

STATISTICAL CONSULTING WITH UNDERGRADUATES – A COMMUNITY OUTREACH APPROACH

Brian Jersky
Sonoma State University
USA

At Sonoma State University, we offer a 2-hour per week class in Statistical Consulting. All our statistics majors must take the class twice, and other students may also take the class. The only prerequisite for the class is a semester of Elementary Statistics. This leads to a very varied class, in terms of statistical ability and experience. Our clients at the Statistical Consulting Center are largely from two sources, namely other departments at the university, and local non-profit organizations. Both these sources typically have projects that are suitable for our consulting class, so that both unsophisticated and advanced students can benefit from it. I will present some examples of these projects, and discuss the perhaps surprisingly high levels of satisfaction of the students, in terms of their learning objectives, and of the clients, in terms of their needs. Faculty also enjoy teaching the class, and the university gets much positive publicity in the community.

INTRODUCTION

Sonoma State is a fairly small, liberal arts focused campus, and is one of the 23 constituent campuses of the California State University (CSU) system. My department, although named the Mathematics department, is responsible for the teaching of statistics as well. All our 7,500 students are required to take a mathematics course for the general education part of their curriculum, which may include any of several possibilities. The most common options are Elementary Statistics, Finite Mathematics, Geometry and Calculus, in that order. Usually, we run about 10 classes of Elementary Statistics of roughly 30 students each, for a total of 300 students per semester. Most of these students are psychology, sociology, biology, or nursing majors. Relatively few are statistics majors.

In the past, most students have taken the Elementary Statistics class, heaved a sigh of relief, and moved on to their other major classes. Probably many still do, although the student evaluations of the class have been very positive since we moved from the traditional teaching of elementary statistics to a reformed method. We now spend half the total class time in a computer laboratory, where we use the program Data Desk, and the rest of the time emphasizing concepts and active learning rather than formulas, in the manner recommended by such authors as David Moore. We use as textbooks the *Introduction to the Practice of Statistics*, by Moore and McCabe (1999), or *Elementary Statistics*, by Triola (2001).

In 1994, a colleague (Susan Herring) and I noted that many of the better students in these classes wrote in their evaluations that they wanted an opportunity to use their knowledge in a large and meaningful project, preferably in their field of interest. Since we were already in the process of introducing a course in statistical consulting for the statistics majors, we wondered if it would be possible to combine the 2 groups in one class. The main reason for this was that we usually have only 5 to 10 statistics majors in any one-year, and our Dean was very strict about not allowing small classes to be offered. (This was during the previous recession in California.) We thought it would be more feasible to offer the consulting class as a combination service and major class. The statistics majors in the class fall into 2 groups: the first year (Freshman) students, with much the same background as the students from the service statistics classes, and the fourth year (Senior) students, who have a fairly advanced level of knowledge. This is so because we require the statistics majors to take the class twice, once early on in their major, and once as a capstone-type course before graduation. Thus the student population in the consulting class is very heterogeneous. This has turned out to be an advantage, rather than a drawback, as we initially feared.

THE STATISTICAL CONSULTING CLASS

When we began teaching this class several years ago, statistical consulting with undergraduate students was relatively rare, at least in the United States. Most university

consulting centers had graduate students actively engaged in consulting, but not undergraduates. Since we do not have graduate students in statistics, this option was not available to us. We were also convinced that undergraduates could profitably consult with benefits to them and the client, even though they were relatively inexperienced. We found that there were two major models for consulting centers at other universities. Either the clients dropped in and the consultants tried to deal with their problems at that time or a week or so later, or the consultants worked on a fairly substantial project, usually in a group, for the whole term. We did not know which, if any, of these models would be appropriate for our students, so we tried both, in two successive semesters.

The first major, semester-long project, was to design, administer, and analyze a six-county survey for Goodwill Industries of the Redwood Empire (GIRE), a local branch of a nationwide non-profit organization that trains low-skilled workers and places them in jobs. Funds are raised largely by selling second hand clothes and other domestic objects in retail stores. GIRE was established in only one of the six counties in this area. The organization wished to expand its operations into the five counties in which it had no retail presence, and required demographic and name and mission recognition information, in order to decide how best to do this.

All twelve students in the class worked on the project, and they were so excited by it, that 4 of the 5 non-statistics majors became statistics majors, even though this required them to spend an extra year at the university. It was fascinating to watch them learning sampling theory so that they could implement the design they wanted. Even the students with only an elementary statistics background could participate effectively in many areas of the project. GIRE paid all the administrative costs of the project, but the students worked for academic credit. Thus both the students and the organization got a good deal.

In the second model we tried to implement a drop-in type of experience with a different class the following semester. This required a good deal more weekly organization, of course, since we needed a lot of suitable clients. I emphasize suitable, because I found that clients needed to be pre-screened by me before the class, or subsets of the class, interviewed them. Most of our clients came from within the university, and included graduate students and faculty members who were writing theses or papers and needed statistical advice.

I was very anxious for them not to have every consulting session taken by the type of client who hands you a disk and says, "Here's the data. I must have it analyzed for the day after tomorrow. I need you to use a three-way ANOVA or possibly a factor analysis. It shouldn't take long." Anyone with any experience in consulting will realize that this is not the kind of project you want inexperienced students to take on! With much planning, I did arrange a reasonably wide range of projects for the 10 students to take on. I usually had four clients in each week, and teams of 2 students (some experienced, some not, and some mixed) were assigned to the clients that interested them. The clients were usually satisfied with the advice and assistance they received, and the students were mostly happy with the experience.

ONGOING EXPERIENCE

The department in which I work has 2 tenured professors of statistics and two adjunct instructors, one of whom worked at Hewlett-Packard before retiring early, and the other of whom is a consulting actuary. Both have extensive contacts with the surrounding high technology and business communities. This is of course a vital aspect of the class.

We have found that teaching the consulting course is best spread over all the instructors, so that the students repeating the class, as they must do if they are majors, get a different view of the subject. Also, the instructors enjoy teaching the class very much, and so scheduling appropriately is important. Luckily, two of the instructors enjoy taking on large, semester-long projects, whereas the other two enjoy the drop-in type of setup. In either case, plenty of lead-time must be given to the instructor to choose appropriate projects. We have found that adequate preparation in this area is the key aspect for the success or otherwise of the course. Initially, one of our concerns was that we would not be able to find sufficient work for the students to do, but we were soon re-assured. There are an astonishingly large number of people in our suburban/rural community who need statistical advice. In fact, we could easily find enough projects of both types on campus. This "in-house" outreach has been very helpful to our department's image on campus, as well as, to a lesser extent, a way for us to attract majors.

However, we also have been surprised by our ability to attract clients from off-campus. Most of our off-campus clients have been non-profits, ranging from community organizations such as Goodwill to State organizations such as the Department of Recreation and Parks, but we have had some business groups as clients as well. One of the things we discovered is that care needs to be taken in how these clients are charged for our services. Clearly the students are doing the work primarily as an academic requirement, and need little or no payment as such, but we need to be careful not to “undercut” for-profit statistical consultants in the community, since this would be an illegal use of State funds.

PROJECTS

In addition to the GIRE project described above, we have been able to take on several other interesting and varied projects. An “in-house” project that was very helpful to my own department was a study that attempted to assess the efficacy of remedial mathematics instruction at Sonoma State. Although all entering students need to have completed at least three years of high school mathematics, many are unable to score high enough in the Entry Level Mathematics (ELM) examination, which most students need to take before entry to be placed in a general education (GE) mathematics class. Astonishingly, about half our incoming freshmen need one or sometimes two semesters of remediation. Our department does this and we wanted to find out if we were doing this any more successfully than the high schools had been.

The consulting class designed a study that captured relevant data from students coming into and leaving remedial classes, as well as data from their subsequent GE mathematics classes. We found a number of surprising things. One of the most interesting, though perhaps depressing, findings was that there was no relationship at all between the grades that students obtained in their remedial mathematics classes and the grades they obtained in their subsequent GE mathematics classes. After the students presented their work at a special department meeting, the department had several interesting meetings, which resulted in some fairly large design changes in the remedial and GE classes. We are currently assessing the effect of these changes, and in fact the Spring 2002 consulting class will be working on this project.

On the other hand, many drop-in projects have been from Biology, Nursing, or Kinesiology Masters students who need help designing their studies, collecting data, and analyzing the results. We have met with the graduate advisors from all these departments to alert them to our service, as well as to give them highlights of what to tell their students. In particular, we tell them to see us as early in the process as possible, to avoid the depressing task of telling people such things as they cannot do multiple regressions with 5 independent variables using 4 subjects, and so on. We have found that most of the graduate students are compliant, and the consulting students are very happy telling them that they cannot help if that is not possible.

Perhaps surprisingly to our students, most of the statistical help that is required is very low level, much of it simply data organizations and numerical or graphical presentation. In fact, one of the things we note as instructors is that we need to look quite hard at a project to make sure it has enough in it to keep advanced students challenged. It is all very well for an early project to require nothing more than a bit of data manipulation, but towards the end of the semester, students want something more challenging.

SOME POSITIVE OUTCOMES OF THE COURSE

The three groups of students – non-majors, beginning and advanced statistics majors – find satisfaction from the course in slightly different ways. The non-majors get the chance to apply the limited knowledge of statistics that they have acquired in their GE statistics class, which they enjoy and which they say gives depth to their learning. Furthermore, they find the class useful at the graduate level, if they so choose, because they know quite accurately what they can do and what they need help with, from a statistical point of view. Additionally, employers tell me that they like students with practical experience, and the projects and reports that the students take with them are attractive in this regard.

Beginning statistics students are usually excited by what statisticians can do, and are impressed by its wide applicability. They are usually much more motivated in later, more mathematical courses, since they know why they are learning the material they are learning. In

fact, the effect on later statistics track courses is the most positive outcome for these students, and for our program. Advanced students again are happy to apply their knowledge to more advanced topics, and generally enjoy teaching other students about it as well. Their graduate school applications are enhanced by this class, as well as their immediate employment opportunities. Even if they do not directly find work with one of the organizations off campus for which they have consulted, they find that their portfolios are enhanced by their project reports. Although they have all previously taken a course in SAS programming as part of their major requirements, it is usually helpful for them to get a refresher experience in this class taken just before they graduate. Instructors enjoy teaching the class, and usually there are more people who want to teach it than we need, even in our small department. It is useful (especially for junior faculty) to help build contacts with the outside community, as well as forge links across campus.

SOME NEGATIVE OUTCOMES OF THE COURSE

Some students are not able to deal with the interpersonal stresses that arise in consulting. This must be monitored quite closely, especially at the beginning of the class. Occasionally, students think they can do more than they can in fact do. (Usually, they think they can do less, and encouragement is called for.) When this happens, it is a recipe for disaster unless nipped in the bud early. It is important for the instructor to be aware of this aspect of consulting with students. There is nothing more embarrassing than to have to extricate a student from a “messy” project, and clients can be very disappointed if promised work is not delivered in a timely fashion. Establishing timetables for the students’ work is crucial in this regard, as it allows them better to structure their effort, as well as giving early warning that things need to be looked into.

Advanced students can be impatient at the (to them) low level of class discussion of topics, and can become unmotivated if this is not noticed and dealt with. I find it is better to lecture as little as possible in the class on purely statistical issues, for this reason. It is always appropriate to allow different groups to be doing different things in class, though it requires a good deal of knowledge of the subject to be able to deal simultaneously with multiple subject areas. Still, it is a good way to model some of the consulting experience to all, especially in showing students how to say that you don’t know something and will have to check it and get back to them. Saying “no” is one of the hardest things to get students to do, once they are fired up about a particular project.

From an administrative point of view, the class is much more demanding for the instructor than a regular two-hour-a-week class is. This is not only because of the “front-loading” required for preparation, and the breadth of knowledge that is required, but also because of the book-keeping requirements of the class. One needs to check several people’s activities each week, if the drop-in method is used, and monitor what the students are supposed to be doing, with whom, and when. In fact this is not very onerous, but it can become problematic if it is not realized that it needs to be done. The heterogeneity of the class makes it that much more difficult to direct instruction. As mentioned above, lecturing is not very effective, except for some aspects of consulting, as opposed to statistics. Instructors will find their own way round this problem, but it does need to be given some thought.

SUMMARY AND CONCLUSION

A two-hour weekly course is offered at Sonoma State University in statistical consulting. The class contains both novice and advanced statistics students, and needs some special care because of this. Two types of consulting are practiced, depending on the preference of the instructor: semester-long projects that are ongoing and quite demanding, or drop-in type sessions that are usually quicker and easy to resolve. Both these methods of consulting have been enjoyed by students and instructors, and have produced learning by students and instructors.

The internal university community has reacted positively to this service. It is necessary for appropriate parties, such as graduate advisors, to be notified of the class and kept up to date of the requirements necessary to use it. External organizations, both non-profit and for-profit, have been keen on the class, both because of what they can get from it immediately, as well as because of the increased effectiveness of our graduates in the market.

REFERENCES

- Moore, D.S., & McCabe, G.P. (1999). *Introduction to the practice of statistics* (2nd edn). New York: W.H. Freeman and Company.
- Triola, M.F. (2001). *Elementary statistics*. Reading, MA: Addison-Wesley.