

**Quantitative Skills Acquisition by Economics Majors:
An Assessment**

This is a report of the assessment project carried out by Miles Finney and Kon Lai with the assistance of Kathleen Ng at California State University, Los Angeles. The participation by a number of other faculty members in the Department of Economics and Statistics is acknowledged.

I. Introduction

This study is an assessment of the quantitative skills retained by the economics majors in the Department of Economics and Statistics at California State University, Los Angeles. This assessment was undertaken for two reasons. First, the increased value society places on quantitative ability leads the department to evaluate exactly how well it is imparting those skills to its students. Second, the recent school- and department-level changes in the quantitative course requirements prompted the department to examine whether students are receiving fundamental quantitative skills training.

This study investigates whether the enunciated department goals regarding quantitative training are being met. The goals stated in the department program review document are: (1) *Economics majors are expected to be able to evaluate summary numerical data and be able to make decisions on such information by the time they complete their program;* (2) *By the time they complete their program economics majors are expected to understand fundamental concepts in statistics such as sampling and biasedness, and be able to consider such factors in making decisions from statistical information;* and (3) *Economics majors should acquire knowledge on how computer technology can assist in generating and analyzing statistical information.*

We created two assessment instruments, a student survey and a diagnostic exam, to evaluate students based on the above department goals. The instruments were administered to students taking the upper division undergraduate courses offered by the economics department in the Spring

quarter, 2000. This report summarizes the findings and discusses what we have learned from the survey results.

II. Characteristics of Surveyed Students

The student survey collected data on characteristics of the respondents such as their major and obtained information on their classroom experiences (appendix A). All except two of the respondents stated they had taken at least one college level statistics course, either at Cal State LA or elsewhere. Although our main purpose is to evaluate the economics majors, the sample data also included business majors who were either minoring in economics or taking Labor Relations (Econ 472) under the Human Resource Management option (Table 1).

Table 1

	<u>Students</u>
Economics Majors	14 (30%)
Non-Economics Majors	33 (70%)
Total Respondents	47

Most of the students entering Cal State LA are transfers from local community colleges. We wanted to get an idea of how many of our students obtain their core statistics instruction from the department. Econ 209 may be the most important statistics course in our quantitative sequence although many transfer students receive community college credit for the course. Table 2 distinguishes students who took Econ 209 from those who did not. All of the students in the sample stated they took some college statistics. Table 2 indicates that a large majority of students,

Table 2

	<u>Took</u> <u>Econ 209</u>	<u>Did Not Take</u> <u>Econ 209</u>
Economics Majors	7 (63.3%)	4 (36.4%)
Non-Econ Majors	25 (80.6%)	6 (19.4%)
Total Respondents	32 (76.2%)	10(23.8%)

both economics and non-economics majors, took their core statistics instruction with the department.

The use of computers to communicate and process information has become increasingly prevalent over the years. The department has begun to change the way its core statistics courses (Econ 209 and 309) are taught by emphasizing computer spreadsheet applications, mainly Excel, in class.

Students who stated they had taken at least one statistics course from the department were asked if they had been exposed to a spreadsheet program such as Excel. Seventy-four percent of the students responded affirmatively. This percentage did not vary between economics and non-economics majors. The department encourages all part-time and full-time faculty to include a computer/spreadsheet component in every basic statistics course taught.

III. Evaluation of Diagnostic Statistics Exam Results

The surveyed students were given a multiple choice exam with ten questions involving elementary statistics concepts (Appendix B). The diagnostic test primarily covers material the students learned in Econ 209 (or equivalent), the first statistics course. As stated in the introduction, the exam evaluates the

degree to which students retain core statistics concepts. The surveyed non-economics business majors serve as a comparison group to the economics majors. It should be noted, however, that the business majors in the survey were not the "usual" business students. Most business students do not take any additional economics courses beyond those required by the BSBA core.

Forty-seven students took the diagnostic exam, 85% of whom answered all ten questions.¹ As indicated by table 3, the average student answered 60% of the questions correctly. Almost one quarter of the students (11 out of 47) scored at least an 80% on the exam.² Seventy-four percent of the students answered at least half the exam correctly.

Table 3

	<u>Students' Score</u>
Mean	.60
Median	.60
Mode	.70
Minimum	.20
Maximum	1 (100%)

The fact that 3/4 of the students obtained a .50 or above on the diagnostic exam is particularly significant. Some faculty members have been concerned that students retain little from one statistics (or economics) course to another. Apparently, the concern is not substantiated by the findings, at least not for this sample of surveyed students.

Students choose to major in economics presumably because they have an advantage in working with the analytical and quantitative aspects of the field.

¹ The summary statistics in table 1 were calculated after throwing out those questions individual students did not answer. Recalculation of the grades in which missing answers are counted as incorrect would not appreciably alter the summary results. The average student answered over nine of the ten questions.

² Two students made a perfect score.

According to table 4, the economics majors scored considerably better than non-majors on the diagnostic exam. The score difference of eleven percentage points is statistically significant based on a formal test for equality of proportions.³ The test suggests that the stronger performance by the sample of economics majors compared to non-majors can very likely describe the relative positions of the corresponding student populations.

Table 4

	<u>Students</u>	<u>Mean Score</u>
Economics Majors	14	.68
Non-Econ Majors	33	.57

Analysis of student performance on specific parts of the exam sheds further light on student retention of statistics concepts. As shown in table 5, the percent of correct answers varied substantially across the questions. Differences in mean scores between economics majors and non-majors were not statistically significant for most of the individual questions. The estimates in table 5 are, therefore, not classified by major.

Table 5

<u>Question</u>	<u>Percent Correct</u>	<u>Question</u>	<u>Percent Correct</u>
One	.83	Six	.66
Two	.85	Seven	.21
Three	.53	Eight	.82
Four	.54	Nine	.27
Five	.61	Ten	.66

Questions one, two and eight are significant in that over 80% of the student responses were correct. The first question asks the student "Why is it

³ The hypothesis test is: $H_0: P_1 - P_2 = 0$ $H_1: P_1 - P_2 > 0$ where P_1 is the proportion of the exam correctly answered by the population of economics majors and P_2 is the proportion of the exam correctly done by non-economics majors. The test statistic ($Z=2.28$) leads us to reject the null hypothesis that the two population proportions are equal at the 5% level of significance.

important in statistics to distinguish between a population and a sample?" In correctly answering the question, the student reveals that she can distinguish between the statistics concepts of sample and population and can determine why it is important to make that distinction. Question two covers much of the same ground - the student must identify the population of a hypothetical study. The distinction between sample and population is a key concept in inferential statistics. Students who can recognize this distinction and realize its importance should understand the basis for the field of study.

Another fundamental idea in inferential statistics is the concept of biasedness. In the context of a hypothetical survey, question three asks if a small random sample, because of its size, is necessarily biased. Students did not perform as well on this important question (53% correct) although it may have been one of the more difficult on the exam.

The remaining question the students performed well on (question eight) prompted them to identify the information conveyed by a distribution of the number of years CSLA students spent acquiring a Bachelor's degree. The students knew what the graph of the distribution generally revealed about the years-to-graduation variable. However, they had trouble actually interpreting the distribution. The previous exam question (seven) refers to the distribution and asks the student to determine the probability a person would take at least six years to graduate. Table 5 shows that only 21% of the students correctly answered this question, the lowest percentage score among all the questions.

Student confusion in evaluating the graph is further noted by observing the breakdown of question seven by major. The question is one of only two in the exam in which the difference in average scores between economics majors and non-majors is statistically significant. Forty-three percent of economics majors answered the question correctly compared to just 12% of non-majors.

The only other question in which fewer than 30% of all respondents provided a correct answer dealt with the definition of a confidence interval (question nine). The students did not realize that calculating a confidence interval for a population mean would be rendered unnecessary if the value of the population mean is already known. This suggests they did not retain, or never grasped, an understanding of the idea behind a confidence interval.

The results for question ten are also interesting because the problem covers regression analysis - a topic beyond the level of Econ 209. The performance by the economics majors on the question was significantly stronger than the non-majors. Eighty-five percent of the economics majors correctly answered the question as opposed to 57% for business students. Regression is an empirical methodology often used in economics, which may explain the higher average grade on the question by the economics students.

Some of the students in the College of Business and Economics arrive as transfers having already taken the first statistics course. Although most of the statistics courses taught in Los Angeles area community colleges articulate with Econ 209, the department does not directly control the material taught in those courses or the quality of instruction. We evaluate student performance on the

diagnostic exam of those who took Econ 209 compared to those who have had statistics credit transferred in. Table 6 reports the comparative performance.

Table 6

Mean Scores for students who:

	<u>Took</u>	<u>Transferred</u>
	<u>Econ 209</u>	<u>209 Credit</u>
Economics Majors (10)	.76	.63
Non-Econ Majors (30)	.56	.64

The results are mixed. Economics and business majors who transferred in Econ 209 credit perform equally well on the exam. Surprisingly, however, those sampled business majors who took Econ 209 have a lower average grade on the exam than those business students with transfer credit. Conversely, and more intuitively, the economics majors who took Econ 209 had an average score 13 points higher than those who did not. These sample results, however, cannot be interpreted to imply that the populations of economics and non-economics majors hold the above pattern. The difference in the proportions is found to be statistically insignificant for either group (see footnote 3). The numbers in table 6 are therefore merely suggestive.

IV. Conclusion

The economics students, who averaged almost seven out of ten questions correct on the diagnostic exam, did reveal a general grasp of statistics concepts. A more defined summary evaluation of the students is given by reviewing the department goals on quantitative skills acquisition and evaluating the evidence on the attainment of those goals.

The first goal: *Economics majors should be able to evaluate summary numerical data and make decisions based on such information....* The evidence suggests that although there remains room for improvement, the economics students performed well - either in an absolute sense or relative to their comparison group - on the questions in which they were prompted to interpret summary statistics either within a distribution or regression equation.

The second goal: *Economics majors should understand fundamental concepts in statistics such as sampling and biasedness, and be able to consider such factors in making decisions from statistical information...* The knowledge demonstrated by economics students on the fundamental statistics concepts needed for decision-making was mixed. The students knew the basic distinction between *sample* and *population* but seemed confused on the important concept of *biasedness* in sampling.

The third goal: *Economics majors should acquire knowledge on how computer technology can assist in generating and analyzing statistical information...* Assessing the attainment of this goal involved surveying the students on their classroom experiences. Almost 3/4 of the surveyed students who took some statistics from the department responded that they had been exposed at least to a computer spreadsheet program in class. This helps the department gauge the extent computer technology has been integrated in the statistics curriculum.

Appendix A

Questionnaire

Name _____

Student ID Number _____

Please answer the following questions by marking the appropriate response. This questionnaire is only for undergraduate students.

1. Please mark the box that best identifies your status at Cal State LA.
 - BA Major in Economics/ Social and Behavior Sciences
 - BA Major in Economics/ Applied Economics
 - BSBA Concentration in Business Economics
 - BSBA Other Concentration
 - BA Other Major

2. You are presently classified as a:
 - Freshman Sophomore
 - Junior Senior

3. Have you taken at least one statistics course at the college level either at Cal State LA or elsewhere?
 - Yes (go to question 4) No (go to 8)

4. Identify the statistics courses you have taken from the Economics department at Cal State LA. (check all that apply)
 - Econ 209 Econ 309 Econ 414 Econ 415
 - None of the above courses (go to 8)

5. Were you ever exposed in any of the statistics courses taken from the economics department at Cal State LA to a spreadsheet program such as Excel to calculate statistics?
 - Yes No

6. Identify the different statistical procedures you have either been assigned to do or was taught to perform in your statistics courses. (check all that apply)
 - Generate Summary Statistics (ex. mean, variance) Generate Regression
 - Generate Graphs of Data

7. Identify the statistical software you have used in the statistics courses taken from the economics department at Cal State LA. (check all that apply)
 - SAS SPSS Forecast Pro Minitab

8. Thank You!

Appendix B

Standardized exam on statistical concepts.

1. Why is it important in statistics to distinguish between a population and a sample?
 - a. Because samples are typically biased.
 - b. Because the researcher normally uses sample information to make a statement about a population.
 - c. Because a sample is normally larger than a population.
 - d. Because the researcher normally uses population information to make a statement about a sample.

Use the following scenario to answer questions 2, 3 and 4.

Suppose you want to acquire information on the job status of students attending Cal State LA in Spring 2000. There are 18,000 such students. You randomly select a sample of 50 Cal State LA students and calculate the percentage of the students who are employed.

2. What is the population you have set out to study?
 - a. College students in California as of Spring 2000.
 - b. College students in Los Angeles as of Spring 2000.
 - c. College students at Cal State Los Angeles as of Spring 2000.
 - d. Fifty students at Cal State Los Angeles as of Spring 2000.
3. Is the sampling procedure used to generate the sample of 50 students biased?
 - a. Yes, because the sample is too small relative to the 18,000 students at Cal State LA.
 - b. No, just as long as each observation in the sample is taken from the identified population, it is unbiased.
 - c. No, random sampling is an unbiased method of sampling from a population.
 - d. It is impossible to tell since we do not know the value of the actual statistics calculated from the sample.
4. The researcher will calculate the percentage of the 50 surveyed students who are employed. Will that percentage equal the percent of all 18,000 students who are employed?
 - a. It could, although there is the possibility of sampling error.
 - b. No, because the sample is too small.
 - c. Yes, we know it will because the sample is unbiased.
 - d. No, we know it will not because the sample is biased.

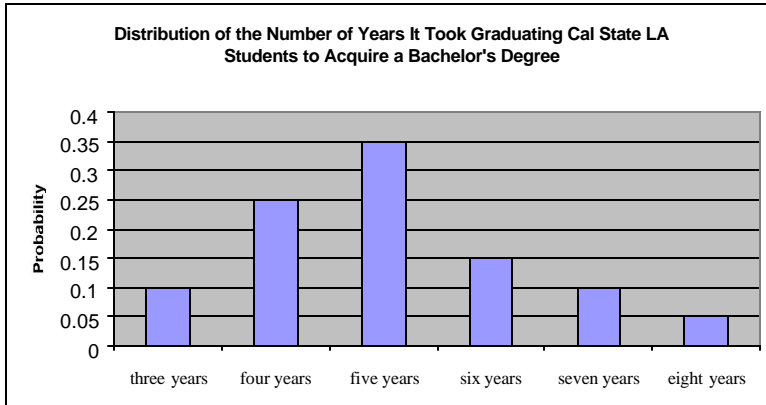
5. In studying a population, the concept of probability is important because,
- a. normally, probabilities can only be guessed at.
 - b. normally, you will not know with certainty the characteristics of the population because you will typically have information only for a sample.
 - c. normally, you will know with certainty the characteristics of the population you are studying.
 - d. normally, probability will fall between 0 and .50.
6. The chart below represents the age distribution of professors hired by California universities this academic school year.

Age	Relative Frequency
25 to under 30	0.18
30 to under 35	0.3
35 to under 40	0.2
40 to under 45	0.18
45 to under 50	0.08
50 to under 55	0.04
55 to under 60	0.02

Observing the distribution above, what is the probability that a professor hired this year will be over 60?

- a. 2%
- b. 6%
- c. 100%
- d. 0%

Use the distribution below to answer questions 7 and 8.



7. Looking at the above distribution, what is the probability that a Cal State LA student will take at least six years to graduate?
 - a. 30%
 - b. 15%
 - c. 25%
 - d. 100%

8. Suppose you were an administrator charged with identifying and assisting those students who take a long time to graduate. How would the above graph assist you?
 - a. It would directly tell you the total number of students who take a long time to graduate - for example, over six years.
 - b. It would give you an idea of the time the typical student takes to graduate and indicate the percentage of students who take an extraordinarily long time to graduate.
 - c. It would tell you the type of student most likely to take a longer time to graduate.
 - d. It would tell you exactly what the standard deviation is of the variable representing the length of time taken to graduate.

9. Suppose you want to find the population mean age of students attending Cal State Los Angeles in Spring 2000. You obtain the age information for all the students attending CSLA during the S2000 and calculate the value of the population mean.
 - a. Calculating a confidence interval for the population mean would be unnecessary since you already know its value.
 - b. Calculating a confidence interval would provide you information regarding the possible value of the population mean.
 - c. Confidence intervals are never calculated for the population mean.
 - d. None of the above

10. Suppose the following equation has been estimated from a sample of Cal State LA employed students: $W=2.20 + 1.22E_1 + .79E_2$ where W is wage in dollars and cents, E_1 is years of education and E_2 is years of experience. Which of the following statements below is a correct interpretation of the equation?
 - a. The average wage in the sample is calculated to be \$2.20.
 - b. A 79 cent wage increase causes experience to increase by 1 year.
 - c. The wage, W , is an independent variable in the equation.
 - d. A year increase in education causes expected wage to increase by \$1.22.