Using a 'Flipped Classroom' Approach to Teach Applied Statistics to Nutrition and Biotechnology Students Using Blackboard Learn™ and R

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Abstract
Background: Teaching statistics to graduate students in the health sciences presents many challenges, including unfamiliarity with requisite math and probability; difficulty in absorbing the material from live in-person lectures; and reliance on 'toy' examples in the absence of statistical software.

Methods: A 'flipped classroom' approach was developed to teach applied statistics to graduate students in the health sciences using Blackboard Learn (TM) and the R statistical computing software. Each week students view video lectures and complete self-assessments with automatic grading and feedback, followed by one hour of discussion/examples and two hours of R instruction/exercises/reinforcement.

Results: This 'flipped classroom' approach provides many advantages, including: 1) Video lectures can be viewed by students on demand; 2) The self-assessments guide which portions of the material need review and emphasis during discussion; and 3) Learning basic R facility provides coding skills while allowing for the use of 'messy' real-world data sets.

Conclusion: Instructors may find that this approach provides better learning experiences and outcomes than face-to-face lectures alone.

Key Words: Teaching, alternative teaching, graduate teaching, flipped classroom, R

1. Introduction

Teaching statistics to graduate students who are not majoring in statistics has many challenges. Some of those challenges are content-based: Non-majors generally have a more limited mathematical background than statistics majors, a long hiatus since their last formal quantitative instruction, or both. Additionally, either by inclination or training, statistics majors tend to be more 'linear thinkers' than non-majors. All this combined, it has been the author's experience that, in a standard lecture-only setting, there is often informational overload for these graduate students, hampering their ability to absorb material covered primarily through lecture.

Further, a lecture-based teaching approach limits the application and usefulness of the material. Without accompanying software for student use, applied examples often need to be synthetic toy examples, e.g. data sets where the mean and variance both work out to integer values. Obviously, this is sub-optimal. If there is a computational aspect to the

course, then that software must be either a) already be familiar to the students (an unlikely scenario) or b) readily/freely available and easy to learn. Regardless, incorporating applied computation into the class will take up a good chunk of the available class time as the aspects that are specific to the software have to be taught on top of the usual statistical material.

Lastly, there may be idiosyncratic challenges that do not mesh well with a lecture-based teaching modality. In the author's case, the student population was a mixture of nutrition and biotechnology students, with different mathematical and programming backgrounds; the course was taught as a once-a-week class in one solid three-hour block; and that three-hour block was on Mondays, starting at 4:00 PM in the late afternoon. Needless to say, none of this lent itself to a purely lecture-based approach, as evidenced by the evaluation feedback the first time this course as taught.

In light of the above, herein a different approach is explored, building off of the 'flipped classroom' teaching methodology.

2. Methods

2.1 Adapting a 'Flipped Classroom' Approach

In a traditional 'flipped classroom', students view lecture materials on their own time (e.g., through taped lecture videos) and then discussion and problem sets are completed during class time; a more detailed examination of traditional flipped classrooms, including some case studies, can be found in an excellent article by Herreid and Schiller in 2013. However, in this setting the author found adapting flipped classroom elements to the existing course to be more beneficial, as classroom time needed to be partitioned between discussion and applied lab activities.

In this setting, the standard workweek flowed as follows: Students watched taped video lectures before class and then completed an auto-grading, multiple choice self-assessment on Blackboard Learn™ (Blackboard Inc., 2017). The first hour of blocked class time was spent on discussion and reinforcement problems, guided by the aggregate scores for the separate questions on the self-assessments. The remaining two hours were spent in an applied R lab (R Core Team, 2014), alternating between instruction and reinforcement activities. After class, students completed a short answer / computational problem set as homework, to be turned in online by a set deadline; and then watched the video lectures for the next week, beginning the cycle anew. Quizzes and examinations were both inserted into class/lab periods as well as provided online, depending on the material to be covered.

2.2 Tools

It is not the place or purpose of this article to promote the use of a particular system for managing the online aspects of such a teaching modality; the author's choice here was driven primarily by the default contract of his home institution. Regardless of the online service used, the same ability to create tailored or auto-grading self-assessments, flexible due dates, timed examinations, accommodations for students with learning disabilities and adaptive release constraints should be available.

The author would, however, recommend the use of R (R Core Team, 2014) for the applied software aspects of such a flipped classroom, when teaching statistics to non-majors. R is free-to-use; easy to install; available for all three major operating systems; and is a fully-functional programming language in its own right, allowing for preprocessing and data

cleaning to occur in the same place as statistical analysis. As a result, R is not as modular as some other statistical software suites, but its learning curve is not particularly steep, especially if the students already have experience with some other object-oriented programming language.

3. Results

3.1 Advantages of this Approach

The approach outlined above has many advantages. First, the use of video lectures means that students can view lectures on their own time, not necessarily all at once (and may view them again as desired); this helps to avoid the informational overload that sometimes occurs in a solely lecture-based setting. Second, the self-assessments provide two benefits: they allow students to receive immediate feedback regarding their mastery of the material while at the same time providing individual and aggregate feedback to the instructor, which aid in directing the discussion topics during formal class time. Third, shifting part of the instruction online frees up time for applied lab instruction, so that real / non-toy examples may be used during the course. Fourth, when the course is over, students will have gained proficiency in a fully-functional programming language, which they can use in other aspects of their professional careers. Last, but not least, it has been the author's experience that students gain more mastery of the material and provide more positive responses when evaluating the class.

3.2 Disadvantages of this Approach

This approach is not without its disadvantages, however. First, the instructors needs to be fluent in the chosen applied statistical software suite. Second, there is a lot of effort required on the front end, specifically preparing the class materials and lecture videos (particularly with respect to captioning, in order for compliance with the Americans with Disabilities Act). Third, while the approach generally elicits more positive feedback from the students, one common complaint the author has observed is that the course feels very time-intensive; this is in part because students essentially have two separate deadlines every week (complete the self-assessment; complete the homework) rather than one. And finally, any issues specific to your chosen online system, such as glitches, system outages or interface issues, will apply to your class' experience as well.

4. Conclusion

In conclusion, the approach delineated above can provide a better experience for the students when teaching statistics to graduate students who are not statistics majors. In the opinion of this author its advantages outweigh its drawbacks and instructors may find that this approach provides better learning experiences and outcomes than face-to-face lectures alone.

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