Abstract

Graduate teaching assistants at Iowa State University develop their teaching skills through an apprenticeship-like process. First year graduate students start out as laboratory instructors/graders. After the first year, some graduate teaching assistants teach a section of an introductory statistics course. This paper describes this apprenticeship-like process and the mentoring and resources provided to graduate teaching assistants.

1 Introduction

The process of training graduate students to be statistics teachers is an informal one in the Department of Statistics at Iowa State University. We do not teach a course for graduate students in methods of teaching statistics. However, we do have a specific process for selecting and mentoring graduate student teaching assistants. First year graduate students start as laboratory instructors/graders where they facilitate hands-on group activities for undergraduate students in introductory statistics classes. Those graduate students who do well as laboratory instructors are given the opportunity to teach a
section of an introductory statistics course in their second year. The department provides mentoring and resources to help graduate student instructors meet the challenges of teaching statistics to undergraduate students.

2 Introductory Statistics Courses

Before discussing the role of graduate students in instruction in the Department of Statistics at Iowa State, it would be helpful to give some background to the reader about the structure of the introductory courses in the department. We offer several different introductory courses, each designed for a particular group of undergraduate majors. Statistics 101 is the general introductory course for all non-business or non-engineering majors. This course meets three times (50 minutes each) a week in a large (approximately 100 students) “lecture” section. Lecture is in quotes because these meetings include small group activities, demonstrations and opportunities for students to actively participate in the class. The class is split into two laboratory sections (approximately 50 students each) for a two-hour laboratory each week. The laboratory sessions consist of hands-on activities including data collection, data analysis, random sampling, designing experiments, and simulation activities on the central limit theorem, confidence intervals and the importance of randomization as a basis for inference. The laboratory period is also used to review for, or give, exams and for students to work on a group data collection and analysis project.

Statistics 104 is the introductory course for agriculture and biology majors. This course meets twice a week for “lecture” (50 minute periods) and
once for a two-hour laboratory. The laboratory is similar to that for Stat 101 but with examples and activities with an agricultural or biological context. The third introductory level statistics course is for business majors, Stat 226. This class meets three times a week in 50 minute “lecture” sections. There is no laboratory component to this course. (There are several different introductory courses for engineering majors, however, these courses are not often taught by graduate students.)

Each semester there are five lecture sections each of Stat 101, 104 and 226 with approximately 100, 50 and 80 students in each section respectively. A faculty member, called the course coordinator, is in charge of each course. In a given semester, the course coordinator usually teaches one section of the introductory course and the remaining sections are taught by graduate students. Graduate students are thus responsible for teaching approximately 80% of the students enrolled in these courses.

Over the years, the introductory courses have evolved in response to the recommendations of the statistics reform movement to include more data, more concepts and more use of the computer. In particular, we have tried to incorporate the suggestions of Moore (1997) in terms of reforming the content and pedagogy in the introductory courses. The primary goals of each introductory statistics course are to have students begin to understand statistical thinking and to be able to apply this understanding and to help answer substantive questions by collecting and analyzing appropriate data. To this end, each course now teaches a mix of methods (how to collect data, how to
display data distributions, how to construct confidence intervals, etc.) and concepts (What is a sampling distribution and how can it be used? What is the interpretation of a confidence interval? Why is randomization important?). To accomplish these goals the “lecture” periods have moved from, to use the words of Professor Moore, “information transfer” to a combination of “information transfer” and “active learning,” while the textbook problems in the laboratories have been replaced entirely with “active learning” small group activities and computer exercises where students do and write about statistics. Because of this switch from “information transfer” to “active learning”, student learning assessments, such as homework, quizzes and exams, in the introductory courses continue to evolve. There is less emphasis on number crunching and more emphasis on interpretation of results.

3 Training Process

3.1 Laboratory Assistant/Grader

Upon entering the graduate program in statistics at Iowa State, many graduate students are given teaching assignments as laboratory assistants or graders for the introductory statistics courses. For example, one typical assignment is to be a laboratory assistant for Stat 101. For this assignment, the laboratory assistants run the prepared two-hour weekly lab and assist the undergraduate students with questions about the course material. They are then responsible for grading the labs and homework assignments for the course. The laboratory assistants and graders work closely with the course instructors and with the overall course coordinator. This coordination helps to ensure consistency across lab sections and course sections.
Many of our first year graduate students have not been exposed to “active learning” types of statistical activities in their own undergraduate careers. One such hands-on activity has each student take a random sample of 20 from a population of 250 women’s heights. Each student constructs a 95% confidence interval for the population mean height. Students are asked to interpret what their confidence interval is telling them about the value of the population mean height. All of the confidence intervals are then displayed on an overhead (with the true value of the population mean height) and the students are asked how the results correspond to the idea of confidence. The lab continues with students using the computer to simulate the repeated random sampling from a population. Here they look at the effects of sample size and confidence level on the confidence intervals and the concept of confidence. By presenting the lab and assisting the undergraduate students the laboratory assistants broaden their own understanding of statistics and statistical concepts.

Approximately half-way through each semester, the laboratory assistants are evaluated by the students and by the course instructors and course coordinator. Based on the student and instructor evaluations plus informal feedback, certain graduate students are selected to become course instructors for an introductory course during their second year of graduate study. These graduate students are generally given their assignments for the following school year during the Spring semester so they have some time over the summer to prepare for the teaching assignment. Every effort is made to
assign a graduate student to teach a section of the course she or he served as a laboratory assistant/grader. Experienced graduate student course instructors may be given a different assignment due to scheduling conflicts.

### 3.2 Graduate Student Instructors

Once graduate students become course instructors in the department, they work closely with the course coordinator on all aspects of teaching and instruction. The course coordinator really serves as a mentor to these students. All graduate student course instructors are given a manual for teaching introductory courses in the department. This manual includes a statement on teaching introductory courses (with the emphasis on data collection and interpretation and concepts), how to get started at the beginning of the semester, and where to go to find teaching resources at the department and university level. To maintain consistency within each introductory course (and to decrease the work load related to their teaching assignment), the course coordinator chooses the textbook and provides the graduate student course instructors with the course syllabus and the course homework and laboratory assignments and answer keys. Graduate student course instructors are then responsible for the remaining aspects of the course: presenting lecture material, conducting in-class activities, writing quizzes and exams, and dealing with the day-to-day logistics of conducting a class.

Although the graduate students are responsible for many aspects of the course, the department has many resources available for them to use to conduct the class. The statistics graduate student organization at Iowa State
keeps a file of old exams, quizzes and lecture notes for each of the introductory courses. Graduate student course instructors are encouraged to add to this file when they graduate. Several course coordinators also provide their lecture notes, PowerPoint presentations, examples and class activities to graduate students to use as a starting point for their own lecture notes. The course coordinators provide assistance to graduate students in writing their exams, and must give their approval to each exam. Because of the evolution of the introductory courses, there is less emphasis on number crunching and more emphasis on concepts on student learning assessments. As laboratory assistants/graders the previous year, graduate student course instructors saw this emphasis in the kinds of questions they graded on homework and laboratory assignments. Now, this emphasis should be reflected in the exams they write. Finally, at the end of the each semester, the course coordinator helps the graduate students with the sometimes daunting task of setting the grading scale for the section.

3.3 Weekly Meetings

In addition to the assistance given to graduate student course instructors, each course coordinator has a weekly meeting with all course instructors. In this meeting, coordinator and instructors talk about ways to present the upcoming material and discuss the homework and laboratory assignments for the next week. The meeting provides the opportunity to discuss what worked and didn’t work in the previous week and discuss ways to actively involve the undergraduate students in the upcoming material. These weekly
meetings also provide the course coordinators with the opportunity to discuss other aspects of teaching and course management, such as how to record and calculate students grades, how to conduct an exam during a class period, and how to deal with difficulties. Much of the business of these weekly meetings is conducted by the course coordinator. However, coordinators ask the graduate instructors what they did in lecture the previous week and what they plan to do the following week. The coordinator also asks the more experienced graduate student instructors about what difficulties they experienced the first time they presented a topic and what they did, or planned to do, the next time they taught this topic. By soliciting the input of the graduate instructors these meetings also help promote peer mentoring of new course instructors by the more experienced course instructors. The weekly meetings are very important in the mentoring of graduate student teaching assistants.

3.4 Evaluation

Course coordinators attend at least one lecture per semester for each of the graduate student course instructors. The coordinator then meets privately with the graduate student to discuss her/his performance and make suggestions for improvement of class management, presentation techniques, and techniques for teaching statistical concepts. At the end of the semester, the department chair and the course coordinator review the students’ evaluations of the graduate student course instructors. If any areas of concern arise, the course coordinator will meet with the graduate student to discuss and develop a strategy for dealing with the concerns.
4 Continuous Improvement

The process of mentoring graduate students and giving them the opportunity to develop as teachers of statistics has been used for many years at Iowa State. Just as the introductory courses content and pedagogy evolve so does our process. Up until five years ago we relied almost exclusively on undergraduate students’ evaluations of laboratory teaching assistants and course instructors. We have since implemented evaluation of laboratory assistants by course instructors and course coordinators and evaluation of course instructors by course coordinators. It would be better if course coordinators, or other faculty in the department, could visit the classes taught by graduate student instructors more often during the semester. The manual for teaching introductory statistics courses has just been revised to better reflect the new pedagogy and content, but the manual for laboratory assistants and graders has not yet been updated. Although we suggest that first year laboratory assistants/graders attend the “lecture” section corresponding to their laboratory, this is not often possible due to schedule conflicts and time constraints. In lieu of this, it might be feasible to have first year laboratory assistants attend several teaching seminars where an experienced instructor would discuss ways to present material on specific topics that undergraduate students find difficult, such as the Central Limit Theorem. This would be an opportunity for the experienced teacher to model good content and good pedagogy at the introductory level.
5 Conclusion

Graduate students play an important role in the instruction of undergraduate students in the introductory statistics courses at Iowa State University. Following the steps outlined above, we attempt to provide opportunities for graduate students to develop as statistics teachers. We have found the close informal mentoring of our graduate students to be very effective in training them to be conscientious teachers of introductory statistics.

6 References