

APPENDIX A

SAMPLING AND ESTIMATION PROCEDURES

To establish valid trends in undergraduate course enrollments and faculty characteristics, the sampling and estimation procedures of the 1980 survey followed closely those of the two preceding surveys.

Sampling Procedure. The National Center for Education Statistics (NCES) report of 1979 opening fall enrollment (Pepin, 1980) listed 3,141 institutions of higher education in 50 states and the District of Columbia. Of these, 725 graduate, professional, or vocational schools offer no regular undergraduate mathematics instruction, so the population for the survey included only the remaining 2,416 institutions.

The survey questionnaires were sent to a stratified random sample of 416 institutions. In choosing the sample, institutions were first stratified according to control and type:

A. Control

1. Public
2. Private

B. Type

1. Universities, with two or more professional schools
2. Four-year college or four-year branch of a university
3. Two-year college or two-year branch of a university or four-year college.

Then, within each control/type stratum, institutions were grouped into zones with approximately equal aggregate square roots of enrollments. From each of the resulting 209 zones, two institutions were chosen for the sample. The procedure for zone formation gave valuable further stratification since it placed institutions of similar size and geographic location in the same zone.

The zone formation method gave different sampling ratios for institutions of different size. Within each control/type stratum larger institutions tended to be in zones with few members and thus were more likely to be sampled. Table A.1 gives the number of institutions in the population and the sample for each stratum.

After sample institutions were chosen, appropriate questionnaires were sent to heads of all mathematical science departments listed under the institutions in the 1980 Mathematical Sciences Administrative Directory. Almost every university and four-year college had a mathematics department; questionnaires were also sent to statistics and computer science departments where

Table A.1

NUMBER OF INSTITUTIONS IN EACH CONTROL/TYPE STRATUM OF
POPULATION AND SAMPLE

Control/Type	Population	Sample
1. Public Universities	95	41
2. Private Universities	65	19
3. Public 4-Year Colleges	407	96
4. Private 4-Year Colleges	830	100
5. Public 2-Year Colleges	914	152
6. Private 2-Year Colleges	<u>105</u>	<u>8</u>
Totals	2,416	416

they existed in sampled institutions. However, in two-year colleges the mathematics programs are often run by departments or divisions of broader scope like mathematics and science, mathematics and engineering, or technology. Questionnaires for two-year colleges were addressed to the "person in charge of the mathematics program".

In the 416 sampled institutions there were 73 separate departments of computer science and 20 departments of statistics. Questionnaires were sent to each of these departments. Table A.2 shows the distribution of computer science and statistics departments in the population and the sample.

Table A.2

NUMBER OF COMPUTER SCIENCE AND STATISTICS DEPARTMENTS IN
POPULATION AND SAMPLE

Control/Type	Population	Sample
Computer Science		
1. Universities	94	41
2. Public 4-Year Colleges	85	26
3. Private 4-Year Colleges	48	6
Statistics (Universities only)	42	20

Previous CBMS surveys have found substantial enrollments in mathematical science courses (mainly computer programming and statistics) taught outside of mathematical science departments. It is important to keep in mind that data on enrollments reported in this volume reflect only data from the mathematical science departments described above.

Estimation Procedures. The course enrollment and faculty data presented in this report are estimates of national totals for institutions of higher education, not totals for responding institutions or estimates for the sample. To arrive at these national estimates, response data were multiplied by weighting factors based on sampling and response rates. Since these rates were different for each type of institution and mathematical science department, the weighting factors were determined separately for each of these groups and for each survey question.

The basic sampling pattern was to select two institutions from each zone, so the procedure for calculating national estimates from responses involved two steps:

1. Zone data estimate = Response data x $\frac{\text{Institutions in zone}}{\text{Respondents in zone}}$.
2. Control/type category data estimate = Sum of zone data estimate

Because the number of respondents in a zone was 0, 1, or 2, this basic weighting method was susceptible to distortion by non-respondents. In practice, responses from similar zones were clustered before extrapolation. For example, the fall 1980 national enrollment in elementary statistics was estimated to be 107,000 students. Calculation of this estimate began with data from public universities. The 95 institutions in this control/type category were grouped into five clusters according to enrollment.

Cluster	Number of Institutions	Average enrollment
1	12	41,400
2	28	26,600
3	35	19,100
4	14	10,900
5	6	9,800

The sample included eight institutions in cluster one, five of which responded to the question on enrollments in elementary statistics with a total of 3,049 students reported. Thus the estimate for cluster one was

$$\frac{12}{5} \times 3049 = 7318.$$

Similar estimates were calculated for each cluster and the cluster estimates were summed to get a national estimate for public universities. The procedure

was repeated for private universities, public and private four-year colleges, and two-year colleges.

For the questions on course enrollments, data from mathematics, statistics, and computer science departments at a single institution were combined before extrapolation. The data on faculty characteristics were treated separately throughout because of interest in how the separate department types differ.

Accuracy of Enrollment Estimates. The validity of results from any questionnaire survey depends on the extent to which respondents accurately report their views or the facts of their situations and the extent to which those responses represent the population as a whole. Since the survey questions asked mainly for factual data readily available to most heads of mathematical science programs, there is little reason to question the accuracy of those responses. The representativeness of the respondents is supported by several quantitative checks.

First, in every control/type stratum and for each type of mathematical science department, response rates were higher than any previous CBMS undergraduate survey. Table A.3 shows that the lowest response rate, 54%, was

Table A.3

RESPONSE RATES IN DEPARTMENTS OF MATHEMATICS,
STATISTICS, AND COMPUTER SCIENCE

	Sample	Respondents	Response Rate
1. Public Universities			
Mathematics	41	40	98%
Statistics	13	8	62%
Computer Science	31	21	68%
2. Private Universities			
Mathematics	19	17	89%
Statistics	7	6	86%
Computer Science	10	7	70%
3. Public Four-Year Colleges			
Mathematics	96	83	86%
Computer Science	26	14	54%
4. Private Four-Year Colleges			
Mathematics	100	72	72%
Computer Science	7	7	100%
5. Two-Year Colleges	160	110	69%

among the 26 sampled computer science departments in public four-year colleges, but the overall response rate for all sampled departments was 76%.

As a check on the sample and respondents, the known fall 1979 enrollment in each responding institution and the estimation procedures for mathematical science data were used to calculate estimates of the national enrollment in each control/type category of higher education. These estimates and the known fall 1979 enrollment in each category are compared in Table A.4. The largest error of estimation is -1.52% in the private college category, again suggesting confidence in the pool of respondents and the estimation procedures.

Table A.4

COMPARISON OF ACTUAL AND ESTIMATED TOTAL ENROLLMENTS IN
MAJOR CONTROL/TYPE CATEGORIES

Control/Type	Estimated Enrollment	Actual Enrollment	Error
1. University	2,800,705	2,839,582	-1.37%
2. Public Four-Year College	2,770,833	2,803,699	-1.11%
3. Private Four-Year College	1,433,779	1,455,913	-1.52%
4. Two-Year College	4,104,460	4,139,282	-0.84%

A list of all responding departments is included as Appendix D of this report.