Evaluating the Effect of "Flipping the Classroom" in a Probability and Statistics Course: A Plan for Formal Assessment

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Abstract

In this paper, the author will detail a plan for assessing the effectiveness of a flipped probability and statistics course. The author has taught the course for more than 20 years and first taught it as a flipped class in the fall of 2012. As a result of this experience, the author has data going back several years with which to compare student performance under the same instructor for each paradigm (traditional and flipped). In addition, while the author teaches in an institution that is moderately small and both section size and number of sections in a given term are limited, colleagues within the department have agreed to participate in a direct comparison of student attitudes and performance. The author will draw on both of these resources to develop a comprehensive assessment of flipped classrooms that will be implemented during the 2017-2018 school year.

Keywords

Flipped classroom. Formal assessment.

Introduction and Background

The concept of the flipped classroom has been around since the mid 1990s, with the idea of flipping the engineering classroom appearing in the literature since 2009[1,2,3,4]. In a flipped (or inverted) classroom, students prepare outside of class by reading, watching videos, etc. designed to introduce the material and the time in the classroom is spent on activities such as problem solving, analysis, or design. The goal is to provide active learning opportunities in the classroom so that students can address actual problem solving with the support of the instructor, as well as to help them develop lifelong learning skills by encouraging them to explore basic concepts on their own outside of the classroom.

Efforts to evaluate the flipped classroom have focused on assessing student attitudes toward the flipped classroom, determining approaches that are most likely to be accepted by students, and comparing performance of students in flipped vs traditional classrooms. Bishop and Verleger[5] provides a comprehensive survey of research in this area prior to 2013 and educators in a variety of fields have implemented and attempted to assess the flipped classroom[6,7,8,9]. Of particular interest are three studies whose methodologies will serve as the basis for the proposed study. One is a study by Mason et al[10] which compared coverage, student performance, and student perceptions across two offerings of the same upper division mechanical engineering course with the same instructor over the course of two years. Similarly, Chetcuti et al[11,12] developed[12] and evaluated[11] a flipped version of an engineering course for non-engineers and performed a post-hoc analysis by comparing the final exam scores and student responses to relevant course evaluation questions of the flipped class to those of several previous years. Marcey and Brint[13]

compared two sections of the same introductory biology course taught by the same instructor in the same term. Building on these methodologies, the proposed study will include both a comparison of performance in the course between the flipped classroom and traditional classrooms in different years by the same instructor, and a parallel comparison of two sections, on flipped and one traditional, by different instructors.

The Plan for Assessing the Flipped Classroom Approach to Probability and Statistics

The questions to be answered by the evaluation are:

1) How does student performance at the end of the flipped class compare to student performance at the end of a class taught in a traditional classroom?

2) How do student perceptions of their learning compare between flipped and traditional classrooms?

To answer these questions, two studies will be conducted. First, a retrospective study will be conducted in which comparable final exam questions and student solutions will be compared. Then, a comparison of two classes (one traditional and one flipped) will be conducted as they are being taught.

The retrospective study will consist of asking a team of evaluators to compare selected problems from final exams taken in the years before the class was flipped to problems from final exams taken when the class was flipped. Over the years in which the course has been taught there are several "standard" problems that appear with minor changes on every final exam. For the evaluation, a sample of these problems will be extracted from the final exams given in "traditional" semesters and final exams given in "flipped" semesters. To avoid bias the problems and student solutions will be copied into a clean file so that the students' solution method is preserved but any grading marks are removed. The problems and solutions will also be coded so evaluators do not know which problems were from traditional classes and which were from flipped classes. In a pairwise comparison, evaluators will be asked to score each problem solution on a scale from "solution A is significantly better" to "solution B is significantly better". They will also be asked to score the test problem on a scale from "problem A is significantly more difficult" to "problem B is significantly more difficult" (in order to normalize the evaluation of student solutions). This retrospective study will provide an evaluation of the effect on student performance of flipping the classroom based on a direct comparison of classes taught by the same instructor under both conditions.

For a more fine-grained assessment of the effect of flipping the classroom on student learning and student perceptions of that learning, a protocol similar to that used by Mason, Shuman, and Cook[10] and by Marcey and Brint[13], but using two sections in the same semester taught by different instructors. A colleague of the author has agreed to participate in the study by collaborating on key learning outcomes and a set of common problems for quizzes and exams. As with the retrospective study, an independent team of evaluators will assess student performance on these problems. In addition, a survey of student perceptions of learning will be conducted at midterm and the end of the course. While all sections of probability and statistics in Mercer's school of engineering use a common textbook and topic coverage and the participating

colleague has experience teaching the course, it is possible that the results can be skewed by student perception of the instructor, so questions on the end of course survey will be included to gauge any differences and these differences will be addressed in the final evaluation.

Expected Results and Application

If the results of this evaluation follow the pattern seen in previous studies, we can expect to find that the flipped classroom results in student performance on a par with or slightly better in the flipped classroom in comparison to students in traditional classrooms. We can also expect to find some small benefit in terms of student perceptions of their understanding of concepts and ability to solve problems. As noted previously, however, the results of a direct comparison based on two sections during the 2017/2018 school year may be limited by the relatively small class sizes. On the other hand, student feedback is expected to provide guidance for further refinement of the flipped classroom and if the study shows potential it may be repeated in subsequent semesters.

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