learned as a Teacher. I learned that I am a teacher who prefers to be over-prepared for class, and tended to spend too much time in course preparation. In addition, I also found that I provided copious amounts of student feedback to allay their anxiety, which is not a sustainable model. It does not help that I am usually detail oriented, and spend a lot of time ironing out (nonessential) details. Moving forward, I would need to look at ways to reduce the workload (especially in terms of providing feedback) by making better use of other devices for provided feedback (e.g., peer evaluations).

Useful Aspects of the Process. Mapping course goals to learning outcomes and then to homework sets and grading rubrics was very useful in organizing the course and developing content. I expect to make use of this structure to help develop a syllabus in future courses.

Future Teaching Support Services. I hope to continue using the services of UITL to solicit student feedback to help with improving and streamlining the course. The staff at UITL have been extremely helpful in obtaining feedback that I can use to improve the current course as well as future courses. Students seem to appreciate this focus on their learning experience, making for a better learning environment.

I was successful in securing support from the 2019 Affordable Learning Exchange (ALX) grant to develop material for this redesigned course. I plan to use these funds to build interactive web applications to visualize statistical concepts (e.g., Law of Large Numbers, Central Limit theorem, statistical power) and address the issue of inaccessibility of concepts of probability. Ideally, these applications will interface well with the learning outcomes of Homework 2.

Confidence in Using Instructional Redesign. I am confident in applying instructional redesign to other courses. However, I will use this process sparingly because it requires a large time commitment prior to the start of the course. Unfortunately, redesigning a course does not guarantee a successful course, limiting the attractiveness of their implementation.