TEACHING QUANTITATIVE RESEARCH METHODS: A QUASI-EXPERIMENTAL ANALYSIS*

Courses on quantitative research methods play a central role in many undergraduate programs in sociology. However, students' anxiety over the courses is a major concern for instructors. Many students perceive the subject as inherently uninteresting and difficult. This paper describes an experiment designed to introduce aspects of quantitative reasoning into a large substantively focused class in the social sciences. The experiment assessed whether students can learn quantitative reasoning skills in the context of a large "nonmethods" class in sociology. The experiment measured students' mastery of these skills by comparing their competence at quantitative reasoning at the beginning and end of the class term. The results revealed that students' abilities to interpret and manipulate empirical data increased significantly. Further, the increase occurred independent of students' basic reasoning skills as measured by baseline SAT verbal and math scores. This paper discusses the implications of these findings for teaching quantitative methods in sociology undergraduate curricula.

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COURSES ON QUANTITATIVE research methods play a central role in many undergraduate programs in the social sciences, particularly in sociology.[1] Most sociology departments offer one or more courses in social statistics or research methods in their undergraduate curricula. Further, many departments require one or more of these courses for their undergraduate majors (American Sociological Association 1990). At the heart of many of the courses is the idea that quantitative, analytical, and reasoning skills—that is, skills in the manipulation and interpretation of empirical data—are essential to understanding modern society and to interpreting much of the research literature in contemporary sociology (e.g., Hagan, Gillis, and Brownfield 1996; Levin and Fox 1994; Loether and McTavish 1993). Loether and McTavish (1993) summarize the importance of these skills for students in the introductory chapter of their widely used text, *Descriptive and Inferential Statistics*:

> The demand for research is growing and research is being conducted by neighborhoods, political parties, and public and private agencies, as well as university investigators.

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[1]The term "quantitative research methods" refers to courses that require students to manipulate and/or analyze data. Most commonly these courses include substantial material on basic social statistics. While some of these courses may be taught as "pure" statistics classes, others may cover a variety of subjects including statistics. In terms of the arguments made in this paper, both types of classes foster problems for students. The problems typically are more severe in those instances where the classes heavily emphasize social statistics.

> Chances are rather high that you will become involved in the conduct and evaluation of some kind of research yourself. Certainly, we cannot read critically and interpret most of the literature in sociology, much less make original contributions to knowledge in this area, without a relatively detailed knowledge of how to interpret statistical arguments and descriptions and apply them to our own ideas and research. (P. 2)

Despite the centrality of statistics and methods courses in sociology curricula, students' anxiety over the courses represents a major concern in their instruction. Many students may perceive these subjects, particularly social statistics, as inherently uninteresting, quite difficult and, like the immunization injections they received as children, a necessary but quite unpleasant aspect of growing older (Hubbell 1994; Markham 1991; Weaver 1982). In courses on statistics, students' fears about mathematical abilities come directly into play. Those who feel incapable of doing mathematical operations often experience extreme anxiety about the simplest statistical operations. Although there may be less fear associated with general research methods courses, any course that emphasizes quantitative techniques in the analysis of sociological data may aggravate students' anxiety. One result of this anxiety is that students may postpone required statistics or methods courses until the very end of their academic careers. This practice can create significant problems for their performance in other courses—often students who have postponed completion of statistics or methods courses are unable to grasp the quantitative material assigned in upper-division classes.

Students' problems with these courses may also reduce the willingness of faculty members to teach them (McBride 1994; Stacks and Hickson 1991). Students' evaluations of courses perceived as extremely difficult, such as statistics and research methods, tend to be lower than their evaluations of other courses (Gillmore and Greenwald 1994). To the extent that universities or colleges seriously consider student course evaluations in assessing faculty performance, some faculty members may routinely avoid teaching statistics or research methods simply to improve their chances of stronger student evaluations.

Thus, one of the major challenges in teaching statistics and courses in quantitative methods is assuaging student anxiety to a level that allows even the most anxious student to apply statistics and analytical methods to sociological problems correctly. While the authors are unaware of any literature on approaches for reducing undergraduates' anxiety about statistics and quantitative methods, numerous studies have examined the contexts in which students learn quantitative skills most effectively. Much of this research suggests that students learn more when teachers use concrete examples and problems that are relevant to students. For example, Markham's (1991) analysis of teaching research methods in introductory courses points to the importance of integrating material on methodology into the discussion of substantive issues in sociology classes. At the center of his argument is the idea that statistics and research methods may be much easier for faculty members to teach and much easier for students to learn in discussions of substantive sociology than they are as "stand-alone" topics or as courses removed from interesting social problems. This observation is related to a more fundamental issue in teaching—identifying the most effective way to engage students with material that they might find difficult or uninteresting. Many educators maintain that if faculty members engage students with interesting sociological questions, students are more motivated to learn difficult skills. This observation has led many educators to conclude, as Markham, that material on statistics and methods is most effectively taught in the context of substantive sociological issues and problems. [2]

[2]Individual faculty members and instructors have published accounts of their own experiences. Included among these are Bruton and Crull's (1980) and Conklin and Robinson's (1985) analyses of teaching methods in introductory sociology courses. Also important is Shep-

In the absence of empirical evidence on students' learning and different approaches to teaching statistics and sociological research methods, many issues about teaching and learning in this area are poorly understood. One important issue is whether teaching that integrates material on statistics and research methods into substantive sociology classes actually increases students' skills in quantitative reasoning when there is no preexisting student anxiety over content. This issue is not trivial. It has direct implications for the development of effective approaches to teaching one of the most challenging courses in undergraduate sociology programs. Further, evidence on the learning effects of different approaches to teaching may assist in determining whether traditional "stand-alone" courses in statistics and research methods, given their attendant pedagogical problems, are a necessary ingredient of undergraduate curricula for most sociology majors.[3]

This paper summarizes the results of an experiment designed to introduce aspects of quantitative reasoning into a large substantively focused class in the social sciences. The central purpose of the experiment was to assess whether it is possible for students, at the earliest stages of their college careers, to learn basic quantitative and analytic skills in the context of a "nonmethods" class in sociology. The specific objectives of the experiment were twofold. The *first* was to ascertain whether material on quantitative reasoning—through exercises and assignments focusing on quantitative reasoning problems and skills—could be effectively introduced into a large lecture course in the social sciences (Sociology of Deviance) that had no substantive focus on statistics or research methods. Because the materials and assignments would primarily be introduced by graduate student Teaching Assistants (TAs) in discussion sections, it was necessary initially to train the TAs in teaching and delivering the materials. The *second* objective was to examine whether the introduction of material on quantitative reasoning skills actually increased students' quantitative reasoning abilities over the course of an academic term. Assignments were designed to expose students to a series of increasingly difficult concepts about causal reasoning and tabular presentations of data. The assignments also required students to analyze and interpret data using causal reasoning concepts. The experiment measured students' mastery of basic quantitative reasoning skills and knowledge by comparing their competence at quantitative reasoning at the beginning and end of the class term. The remainder of this paper describes the quantitative reasoning exercises and assignments developed for the class, how the material was taught, and the results of the experimental analysis of students' learning.

DEVELOPMENT OF QUANTITATIVE REASONING MATERIAL

We developed the quantitative reasoning material in four steps. First, we established baseline levels of competence for "average" undergraduate students in entry-level sociology courses. We tested students for basic math and analytic skills. Second, we developed quantitative reasoning materials, in the form of exercises and assignments in interpreting and analyzing empirical information, based upon knowledge of these baseline competence levels and upon the teaching skills of TAs who were scheduled to introduce them. Third, we pretested and revised the assignments in an ongoing course prior to their introduction in the large enrollment sociology class. We summarize each of these steps below.

Establishing Baseline Competence Levels

The first step in developing the experimental materials was measuring average baseline levels of competence in quantitative reason-

elak, Moore, and Curry-Jackson's (1992) analysis of critical reasoning skills.

[3]The term "learning" is used here to refer to an actual improvement over the course of the academic term, including the acquisition of measurable reasoning skills and knowledge about research methods and statistics.

ing skills of entry-level undergraduates. This required development and administration of a quantitative skills test to a "typical" entry-level sociology class. This test was adopted from materials developed for mathematics classes, asking students to answer questions about two-by-two and more complex tables showing bivariate and multivariate statistical relationships.

Development of Materials

Once baseline competence levels were established, learning modules were developed with three objectives in mind. First, they should serve to assist in introducing the substantive material for the class. Thus, each module was framed in terms of a single question to be addressed in the class and included introductory material describing the question and relevant theoretical material about the question. Second, each exercise was developed with a specific quantitative problem or set of problems related directly to the central substantive question. Third, each module included classroom illustrations and a specific homework assignment for the students. The homework required the students to manipulate data (e.g., computing percentages) and to interpret the data in a written assignment of two to three pages in length.

Pretest and Revision

The modules were pretested in a small classroom setting (summer term) prior to the implementation of the experiment. The assignments were introduced in the pretest exactly as they would be introduced and taught by TAs in the quiz sections during the experiment. Based upon direct feedback from students and their performance on the assignments, the modules were revised for introduction into a sophomore-level sociology class with a large enrollment that was taught during a regular academic term.

IMPLEMENTATION OF QUANTITATIVE REASONING MODULES

As noted earlier, the structure of the class (Sociology of Deviance) included lectures and quiz sections. Lectures met three times a week and were delivered by the instructor. Quiz sections, where students met twice a week in groups of 25, were taught by graduate student TAs. The content of the course was divided into five segments corresponding to major sociological perspectives on deviant behavior and social control. Each part of the class was comprised of a series of lectures delivered by the instructor, a series of lessons delivered by the graduate student TAs in discussion sections, and a series of readings from scholarly articles and books. The course emphasized, as learning objectives, the development of critical reasoning skills, the mastery of knowledge about social phenomena and their explanation from the perspective of sociological theories, and the effective application of knowledge to solving problems of public policy.

Material on quantitative reasoning was introduced in a series of stages in lectures and quiz sections. During the first week of the term, the lecturer delivered presentations on quantitative reasoning skills (e.g., table reading, computation of percentages, interpretation of findings) and the logic of causal analysis in the context of a sequence of examples of juvenile delinquency and its correlates. Following this presentation, three subsequent presentations or modules were delivered by TAs in quiz sections over the course of the academic term. These modules were deliberately spaced two to three weeks apart and were of increasing difficulty. Each presentation was divided into three components: short lectures by the TAs, classroom discussions of the ideas and the materials, and written homework assignments. The short lecture part of the modules consisted of linking data to a subject (e.g., anomie and suicide, neighborhood disorganization and crime, class conflict and the control of mental illness) that students were studying in the class. Class discussions followed these lectures. The discussions centered around in-class assignments in which students individually and collectively worked to answer questions about a tabular presentation of data

on the classroom subject. Finally, students were assigned short essays of two to three pages in length, in which they were asked to interpret additional data and apply their interpretations to the theoretical issues addressed in quiz sections. These essays were graded and included as part of the course grade.

An illustration of one of the modules, as integrated into the class materials, may prove useful here. One of the major objectives in the class was for students to learn how to apply sociological theories of deviance and social control to explain contemporary social problems. One segment of the class examined macrolevel theories of conflict and social control. In addition to several lectures, students examined writing and research on Marxist or conflict theories of deviance to explain race and gender differences in rates of imprisonment across regions of the country. As part of the preparation for the assignment (see Appendix A), students read the published research of one of the present study's authors (Bridges, Crutchfield, and Simpson 1987) and contrasted it with other work on the same general subject (Chambliss 1975). Then, in their quiz sections, students participated in an in-class activity, applying the ideas they learned from lectures and class readings to tabular data on patterns of imprisonment presented by the TAs. Students discussed the analysis and interpreted the data in terms of the substantive questions raised by the theories. At the end of the discussion section, the students received a writing assignment in which they analyzed and interpreted another set of tabular data, similar to the data analyzed in class (see Appendix A). The assignment was due at the beginning of the next quiz section, usually two days later. After turning the assignment in, students participated in a second activity and discussion involving the completed writing assignment.

THE STUDY

Data on student learning of the material and skills on quantitative reasoning were collected using a one-group pretest/posttest experimental design. Only students who completed both the pre- and posttests were included in the analyses. The tests were administered as follows. On the first day of the academic term, students' quantitative reasoning skills were measured with the pretest (see Appendix B). At the very end of the term, students quantitative reasoning skills were measured with a posttest. The posttest was identical to the pretest.[4] Students were given approximately 15 minutes to complete each test.

The test consisted of 10 questions designed to measure students' quantitative reasoning and table-reading skills. The questions were developed in a manner that would reveal changes in students' performance that would be attributable to changes in quantitative reasoning ability rather than to substantive knowledge contained in the course or in sociology in general. Questions were divided into three sections addressing three progressively difficult concepts. The first section measured students' ability to identify the relationship between two variables. The second section introduced the concept of theory. This section included a short vignette describing a theory and four tables reporting findings. Students were asked to determine which of the four tables offered evidence supporting the theory and which of the four tables offered evidence disproving the theory. The final section addressed the issue of linearity in statistical relationships. In this section, students were asked to determine the relative fit of several relationships—that is, whether the relationships were linear or nonlinear.

Students were given a graded test score

[4]There was little reason to believe that students could or would remember their responses to the earlier test. Students were never given the answers to the pretest. Further, an extensive amount of time (10 weeks) separated the pretest and posttest. Finally, students were introduced to numerous assignments and information similar to the posttest over the course of the academic term. It would be difficult, given the amount of information covered, for students to remember the questions or responses to the pretest.

ranging from 0 to 10, depending upon the number of questions they answered correctly. Partial credit was not given. Neither the pre- nor posttests counted as a grade or as extra credit for the students. However, material from the learning modules introduced in the lectures and the discussion sections did factor into students' grades, as noted above, because the students were graded on the quantitative writing assignments and on quantitative exam questions administered throughout the quarter.

Finally, TAs proctored the pretest and posttest measurements, collecting observational data on the students as they completed the tests. Although not systematic, two types of observational information were collected. First, TAs monitored the time required to complete the tests. Second, they observed whether students were actively engaged in completing the tests—that is, whether the classroom was quiet and students concentrated heavily on the tests.

RESULTS

Table 1 exhibits the mean levels of correct responses for the pre- and posttests for the entire class and for those students who completed both tests. The difference of means for the latter group is significant, revealing a substantial increase in correct scores over the experimental period. For reasons exhibited and discussed below, we are inclined to attribute this increase to learning and the acquisition of quantitative reasoning skills. Quite clearly, students performed better, on average, on the posttest. Whereas the mean number of correct answers for the pretest was 5.71, the posttest mean was 6.73. This represents a 20 percent increase in correct responses between test administrations.

It is possible that students' basic reasoning and analytical skills may contribute to these differences. Students with strong basic reasoning skills—as reflected in mathematical or even verbal reasoning performance—may be more likely to grasp the concepts in lectures and in quiz sections such that posttest scores would be higher than for those students with weak basic skills. The concern here is that some students may enter the class with either much stronger reasoning skills than others or an accumulated academic advantage such that their learning will be significantly shaped by their skills or their past academic success (Neuman 1989; Walberg and Tsai 1983). According to this reasoning, the pretest/posttest differences may be influenced as much by an individual's quantitative reasoning ability and/or

Table 1. Pretest/Posttest Comparisons of Quantitative Reasoning Assessment

Pretest/Posttest	Mean Correct Responses	Standard Deviation
Sample		
Total Pretest (N=455)	5.73	2.11
Total Posttest (N=307)	6.73	2.07
Subjects Completing Pre- and Posttests		
Pretest (N=261)	5.71	2.03
Posttest (N=261)	6.73	2.08
$t = 8.06$ ($p < .001$)		

test-taking skills prior to the experiment as they are to the experimental introduction of quantitative reasoning materials in the class. In order to examine whether the experimental results reported in Table 1 were related to quantitative reasoning skills prior to the course and the experiment, we collected additional data on students' SAT verbal and math scores.

Of the 455 students who completed the pretest, 414 had also submitted SAT scores at the time they were admitted to the university. Of the 261 students who completed both the pretest and the posttest, 260 had submitted SAT scores at admission. Table 2 exhibits the correlations between the SAT scores, pretest and posttest scores, and their differences. The correlations between the SAT scores and the pretest and posttest scores are statistically significant in the predicted direction—students with stronger skills as measured by the SAT achieved higher quantitative reasoning scores than those with weaker SAT skills. However, the correlations are not particularly large (r = .30, .24; .31, .28; .31, .26). We infer from the relatively low values of these correlations that the quantitative reasoning test measured something different and distinct from the skills measured by the SAT. Further, the correlations between the verbal portion of the SAT and the pretest and posttest scores were equivalent in strength to the correlations between the math portion and the pretest and posttest scores. Thus, our quantitative reasoning results measure analytical abilities that are different from math or verbal skills that are reflected in SAT performance. [5]

Equally important is that the correlations between the SAT scores and the pretest/posttest difference scores are near zero (r = .04, .02, .03). Students' improvements in quantitative reasoning skills, as reflected in the difference scores, are not associated with their analytical skills as measured by the SAT upon entering the university. Thus, students with low verbal or math scores were just as likely to achieve improved quantitative reasoning skills as students who entered with high math or verbal scores. We also performed a repeated measures analysis of covariance with SAT total score as the covariate and pre- and posttest as the repeated measure. This test examined the hypothesis of no difference between pre- and posttest scores on the quantitative reasoning test, once differences in ability as reflected in SAT scores were removed. However, the differences between the pre- and posttest scores remained sizable and statistically significant in this analysis ($F = 63.59$; $df = 1, 259$; $p < .001$), indicating as above that the change from pretest to posttest was substantial and statistically independent from SAT scores.

One possible interpretation of the results is that the difference between the pretest and posttest scores reflects improvements in test-

[5]The results reported in Table 1 also reveal that the differences between the pretest mean of students who took the posttest and those that did not were negligible. This result suggests that the students who were and were not present for the posttest did not differ systematically on quantitative ability.

Table 2. Pearson Correlations Between Students' SAT Verbal, Math, and Total Scores with Pretest, Posttest, and Difference Scores

SAT Scores	Pretest Score	Posttest Score	Difference
SAT Verbal	.30*	.24*	.04
SAT Math	.31*	.28*	.02
SAT Total	.31*	.26*	.03

* $p < .05$

ing skills rather than improvements in actual reasoning skills—that is, improvements in guessing the answers correctly rather than deriving answers from correct manipulations of data. While it is impossible to test this hypothesis definitively, TAs' observations about the test-taking performance of students in the sessions shed some light on this issue. TAs generally reported that the testing situations for the pre- and posttests were quite similar. Students completed the tests in about the same amount of time for both sessions—there were no more "late" or "early" finishers in the pretest than the posttest. Further, students exhibited the same level of seriousness and commitment to the task in both sessions. Very few students in either session failed to answer all of the problems. Further, there were no more inquiries from students about the test questions (e.g., "I don't understand what this question means. Could you explain it to me?") during the pretest session than during the posttest session. Thus, there is no observational evidence from students' behavior during testing sessions that suggests the students were more adept at taking the posttest than the pretest, having worked with similar material a few times over the course of the term.

A related issue is whether students' uncertainty or anxiety over the course changed with the introduction of the quantitative reasoning modules. We did not incorporate any anxiety measures into the study design. However, we compared students' evaluations of the experimental course before and after the experiment was conducted in order to examine how students' perceptions may have changed. Three aspects of the evaluations were examined. The first was a measure of students' satisfaction with the assignments and grading practices. The second measured students' perception of the reasonableness of assigned work. The third measure assessed students' beliefs about the clarity of the instructor's expectations of them. No qualitative data or written comments by students regarding the assignments were available for the analyses.[6]

Our analyses of these measures found that students' evaluations of the course were higher on each of the measures for the experimental period than in previous courses. Prior to the inclusion of the quantitative reasoning modules, students consistently rated the clarity, level of organization, and structure of assigned work in the class as relatively low. Following inclusion of the modules, a higher proportion of students felt that the assignments were clear, that expectations were certain, and that the organizational level of the class was high. One interpretation of this pattern is that the structured nature of the quantitative work, unlike previous writing assignments used in the course, actually increased the clarity of tasks and students' perceptions of what was expected from them. By increasing the organization and predictability in assignments, the inclusion of quantitative reasoning modules may have actually improved students' assessments of the course overall and material included in the course. While this reveals little about whether teaching quantitative methods in this manner reduces student uncertainty and anxiety relative to traditional teaching approaches, it does suggest that adding carefully structured quantitative material to a substantively oriented class does not increase students' uncertainty, confusion, or frustration with the class.[7]

[6] While qualitative data concerning the statistical modules were not available at the time of the present study, we did examine the qualitative evaluations of the class shortly after the course had concluded. There were no remarkably positive or negative comments concerning the assignments or their use in this data.

[7] The assignments were pretested numerous times on students in classes prior to their use in the experiment. Many of the early problems pertained to the clarity of assignment questions and how the questions related to data presented along with the assignment. A set of study tips for data and table reading was given to students early in the quarter to help them "walk through" any set of data or table they encountered. A related problem that emerged early in the pretest was that many students seemed to "freeze" cognitively when the first set of tabular data

DISCUSSION

In the second edition of his now classic textbook, *Social Statistics*, Hubert Blalock (1972) wrote that "one of the most difficult problems encountered in the teaching of applied statistics is that of motivating students, both in enabling them to overcome their fears of mathematics and in learning to apply statistics to their own field of interest" (p. xi). Our quasi-experiment examined the problem of teaching certain aspects of social statistics and quantitative reasoning in the context of a substantive sociology class. The experimental results suggest that students' ability to interpret and manipulate empirical data increased over the course of a single term in which instructors introduced quantitative reasoning modules as part of the course material. Further, the increase occurred above and beyond the effects of students' basic reasoning skills as measured by baseline SAT verbal and math scores. Thus, the improvements in learning are not necessarily attributable to certain types of students or student experiences prior to participating in the experiment or the class.

Although these analyses suggest that instructors may achieve significant improvements in students' learning of statistics and methods skills in "nonmethods" classes, the results do not inform debate over many important concerns in teaching sociological methods. First, our experimental results do not address whether instruction in the manipulation and interpretation of data in substantive classes is more effective pedagogically than instruction in "stand-alone" statistics classes. The analysis performed in the present study involved no comparisons between learning in a substantive sociology class with learning in a class devoted entirely to social statistics or research methods. Indeed, it is quite possible that greater improvements in quantitative reasoning, as measured in the present study, might be achieved in a statistics or methods class. An important consideration in comparing the two types of instruction would be to separate differences between substantive and methods courses in teaching and delivering material to students. Any such comparison would need to separate "instructor effects" on learning from the effects of actual exposure to material about quantitative methods and analyses. An obvious approach to the comparison would be to conduct the experiment by having the same instructor teach the same material in two different types of classes—one a substantive class and the other a statistics or methods class—and then compare student learning between the two types of classes, adjusting for other important factors like class composition and baseline reasoning skills.

A second area that our analysis does not address is the relative effectiveness of different strategies for teaching research methods and statistics. While many scholars believe teaching that incorporates extensive use of interesting examples and problems enhances learning, there is little empirical evidence in research on instruction in the social sciences supporting this belief. The present study suggests only that students can learn skills in interpreting and analyzing data in classes

were presented in class. To address this problem, the lecturer devoted two complete classes to training students in table reading, from frequency distributions to three-way tabular analyses. Using very intuitive examples and open question-and-answer periods throughout the lectures, we found that most students quickly overcame their initial fears of data analysis. A final problem that we encountered had more to do with assisting students in drawing causal inferences from tabular relationships. Students often confused "cause" with "effect" and, as a result, interpreted data on relationships between variables incorrectly. To address this problem, the lecturer and the TAs began by offering examples that were so simple as to be almost absurd and then progressively advanced the discussion to more complex relationships. In our experience, a pedagogical problem had to do with what level to "pitch" the class. In order to avoid losing students' interest, we decided to pitch the material at a very low level initially and then progressively increase the difficulty of the material to a level that met our minimal acceptable goal of the types of analyses we expected students to learn.

that emphasize substantive issues and problems in sociology. Educators must examine whether there are particularly effective teaching strategies for instruction in social statistics and methods. Among the areas of concern must be issues such as techniques for integrating abstract material on mathematics and statistics with concrete research problems (Markham 1991), effective exercises that give students opportunities to practice skills in the manipulation and analysis of data (Stacks and Hickson 1991), the use of active learning strategies in the classroom that emphasize quantitative reasoning skills (Jenkins 1995), and the use of computer technology in analysis problems (Magnuson-Martinson 1995; Persell 1992).

Despite the limitations of the present study, our analysis has important implications for incorporating material on statistics and research methods into undergraduate training in sociology. An issue raised by our analysis is whether required courses in statistics and research methods are a necessary part of undergraduate curricula. In light of students' anxiety about these courses and some faculty members' justifiable aversion to teaching them, alternative curricula may prove more effective. By integrating training on quantitative reasoning into core substantive courses in the sociology curriculum—quantitative reasoning across the curriculum—programs may enhance learning of quantitative reasoning skills without requiring sociology majors to complete formal courses in these methods, at least as those courses have been conventionally taught. Since most students who complete sociology majors do not participate in postbaccalaureate education, they may not require extensive training in specific quantitative techniques used in sociological research (e.g., sampling techniques, inferential and multivariate statistical methods, and experimental design). Programs can retain courses in statistics and methods for those students who expect to pursue graduate education or who desire additional training in quantitative research techniques. Alternatively, those programs seeking to improve the training of undergraduates in methods and statistics might consider incorporating quantitative reasoning in core substantive courses in the curriculum as a prerequisite to more advanced methods and statistics courses. Rather than allowing students to bypass traditional metods and statistics courses altogether, these programs might better prepare their students for advanced courses by giving them introductory doses of methods and statistics in early substantive courses. This strategy might have the effect of reducing anxiety to a level that enables students to participate more effectively in the advanced classes.

Instructors choosing to utilize this approach to teaching methods and/or statistics will need to develop effective strategies for incorporating quantitative reasoning into the class material. Based on the findings of this experiment, we have at least three suggestions. First, examples and assignments using quantitative methods must be developed with extreme care. The assignments should draw on substantive subjects that are inherently interesting to undergraduates. They need not all cover topics in sociology like crime, violence, or human sexuality, to which many undergraduates are immediately drawn. But students must be attracted to the material for substantive, not methodological reasons. Students rarely are attracted to methodological issues or concerns. Second, the assignments should involve similar types of operations so that students repeat the same types of operations over numerous applications. Repetition in solving methodological problems reduces anxiety and, for many students, increases learning. In-class discussions of the assignments also contribute significantly to student learning. Third, instructors must design the assignments at a level of difficulty that most students in the class, particularly the most anxious and challenged, can master. By designing material that students with the *least* amount of skill and the *most* amount of anxiety can learn (and then progressively increasing the difficulty of the assignments over the quarter), faculty members can ef-

fectively diminish student anxiety as confidence in the material and methods increases.

Most sociology programs are based on the assumption that undergraduate students benefit from training in correctly manipulating and interpreting quantitative information (Conklin and Robinson 1985; Szafran 1983). Our results suggest this can be accomplished in substantive courses in sociology with changes in the content of course material and the focus of instruction. Obviously, our experiment represents only a modest effort in this direction. An integrated curriculum with additional courses presenting different examples and analysis techniques would be necessary to implement this idea fully. This approach to teaching and learning would circumvent many of the pedagogical problems experienced in "stand-alone" statistics and research methods classes. Given the serious problems these courses engender for students and faculty members, reexamining their role in undergraduate curricula may prove useful, particularly if the examination focuses on the types of basic quantitative skills that can be introduced in substantive classes. While formal training in statistics and research methods should be retained and required for those students who intend to pursue postbaccalaureate studies in sociology, such training may not be the most effective approach to improving the quantitative reasoning skills of the majority of sociology majors. Programs might more effectively situate basic training in quantitative reasoning skills within substantive courses in which students have personal interests and in which faculty members are already heavily invested in teaching. Introducing quantitative reasoning into substantive courses would also connect training in research methods, especially statistics, with important substantive issues in sociology. This would allow students to apply the methodological skills they develop to sociological questions, thereby revealing precisely what sociologists do. It would also better prepare students for more advanced study in their substantive areas of interest.

APPENDIX A. EXAMPLE OF QUANTITATIVE REASONING ASSIGNMENT

SOCIOLOGY 271

QUIZ SECTION WRITING ASSIGNMENT

Table 1 includes information on characteristics of states and rates of confinement for chronic mental illness in the United States. In your essay, answer the following questions about the table. Your essay should be 2-3 double-spaced typed pages in length (12 point font and 1 inch margins).

a. What is the relationship of state rates of crime, unemployment, educational attainment, and percentage of minorities in the population *with* rates of confinement for whites and minorities for chronic mental illness? Describe these in depth.

b. How would conflict theories of deviance explain these relationships? Be specific. In your answer, be certain to describe the major arguments of the theories.

Table 1. State Rates of Confinement in Mental Hospitals for Chronic Mental Illness

	White Confinement Rates			*Minority Confinement Rates*		
Factor	States with Low Rates	States with Medium Rates	States with High Rates	States with Low Rates	States with Medium Rates	States with High Rates
Crime Rate	5.6	6.3	7.5	4.0	5.7	6.9
Unemployment Rate	5.4	11.5	18.2	10.3	10.2	10.4
Average Grade Level Achieved	12.2	11.4	10.3	12.1	10.9	9.8
Percent Minority	15.3	16.1	15.9	8.3	15.6	24.2

Note:
Crime Rate = The number of crimes committed per 1,000 persons in the population.
Unemployment Rate = The number of persons unemployed per 1,000 persons in the population.
Average Grade Level Achieved = The average grade level achieved in school by adults in the population.
Percent Minority = The percentage of persons of color in the total population.
Example: The crime rate in states with low white confinement rates for mental illness is 5.6, meaning that 5.6 crimes per 1,000 people were committed in those states.

APPENDIX B. QUANTITATIVE REASONING PRETEST AND POSTTEST

Analytical Reasoning Exercise

We say that two variables are positively related if when the value of one increases so does the value of the other and vice versa. Two variables are negatively related when the opposite is true; that is, when the value of one variable increases, the value of the other decreases.

Table A presents the (hypothetical) relationship between number of homicides and the number of hand guns owned per 10,000 people in three countries.

	Country 1	Country 2	Country 3
Homicide Rate	25	10	20
Hand Gun Ownership Rate	130	75	120

1. Is the relationship between rates of handgun ownership and homicide:
   a. Positive?
   b. Negative?
   c. No relationship?
   d. Cannot tell from the data?
2. Based on these data alone, what would you predict the effect of stiffer gun control laws on homicide rates?
   a. The homicide rates would increase.
   b. The homicide rates would decrease.
   c. There would be no effect on homicide rates.
   d. The data lead to no specific prediction.

Professor Ging Newtrich feels that the way to decrease homicide is to increase family values by encouraging such things as church attendance and prayers in school. One prediction his theory might make, then, is that greater church attendance would lead to less homicide. To investigate his theory, four studies were done in four different metropolitan areas. In each study, the areas were divided into three sections: the inner city, the rest of the city, and the nearby suburbs. The results of the four studies in terms of rates of church attendance and homicide are shown in Tables A through D below.

Table A.

Rates	Inner-City	Outer-City	Suburbs
Church Attendance	35	28	26
Homicide	14	12	1

Table B.

Rates	Inner-City	Outer-City	Suburbs
Church Attendance	15	25	35
Homicide	12	5	2

Table C.

Rates	Inner-City	Outer-City	Suburbs
Church Attendance	12	16	22
Homicide	18	17	15

Table D.

Rates	Inner-City	Outer-City	Suburbs
Church Attendance	30	29	32
Homicide	18	17	15

3. In which table do the data *strongly* support the professor's theory?
   a. Table A
   b. Table B
   c. Table C
   d. Table D
4. In which table do the data provide *weak* support for the professor's theory?
   a. Table A
   b. Table B
   c. Table C
   d. Table D
5. In which table do the data suggest that the theory is wrong?
   a. Table A
   b. Table B
   c. Table C
   d. Table D
6. In which table do the data offer the least evidence for or against the theory?
   a. Table A
   b. Table B
   c. Table C
   d. Table D

Sociologists are often not only interested in the direction of a relationship (positive or negative) but also in its shape. For example, relationships can be basically linear, which means that when one variable increases, the other increases (or decreases) proportionately the same amount. The table below illustrates relationships of different shapes.

This table presents hypothetical data on programs developed to reduce prisoner recidivism. Recidivism means being jailed again after already having served time. Let us say that without any special programs, the average rate of recidivism is 33 percent. In other words, 33 percent of the prisoners will return to jail at some time after they have been released. The table below presents the recidivism rates per dollar spent on each prisoner for three different programs designed to reduce the recidivism rate.

THE PERCENTAGE OF RECIDIVISM

Amount Spent Per Inmate

	$10,000	$20,000	$30,000	$40,000	$50,000	$60,000
Program A	29%	26%	22%	19%	15%	12%
Program B	27%	22%	19%	16%	14%	13%
Program C	31%	29%	26%	22%	17%	11%

7. If your goal was to reduce recidivism, which of the programs would you recommend if you had few dollars to spend per inmate?
   a. Program A
   b. Program B
   c. Program C
   d. Cannot tell from the data provided
8. Which program would you recommend if you had lots of money and could spend as much as needed?
   a. Program A
   b. Program B
   c. Program C
   d. Cannot tell from the data provided
9. Which program appears to be the least likely to lower the recidivism rate to less than 5%, no matter how much money is spent?
   a. Program A
   b. Program B
   c. Program C
   d. Cannot tell from the data provided
10. In the long run, which program could save the state the most money?
    a. Program A
    b. Program B
    c. Program C
    d. Cannot tell from the data provided

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