Promoting Active Learning: Student-Led Data Gathering in Undergraduate Statistics

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Promoting Active Learning: Student-Led Data Gathering in Undergraduate Statistics

Jennifer A. Strangfeld[1]

Abstract

Scholarship on teaching undergraduates increasingly emphasizes the benefits of providing students with an active role in their education whereby instructors are more aptly described as facilitators of knowledge rather than merely providers of it. Additionally, recommendations from the American Sociological Association aimed specifically at the undergraduate sociology curriculum argue that students must engage as practitioners of sociology at each level of their program development. In short, undergraduates should *do* sociology—not just read or write sociology. Applying this recommendation to teaching statistics, I suggest organizing a course around a student-led research project in which students generate the topics, questions, and data that are then used to complete a substantive research paper. Students are given the opportunity to be actively engaged in all stages of the research and data-gathering process. Students also present their work in student roundtables, further legitimating their important contributions as researchers.

Keywords

social statistics, active learning, quantitative methods, research methods

The challenges of teaching undergraduate statistics in sociology are often seen as unique compared with the challenges of teaching seminar or content-specific courses. These challenges are often connected to several factors: statistics courses are generally required for fulfillment of the sociology major, many students express anxiety about math-based statistics, and the lack of a content-specific focus often makes the statistics course feel more like an obstacle to overcome rather than an integral part of developing a student's sociological skill box (Auster 2000; Blalock 1987; Onwuegbuzie and Wilson 2003; Paxton 2006; Potter 1995). The first two challenges are generally assumed to be interconnected; the anxiety students may feel is often related to the fact that they are required to learn a skill that they believe comes to them only with great difficulty. Several articles offer potential solutions to these challenges, focusing specifically on games or activities that reinforce important and specific concepts in a fun and more accessible way (Auster 2000; Leech 2008; Trumpower 2010; Wybraniec and Wilmoth 1999). The third challenge of overcoming the lack of content-specific focus and the disassociation between statistics and the larger social issues students care about is arguably more complicated, in

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terms of both its application to course curriculums and measurable outcomes of success. A foundational component of sociology is asking questions and finding answers through data gathering and analysis. Undergraduates who do not see a connection between their own substantive interests and research method arguably fail to grasp an essential component of their discipline. Thus, although reducing student anxiety has its place in statistics courses, it should not be an end in itself. Instead, a primary goal of sociological statistics should be to develop the research skills necessary to be an effective practitioner of sociology. One way to accomplish this is by empowering students through guided research and data gathering.

Schumm et al. (2002) discuss an experience in which students failed to retain the information learned in statistics courses or lacked confidence in their abilities to apply the skills they learned to their own research projects. Similarly, Blalock (1987) argues that students often fail to understand the applicability of concepts beyond problems that exactly or closely match those they have already encountered. In essence, although students could succeed in their statistics courses by correctly answering examination questions and even using computer-based statistical software, statistics still appeared to be an isolated experience for students. In Blalock's (1987:164) often-cited piece on teaching statistics, he makes an interesting, although arguably problematic, point: "Few will enter statistics courses with the definite expectation of building upon them in a sustained manner. *Most will tend to see their work in statistics as terminal, and all but a relatively small fraction will be correct in this assessment* [my emphasis]." In reading this, it occurred to me that perhaps one of the reasons why students do not see statistical analysis as part of their ongoing engagement as sociologists is because we, as instructors, see their involvement as a finite and isolated experience as well.

In her article on teaching strategies for statistics, Potter (1995:262) makes the powerful assertion that "perhaps the most important goal of a course in statistics . . . is to encourage students to be practitioners." She advocates student participation and engagement, positioning students as active rather than passive recipients of knowledge. Macheski et al. (2008:42) concur that in theory and methodology courses "there is a need to create an environment that encourages students to be active and engaged participants in their own learning." This engagement, they argue, must be an integral part of the course design, not just a specific exercise for students to complete.

Recent scholarship on teaching practices has given greater emphasis to active or "inquiry-guided" learning whereby educators facilitate or guide the learning process among students rather than rely exclusively on lectures and memorization (Atkinson and Hunt 2007). Active or inquiry-guided learning encourages students to be actual practitioners of sociology. Such an approach must not assume that students' experiences and involvement with statistics are any more terminal than any other substantive, research, or theory course that they complete.

The development of students as practitioners of sociology is intimately linked to research and data analysis skills. In 2002, the American Sociological Association (ASA) and the Social Science Data Analysis Network at the University of Michigan–Ann Arbor together launched the Integrating Data Analysis project designed to facilitate more holistic integration of research skills and analysis into the undergraduate curriculum (Howery and Rodriguez 2006). The impetus for this project was a recognition that undergraduates often failed to see how research connected to their other substantive courses and interests (Howery and Rodriguez 2006). Although the project emphasized the infusion of data analysis skills into lower division classes, the principles of developing sociological research practitioners throughout the curriculum still apply. Students become sociologists by doing sociology, not just by reading about it. They also become researchers by doing research, not just learning the formulas behind it.

In 2004, a task force appointed by the ASA in 2001 issued curriculum recommendations for the sociology undergraduate major (McKinney et al. 2004). The task force suggested a curriculum model consisting of four stages of development whereby students engage in empirical research at all levels of the sociological curriculum based on developmental expectations appropriate to different stages of their degree programs. The task force's fundamental argument was that the development of sociological

knowledge occurs alongside the development of research skills. Although the task force used this point to advocate incorporation of research into both introductory and upper division courses, their point has applicability to developing curriculums in statistics and research methods courses as well. If research should not be absent from substantive courses, then likewise students' substantive interests should not be absent from their methodology courses. A student-led research project is thus designed to facilitate and/or maintain that link between knowledge and practice.

STUDENT-LED RESEARCH PROJECTS

One way to pursue an active learning approach in a class designed to build research analysis skills is to have students collect data and do their own guided research project. Many textbooks come with a CD of General Social Survey (GSS) or other collected data that can be used for this purpose. However, the downside of using these data is that the topics and questions are already predetermined. Consequently, students are basing their research projects on what others have found interesting or important to investigate. Although there is nothing inherently wrong with this, having students collect their own data gives the students greater control over their research projects and adds a dimension to their skill building that is absent when they rely on data that have already been collected.

At the start of the term, I use the Blackboard™ survey assessment tools to create a basic survey of demographic questions such as gender, race, sexual orientation, income, units completed, religion, and GPA. At the end of the first week of classes, I ask students to brainstorm about topics of interest to them and bring two ideas to the following class period. They are told that they will be required at the end of the term to use the data collected to complete a research project that must include a short literature review and data tables. Examples of topics students have chosen include behavioral questions about studying; Internet use; dating; exercise and eating; sociopolitical issues such as homophobia on campus, medical marijuana, and recycling; and campus-specific issues related to athletics, dining services, and class availability.

At the start of Week 2, students come to class with their two topics of interest. I break the class into groups of about five students, and each student offers his or her topic suggestions to the other group members. The group picks only two topics that are then presented to the larger class. All topics are written on the chalkboard. Once the topics have been written out, the class works as a whole to narrow down the number of topics to four. This is done by a hand vote of each student's top two topics. Those topics with the lowest votes are eliminated until we are left with only four. Students then return to their groups and are assigned two of the remaining topics for which they must construct three questions that relate to their topic. Since more than one group is writing questions related to a given topic, the total number of questions for each topic varies from five to eight.[1] Once students have come up with their questions, a member of the group reads the questions to the class. Questions are presented to the larger class by topic rather than by group. Other students and the instructor can ask for clarification about wording and intent and/or offer critical feedback. Each group turns in its questions (with modifications) to the instructor. Questions are then grouped by topic and added to the Blackboard survey. The end result is one similar to the GSS in which related questions appear in groups.

Once the survey is uploaded, students have about one week to complete it. After students have completed the survey, the data must be downloaded into Excel first and then imported into SPSS. (I have also done the survey using Qualtrics, which can be downloaded directly into SPSS.) Once in SPSS form, the data set can be loaded as a Blackboard link. In class, students are instructed to download a copy of the data set into their own files so that they can make changes as needed (i.e., recoding variables) without overwriting work of other students.

In the first stage of the research project (completed by about the end of Week 3 or 4), students choose a topic from the survey data. They then conduct a short literature review of five peer-reviewed sources that details information about sample size and demographics, how the data were collected, and the key or relevant findings of the authors. Students are told to focus not only on the

results of the research they are reviewing but also on the process by which those results are achieved. Drawing on the literature review, students then write five related research questions of their own, of which two must be testable research hypotheses. Thus, three can just be simple descriptive data questions (i.e., the percentage of students who are members of a campus club or organization), whereas two must articulate a relationship between two variables (i.e., whether women have higher campus club membership than do men). Once completed, the literature review and research questions are turned in together for instructor review.

In the second stage (completed about two-thirds of the way through the term), students complete a methodology section that describes how, when, and from whom (in general) their own data were collected and a results section that includes descriptive-level data analysis for each of the variables included in their research questions. In the methods section, students include basic demographic information from the respondents such as race, gender, average income, and academic class standing distributions. Students also indicate how questions relevant to their project were asked on the survey as well as response categories for those questions. In the descriptive analysis, students include measures of central tendency and appropriate measures of variability for each of their research variables and either frequency tables or pie or bar charts depending on their appropriateness for the project. Students at this stage may also demonstrate basic recoding of variables. Finally, students should be able to answer their three descriptive research questions presented in the first stage of their research project. This methods and descriptive analysis is also then turned in to the instructor for review.

At the end of the term, students complete the third stage of their project, which includes modifications to the first two stages plus analysis of their two research hypotheses and a conclusion. The analysis section incorporates chi-square tests, *t*-tests, analyses of variance, and/or regression models, whichever are most appropriate for students' research hypotheses. Determining the most appropriate test is the biggest challenge for students. Consequently, I devote at least one class period (preferably two) as a "project day" near the end of the term, during which students work on their research while I circle the room. As for the conclusion, students are asked to summarize their findings, determine the level of support for their research hypotheses, and offer a possible sociological explanation for their findings.

At the last class period, students are divided into groups of four and present their research findings to the group, mimicking the conference roundtable format. Each student gives a 10- to 12-minute presentation that contextualizes the research within his or her literature review and then explains his or her research questions and findings. After all four students have presented, the students conduct a short question-and-answer session. Finally, students evaluate one another's presentations with a simple rubric checklist that focuses on clarity of presentation, timeliness, and organization. This roundtable format not only is beneficial for its practice of general presentation skills but also further legitimates student research by giving students an audience beyond just the instructor.

EVALUATION OF LEARNING OUTCOMES

Students most often used chi-square tests and *t*-tests to address their specific research questions. Many opted to compare gender groups, racial groups (generally divided into two groups, namely, white and racial minority), or student athlete status (athletes versus nonathletes) on such topics as support for legalization of marijuana, use of birth control, and amount of study hours per week. In other instances, students found correlations between specific attitudes and/or behaviors. For example, using a chi-square test, students found that those who supported full legalization of marijuana for adults regardless of medical need were significantly less likely to believe that marijuana is an addictive drug. Also, chi-square tests showed no correlation between GPA and the amount of hours students reported using social networking sites.

In my most recent application of this project to my statistics courses, proficiency with descriptive-level analysis skills (demonstrated in the second stage of the project) was evident among all students. Based on the grading rubric, proficiency was

Table 1. Student Evaluation Responses.

	Strongly Agree/ Somewhat Agree	Neither Agree nor Disagree	Strongly Disagree/ Somewhat Disagree
The researcher project was useful in applying concepts.	80.4%	14.3%	5.4%
	Very Confident	Somewhat Confident	Not Very Confident
Level of confidence in understanding statistics	37.0%	59.3%	3.7%
	More Successful	As Successful as Expected	Less Successful
Self-reported "level of success" with the course	53.7%	33.3%	13.3%

defined as correctly applying and interpreting measures of central tendency and measures of variability and constructing at least one graph or table. For the more advanced statistical analysis, students must demonstrate appropriate use and interpretation of at least one inferential test or regression model. About 20 percent of students struggled with some aspect of this, most commonly applying the wrong statistical test. Generally, students who come prepared and organized on the designated in-class project work days, particularly at the end of the term, are less likely to have trouble using and interpreting appropriate statistical tests.

It is difficult to assess the long-term learning outcomes of this approach. However, evidence from student surveys and evaluations suggests that students respond positively to this project. In general, standard course evaluations over two semesters (fall 2010 and spring 2011), covering four sections of social statistics, demonstrated positive reviews ($n = 76$). Students were asked to rate their workload, the instructor, and the overall quality of the course on a 7-point scale ranging from "extremely poor" (1) to "excellent" (7). The median response for students' "level of effort" in the course was 6 as was their assessment of their "increase in skills/understanding as a result of taking this course." In elaborating specifically about this skill development, several students noted the usefulness of the research project in particular. Comments are as follows:

- I feel I have a better understanding of SPSS and statistics and will be able to use it during my senior project.
- The SPSS project is kind of a cool way to apply what we've learned.
- This stats class uses methods that I could see being useful in real life. Other stats classes I have taken did not.
- I now know tests that can help me explain findings in my research.
- Wish I took this course earlier. Would have been helpful for capstone.
- Learned a lot which can be used for the future.

Additionally, a survey of students enrolled in two sections of statistics in the spring 2012 semester asked whether "the research project was useful in helping me apply concepts learned in class." Just more than 80 percent of students either strongly agreed or somewhat agreed with this statement ($n = 56$; see Table 1). These same students were also asked to rate their level of confidence in understanding basic statistics. More than one-third of students (37 percent) felt "very confident" in their abilities, and more than 96 percent of students felt either "very confident" or "somewhat confident" in their abilities. There are no pretest data available, so it is unclear the extent to which students' level of confidence is a product of the class or a product of just general confidence. However,

it is unlikely that many students have significant experience with statistics before entering the classroom and thus would not be expected to be "very confident" in their statistical knowledge. Finally, these students were asked to self-report their level of success with the course. More than half of the students (53.7 percent) reported that they were "more successful" than they anticipated, whereas one-third (33.3 percent) were "as successful as expected." Although this measure is not directly tied to the research project itself, it nonetheless indicates that students are feeling successful within a class designed around active research.

CONCERN ABOUT GENERALIZABILITY

An important consideration is the issue of generalizability. First, it is important for students to understand that the data they collect are appropriately viewed not as a sample of the larger student body but rather as a population of students who fit a particular criterion (namely, sociology students enrolled in statistics in a particular term). I believe that opportunities to collect data, even at rudimentary levels, reinforce the principles of practice described earlier in the ASA curriculum guidelines. Nonetheless, given that the data are thus not generalizable, I do not treat the student-led project as a replacement for work done with random data sets like the GSS; rather, the project adds to such work. Students still do in-class activities, homework, and examinations using data that allow them to generalize to the larger population. But the student-led project gives students more insight into how data are gathered and more involvement in the course curriculum itself.

A second important point is to consider the learning objective of the student-led project. In my design, the emphasis of the project is more on the process rather than the outcome. Although I do evaluate the extent to which students use appropriate tests and draw reasonable conclusions, they also have examinations and homework problems that accomplish this same thing. Simply focusing only on outcomes would merely repeat the learning objectives of these other measures. Thus, what the student-led project brings to the classroom is a focus on the actual work of data collection and management. This is evident in the significant class time and energy devoted to the first stage of the project in which students are locating scientific literature, developing research hypotheses, transforming those hypotheses into survey questions, and collecting responses to those questions. The emphasis on process over outcome is further demonstrated by the fact that students make changes to and resubmit the first two stages of the project.

Finally, I do not deny that the absence of a probability sampling technique requires meticulous discussion about samples versus populations and the scope of generalizability. I also recognize that requiring students to conduct inferential tests and regression models using their data arguably complicates this even further in that students are drawing conclusions about relationships between variables based on limited data. However, students are not conducting their research in a vacuum. Their analysis and finding are filtered through a scholarly literature review whereby the students compare whether their class is similar to or different from the larger social patterns and findings noted by others. They are essentially asking, How do I (or our class) compare? This is a different question than attempting to find generalizable patterns.

CONCLUSION

The primary goal of this project is to have students *do* sociology using quantitative methods. The curriculum guidelines articulated by the American Sociological Association clearly emphasize the importance of actively engaging undergraduates in the art and practice of sociology at all levels of their learning. Students learn not just by listening and discussing but also by doing. It is imperative that as educators we focus not just on telling students about our discipline or the formulas and techniques we use but also on giving them opportunities to use those tools themselves and learn through their own investigations. Sociology is a dynamic and evolving science, and thus, it is important that our students experience the discipline in active and dynamic ways.

There are many ways to accomplish this in a research analysis or statistics course, and certainly the student-led project is only one possible avenue for accomplishing this goal. However, I argue that the student-led project offers benefits that are

missing from approaches that rely on pregathered data sets alone or solving word problems through homework or in-class activities. The most significant benefit is that students have an opportunity to design research questions that are of interest and relate directly to them. Students can ask questions that might be overlooked in other research or address topics that are localized to their time and place, whether or not those topics would warrant research on a larger scale. In addition, the student-led research project gives students greater opportunity for participation in their education. They have leadership in directing some aspect of the course curriculum, which helps diminish the expectation of students as passive recipients of knowledge, an expectation that runs counter to the principles of active learning. Finally, the student-led project focuses on the process of research, not just the outcome. Using pregathered data skips over learning opportunities and skills associated with collecting data in the first place. Although students may have experience with data collection in other courses, collecting data in a class specifically designed for teaching research skills and data analysis allows for greater depth and attention to the nuances of the data collection process.

It does both students and faculty a disservice to engage our students as if their work in statistics is terminal, as Blalock (1987) suggests. Even if most of our students do not go on to careers as practicing sociologists per se, we still believe that they will apply the sociological perspectives and ideas they learn in our classes to their lives in meaningful ways. This should be true for any given class, regardless of whether it is a substantive seminar course, a theory course, or a methods course. If we anticipate that our students' statistical work is terminal, then one can arguably question why students are asked to learn it in the first place. I designed this project because I want to encourage students to see a connection between statistics and the issues and concepts that excite them about sociology. I want to help them see that statistics is not just a hoop that faculty make them jump through on their way to the more exciting classes. Whether or not our students are future practitioners of statistics or of sociology in general, it is imperative that we as faculty continually look for ways to actively involve students in doing sociology and support their own creative ideas. Although the student-led project is not a perfect vehicle for accomplishing this, it nonetheless provides a fresh approach to designing a research analysis and statistics course.

NOTE

Reviewers for this manuscript were, in alphabetical order, Ginger Macheski and Robin D. Moremen.

1. Students are assumed to have had some survey writing experience from their research methods class. Students who have not had this experience use the group as a resource for developing appropriate questions.

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