CONFERENCE BOARD OF THE MATHEMATICAL SCIENCES

REPORT OF THE SURVEY COMMITTEE

VOLUME VI

UNDERGRADUATE MATHEMATICAL SCIENCES IN UNIVERSITIES, FOUR-YEAR COLLEGES, AND TWO-YEAR COLLEGES, 1980-81

JAMES T. FEY
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with the technical assistance of
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Supported by the National Science Foundation under grant SED7919946

Available from:
Conference Board of the Mathematical Sciences
1500 Massachusetts Ave., N.W., Suite 457-8
Washington, D.C. 20005

Price: $6.00 prepaid

Library of Congress Card Number 67-30335

JOHN W. JEWETT: A MEMORIAL TRIBUTE

John Jewett, the Chairman of the CBMS Survey Committee, died this summer at the age of fifty-six, while the preparation of this volume was in process. He was my own Ph.D. student, and a person I admired and respected. I was very proud of him and am glad to have the opportunity to write about him for this volume.

He was involved in these Surveys from the outset. I was the first chairman and promptly asked him to be executive secretary, knowing that this would assure the success of our first volumes. When I left the chairmanship, he replaced me. The success of the Surveys -- and they have been successful -- is due to a major extent to his dedication, hard work and wisdom.

John's doctoral thesis was one of the first in differential topology. I anticipated an outstanding research career for him, but he chose to put his talents into his teaching and his administrative and committee work. He had been raised as a faculty child at Oklahoma State University and it gave him great pleasure to return there as chairman of the mathematics department, where he remained for the rest of his life.

Gentle, and with a wry sense of humor, his wisdom and judgment were widely respected. He served on many committees of the Mathematical Association of America, such as the Committee on the Undergraduate Program in Mathematics, and was vice-president of that organization. The American Mathematical Society put him on such major policy committees as the Committee on Employment and Educational Policy, the Committee on Relations with Government, the Committee on Science Policy, and the Committee on Academic Freedom. To all these assignments he brought the same high qualities he brought to the Survey.

His death is a loss to us all, but particularly to me. I miss him greatly.

Gail S. Young
Professor of Mathematics
The University of Wyoming

PREFACE

At five year intervals, beginning in 1965, the Conference Board of the Mathematical Sciences (CBMS) has conducted four surveys of undergraduate course enrollments, faculty, and teaching patterns in the mathematical science departments of universities, four-year colleges, and two-year colleges in the United States. The basic purpose of these surveys has been to provide information useful for decision-making in mathematical science departments, professional organizations, and government agencies. In particular, the surveys have reflected the interests of the member organizations of CBMS* and have drawn on the expertise and experience of prominent individuals from the various areas of the mathematical sciences represented by those organizations. On the other hand, restricting the scope of the surveys to the mathematical sciences has provided a certain unity and coherence that would have been lacking had the surveys been aimed at a wider range of disciplines.

All four CBMS surveys, and a similar U.S. Office of Education survey for 1960, have addressed two basic questions:

1. What are the national undergraduate course enrollments in mathematics, statistics, and computer science, how are those enrollments distributed among various types of higher education institutions, and how do the enrollment patterns change over time?
2. What are the numbers, qualifications, personal characteristics, and teaching responsibilities of mathematical science faculty, and how do those variables change over time?

In addition to these fundamental issues, individual surveys have focused on questions of timely interest. In particular, the present survey has tried

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*Listed in alphabetical order these organizations are the American Mathematical Association of Two Year Colleges, the American Mathematical Society, the American Statistical Association, the Association for Computing Machinery, the Association for Symbolic Logic, the Association for Women in Mathematics, the Institute of Mathematical Statistics, the Mathematical Association of America, the National Council of Teachers of Mathematics, the Operations Research Society of America, the Society of Actuaries, the Society for Industrial and Applied Mathematics, and The Institute of Management Sciences.

to quantify anticipated increases in remedial mathematics, statistics, and computer science enrollments as well as changing patterns in organizing mathematical science instruction and changes in the administrative structure of mathematical science departments.

Questionnaire design and overall advice and guidance for the present survey were provided by the CBMS Survey Committee. The eight members of that Committee and the executive secretary for the project are listed below.

Donald J. Albers, Menlo College
William F. Atchison, University of Maryland
Wendell H. Fleming, Brown University
John W. Jewett, Oklahoma State University
Don O. Loftsgaarden, University of Montana
Martha K. Smith, University of Texas
Robert J. Thompson, Sandia Laboratories
Joseph Waksberg, WESTAT Research Corporation
James T. Fey, University of Maryland, Executive Secretary

Professor Jewett, who co-authored several earlier volumes in the CBMS survey series and chaired the Survey Committee from 1975 through mid-1981, played a crucial role in the planning and initial data analysis for the present study. His sad death in July 1981 was a deep personal and professional loss for the Committee. Professor Fleming accepted the Committee chairmanship after Professor Jewett's death.

The work of survey sample design, data collection and organization, data analysis and report writing has been shared by several people. The design of the sampling and estimation procedures was chiefly the work of Joseph Waksberg, a nationally and internationally known figure in this area of statistics. The organization and compilation of data from the survey questionnaire responses and the computation of the resulting estimates were done by Clarence Lindquist. Dr. Lindquist has provided such technical assistance for each of the preceding CBMS undergraduate surveys. In addition, he designed and carried out the above-mentioned U.S. Office of Education study for 1960.

The analysis of the survey results and the writing of the present report have been primarily the work of James Fey and Don Albers. An expert on mathematics education, Professor Fey was the executive secretary for both the present and the 1975 CBMS survey project. He also served in that capacity for the production of the Conference Board's highly regarded 1975 report Overview and Analysis of School Mathematics Grades K-12. Professor Albers, The Committee's principal source of knowledge and expertise regarding the mathematical sciences in two-year colleges, largely authored the chapters on that subject in both the present and the 1975 survey reports. In addition to designing the questionnaires for the present survey, the members of the Survey Committee have received drafts of the chapters of the report as they were produced and have made a number of helpful comments.

It is especially fitting that the tribute to Professor Jewett that appears in the front of the present volume should be contributed by Gail S. Young. In addition to being Professor Jewett's mentor and doctoral dissertation adviser, Professor Young worked closely with Professor Jewett on all the previous volumes of the CBMS survey series, chairing the Survey Committee from its inception in 1965 through the early 1970's and continuing as a member of of the Committee for the 1975 survey, when Professor Jewett took over the chairmanship.

CBMS and its Survey Committee are indebted to Helen Daniels of CBMS headquarters, who did the expert camera-ready typing of the report, and to CBMS Executive Director Truman Botts, who was the director of the project, as he was of the 1970 and 1975 survey projects. Special thanks and appreciation for grant support are due the National Science Foundation, which also supported the Conference Board's 1970 and 1975 undergraduate surveys.

October 1981

Wendell H. Fleming
Chairman, CBMS Survey Committee

CONTENTS

SUMMARY OF MAJOR FINDINGS

In this summary we present some highlights of the 1980 CBMS survey results, leaving detailed presentations of the data to the chapters that follow. Some trends were found to be common among all types of institutions, for instance, increased elementary service course loads and the rapid growth of computer science. Nevertheless, there were also significant differences according to type of institution (university, public or private four-year college or two-year college). The summaries of major findings for four-year institutions and for two-year colleges are presented separately.

The Survey Committee, in publishing the results of its investigations, has always felt its fundamental responsibility to be the neutral presentation of a factual background for use by those in education and government who make decisions about the mathematical sciences, the fundamental premise being that informed decisions are likely to be superior to decisions based merely on hearsay or wishful thinking. Beginning with Chapter 1 the present volume maintains that posture, attempting to describe what the data *say* without assuming the more interpretive role of making subjective assertions about what the data *mean*. In the course of the present summary, we shall try to suggest something of their significance without, however, presuming to offer any recommendations for specific actions which the mathematical community should take.

Our findings concern mathematical science enrollment trends, undergraduate majors, instructional formats, faculty, and administrative organization of mathematical science departments. The data given are estimates of national totals for fall 1980 in institutions of higher education. The estimates are based on responses to a questionnaire survey sent to universities and colleges in a sample of 416 institutions. The sampling and estimation procedure are explained in Appendix A. The table on the following page shows sampling and response rates in various categories of institutions and departments.

The generally high response rates give us confidence in most estimates. However, for some questions the actual reported numbers were so small that the data must be used with caution.

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

	Population	Sample	Respondents	Response Rate
1. Universities				
Mathematics	160	60	57	95%
Statistics	42	20	14	70%
Computer Science	94	41	28	68%
2. Public 4-Year Colleges				
Mathematics	407	96	83	86%
Computer Science	85	26	14	54%
3. Private 4-Year Colleges				
Mathematics	830	100	73	73%
Computer Science	48	6	6	100%
4. 2-Year Colleges	1019	160	110	69%

Summary for Four-Year Institutions

For four-year colleges and universities, highlights of the survey results and prospects for the 1980's can be summarized as follows.

1. Mathematical science course enrollments grew substantially, with a dramatic growth in computer science. There was a 33% increase in total mathematical science course enrollments from 1975 to 1980, compared to an increase of only 8% in full-time-equivalent enrollments in all fields during the same five-year period. In contrast, during the previous five years 1970 to 1975 mathematical science course enrollments grew by only 8%, compared to an increase of 11% in all fields.

Most of this 33% increase in course enrollments from 1975 to 1980 was concentrated in elementary service courses and in computing courses. There was a 30% increase in calculus enrollments and a 196% increase for computing and related courses. Enrollments in remedial (high school level) courses were up 72%. Remedial courses now constitute 16% of all mathematical science enrollments. (For public four-year colleges the figure is 25% and, as noted below, it is even higher for two-year colleges.)

This substantial increase in the service course load from 1975 to 1980 was not indicated by trends during the years immediately preceding this period. One reason for the increase was the surge of student interest in such practically-oriented majors as engineering and business, where employment prospects have recently been excellent. The large increase in remedial mathematics confirms evidence from various other sources that a disappointingly large proportion of students in the U.S. come to college quite poorly trained in mathematics. Another factor contributing to increased elementary mathematics enrollments appears to be the growing use of quantitative methods in the social, biological, and management sciences.

2. Computer science grew rapidly, measured by any standard. As mentioned above, enrollments in computing courses nearly tripled from 1975 to 1980. There were estimated to be about 8900 computer science bachelor's degrees for the academic year 1979-1980, compared with only 3600 for 1974-1975. At the same time the number of bachelor's degrees in mathematics fell from 17,700 for 1975-1975 to 10,200 for 1979-1980. The number of mathematical science bachelor's degrees with majors in secondary teaching fell from 4800 in 1974-1975 to only 1750 for 1979-1980. At the same time, the rapid growth of the computer/high-technology industry in the U.S. has created excellent employment opportunities for computer science graduates at all levels (bachelor's through Ph.D.). This has made the recruitment and retention of computer science faculty difficult, particularly in institutions without graduate programs. Only about half of computer science faculty in four-year colleges hold doctoral degrees. Among 830 private colleges only about 220 mathematical science faculty have their highest degree in computer science, and only about 40% of those have Ph.D.'s in computer science.

3. Upper division mathematics courses experienced a modest enrollment increase, 4% overall from 1975 to 1980. Enrollments were up in courses with a more applied flavor, but down in mathematics courses for prospective teachers (-37%) and in advanced "pure mathematics" courses (-19%). As the number of mathematics majors has declined, an adequate spectrum of upper division mathematics courses is not available in many departments. This problem is more severe in four-year colleges than in universities. For example, among private

colleges only 13% offer a college-level geometry course, and the offerings in applied mathematics are quite meager. While logic is an important topic for computer science, only 30% of university mathematics departments and only about 7% of four-year college departments offer a course in mathematical logic.

4. Instructional formats. The 1980 survey inquired about the instructional format used in selected elementary courses (finite mathematics, calculus, computer programming, elementary statistics). Overall nearly 60% of all students in these courses are taught in small classes with fewer than 40 students. Most of the rest are taught in large classes of 40-80 students or in large lectures (with or without recitation sections). Fewer than 1% were taught using self-paced instruction or other modes. (This is in contrast to two-year colleges, where alternate instructional modes are used increasingly.)

The percentages of students in four-year institutions taught in small classes vs. large classes or lectures varied widely according to the type of institution. In universities only 36% of students in these selected courses were taught in small classes, compared to 79% in private four-year colleges.

5. Faculty loads, part-time vs. full-time faculty. Numbers of mathematical science faculty increased by about 13% from 1975 to 1980 measured on a full-time-equivalent (FTE) basis. Since this was substantially less than the 33% overall increase in course enrollments during the same five-year period, an increase in faculty loads resulted. Mathematical science course enrollments per FTE faculty member increased from 77 in 1970 to 83 in 1975 and to 98 in 1980. Thus course enrollments per FTE faculty increased by 27% during the decade 1970-1980, with most of the increase during the last half.

During the ten-year period 1970-1980 there has been an increase in faculty loads, measured in the number of credit hours taught per week, though the increase was more marked from 1970-1975 than in the period 1975-1980. For example, 80% of faculty in university mathematics departments taught less than 9 hours per week in 1970, but in 1980 only 62% taught less than 9 hours per week. In 1970, 47% of faculty in public four-year college mathematics departments taught less than 12 hours per week, but in 1980 this percentage had decreased to only 20%.

The survey data show other disturbing trends. There was a 75% increase in the number of part-time faculty from 1975 to 1980, compared to only an 8% increase in full-time faculty during the same five-year period. The percentage of faculty granted tenure during 1980 was much lower than during 1975. These data presumably reflect the preoccupation of many institutions of higher learning with holding down costs, and with avoiding additional longer term commitments to faculty. On the other hand, some departments in four-year colleges are unable to hire (or to retain) full-time faculty with desired credentials, especially for positions in computer science, statistics, or another applied mathematical science. In such instances, hiring a part-time person is sometimes the best available alternative.

6. Faculty qualifications. A national goal during the 1960's was to raise the educational qualifications of college teachers up to the doctoral level. A great deal of progress was made toward that goal between 1965 and 1975, but more recently there has been slippage in the mathematical sciences. In 1980 over 90% of full-time mathematical science faculty in universities have doctorates. However, only 66% of those in four-year colleges have doctorates, compared to 71% in 1975.

The continued availability of enough qualified teaching assistants is in doubt, with many departments seeking TA's from other sources in addition to their own graduate students. In 1980 over 25% of all TA's employed by mathematical science departments were not mathematical science graduate students (graduate students in other fields, undergraduate TA's and others). The rapid decline in numbers of mathematics majors suggests that departments with traditional mathematics graduate programs may encounter still more difficulty in recruiting TA's in the years ahead.*

7. Faculty employment, demographic characteristics, mobility. The estimated total number of full-time mathematical science faculty in four-year colleges and universities in the U.S. increased from about 16,900 in 1975 to 18,300 in 1980. The addition of some 280 positions per year contributed to a better academic job market for mathematicians than during the bleak period

*On the other hand, annual American Mathematical Society Survey data indicate that numbers of mathematics graduate students were nearly stable during 1978-1980 following an earlier decline. See NOTICES AMS, February 1981, p. 172.

immediately preceding these years. From 1970 to 1975 there was essentially no change in the number of full-time mathematical science faculty, and numbers of new Ph.D.'s per year reached an all time high.

The CBMS survey data indicate little change in the total number of tenured mathematical science faculty between 1975 and 1980. Since the total number of full-time faculty increased by 1400, the percentage with tenure declined, from 72% in 1975 to 67% in 1980. Numbers of deaths and retirements are insufficient to account for this change. Among probable contributing factors are the growth of young computer science departments (only about half of computer science department faculty were tenured in 1980), stricter tenure policies of some institutions, and the development of opportunities in industry for Ph.D.'s during the 1970's which attracted some faculty away from academe. In 1980 greater movement between academic jobs in mathematical science departments and nonacademic jobs was observed than in earlier CBMS surveys. Among doctorate-holding faculty newly hired for fall 1980, about 125 came from nonacademic positions, while 290 left for nonacademic positions between the academic year 1979-1980 and fall of 1980. This resulted in a new outflow to nonacademic positions of about 1% of doctorate-holding mathematical science faculty during a single year.

The percentage of full-time mathematical science faculty who are women increased from 10% in 1975 to 14% in 1980, with a median age for women faculty about five years less than for men.

The AMS Survey monitors trends in faculty employment, demographic characteristics, and mobility annually.* AMS and CBMS surveys results indicate very similar trends, but do not agree in all details.

8. Administrative organization of mathematical science departments. In universities, mathematics and computer science are usually found in separate departments. There are often separate departments of statistics, operations research, or applied mathematics as well. However, in four-year colleges these various subjects are more commonly taught within a single department which includes traditional mathematics. This is particularly true in the smaller private colleges.

*Reported in February, October and November issues of the NOTICES AMS.

In universities rather few instances of administrative restructuring of mathematical science departments were reported. Most of these changes involved the formation of a new computer science department. In public four-year colleges a greater rate of administrative reorganization was reported. Reorganizations included consolidations of mathematical science departments into larger administrative units, creation of computer science departments and the addition of computer science programs and titles in many mathematics departments.

9. Prospects for the 1980's. Student enrollments in four-year institutions are expected to decline as the size of the 18-21 age group decreases. U.S. government sources project an overall enrollment decline by 1985 of some 7% from the 1980 peak. The impact in the mathematical sciences may be less, so long as present career-oriented attitudes among college students persist. Nonetheless, mathematical science enrollments may be expected to increase at a slower rate from 1980 to 1985 than from 1975 to 1980.

There is likely to be a continuing problem in obtaining adequate resources to cover the instructional load in the mathematical sciences. While there was some increase in numbers of faculty (full-time and part-time) during the late 1970's, the increase was by no means sufficient to cover the substantially heavier instructional loads. There is presently little evidence that, in the years immediately ahead, higher education will command enough priority in the competition for scarce public funds to alleviate matters.

The traditional role of upper division instruction in college and university mathematics departments has been the training of future mathematics teachers and researchers. These programs are being deserted by students more interested in careers in the computing field, or to a lesser degree, as practitioners in an applied mathematical field such as statistics or operations research. This poses a dilemma for mathematics departments regarding their instructional mission in the years ahead. Is it to be preponderantly elementary service courses, or can programs of broader appeal be introduced? For example, there are successful joint majors in mathematics-computer science, mathematics-economics, or mathematics-biology in many institutions. There are reports of shortages of high school mathematics teachers, as many teachers leave for well-paying jobs in industry. How can student interest in teaching careers be rekindled? There is also the need to maintain a core of future researchers and college level teachers, to replace an aging national mathematics faculty. While numbers of mathematics professors retiring per year are expected to remain relatively low during the 1980's, there will be a large increase in retirements during the 1990's. Considering the nearly ten-year lead time from entry into graduate school until crucial tenure decisions are made, there should be many tenured positions in colleges and universities for students now at the point of starting graduate studies.*

In the shorter term, there is a critical problem of recruiting and retaining enough computer science faculty. If the explosive growth of enrollments in computing courses continues, the problem can only become more acute. More generally, many four-year college departments have difficulty recruiting doctorate-holding faculty in the applied mathematical sciences, to develop programs and teach courses in those areas. Numbers of new Ph.D.'s in both pure and applied mathematical fields have been declining, and there are attractive alternatives in industry.

A more fundamental national problem is to upgrade pre-college mathematics in the schools.** To a considerable extent this lies outside the scope of the present report, although college and university departments can help through their role in training teachers. It is in their own self-interest to help as they can. The continuing flood of entering students poorly prepared in mathematics threatens to distort the normal educational goals of mathematical science departments in institutions of higher education.

Summary for Two-Year Institutions

During the period 1975-1980, mathematics programs in two-year colleges underwent significant changes. Combined trends in enrollments, programs, student populations, and faculty populations do not bode well for the mathematical

*This issue is discussed further in the NOTICES AMS, February 1979, pp. 111-112

**Detailed recommendations on this issue are made in the 1980 NCTM report, An Agenda for Action: Recommendations for School Mathematics of the 1980's.

sciences in two-year colleges. Summaries of these trends follow.

1. Enrollment Trends -- Computer Science Gains. Mathematical science enrollments grew by 20%, keeping pace with overall enrollment gains of 19%. This gain was much less than the 50% growth in the previous five-year period, 1970-1975. Nearly all of the 20% gain was due to explosive growth of computer science courses and continued expansion of remedial courses. Computer science gains alone accounted for 43% of the total gain in enrollments. Remedial courses (arithmetic, elementary high-school algebra, general mathematics, and high-school geometry) now account for 42% of all two-year college mathematics enrollments. *Dealing with remediation* was identified by survey respondents as far and away the biggest problem facing two-year college mathematics faculty in 1980.

2. Program Trends -- Shift Away From Liberal Arts. Enrollments in occupational/technical programs grew to more than one-half of all full-time equivalent enrollments, outdistancing college-transfer enrollments. In 1975, by way of contrast, occupational/technical programs accounted for slightly more than one-third of all full-time equivalent enrollments. These shifts in student preferences away from liberal arts were mirrored in enrollment gains of applied courses and sharp declines in courses such as mathematics for liberal arts.

3. Population Trends -- Part-Timers in the Majority. Part-time enrollments increased from 53% of all enrollments in 1975 to 63% in 1980. This trend to an increased part-time majority may help to explain the program trends noted above.

4. Faculty Trends -- Full-Time Faculty Declined in Size. Although enrollments in mathematical science courses grew by 20%, the full-time faculty decreased by 5%. For whatever reasons -- burnout, economic exigencies, frustrations with remediation, increased teaching loads -- the full-time faculty of 1980 was smaller than that of 1975. Our age distributions indicate that those leaving the profession tend to be at least 45 years of age, which strongly suggests that experienced teachers are finding employment other than teaching. The financial problems of full-time faculty are underscored by the fact that nearly one-half of them are teaching *overloads* for extra money. The

typical faculty member is now teaching 30 more students than he taught in 1970.

During the same time frame, the *part-time faculty nearly doubled in size*. Part-timers now outnumber full-timers. If the full-time faculty teaching overloads had been smaller, then it is likely that the part-time fraction would have been even larger.

5. Instruction Trends -- Self-Pacing Methods Continue to Expand. Every alternative instruction mode that we monitored showed a gain in usage from 1975 to 1980. In particular, *independent study*, *modules*, *PSI*, *computer-assisted instruction*, and several other alternative techniques registered gains. The standard lecture-recitation format is still strongly dominant, but experimentation clearly is growing. It's interesting to note that although computers and calculators are now widespread among two-year colleges, their impact on the teaching of mathematics seems to be slight at best.

Chapter 1

ENROLLMENTS IN UNDERGRADUATE MATHEMATICAL SCIENCE COURSES: UNIVERSITIES AND FOUR-YEAR COLLEGES

This chapter reports estimated national enrollments in university and four-year college mathematical science courses for fall 1980. The data are compared and contrasted with results of previous CBMS surveys and enrollment patterns in other fields of higher education. Special attention is given to the interaction of four-year and two-year mathematics programs and enrollments.

Highlights

- From 1975 to 1980 mathematical science course enrollments in universities and four-year colleges increased by 33%, compared to an increase of only 7% in full-time-equivalent enrollments of those institutions.
- The enrollment increases were concentrated in computer science, remedial mathematics, pre-calculus courses, and calculus for physical scientists and engineers.
- Largest enrollment decreases were in liberal arts mathematics and courses for elementary school teachers.
- Statistics and upper division mathematics enrollments increased slightly, with the mathematics increase concentrated in applied topics like differential equations.
- The number of bachelors degrees in mathematics and statistics decreased by 42%; in computer science there was an increase of 145% to a total nearing two out of five mathematical science degrees.
- Of the fall 1980 freshmen in higher education, only .6% plan to major in mathematics or statistics, but 4.9% plan to major in computer science, data processing, or computer programming.
- Two-year college mathematical science enrollments increased at about the same rate as enrollments in those institutions, with growth concentrated in remedial courses and computer science. The two-year college share of all undergraduate mathematical science enrollments is now 34%, compared to 37% in 1975.

The data elaborating these highlights and giving longer term trends are presented in the sections that follow.

1.1 Enrollment Trends in Higher Education

The numbers and distribution of mathematical science course enrollments are influenced by broader trends in higher education enrollment and by the curricular choices of those students. Since 1975, undergraduate enrollments have continued the long trend of growth, though projections for the next decade suggest that the growth might be coming to an end.

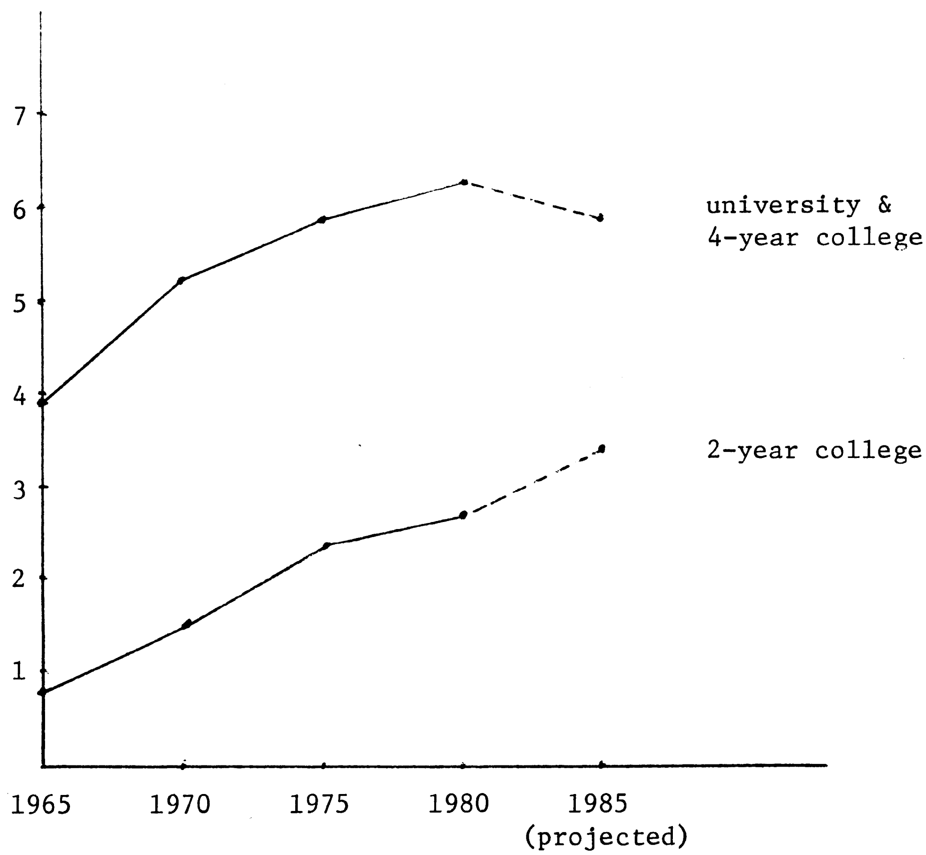
The curricular areas of concentration chosen by undergraduates have changed dramatically over the past decade, with consequent impact on the types of mathematical science courses offered and elected by undergraduates. The probable academic majors indicated by freshmen entering college in 1980 suggest further changes not yet fully reflected in the enrollment data collected for the present study.

The following tables and charts give details of such background enrollment information useful for explaining and interpreting the mathematical science data given later.

FULL-TIME-EQUIVALENT ENROLLMENTS IN ALL HIGHER EDUCATION

Since 1965, full-time-equivalent (FTE) enrollments in higher education have grown by 100%. The two-year college share of this enrollment has increased from 17% to 34%, but more than half of the TYC enrollment is in non-degree-credit occupational/technical programs. Current projections suggest levelling off and modest decline in total enrollments for higher education during the next decade.

Figure 1.1
(millions of students)



Source: Projections of Education Statistics to 1986-87.

PROBABLE MAJORS OF ENTERING FRESHMEN IN HIGHER EDUCATION

From 1975 to 1980 student choices of academic major shifted toward business, engineering, and computer science and away from the physical sciences, arts and humanities, and education. Since 1966, the number of entering freshmen planning a major in mathematics has dropped from 4.5% to .6% of the total.

Table 1.1
(percent of all freshmen)

Subject Areas	1966	1970	1975	1980
Biological Sciences	10.9	12.9	17.5	17.8
Business	14.3	16.2	18.9	23.9
Education	10.6	11.6	9.9	7.7
Engineering	9.8	8.6	7.9	11.8
Humanities and Arts	24.3	21.1	12.8	8.9
Mathematics and Statistics	4.5	3.2	1.1	0.6
Physical Science	3.3	2.3	2.7	2.0
Social Sciences	8.2	8.9	6.2	6.7
Other Technical*	2.2	3.7	8.6	8.2
Undecided and Other	11.8	11.6	14.5	12.4
Total Number of Full-Time Freshmen (in thousands)	1,163	1,617	1,761	1,712

*Includes computer science; in 1980, 4.9% of entering freshmen indicated a probable major in computer science, data processing, or computer programming.

Source: Astin, A. W., King, M. R., & Richardson, G. T. The American Freshman: National Norms for Fall 1980, and earlier editions of this report.

NUMBER OF FRESHMAN PROBABLE MATHEMATICAL SCIENCE MAJORS IN HIGHER EDUCATION

Since 1970, the number of students planning to major in mathematics or statistics has declined by 80%. The number of students planning to major in computing has grown to over 84,000 in the same period. These planned majors can be compared to actual earned degrees in Table 1.4 and Table 1.12.

Table 1.2

(numbers of full-time freshmen)

Institution Type	1970 Mathematics and Statistics	1975 Mathematics and Statistics	1980 Mathematics and Statistics	1980 Computing*
Universities	15,600	6,400	3,178	15,098
Four-Year Colleges	27,600	9,300	5,712	28,560
Two-Year Colleges	9,200	3,000	1,359	40,781
All Institutions	52,400	18,700	10,249	84,439

*Comparable data not available for earlier years.

Source: Astin, A. W., King, M. R., & Richardson, G. T. The American Freshman: National Norms for Fall 1980 and earlier editions of this report.

FULL-TIME UNDERGRADUATE ENGINEERING ENROLLMENTS

From a relative minimum in 1973, undergraduate engineering enrollments have grown steadily to an all-time high of 365,000 in 1980. Since the number of freshman engineering students was also an all-time high in that year, the influence of engineering enrollments on mathematics course demand is likely to continue strong over the next several years.

Figure 1.2

(enrollments in thousands)

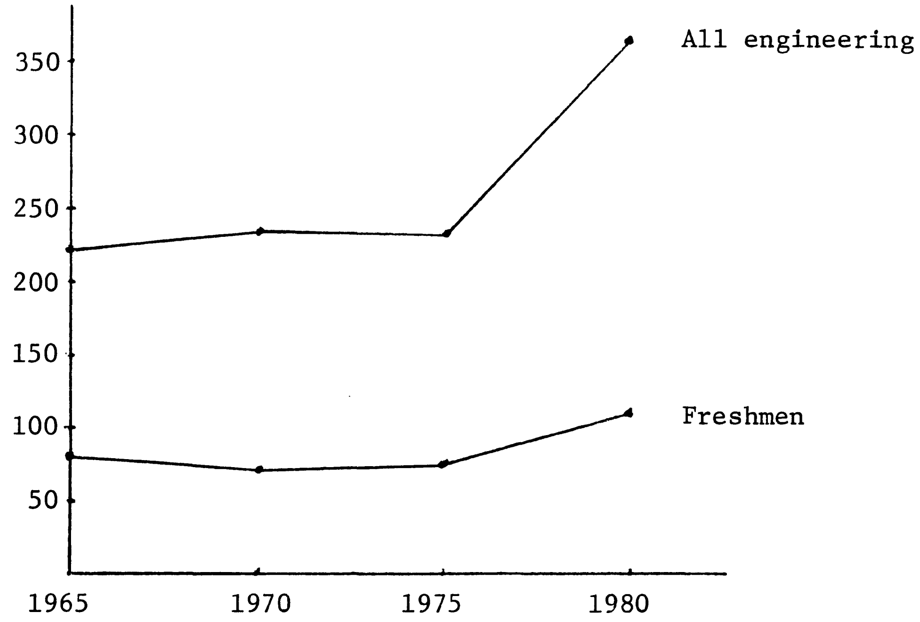


Table 1.3

(enrollments in thousands)

	1965	1970	1975	1976	1977	1978	1979	1980
Freshmen	80	72	75	82	89	96	104	110
All Engineering	220	232	231	258	289	311	340	365

Source: Engineering Manpower Commission. Engineering and Technology Enrollments, Fall 1980.

EARNED BACHELOR'S DEGREES FOR SELECTED FIELDS

Trends in the distribution of earned bachelor's degrees have roughly followed the projected majors of entering freshmen, with a time lag. Engineering and business have grown, while humanities, social sciences (including education), and mathematics have declined.

Table 1.4
(degrees in thousands)

Subject Area	1960-61	1965-66	1970-71	1975-76	1979-80*
Humanities and Related Fields	52	87	140	140	129
Social Sciences and Related Fields	136	226	382	369	323
Business and Management	56	64	116	143	174
Natural Sciences and Related Fields**	114	126	172	216	253
-Biological Science	16	27	36	54	55
-Computer Science	-	-	2	6	8
-Engineering	36	38	50	46	74
-Mathematics and Statistics	13	20	25	16	9
-Physical Science	15	17	21	21	24

*Projected

**Includes agriculture and health fields in addition to those listed.

Source: Projections of Education Statistics to 1987-88.

1.2 Course Enrollments in Mathematics, Statistics, and Computing

For the past 20 years mathematical science course enrollments have grown faster than overall enrollments in higher education. However, during that period the areas of greatest growth have changed from time to time. During the 1960's the largest course enrollment increases were in calculus and upper division mathematics, with computer science and statistics making large percentage increases from relatively small bases. From 1970 to 1975 computer science and statistics continued their rapid growth, but upper division mathematics enrollment dropped by 32%.

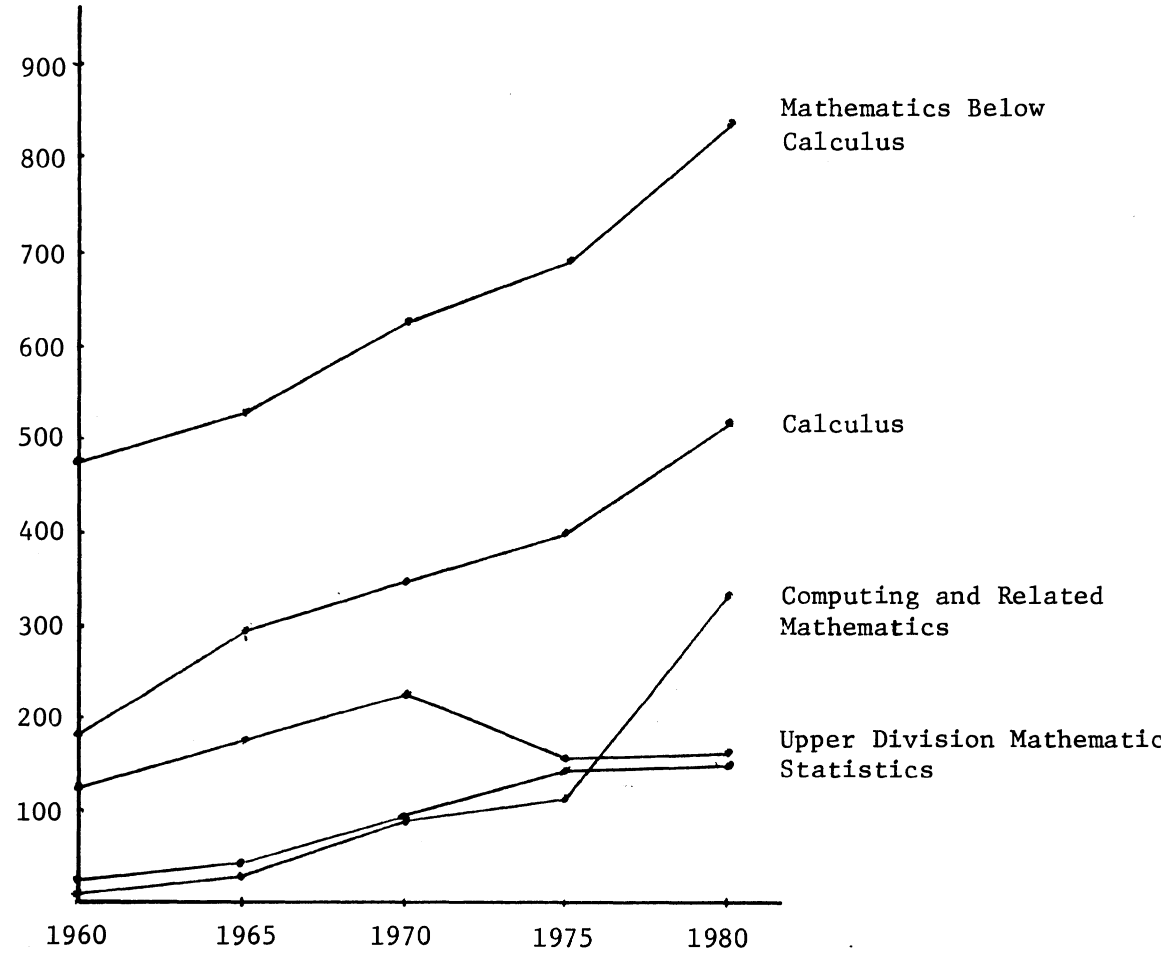
Between 1975 and 1980 course enrollment growth has been concentrated in computer science, remedial mathematics, and calculus, while upper division pure mathematics has continued to decline and statistics has experienced only modest growth. To knowledgeable readers none of these trends will be a surprise and some explanations are not hard to generate. The job opportunities in computing and engineering are attracting large numbers of students to these fields and thus the enrollment increases in computer science courses and calculus for physical science and engineering. However, it appears that calculus, for example, is becoming more widespread as a requirement for other fields as well. Those who choose to continue as mathematics majors are strengthening their background in applied areas, at the expense of traditional pure mathematics courses. Many mathematics educators have reported declining preparation of entering college students, and thus the increase in remedial offerings and enrollments is natural.

The clear overall impression from course enrollment data is a shift toward mathematical science courses that are applicable as preparation for specific post-college careers.

MATHEMATICAL SCIENCE ENROLLMENTS IN UNIVERSITIES AND FOUR-YEAR COLLEGES

Between 1975 and 1980 all mathematical science enrollments increased by 33%, compared to 7% for FTE enrollments in all fields. The 30% increase in calculus and the 196% increase in computing courses led the way.

Figure 1.3
(enrollments in thousands)



MATHEMATICAL SCIENCE ENROLLMENTS BY COURSE LEVEL AND TYPE OF INSTITUTION, 1970-1980

Enrollments in mathematics below calculus, calculus, and computing have increased steadily in universities and four-year colleges. However, only private colleges experienced growth in upper level mathematics during the past five years and only public colleges had growth in statistics during that period.

Table 1.5

(Enrollments in thousands)

Type of Course	Universities 1970	1975	1980	Public College 1970	1975	1980	Private College 1970	1975	1980
Mathematics Below Calculus	224	243	277	293	333	408	113	116	152
Calculus	185	193	247	99	114	154	61	90	116
Upper Level Mathematics	114	67	61	65	50	51	50	38	49
Statistics	49	67	58	22	45	61	21	29	30
Computing and Related Mathematics	57	61	116	17	31	130	16	20	86
Total	629	631	759	496	573	804	261	293	433

MATHEMATICS COURSE ENROLLMENTS IN UNIVERSITIES AND FOUR-YEAR COLLEGES BY TOPIC AREA, 1960-1980

Recent large enrollment increases have been in remedial courses (+72%), pre-calculus and calculus courses (+31%), and advanced applied courses including differential equations (+55%). Mathematics courses for teachers (-37%) and advanced pure mathematics (-19%) continued their decline from 1970 peaks.

Table 1.6*

(enrollment in thousands)

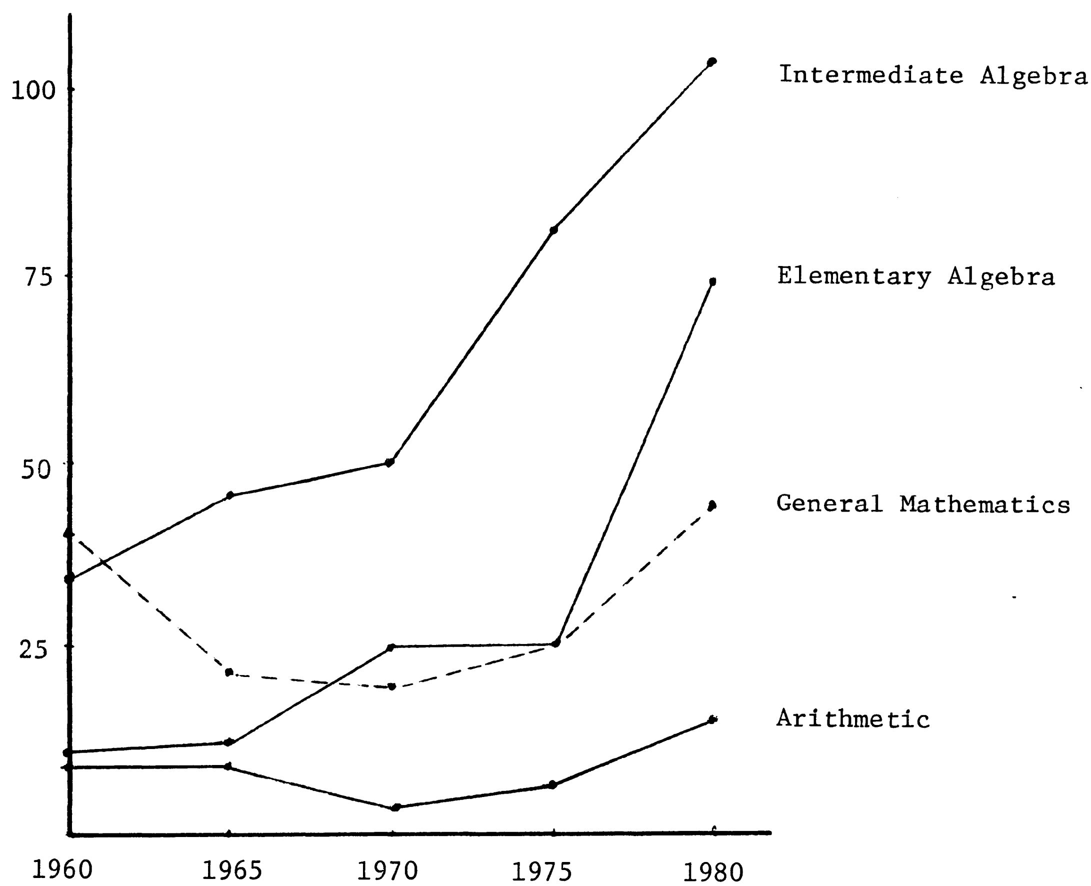
Subject	1960	1965	1970	1975	1980
1. Arithmetic/General Mathematics	48	29	23	32	63
2. High School Algebra & Geometry	48	60	78	109	179
3. Business Mathematics	17	21	18	47	48
4. Liberal Arts Mathematics	36	87	74	103	63
5. Mathematics for Elementary Teachers	23	61	89	68	44
6. College Algebra, Trigonometry, Analysis	235	262	301	259	345
7. Finite Mathematics	1	7	47	74	95
8. Analytic Geometry & Calculus	184	295	345	397	517
9. Differential Equations	29	31	31	29	45
10. Linear & Matrix Algebra	4	19	47	28	37
11. Modern Algebra	11	20	23	13	10
12. Advanced Calculus	17	20	20	14	11
13. Applied Mathematics	19	21	20	18	28
14. Numerical Analysis	3	5	11	8	10
15. Other Advanced Mathematics	42	67	88	53	30
Total	717	1,005	1,215	1,252	1,525

*Enrollment data for each course in each control/type stratum are given in Appendix E. Statistics and computer science are not included here.

REMEDIAL MATHEMATICS* IN UNIVERSITIES AND FOUR-YEAR COLLEGES

Since 1960, enrollment in remedial arithmetic, general mathematics, and algebra has increased by 165%. Those courses now constitute 16% of all mathematics enrollments, compared to 13% in 1960. The biggest increase occurred between 1975 and 1980, matching a period of widespread reports that high school preparation in mathematics has declined sharply.

Figure 1.4
(enrollments in thousands)



*High school level courses; courses 1-5 in list of Appendix E.

ENROLLMENT IN REMEDIAL MATHEMATICS COURSES

In public colleges remedial courses include 25% of all mathematics enrollments; for universities and private colleges the shares are only 10% and 9% respectively.

Table 1.7

(enrollments in thousands and % of all mathematics)

Course	Universities 1975	Universities 1980	Public Colleges 1975	Public Colleges 1980	Private Colleges 1975	Private Colleges 1980
Arithmetic for College Students	-	2(-)	5(1%)	11(2%)	1(-)	1(-)
General Mathematics (Skills, Operations)	-	4(1%)	23(5%)	37(6%)	3(1%)	8(3%)
High School Geometry	-	-	1(-)	1(-)	1(-)	-
Elementary Algebra	4(1%)	13(2%)	22(4%)	54(9%)	L(-)	7(2%)
Intermediate Algebra	26(5%)	44(7%)	46(9%)	48(8%)	9(4%)	12(4%)

AVAILABILITY OF REMEDIAL MATHEMATICS COURSES

Very few private colleges offer remedial courses, but nearly half the universities offer intermediate algebra and over half the public colleges offer elementary algebra.

Table 1.8

(percent of institutions offering course)

Course	Universities	Public Colleges	Private Colleges
Arithmetic	6%	15%	2%
General Mathematics	11%	28%	7%
High School Geometry	0	10%	2%
Elementary Algebra	27%	45%	10%
Intermediate Algebra	41%	43%	21%

AVAILABILITY OF SELECTED UPPER LEVEL MATHEMATICS COURSES IN UNIVERSITIES AND FOUR-YEAR COLLEGES, 1980

As the number of mathematics majors has declined, upper division enrollments and course offerings have been diminished. For instance, only a third of all universities offer history of mathematics and only an eighth of all private colleges offer advanced geometry.

Table 1.9

(% of institutions offering course in 1980*)

Course	Universities	Public Colleges	Private Colleges
1. Theory of Numbers	45%	29%	8%
2. Combinatorics	28%	11%	3%
3. Foundations of Mathematics	19%	19%	3%
4. Set Theory	20%	13%	2%
5. History of Mathematics	31%	29%	7%
6. Geometry	54%	50%	13%
7. Mathematics for Secondary School Teachers	29%	30%	9%
8. Mathematical Logic	30%	13%	4%
9. Applied Mathematics/ Mathematical Modelling	38%	20%	4%
10. Biomathematics	2%	8%	1%
11. Operations Research	23%	13%	4%

*Estimate based on number of institutions reporting enrollment or L for later offering in the year.

PROBABILITY AND STATISTICS COURSE ENROLLMENTS IN UNIVERSITIES AND FOUR-YEAR COLLEGES

From 1975 to 1980 enrollments increased in elementary statistics but declined in elementary probability. Overall, statistics enrollments in mathematics or statistics departments increased only 5.6%, less than the FTE enrollment growth for four-year institutions and in contrast to rapid growth rates observed in previous surveys. However, statistics is also taught for special audiences in a variety of other academic departments.

Table 1.10

(enrollments in thousands*)

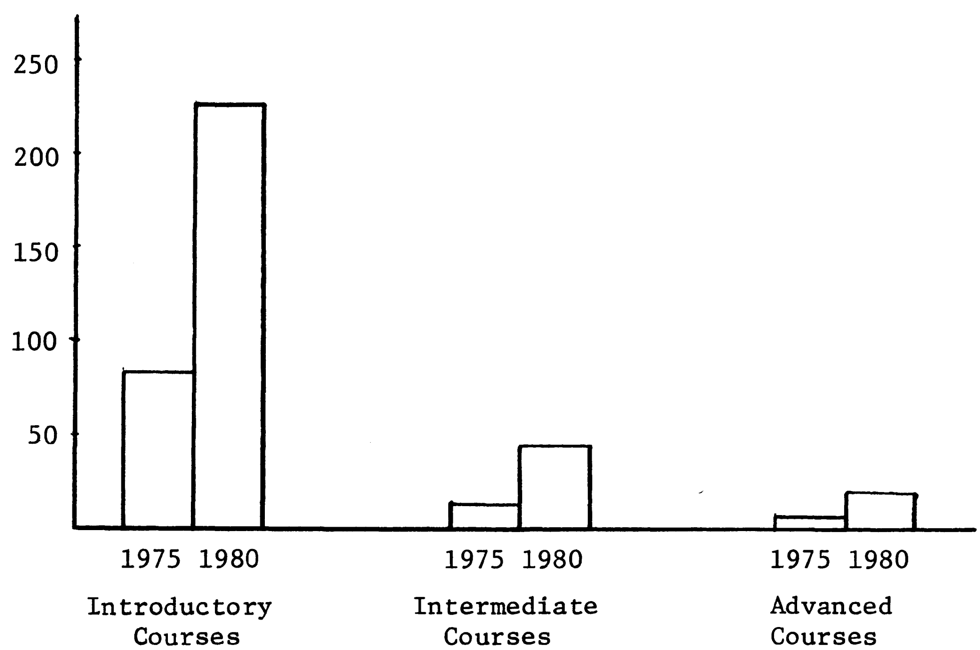
Course	1975	1980
1. Elementary Statistics	74	87
2. Elementary Probability	25	17
3. Mathematical Statistics	14	16
4. Probability	8	13
5. Applied Statistical Analysis	10	8
6. Design and Analysis of Experiments	2	2
7. Other	8	6
Total	141	149

*Does not include statistics taught outside of mathematical science departments.

COMPUTER SCIENCE ENROLLMENTS IN UNIVERSITIES AND FOUR-YEAR COLLEGES

The most striking result of the course enrollment survey is the nearly 200% increase in computer science. Those courses now generate over 16% of all mathematical science enrollments and they are increasingly given by separate departments of computer science. As in mathematics and statistics, the largest share of computer science enrollment is in lower level courses.

Figure 1.5
(enrollments in thousands*)



*Includes only enrollments in mathematical science departments (including computer science departments). In the 160 universities there are an estimated 94 separate departments of computer science. There are an estimated 85 computer science departments in the 407 public colleges, and 48 computer science departments in the 830 private colleges. However, computer science courses are often taught by mathematics departments.

The mathematical science departments responding to the survey also reported 30,000 computer science course enrollments not categorizable by one of the ACM Curriculum '78 labels and thus not covered by Figure 1.5.

COURSE ENROLLMENTS IN COMPUTER SCIENCE AT UNIVERSITIES AND FOUR-YEAR COLLEGES

There was strong enrollment growth in nearly every computer science course offering. However, the bulk of the increase from 1975 to 1980 occurred in beginning programming courses. The new course "Computers and Society" established a substantial enrollment.

Table 1.11

(enrollments in thousands)

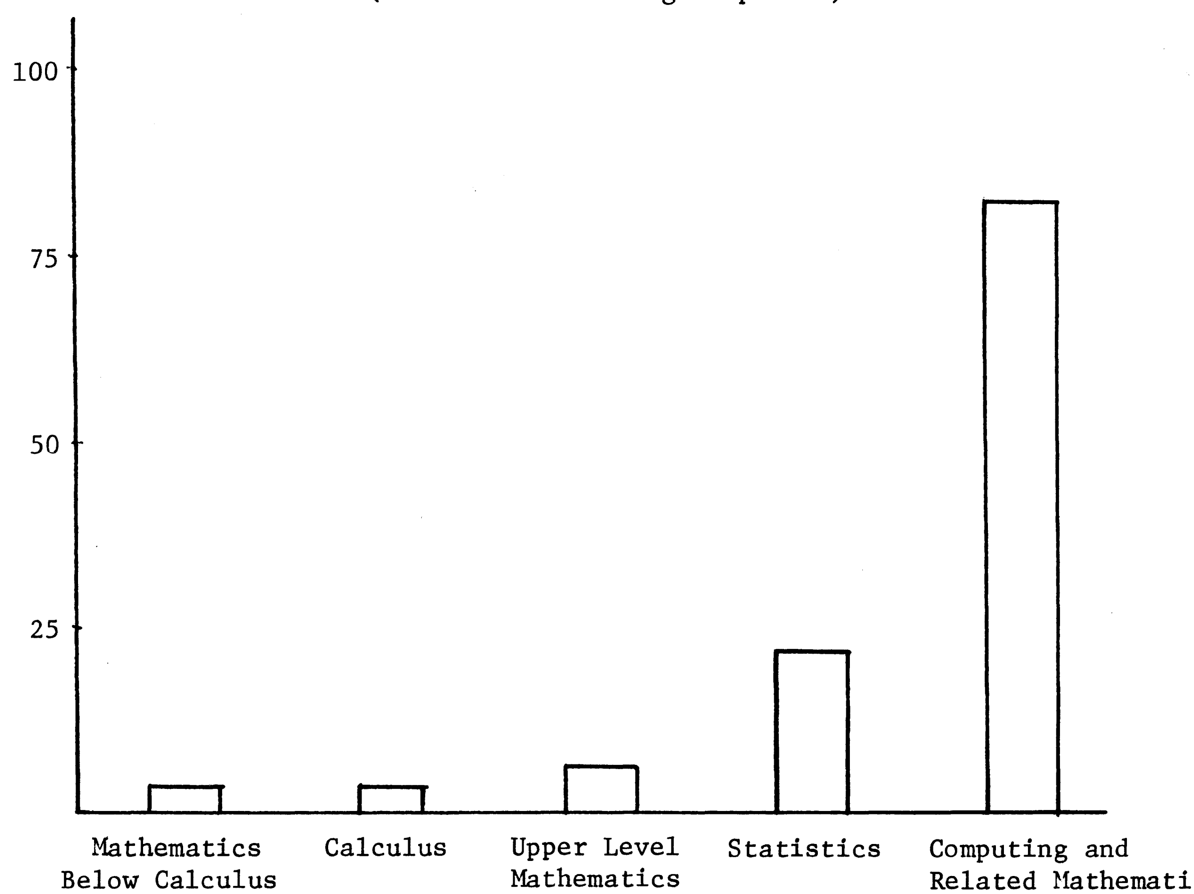
Subject	1975	1980
1. Computer Programming I (CS1)*	50	154
2. Computer Programming II (CS2)	13	32
3. Introduction to Computer Systems (CS3)	13	16
4. Discrete Structures	3	9
5. Computer Organization (CS4)	3	12
6. File Processing (CS5)	3	7
7. Operating Systems and Computer Architecture (CS6)	2	7
8. Data Structures and Algorithm Analysis (CS7)	3	12
9. Organization of Programming Languages (CS8)	7	6
10. Computers and Society (CS9)	NA	16
11. Operating Systems and Computer Architecture II (CS10)	NA	2
12. Database Management Systems Design (CS11)	1	4
13. Artificial Intelligence (CS12)	1	1
14. Algorithms (CS13)	1	2
15. Software Design and Development (CS14)	NA	2
16. Theory of Programming Languages (CS15)	NA	1
17. Automata, Computability, and Formal Languages (CS16)	1	2
18. Numerical Mathematics (CS17, 18)	1	6
19. Other Computer Science	5	30
Totals	107	321

*CS numbers refer to courses described in Curriculum '78, Communications of the Association for Computing Machinery, 1979, 22(3), 147-166. The 1975 data are for comparable courses in the 1975 CBMS survey list.
Enrollments are only those reported by mathematical science departments, thus not including computer programming taught by a business or engineering school, for example.

COMPUTER USE IN MATHEMATICAL SCIENCE COURSES, 1980

Very few mathematics students use computers as part of their coursework. Applied mathematics (16%), linear algebra (12%), and liberal arts mathematics (12%) are the most likely to use computers. About one-fifth of statistics students use computers.

Figure 1.6
(% of students using computers)



*Primarily numerical analysis

1.3 Bachelor's Degrees in Mathematical Sciences

In 1974-75 the CBMS survey reported 27,817 bachelor's degrees in various special areas of the mathematical sciences, including 19,043 in mathematics and statistics, 3,636 in computing, and 4,778 in secondary teaching. In that same year, only 18,700 entering college freshmen planned a major in mathematics or statistics and the number planning to enter teaching had begun its recent decline. These projections foretold a sharp drop in mathematics and secondary teaching degrees to be completed four years later.

The anticipated drop in completed mathematics and statistics (-37%) and secondary teaching (-63%) majors has occurred, bringing those numbers to roughly the level of 1960-61 when the college population was much smaller. At the same time, bachelor's degrees in computer science increased by 145% to constitute nearly two of five degrees in mathematical sciences. The projections of academic majors for 1980 entering college freshmen suggested further drastic growth in this sector lies ahead.

There are indications that many of the remaining mathematics majors are "doubling" in computer science and that employment for mathematics graduates is commonly in computer-related positions. Taken together, these trends raise fundamental concerns about the "traditional" mathematics majors. The sharp decline in undergraduates preparing for secondary teaching has already aggravated a shortage of qualified teachers.

SPECIALIZATION OF EARNED BACHELOR'S DEGREES IN MATHEMATICAL SCIENCES

From 1975 to 1980 earned bachelor's degrees in mathematics, statistics and secondary teaching decreased by 42%. Computer science degrees increased by 145%. In universities 83% of computer science degrees are from computer science departments; in public colleges the fraction is 56%. However, many public colleges have joint mathematics and computer science departments.

Table 1.12
(numbers of bachelor's degrees)

Special Area	1974-75	1979-80
Mathematics	17,713	10,160
Statistics	570	467
Computer Science	3,636	8,917
Actuarial Science	70	146
Applied Mathematics	886	801
Secondary Teaching	4,778	1,752
Other	164	580

1.4 Mathematical Sciences in Four-Year and Two-Year Institutions

Over the past twenty years the two-year college sector of undergraduate enrollment has increased rapidly to now include 29% of all FTE students in higher education. These two-year college students now provide over 34% of all undergraduate mathematical science enrollments, all at the lower division level. However, this fraction has declined since 1975 when two-year college mathematical science enrollments were 37% of the total for all higher education.

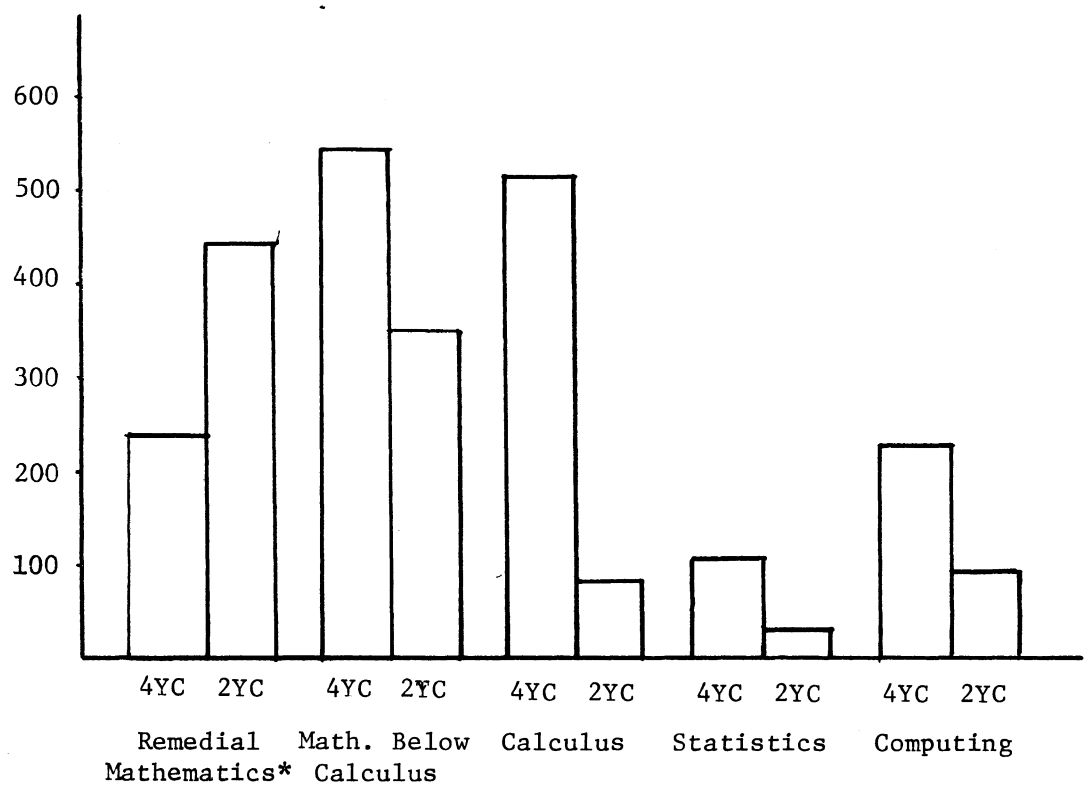
During the past ten years, two-year college enrollments have shifted markedly from degree-credit or transfer programs to non-degree-credit or occupational/technical programs. This change has been reflected in the distribution of mathematics enrollments in those colleges.

LOWER DIVISION MATHEMATICS, STATISTICS, AND COMPUTER SCIENCE AT FOUR-YEAR AND TWO-YEAR INSTITUTIONS, 1980

The two-year colleges devote a greater fraction of their teaching to remedial and occupational/technical service courses than do four-year schools

Figure 1.7

(enrollments in thousands)



*Includes common high school courses through intermediate algebra; courses 1-5 in list of Appendix E.

TRENDS IN DISTRIBUTION OF LOWER DIVISION MATHEMATICAL SCIENCE COURSE ENROLLMENTS

Patterns of growth and decline in specific course enrollments are similar in four-year and two-year institutions. However, there are indications that many two-year occupational/technical programs are providing their own mathematics service courses, making the figures given here an underestimate of actual mathematics instruction.

Table 1.13

(enrollments in thousands)

Subject	Four-Year 1970	Four-Year 1975	Four-Year 1980	Two Year 1970	Two Year 1975	Two Year 1980
Remedial Mathematics*	101	141	242	191	245	440
Business Mathematics	18	47	48	33	79	61
Liberal Arts Mathematics	74	103	63	57	72	19
Mathematics for Elementary School Teachers	89	68	44	25	12	8
Finite Mathematics	47	74	95	12	12	19
College Algebra/Trigonometry	301	259	345	124	149	174
Analytic Geometry and Calculus	345	397	517	68	73	86
Technical Mathematics	---	---	---	29	53	80
Computer Science**	NA	85	230	13	10	95
Statistics***	NA	99	104	16	27	28

*Courses 1-5 in Appendix E
**Courses 55-61 in Appendix E
***Courses 46, 47 in Appendix E

1.5 Summary

Over the past five years undergraduate mathematical science course enrollments in universities and four-year colleges increased by 33%, a rate far greater than overall enrollment increases in those institutions. However, the increase was not evenly distributed among subject areas within the field. The growth in computer science was spectacular and nearly all the remaining increase was concentrated in two areas -- remedial mathematics and calculus or advanced mathematics for scientists and engineers. There were sharp declines in liberal arts mathematics, courses for prospective teachers, and advanced pure mathematics. The number of bachelor's degrees in computer science more than doubled, while the degrees in mathematics and statistics dropped sharply.

Projection of these trends, and planning to respond effectively, are very difficult tasks. The expressed educational objectives of current entering freshmen suggest continued growth in engineering and computer science and declines in education and mathematics. However, engineering enrollments have been cyclical in the past and there are predictions that developments in computing will reduce the need for highly trained personnel in that area. There is a national shortage of secondary school mathematics teachers that might soon entice greater numbers of students back into those college programs. The additional factor to be considered in projections is demographic data which predict declines in the number of college-age Americans. Returning and continuing students have confounded this effect in the past decade, but we may be reaching boundaries of the potential audience for collegiate mathematical science courses.

Taking numbers of course enrollments as a measure, the mathematical science departments are currently prospering. Reasonable projections suggest that this prosperity will continue into the near future. However, the pattern of enrollments is far from optimal for the preferences of most faculty -- with the decline in advanced mathematics students and increase of less attractive, lower level courses. Those students, greatly reduced in number, who continue to elect a mathematics major are concentrating in applied areas, statistics, and computing which are not the specialties of most current faculty. The decline in numbers of potential secondary school mathematics teachers is also an ominous sign for the long-term improvement of school mathematics.

Chapter 2

MATHEMATICAL SCIENCE FACULTY: UNIVERSITIES AND FOUR-YEAR COLLEGES

This chapter describes the number, educational qualifications, and selected personal characteristics of mathematical science faculty in universities and four-year colleges during fall, 1980. The data are compared and contrasted with faculty information from previous CBMS surveys and other studies of higher education in the sections that follow.

Highlights

- From 1975 to 1980 the full-time mathematical science faculty in universities and four-year colleges increased by 8% compared to a 3% increase in all faculty of these institutions.
- The part-time mathematical science faculty increased by 75% compared to a 28% increase of part-time faculty in all higher education.
- The greatest percentage increase of full-time faculty was in computer science (university departments +25%) and in private college mathematics departments (+16%).
- The increase in part-time faculty has occurred in every type of department. Further, use of teaching assistants doubled in computer science and private college mathematics departments.
- The percent of public and private college faculty holding doctorates declined (74% to 69% and 69% to 64%) during the five-year period. Public college computer science faculty are least likely to hold doctorates (51%).
- The age profile and median age of mathematical science faculty have not changed markedly over the past five years. However, the overall tenure rate has dropped from 72% to 67% and in computer science only 49% are tenured.
- The number of women on mathematical science faculties has increased from 10% to 14%, with median age for women faculty about five years less than that for men.

2.1 Characteristics of Faculty in All Higher Education

For most colleges and universities the past five years have been a period of increasingly restricted resources to meet still growing student populations. At the same time there have been pressures to increase numbers of minority and women faculty and to keep untenured faculty positions for new entrants into the profession.

In the competition for scarce resources, the needs of the mathematical sciences are compared to those of other university departments and programs in search of some quantitative guides to decision making. The data in this section indicate the current situation and longer trends in all higher education faculty numbers, tenure, and teaching loads. They provide a useful backdrop for judging the status of the mathematical sciences.

FACULTY IN ALL HIGHER EDUCATION, 1965-1980

Since 1965, the full-time faculty in higher education has increased by 89% and the part-time faculty by 76%. However, the student faculty ratio has also increased in the same time period. The growth in two-year college faculty has been at a much greater rate than in four-year institutions.

Table 2.1
(faculty in thousands)

	1965	1970	1975	1980*
Four-year Institutions				
FTE Faculty	NA	322	360	372
FTE Students/FTE Faculty**	NA	16.1	16.4	16.9
All Higher Education				
Full-Time Faculty	248	369	430	468
Part-Time Faculty	92	104	142	162
FTE Students/FTE Faculty	16.8	16.6	17.4	18.2

*Projected

**FTE equals full-time plus one third of part-time

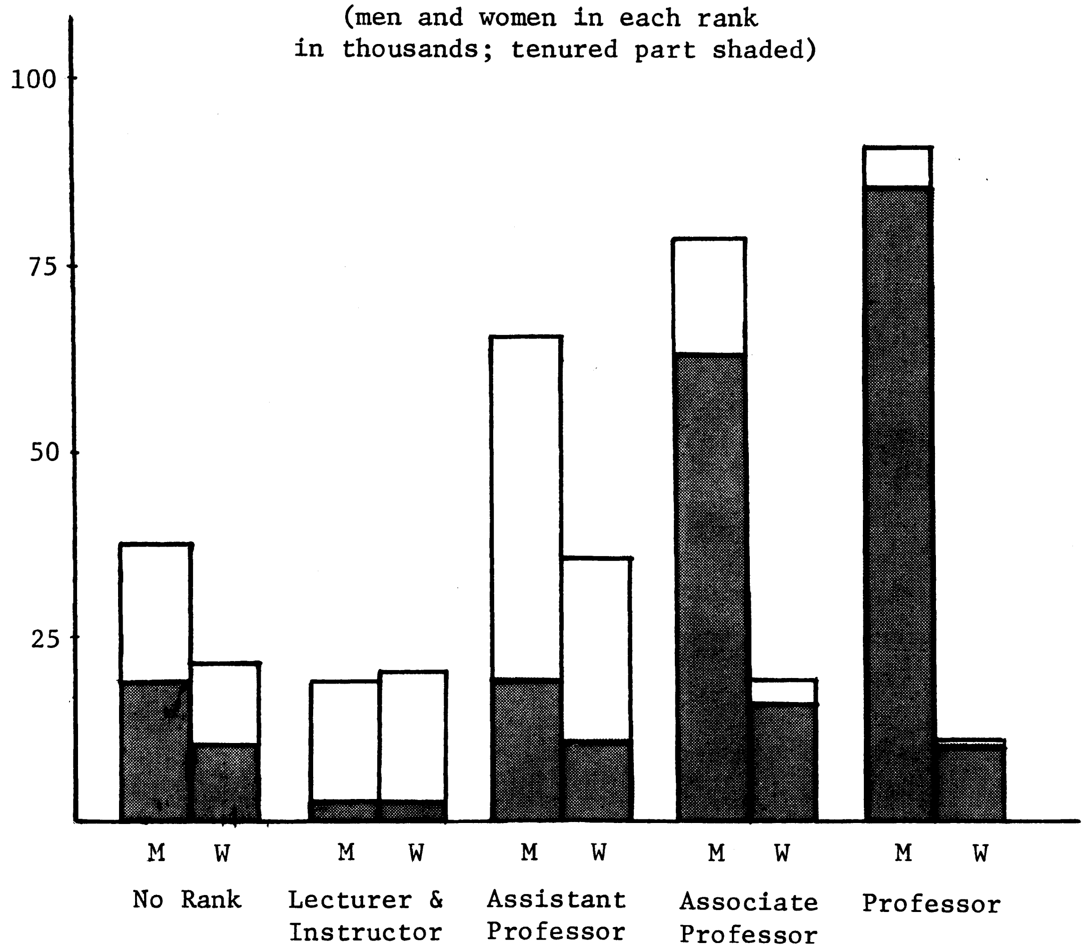
Source: Projections of Education Statistics to 1985-86.

DISTRIBUTION OF FULL-TIME FACULTY BY RANK, TENURE STATUS, AND SEX IN 1979-1980

In all higher education men comprise 74% of the full-time faculty. Over 64% of these men hold tenure, compared to 43% of women faculty; men repı sent 90% of the full professors and 80% of the associate professors.

Figure 2.1

(men and women in each rank in thousands; tenured part shaded)



Source: Smith, C. R., Faculty Salaries, Tenure, and Benefits 1979-80.

2.2 Faculty in Departments of Mathematics, Statistics, and Computer Science

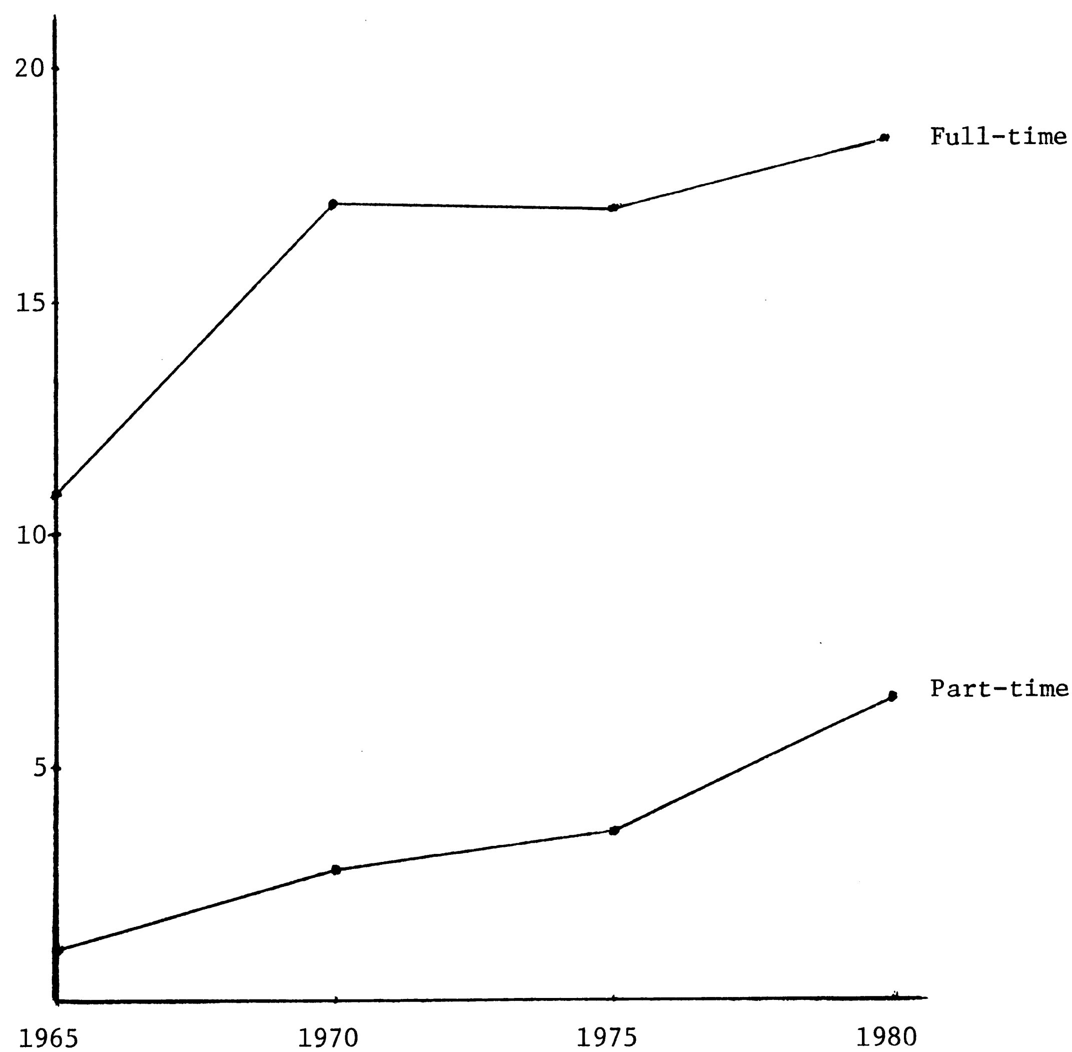
Between 1970 and 1975 the size of the full-time mathematical science faculty decreased by about 1% in colleges and universities, despite an 8% increase in mathematical science enrollments during that period. Some of the course load was covered by a 27% increase in part-time faculty, but enrollments per FTE faculty member increased by 18%. Given this trend of faculty size falling behind enrollment growth, the 33% increase in enrollments between 1975 and 1980, a period of diminishing resources for all higher education, was likely to outstrip new faculty positions. The data in this section show that while FTE mathematical science faculty increased between 1975 and 1980, the percent increase (13%) fell far behind enrollment growth.

Because the growth of mathematical sciences has been most dramatic in computer science, many of the additions to faculty would be expected in computing. Further, these relatively new departments in a young field are also likely to have different age and tenure profiles than the maturing mathematics departments. This section includes data bearing on these questions as well.

UNIVERSITY AND FOUR-YEAR COLLEGE MATHEMATICAL SCIENCE FACULTY, 1965-1980

From 1975 to 1980 full-time mathematical science faculty increased by 8% and part-time faculty increased by 75%. The FTE faculty thus increased by 13% compared to an increase of 33% in mathematical science enrollments. The total FTE faculty in universities and four-year colleges increased by only 3% in the same time period.

Figure 2.2
(faculty in thousands)



FACULTY IN MATHEMATICS, STATISTICS, AND COMPUTER SCIENCE, 1980

From 1975 to 1980 the largest faculty increase occurred in private college mathematics departments (+832 FTE). Faculty in departments of computer science also increased to a number about 9% of all FTE mathematical science faculty. These two types of departments also experienced the greatest course enrollment increases.

Table 2.2

	1970		1975		1980	
Type of Department	Full	Part	Full	Part	Full	Part
Universities						
Mathematics	6,235	615	5,405	699	5,605	1,038
Statistics	700	93	732	68	610	132
Computer Science	688	300	987	133	1,236	365
Public Colleges						
Mathematics	6,068	876	6,160	1,339	6,264	2,319
Computer Science	NA		NA		436	361
Private Colleges	3,352	945	3,579	1,359	4,153	2,099
Total	17,043	2,829	16,863	3,598	18,304	6,314

MATHEMATICAL SCIENCE TEACHING ASSISTANTS IN UNIVERSITIES AND FOUR-YEAR COLLEGES

The number of teaching assistants doubled from 1975 to 1980 in computer science and private college mathematics departments, while use of TA's declined in statistics and public college mathematics departments. Over 20% of all TA's are not graduate students, up from only 6% in 1975. In university mathematics departments an even greater fraction are not mathematics graduate students.

Table 2.3

Type of Institution	1970	1975	1980
Universities			
Mathematics	5,999	5,087	5,491
Computer Science	309	835	1,813
Statistics	747	690	546
Public Colleges			
Mathematics	1,804	1,805	1,535
Computer Science	NA	NA	90
Private Colleges	146	559	1,154
Total	9,005	8,976	10,629

2.3 Educational Qualifications of Mathematical Science Faculty

Mathematical science faculties in colleges and universities grew most rapidly during the 1960's. At the same time the production of doctorates in the field increased, creating a pool of well qualified new faculty members, and in every type of four-year mathematical science department the fraction of the faculty holding doctorates increased.

Since 1975, the number of doctoral degrees annually in mathematics has declined and the doctorates in computer science have not grown nearly fast enough to meet the demand for new faculty in these departments. Combined with the huge increase in mathematical science enrollments, these trends in the faculty pool raise concern about decline in the educational qualifications of university and four-year college faculties. The growing fraction of positions covered by part-time faculty adds another troublesome element to the situation.

Survey data suggest that, while university mathematical science departments have been able to maintain a high level of doctoral faculty, in both public and private colleges the fraction of non-doctoral faculty has increased since 1975.

DOCTORATES AMONG FULL-TIME MATHEMATICAL SCIENCE FACULTY

From 1975 to 1980 the fraction of public and private four-year college faculty with earned doctorates decreased, reversing the trend of 1965 to 1975.

Figure 2.3
(percent holding doctorate)

FIELD OF HIGHEST DEGREE FOR FULL-TIME MATHEMATICAL SCIENCE FACULTY, 1980

In four-year colleges, those faculty whose highest degree is in computer science are least likely to hold a doctorate, indicating demand for those skills regardless of degree.

Table 2.4

(number of faculty and % doctorate by field of highest degree)

Type of Institution	Field of Doctorate: Mathematics	Statistics	Computer Science	Mathematics Education	Other
Universities (6,937 doctorates)	5,326 (94%)	793 (98%)	862 (89%)	125 (86%)	320 (87%)
Public Colleges (4,670 doctorates)	4,607 (70%)	429 (89%)	583 (59%)	800 (63%)	280 (77%)
Private Colleges (2,652 doctorates)	3,196 (65%)	209 (59%)	218 (39%)	283 (64%)	247 (75%)

FIELD OF HIGHEST DEGREE FOR FULL-TIME STATISTICS AND COMPUTER SCIENCE FACULTY, 1980

Virtually all statistics department faculty hold a doctorate in statistics. Over 90% of university computer science faculty hold doctorates, but 40% of these are not in computer science. In public college computer science departments 59% of the faculty hold doctorates, again in a variety of different fields.

Table 2.5
(number of faculty and % doctorate by field of highest degree)

	Field of Highest Degree				
Type of Department	Mathematics	Statistics	Computer Science	Mathematics Education	Other
University Statistics	55 (83%)	533 (98%)	0	0	22 (86%)
University Computer Science	222 (91%)	16 (100%)	766 (90%)	0	235 (88%)
Public College Computer Science	106 (55%)	5 (100%)	218 (61%)	19 (74%)	88 (55%)

FIELD OF HIGHEST DEGREE FOR PART-TIME MATHEMATICAL SCIENCE FACULTY, 1980

From 1975 to 1980 the number of part-time faculty increased by 75%. The fraction of this part-time faculty holding doctorates is much lower than the full-time faculty. Since 1975 that doctorate percentage has dropped sharply among part-time university faculty.

Table 2.6

(number and % doctorates by field of highest degree)

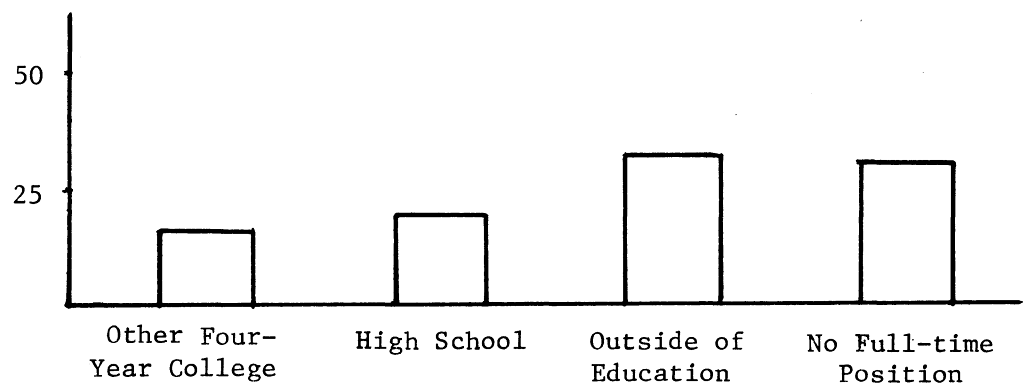
Type of Institution	Field of Highest Degree: Mathematics	Statistics	Computer Science	Mathematics Education	Other
Universities	905 (24%)	107 (63%)	288 (32%)	59 (35%)	177 (39%)
Public Colleges	1,464 (20%)	72 (43%)	354 (17%)	348 (17%)	442 (45%)
Private Colleges	1,364 (30%)	45 (19%)	184 (34%)	221 (21%)	285 (51%)

SOURCES OF PART-TIME MATHEMATICAL SCIENCE FACULTY, 1980

There are substantial numbers of part-time faculty members drawn from positions in high schools, other four-year colleges, non-academic work, and other part-time work.

Figure 2.4

(% of part-time faculty with given other employment)



Mathematics, statistics, and computer science departments seem to draw their part-time faculties from different sources.

Table 2.7

(% of part-time faculty with given other employment)

Type of Department	Other 4-Year College	High School	Non-Academic Position	No other full-time Position
Universities				
Mathematics	9%	19%	26%	45%
Statistics	22%	-	52%	25%
Computer Science	34%	-	51%	15%
Public Colleges				
Mathematics	15%	23%	29%	32%
Computer Science	11%	4%	74%	11%
Private Colleges	18%	16%	30%	36%

2.4 Age, Tenure, Sex, and Racial Composition of Mathematical Science Faculty

Over the past ten years faculty in all higher education became older and increasingly tenured as the rapid growth of the 1960's slowed markedly. For the mathematical sciences, fields well known for major contributions by young faculty, the problems of an aging and highly tenured faculty raise special concerns.

Women and minorities have traditionally been underrepresented as students and faculty in mathematics, science, and engineering. The 1975 CBMS survey showed 10% of all mathematical science faculty were women, and these were concentrated in younger age groups. Blacks (1%) and Hispanics (1%) also comprised a very small fraction of mathematical science faculty in 1975.

Data in this section show some encouraging effects of recent work designed to increase participation of women in mathematics, an increase from 10% to 14% of the full-time faculty. The number of black mathematical science faculty has doubled since 1975, but still constitute less than 3% of the total.

AGE DISTRIBUTION OF FULL-TIME MATHEMATICAL SCIENCE FACULTY, 1975 AND 1980

From 1975 to 1980 the age profile of full-time mathematical science faculty in universities and four-year colleges did not change much, though the median age is now perhaps one year older. The only significant overall change was a decline for age range 30-34: in 1975 twenty-two percent of the faculty fell in that age range, while in 1980 only seventeen percent did. In compensation, the percentages in each of the age ranges 35-39, 40-44, 45-49, 50-54, 55-59 were roughly one higher in 1980 than in 1975.

Public colleges tend to have the fewest faculty members under 35 (20%) and private colleges the fewest over 50 (14%). In all three types of institutions, only 5% of the faculty is over 60 years old and the median age is about 40 years.

Table 2.8

(% in each age interval, 1980)

	Age Interval							
Type of Institution	<30	30-34	35-39	40-44	45-49	50-54	55-59	≥60
Universities (7,451 faculty)	13%	17%	18%	17%	13%	11%	6%	5%
Public Colleges (6,700 faculty)	6%	14%	23%	23%	13%	10%	7%	4%
Private Colleges (4,153 faculty)	12%	20%	37%	11%	7%	6%	3%	5%
All Institutions (18,304 faculty)	10%	17%	23%	18%	12%	10%	6%	5%

TENURE STATUS OF MATHEMATICAL SCIENCE FACULTY, 1980

In 1980, 67% of mathematical science faculty had tenure compared to 72% in 1975 and 58% for all higher education. Mathematics and statistics departments are much more heavily tenured than computer science (less than 50%). This last fact represents a change from 1975 when 65% of computer science faculty were tenured. The newly established computer science departments appear to be building their own faculties now, not drawing tenured faculty from related fields.

Table 2.9

Type of Institution	Tenured Ph.D.	Tenured non-Ph.D.	Non-Tenured Ph.D.	Non-Tenured non-Ph.D.
Universities	64%	4%	28%	4%
Mathematics	67%	4%	25%	4%
Statistics	62%	2%	35%	1%
Computer Science	48%	4%	41%	7%
Public Colleges	52%	19%	16%	13%
Mathematics	53%	20%	15%	12%
Computer Science	38%	11%	25%	26%
Private Colleges	38%	16%	26%	20%
All Institutions	55%	12%	23%	10%

NEWLY TENURED MATHEMATICAL SCIENCE FACULTY, 1975 AND 1980

The rate at which mathematical science faculty gain tenure dropped sharply between 1975 and 1980. In 1980 only 1.5% of the full-time faculty were granted tenure compared with 4.6% in 1975. The modal year of doctorate for those granted tenure was 1974; however, in public colleges the 95 newly tenured faculty had doctorates evenly distributed from 1968 through 1975.

Table 2.10

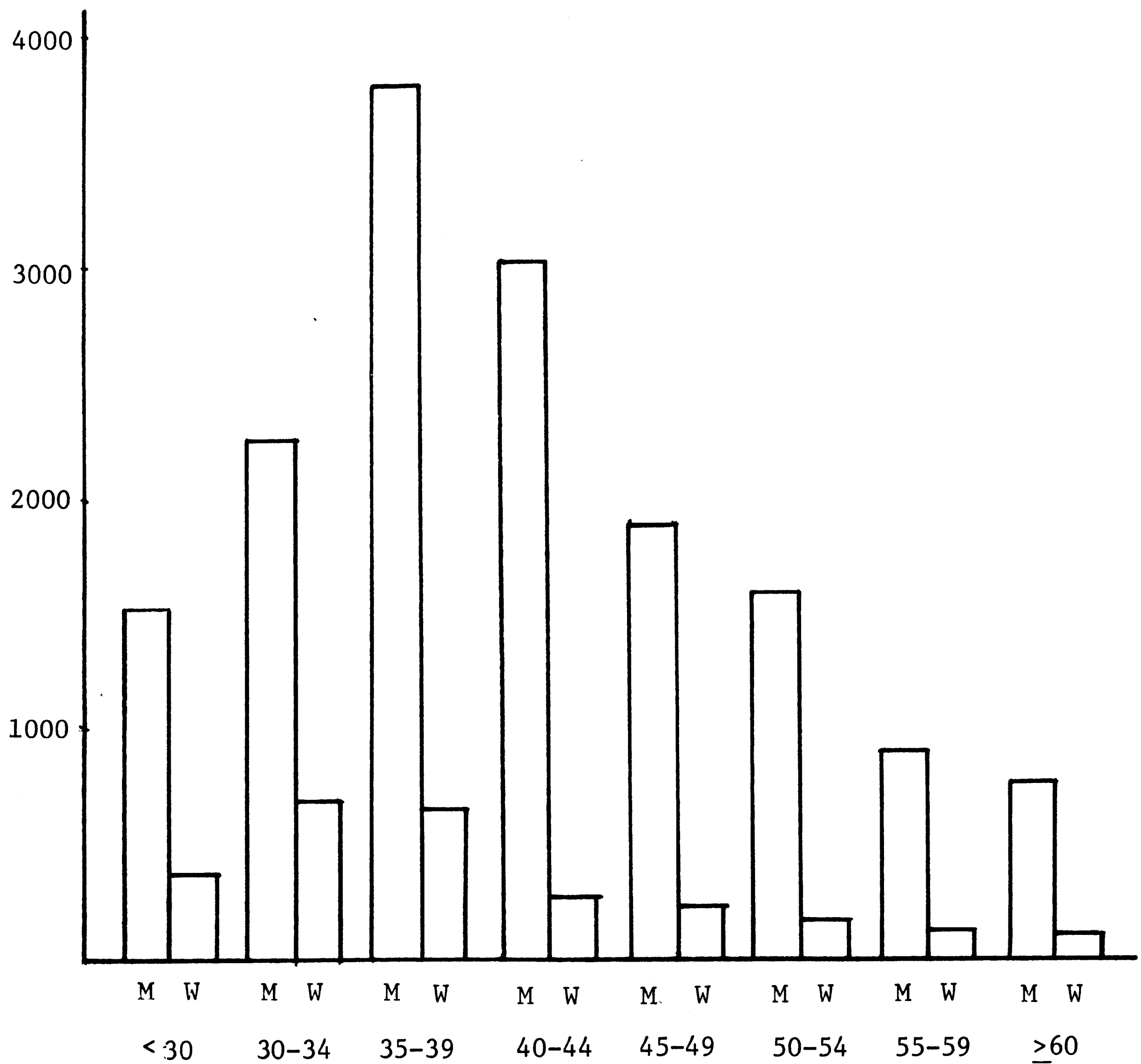
(% of full-time faculty)

Type of Department	1975	1980
Universities		
Mathematics	4%	1.1%
Statistics	6%	4.1%
Computer Science	7%	2.6%
Public Colleges		
Mathematics	4%	1.5%
Computer Science	NA	4.6%
Private Colleges	5%	1.1%

DISTRIBUTION OF FULL-TIME MATHEMATICAL SCIENCE FACULTY
BY AGE AND BY SEX, 1980

Women comprise 14% of mathematical science faculty, the greatest number in public colleges (18%) and least in universities (9%). All three figures are up substantially from 1975 when only 10% of the mathematical science faculty were women. The median age for women is about five years less than that for men.

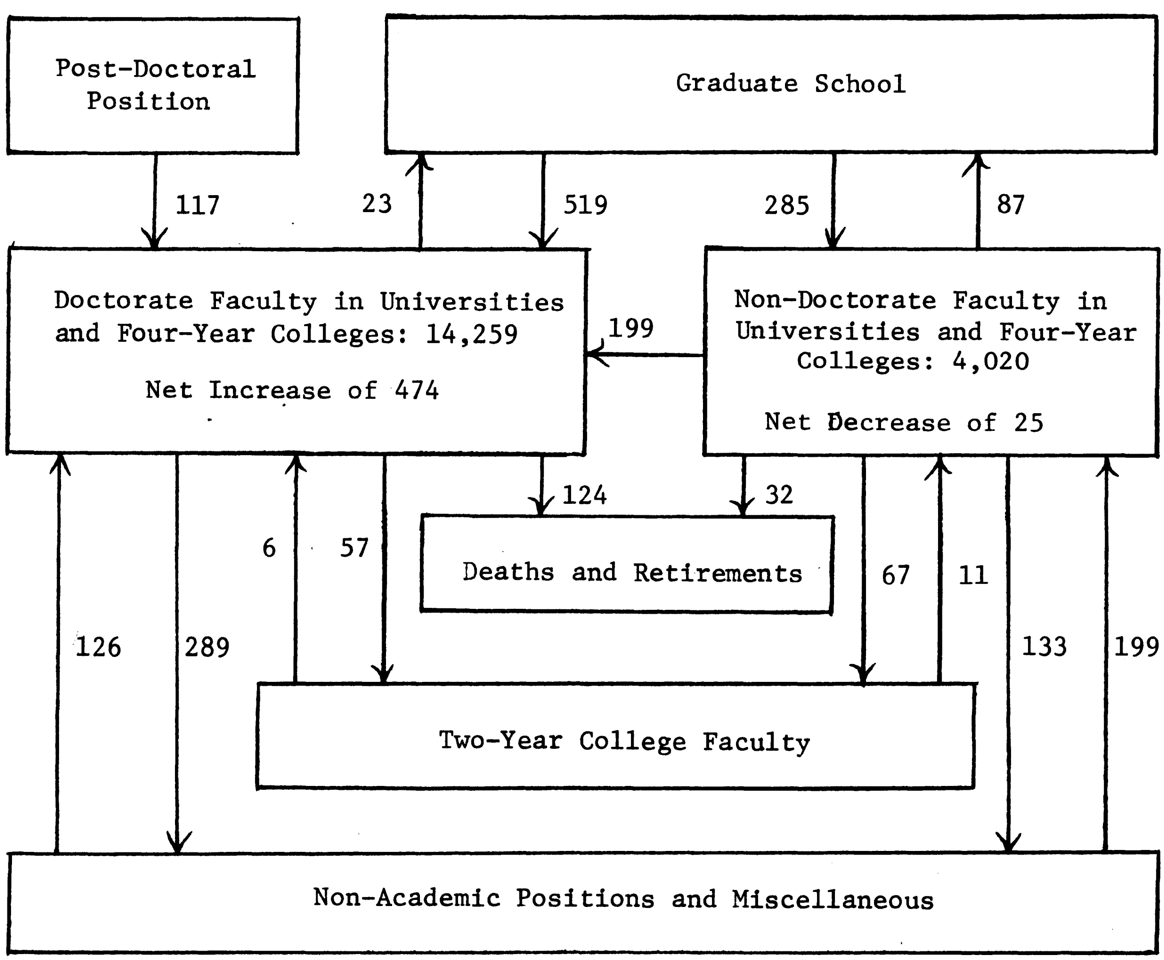
Figure 2.5
(numbers of men and women in each age interval)



FACULTY MOBILITY IN UNIVERSITY AND FOUR-YEAR
COLLEGE MATHEMATICAL SCIENCE DEPARTMENTS, 1979 to 1980

As in 1974-75 graduate school is the source of the greatest number of new university and four-year college mathematics faculty. However, the number of faculty added from non-academic positions is much greater in 1980 at both the non-doctoral (197 compared with 3 in 1975) and doctoral level (126 compared with 46 in 1975). Public and private college mathematics departments are hiring most of the new non-doctoral faculty. A substantial share (83) of the doctoral faculty leaving for non-academic positions are from university mathematics departments.

Figure 2.6
(numbers of full-time faculty)



2.5 Summary

Between 1975 and 1980 the full-time mathematical science faculty of universities and four-year colleges increased by 8% to 18,279. The growth rate compares favorably with the 3% increase in all faculty of universities and four-year colleges. The mathematical science faculty growth was concentrated in the computer science and private college mathematics departments which experienced greatest course enrollment increases during the period.

The number of women on full-time mathematical science faculties increased from 10% to 14%, and the number of blacks doubled (though to only 3%). In contrast to predicted trends toward older, highly tenured faculties, the age profile of mathematical science faculty in 1980 is very similar to that of 1975 and the fraction with tenure actually dropped from 72% to 67%.

In contrast to this optimistic view of developments for mathematical science faculty, the survey data show some disturbing trends. From 1975 to 1980 the part-time faculty increased by 75%. The increase in full-time-equivalent faculty (+13%) fell far short of the 33% increase in mathematical science enrollments. The use of teaching assistants doubled in computer science and private college mathematics departments and a sharply higher fraction of these TA's are not mathematical science graduate students. The doctorate share of full-time mathematical science faculty declined in public and private colleges, with as few as 51% of public college computer science faculty holding doctorates.

There are several other puzzling findings in the faculty data. In 1975 there were 2,700 full-time mathematical science faculty in the 40-44 year age group. Five years later, in 1980, this group that one would expect to be very stable had shrunk by 500. The data on faculty mobility show that in one year, 1979-80 nearly 300 doctorate faculty left universities and four-year colleges for non-academic positions. Together with the widely reported shortage of qualified computer science faculty, these data raise concerns that the financial gap between academic and industrial positions may be drawing away a number of very capable faculty -- with less qualified people entering to fill their places. The reductions in numbers of mathematics graduate students does not offer encouragement for the future.

Chapter 3

MATHEMATICAL SCIENCE ADMINISTRATIVE STRUCTURES AND INSTRUCTIONAL PRACTICES IN UNIVERSITIES AND FOUR-YEAR COLLEGES

This chapter describes recent changes in the administrative organization of mathematical science departments, faculty teaching loads, and dominant instructional formats in those departments at universities and four-year colleges. In particular, the data indicate ways that computer science, statistics, and applied mathematical science programs are administratively related to traditional mathematics departments. They also show effects of enrollment increases on teaching responsibilities and approaches of the faculty.

Highlights

- Between 1975 and 1980 roughly 10% of universities and four-year colleges made some administrative restructuring of mathematical science departments. The most common change was merger of private college mathematics departments into larger, more diverse units.

- In 28 of the larger public colleges, computer science departments were formed; private colleges more commonly expanded the scope and title of mathematics departments to include computer science.

- From 1975 to 1980 the number of mathematical science course enrollments per FTE faculty member increased by 18%, returning to the level of 1965.

- The expected credit-hour teaching loads of mathematics faculty and statistics faculty have changed little since 1975, but university computer science teaching loads have decreased markedly, with 24% of these departments expecting less than six hours per semester.

- In a sample of lower level mathematics, statistics, and computer science courses, nearly three-fifths of all students are in classes smaller than 40. Lectures and large classes are far more common in universities than in colleges.

- Regular faculty sabbatical leave programs are operating in a majority of mathematical science departments.

3.1 Administrative Structure of Mathematical Science Programs

During the 1970's course enrollments in statistics and computer science at four-year institutions increased by 62% and 269%, respectively. These areas now account for 24% of all mathematical science enrollments. Furthermore, each area has begun to acquire an academic identity quite distinct from the traditional mathematics departments. Not surprisingly, this emergence of independent disciplines has led to changes in the department administrative structure of mathematical science programs.

The 1980 CBMS survey questionnaire asked mathematical science department chairs to describe any such changes that might have occurred over the past five years. The specific questions were:

2(a) Is your department a part of a larger administrative unit in the mathematical sciences (e.g., a division or school of mathematical sciences)?

3(a) Between 1975 and 1980 was your department together with one or more other departments, consolidated into a larger administrative unit (e.g., a Division of Mathematical Sciences or Department of Electrical Engineering and Computer Science)?

(b) Between 1975 and 1980 was your department divided with part of your faculty entering a new department (e.g., a new department of Statistics or Computer Science)?

(c) Was your present department created since 1975?

(d) Other major changes in administrative structure?

Although responses to questions 2(a) indicated great diversity in the interpretation of the phrase "larger unit in the mathematical sciences", there is very little evidence of movement toward such administrative structuring. The most common pattern is separate departments of mathematics, statistics, and computer science in universities and large colleges, with joint mathematics and computer science departments common in the smaller colleges. Also in the smaller colleges the various mathematical science departments are being combined with a wide range of other science departments into divisions of science -- some including biology, psychology, business, physics, chemistry, and physical education. As might be expected, the new departments created in the mathematical sciences are primarily departments of computer science. From 1975-1980 this occurred most often in public four-year colleges. In smaller colleges computer science was most commonly accommodated by adding its programs and title to that of existing mathematics departments.

ADMINISTRATIVE RESTRUCTURING OF UNIVERSITY MATHEMATICAL SCIENCE DEPARTMENTS, 1975-1980

Between 1975 and 1980 there were few new mathematical science departments formed in universities -- either by consolidation or division of traditional departments. The changes that did occur were formation of computer science departments. There are now 94* computer science and 42* statistics departments in the 160 universities.

Table 3.1

Type of Change	Instances*	
1. Consolidation of departments into larger administrative units	5 yes	155 no
2. Division of departments to form one or more new departments	12 yes	148 no
3. New departments created	7 yes	153 no
4. Other major changes	5 yes	155 no

*Estimated from the sample respondents.

ADMINISTRATIVE RESTRUCTURING OF PUBLIC COLLEGE MATHEMATICAL SCIENCE DEPARTMENTS, 1975-1980

In roughly 10% of public four-year colleges, mathematical science departments have recently been combined with other physical, natural, and behavioral science departments into larger administrative units such as schools of science. Few mathematics departments have been sub-divided into new special focus departments. However, 28 of the estimated 71 public college computer science departments were created between 1975 and 1980, and many mathematics departments added computer science to their programs and titles.

Table 3.2

Type of Change	Instances*	
1. Consolidation of departments into larger administrative units	43 yes	364 no
2. Division of departments to form one or more new departments	11 yes	396 no
3. New departments created	28 yes	379 no
4. Other major changes	46 yes	361 no

*Estimated

ADMINISTRATIVE RESTRUCTURING OF PRIVATE COLLEGE MATHEMATICAL SCIENCE DEPARTMENTS, 1975-1980

The most common administrative change for private college mathematical science departments was merger with other science departments into divisions or departments of science and mathematics. This consolidation occurred most often in smaller colleges. There were few newly created computer science departments, but expansion of a mathematics department to include computing was more common.

Table 3.3

Type of Change	Instances*	
1. Consolidation of departments into larger administrative unit	155 yes	675 no
2. Division of department to form one or more new departments	19 yes	811 no
3. New departments created	71 yes	759 no**
4. Other major changes	71 yes	759 no

* Estimated
**Most of these repeat entries in (1)

3.2 Teaching Loads and Instructional Formats

The data of chapters 1 and 2 show that between 1975 and 1980 mathematical science course enrollments increased by 33% while FTE faculty rose by only 13%. These differential growth rates produced an 18% increase in the number of enrollments per faculty member. The pressure of such increased teaching responsibilities, with limited new resources, could be expected to cause changes in the way mathematics instruction is delivered and in the working conditions of the faculty.

The 1980 CBMS questionnaire surveyed the patterns of instructional delivery by asking for detailed information about the teaching of five lower level courses: finite mathematics, calculus for physical scientists and engineers, calculus for biological and management sciences, computer programming I, and elementary statistics. The questionnaire also sought information on average teaching loads for faculty and utilization of teaching assistants. On these questions it was possible to make comparisons with findings of previous surveys.

MATHEMATICAL SCIENCE ENROLLMENTS PER FTE MATHEMATICAL SCIENCE FACULTY MEMBER

From 1975 to 1980 enrollments per FTE faculty member in mathematical sciences increased by 18% to a ratio very close to that of 1965. The sharp increase occurred in every type of four-year institution, probably reflecting the growth in lower level, large section courses.

Figure 3.1*

(enrollment per FTE faculty members)

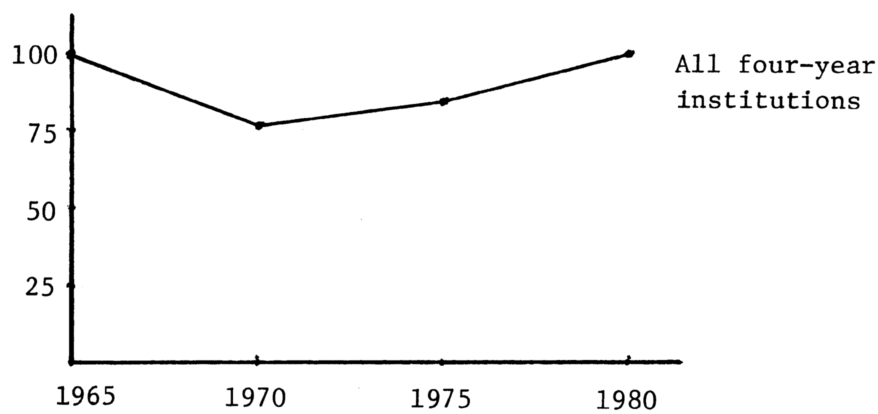


Table 3.4*

Type of Institution	1965	1970	1975	1980
Universities	104	79	85	96
Public Colleges	101	78	87	105
Private Colleges	90	71	73	90
All Institutions	99	77	83	98

*Not including graduate teaching assistants in the faculty count. Data for 1960 not available.

EXPECTED CREDIT-HOUR TEACHING LOADS IN MATHEMATICS DEPARTMENTS

Since 1975 there appears to have been little net change in the expected credit-hour teaching loads at universities and public colleges and a modest increase in private colleges. About half the universities give reduced loads to faculty who are either active researchers, lecturers in large courses, or administrators. In public colleges reduced loads are commonly given for researchers, administrators, advisors, or large class lecturers (in that order of frequency), and in private colleges nearly all reductions of the normal teaching load are for administrators. A few schools give different loads for different professorial ranks -- usually less for full professors.

Table 3.5

(% of mathematics departments with indicated teaching load)

	Credit-Hour Load						
Type of Institution	<6	6	7-8	9	10-12	12	>12
1. Universities							
1970	8%	40%	32%	8%	5%	7%	-
1975	-	26%	39%	21%	5%	10%	-
1980	10%	23%	29%	26%	4%	9%	-
2. Public Colleges							
1970	-	3%	5%	14%	25%	35%	18%
1975	-	1%	5%	1%	14%	57%	21%
1980	-	3%	6%	4%	7%	59%	22%
3. Private Colleges							
1970	-	-	-	7%	17%	60%	16%
1975	-	4%	2%	6%	18%	56%	14%
1980	2%	3%	5%	7%	17%	45%	22%

EXPECTED CREDIT-HOUR TEACHING LOADS IN STATISTICS AND COMPUTER SCIENCE

Since 1975 expected teaching loads in university statistics departments have tended to concentrate more in the 6-8 semester hour range. University computer science credit-hour loads have declined markedly with 24% of all departments expecting less than 6 hours. However, the emerging public college computer science departments have expected teaching loads very similar to their mathematics department counterparts.

Table 3.6

(% of departments with indicated teaching load)

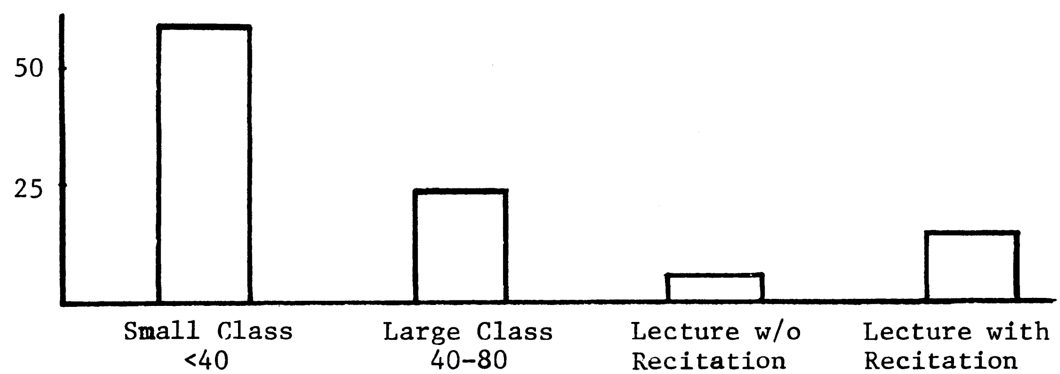
Type of Department	<6	6	7-8	9	10-11	12	>12
1. University Statistics							
1970	44%	28%	12%	8%	8%	-	-
1975	17%	45%	11%	17%	5%	5%	-
1980	9%	41%	34%	16%	-	-	-
2. University Computer Science							
1970	17%	46%	27%	-	7%	3%	-
1975	14%	34%	19%	14%	14%	5%	-
1980	24%	44%	8%	16%	4%	4%	-
3. Public College Computer Science, 1980	-	7%	-	23%	-	54%	15%

INSTRUCTIONAL FORMATS IN SELECTED MATHEMATICAL SCIENCE COURSES, 1980

Nearly three-fifths of all students in finite mathematics, calculus, computer programming, and elementary statistics are taught in small classes. These small classes are most common in finite mathematics and statistics. Large lectures with recitation sections are more common in calculus and computer programming than in the other two courses.

Figure 3.2

(% of students taught by each format)



Lectures, with or without recitation sections, enroll nearly one-third of students in the selected courses at universities. In both public and private colleges a small class format is much more common.

Table 3.7

(% of students taught by each format)

Institution Type	Small Class	Large Class	Lecture w/o Recitation	Lecture with Recitation	Other
Universities	36%	31%	10%	21%	1%
Public Colleges	67%	21%	2%	9%	-
Private Colleges	79%	13%	1%	7%	-

UTILIZATION OF TEACHING ASSISTANTS IN MATHEMATICS, STATISTICS, AND COMPUTER SCIENCE, 1980

Data in Chapter 2 show that from 1975-1980 the number of mathematical science teaching assistants increased by 18%, mostly in computer science and private college mathematics departments. Further, the fraction of TA's who are not graduate students (e.g., undergraduate TA's) more than tripled to over one in five. The major roles of TA's are teaching their own classes, conducting recitation sections, tutoring, and paper grading, but the use of TA's varies widely from department to department.

Table 3.8
(% of TA's in each principal role)

	Role				
Type of Department	Teaching Their Own Class	Conducting Quiz Section	Paper Grading	Tutoring	Other
1. University					
Mathematics (n=5491)	50%	29%	11%	8%	1%
Statistics (n=546)	8%	42%	28%	22%	-
Computer Science (n=1813)	18%	21%	36%	26%	-
2. Public College					
Mathematics (n=1535)	29%	15%	15%	27%	15%
Computer Science (n=90)	26%	-	57%	17%	-
3. Private College Mathematics (n=1154)	7%	19%	24%	50%	-
All Departments (n=10,629)	33%	25%	19%	20%	3%

SABBATICAL LEAVE POLICIES

The great majority of universities and four-year colleges have regular sabbatical leave plans. The grant of such leave depends, in most institutions, on well-defined research plans.

Table 3.9

(% of departments in each category)

Type of Department	Automatic	Leave Conditions With Research Plan	Other	No Sabbatical
1. University				
Mathematics (n=160)	8%	61%	16%	15%
Statistics (n=45)	28%	56%	16%	-
Computer Science (n=94)	12%	74%	4%	10%
2. Public College				
Mathematics (n=407)	5%	52%	19%	24%
Computer Science (n=71)	7%	55%	14%	24%
3. Private College (n=830)	11%	51%	14%	24%

3.3 Summary and Interpretations

The major course enrollment and faculty trends from 1975 to 1980 have led to pressures for change in the administration and delivery of instruction in mathematical sciences. The continuing growth of computer science as a major sector of the field has led to formation of independent computer science departments in most universities and in many large public colleges. In private colleges many mathematics departments have expanded their titles and programs to include computer science. However, it appears that pressures for administrative economy are leading to broader consolidations that include mathematical science programs in units that also have responsibility for a variety of physical and social sciences.

The rapid growth in mathematical sciences course enrollments out-paced growth in faculties, resulting in increased ratios of students to faculty. The increase from 1975 to 1980 was 18% overall, but the 1980 level is nearly identical to that of 1965. The normal credit-hour teaching loads for mathematical science faculty have decreased in university computer science departments, increased in private college mathematics departments, and changed little in other types of departments. The students in those courses are now increasingly likely to be in lower level courses, but, except for university departments, the teaching is still predominantly in small classes (<40). As a strategy for coping with the increased, lower-level enrollments, departments are making greater use of teaching assistants, but many of these TA's are not mathematics graduate students.

The trends in these data are hardly encouraging, suggesting that gains of the 1965-1975 period are being lost to pressures of enrollment, limited resources, and a diminishing pool of graduate student teaching assistance.

Chapter 4

MATHEMATICAL SCIENCE OFFERINGS, ENROLLMENTS, AND INSTRUCTIONAL PRACTICES IN TWO-YEAR COLLEGES

This chapter reports estimated national enrollments in two-year college (TYC) mathematical science courses for fall 1980. The data are compared and contrasted with results of previous CBMS surveys in 1966, 1970, and 1975 and with general enrollment trends in two-year colleges.

Highlights

- Between 1975 and 1980 growth in total two-year college enrollments slowed, increasing by only 19% in the five-year period. Mathematical science enrollments also increased at a slower rate than earlier periods, up by only 20%.

- In two-year colleges occupational/technical program enrollments now lead college transfer enrollments, and part-time students now account for nearly two-thirds of two-year college enrollments.

- Since 1975 computer course enrollments have exploded and now outnumber those in calculus.

- Access to computers is up sharply, but the impact of computers on mathematics teaching has changed little since 1975.

- The growth in remedial course enrollments has slowed, but still amounts to 42% of two-year college mathematical science enrollments.

- The fraction of total mathematical science enrollments included in precalculus, calculus, and statistics courses has levelled off.

- There has been a sharp decline in enrollments for courses in mathematics for liberal arts, and analytic geometry has all but disappeared as a separate course.

- Use of self-pacing instruction continues to spread among two-year colleges, and mathematics labs can now be found in more than two-thirds of all schools.

- Since 1970 enrollments in mathematics courses taught outside of mathematics programs have nearly tripled.

4.1 An Overview of Two-Year Colleges

During the last 20 years, no other sector of higher education has grown so rapidly as have two-year colleges. In the 60's, their enrollments tripled; in the 70's, they doubled. In the 80's, two-year colleges are the only post-secondary institutions expected to grow. In 1960, two-year colleges accounted for only one-sixth of all undergraduate enrollments in mathematics. Today, they account for more than one-third of all enrollments.

Explosive growth of such proportions has been accompanied by changes in programs, student populations, and faculty populations. These changes have been nothing short of revolutionary, causing some to wonder what the word "college" means in the name "community college." In the early 60's, most two-year colleges had a liberal arts orientation, serving as feeders for four-year colleges. By the mid-60's, program emphases had undergone considerable change. A host of new programs in vocational/technical areas were introduced: data processing, dental hygiene, electronics, practical nursing, automotive mechanics, accounting, bricklaying, carpentry, and police and fire science, to name a few. Today, less than half of two-year college students are enrolled in college transfer programs. The growing majority of students are now enrolled in vocational/technical programs.

Most of the students of the 60's were 18- and 19-year old high school graduates, planning to move on to four-year transfer colleges. Most of them were single, white, male, and attending on a full-time basis. Today, two-thirds of the students are over 21, one-third are married, some lack high school degrees, one-fourth are minority students, and more than one-half are women. Nearly two-thirds of these students are attending on a part-time basis, and one-half start their studies after age 21. Many of these students require training in remedial mathematics (arithmetic, high school geometry, elementary and intermediate algebra, and general mathematics). The growth of remedial courses has been dramatic; today they account for 42% of all two-year college mathematics enrollments. Simultaneously, calculus enrollments have dropped to only 10% of all enrollments.

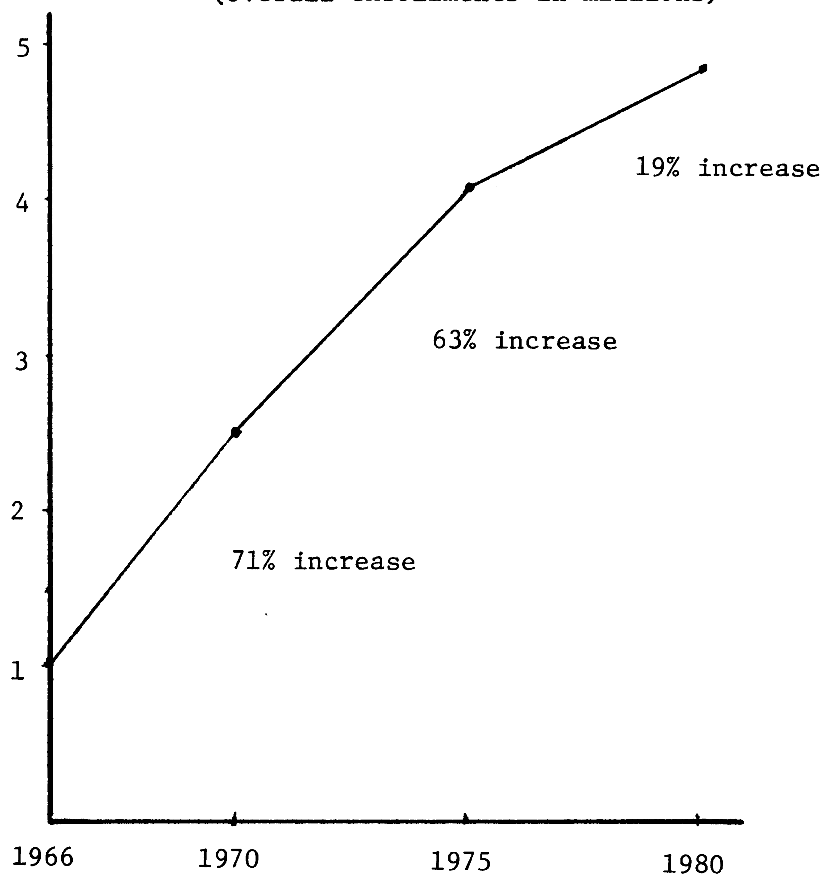
Faculty populations have also changed since 1960. Then nearly two-thirds of full-time faculty previously taught in high schools. Many of them entered two-year colleges expecting to move up to calculus-level courses. In a short time, they found themselves teaching courses in arithmetic. Since then, economic pressures have resulted in a sharp swing toward the use of part-time faculty. In the mid 60's, full-timers outnumbered part-timers by two to one; today, part-timers outnumber full-timers. Another aspect of difficult economic times is the growing phenomenon of overload teaching. At present, nearly one-half of all full-time faculty are teaching overloads.

Additional details on trends in course offerings and changes in two-year college teaching environments are given in the following pages.

TRENDS IN OVERALL TWO-YEAR COLLEGE ENROLLMENTS, 1966-1980

Two-year college enrollments now total nearly 5,000,000. Growth of two-year college enrollments slowed to a 19% increase over the period 1975-1980. During that five-year period, mathematical science course enrollments showed virtually the same percentage increase.

Figure 4.1
(overall enrollments in millions)



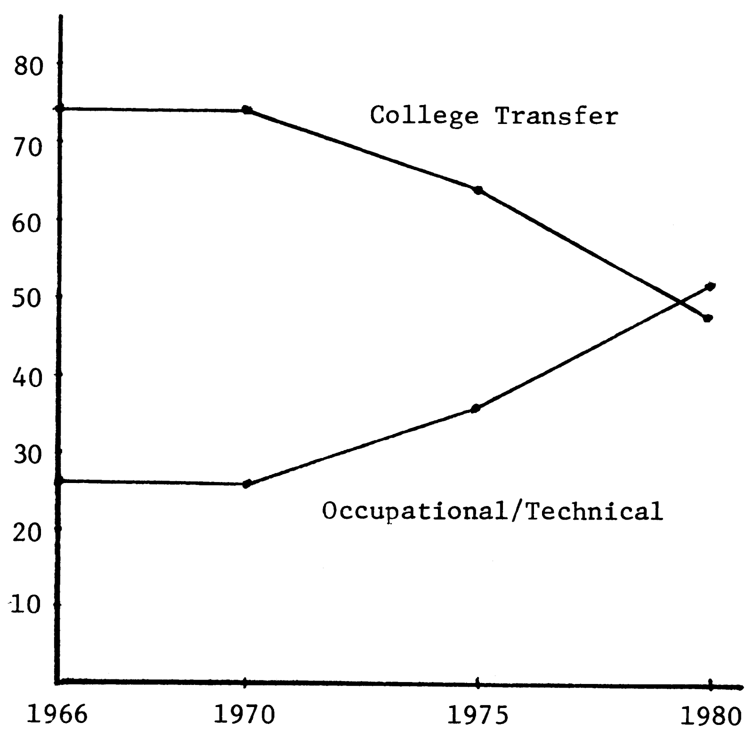
Year	1966	1970	1975	1980
Fall Enrollments	1,464,099	2,499,837	4,069,279	4,825,931

Source: 1981 Community, Junior, and Technical College Directory, AACJC, One Dupont Circle, N.W., Washington, D.C. 20036.

COLLEGE TRANSFER AND OCCUPATIONAL/TECHNICAL ENROLLMENTS IN TWO-YEAR COLLEGES, 1966-1980

Full-time-equivalent enrollments in occupational/technical programs now lead enrollments in college transfer programs. From 1966 to 1975 the reverse was true.

Figure 4.2
(percentage of full-time-equivalent enrollments)



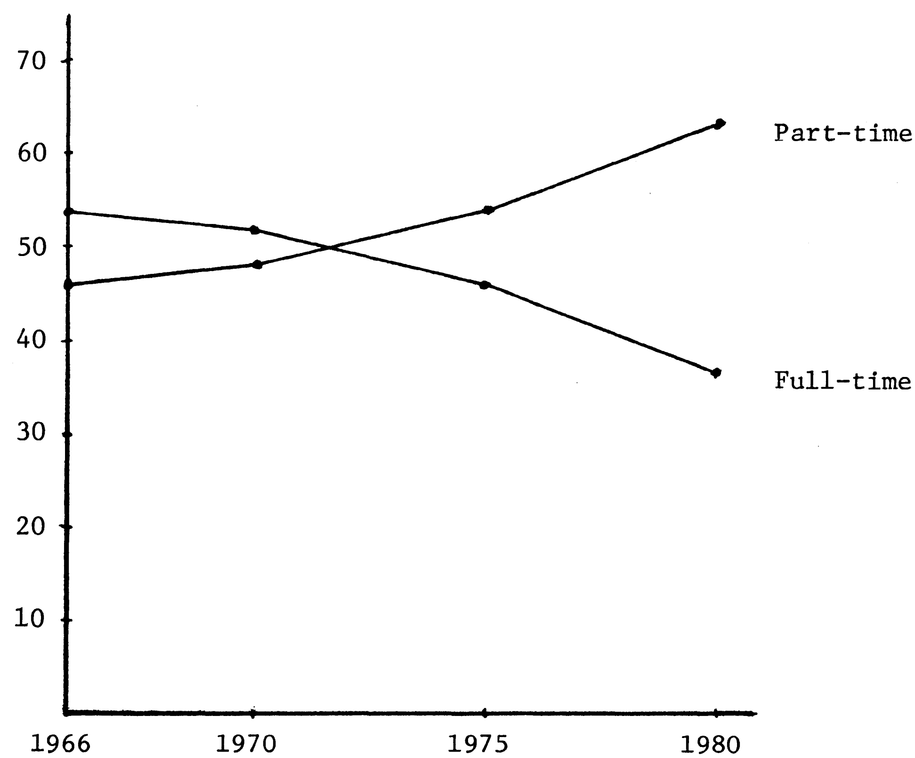
	1966	1970	1975	1980
College Transfer	74%	74%	64%	48%
Occupational/Technical	26%	26%	36%	52%

Source: Projections of Education Statistics to 1986-87 and CBMS questionnaire data for 1980.

FULL-TIME VERSUS PART-TIME ENROLLMENTS IN TWO-YEAR COLLEGES, 1966-1980

Part-time enrollments overtook full-time enrollments in 1972. In 1980 part-time enrollments accounted for 63% of total enrollments.

Figure 4.3
(percentage of total enrollments)



Year	1966	1970	1975	1980
Full-time Fall Enrollments	792,006	1,282,604	1,726,302	1,795,442
Part-Time Fall Enrollments	664,157	1,164,797	2,002,269	2,996,264

Sources: Community, Junior, and Technical College Directory 1967, 1972, 1976, 1981.

4.2 Trends In Two-Year College Mathematics Enrollments

A slowing in the growth of mathematics enrollments marked the five-year period 1975-1980. Building on a small base in 1975, computing courses jumped by 850%! Among the still growing remedial course group, arithmetic increased by 81%. Technical mathematics courses, perhaps as evidence of a turn toward the applied side, registered large gains (58%). Providing additional evidence of this turn, courses in mathematics for liberal arts declined sharply to 19,000 enrollments, which is less than the 1966 level of 22,000 enrollments. Courses in calculus, precalculus, and statistics showed small percentage gains since 1975.

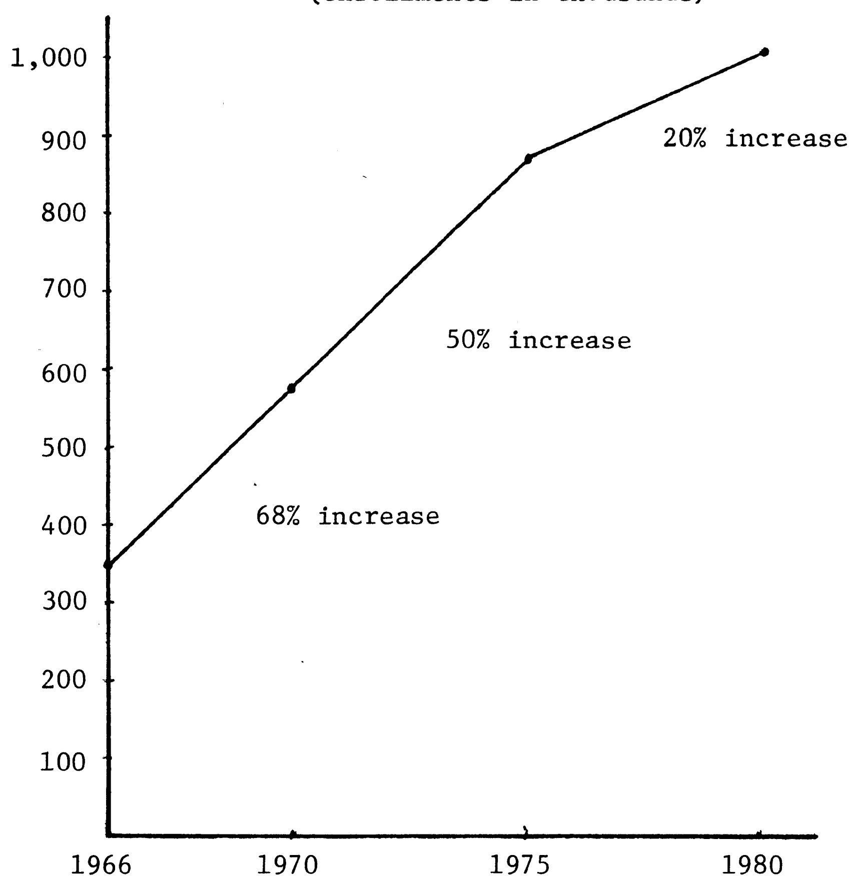
To a great extent, patterns of enrollment growth were accompanied by similar patterns of availability of mathematics courses in two-year colleges.

GROWTH OF MATHEMATICS ENROLLMENTS IN TWO-YEAR COLLEGES

Enrollments in mathematics courses increased by 20% from 1975-1980, and thus kept pace with the *overall* enrollment increase of 19%. Prior to 1975, the rates of increase were much higher.

Figure 4.4

(enrollments in thousands)



Year	1966	1970	1975	1980
Fall Enrollments	348,000	584,000	874,000	1,048,000

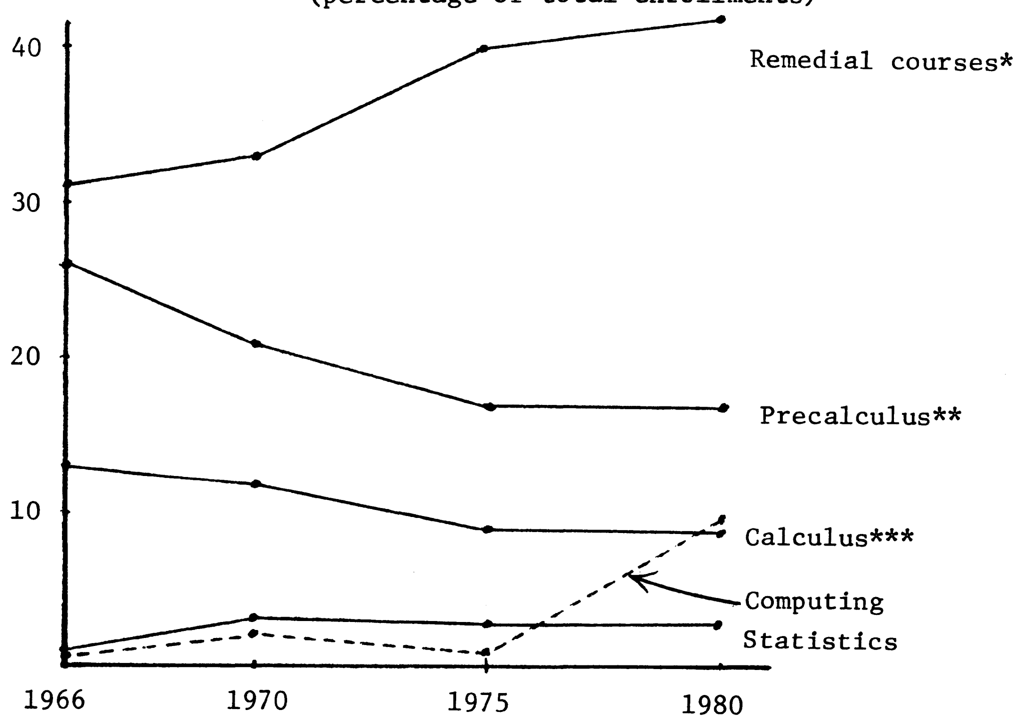
ENROLLMENT TRENDS IN MATHEMATICAL SCIENCE COURSE GROUPS, 1966-1980

Courses in computing surged to more than 9% of total mathematics enrollments and now exceed calculus enrollments. Remedial courses continued to grow over the 1975-1980 period, but their growth is down from 1970-1975. Calculus, precalculus, and statistics remained level from 1975 to 1980.

The computing boom is even more dramatic when courses outside the mathematics program are included. The addition of these "outside" courses nearly doubles the computing enrollments figure for 1980.

Figure 4.5

(percentage of total enrollments)



*Remedial courses include arithmetic, high school geometry, elementary algebra, intermediate algebra, and general mathematics (courses 1-4, 10).

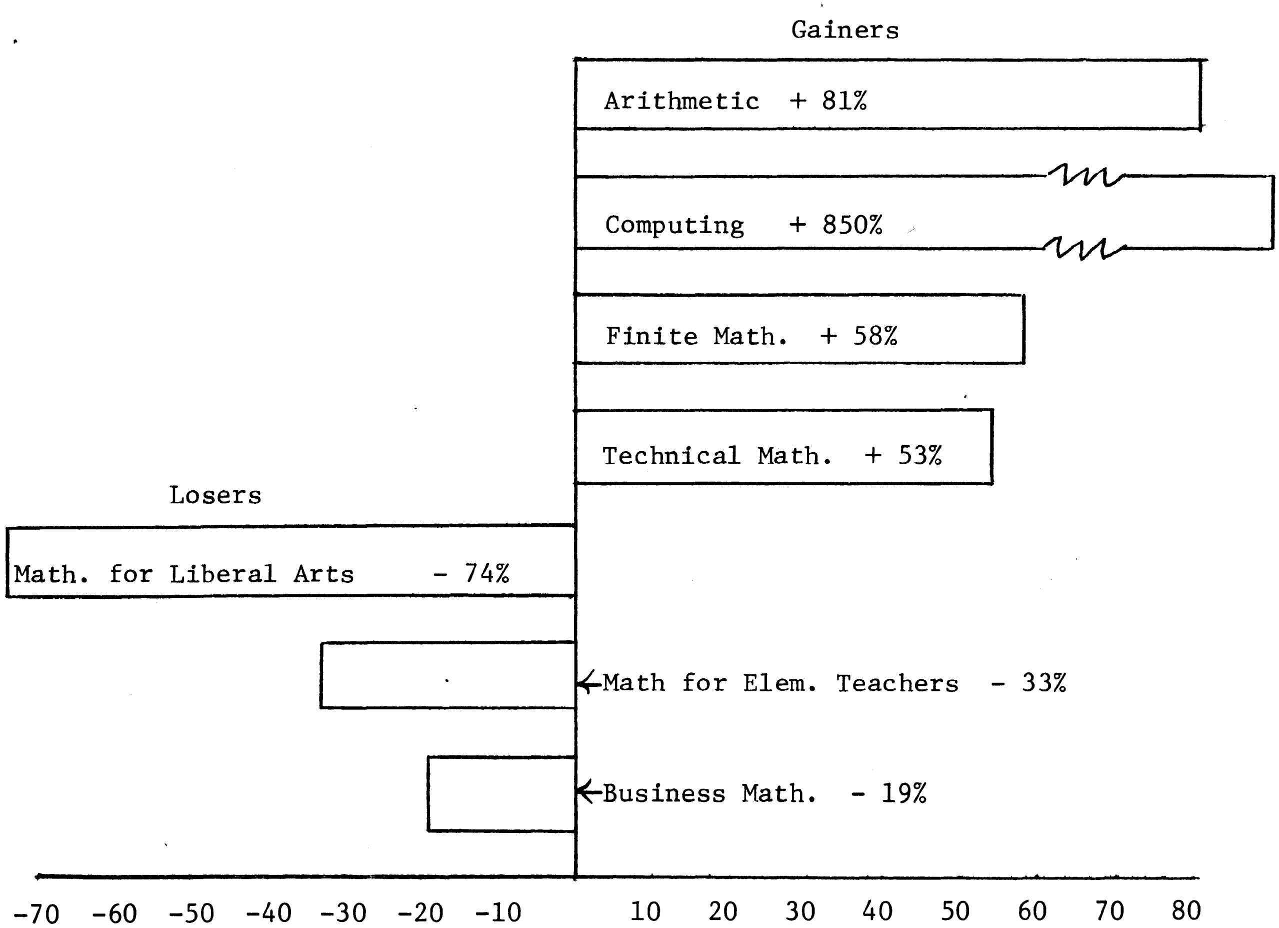
**Precalculus courses include college algebra, college algebra and trigonometry, trigonometry, and elementary functions.

***Calculus includes courses 17-21 on the questionnaire.

CHANGES IN TWO-YEAR COLLEGE MATHEMATICS ENROLLMENTS, 1975-1980

Courses of an applied nature showed the largest percentage increases in enrollments over the period 1975-1980, reflecting the greatly increased occupational/technical focus of two-year colleges. The sharp enrollment decrease in courses in mathematics for liberal arts is evidence of a turning away from the liberal arts. The decline in business mathematics enrollments is puzzling. It should be noted that this course gained in enrollments in divisions outside mathematics. Mathematics for elementary teachers continues to decline, down to one-third of its 1970 enrollment level.

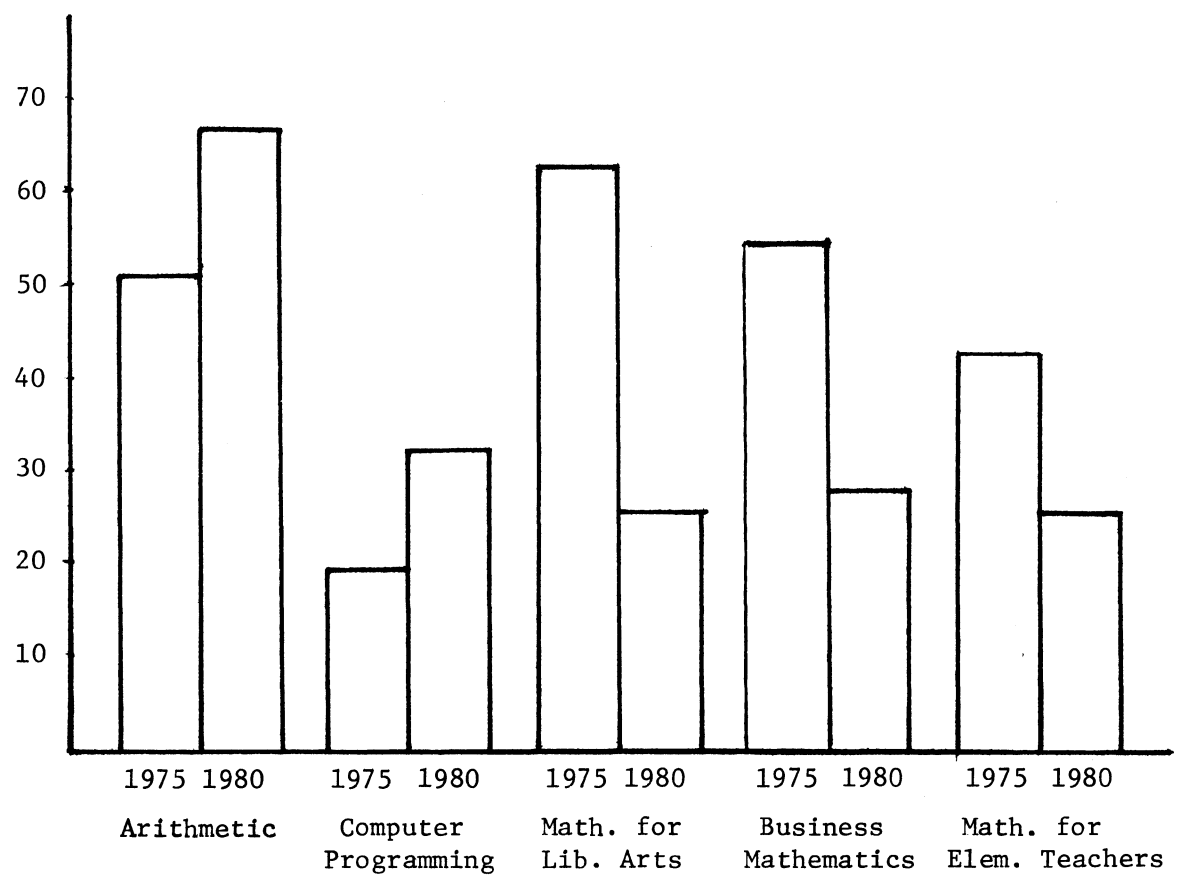
Figure 4.6
(percentage enrollment change, 1975-1980)



TRENDS IN AVAILABILITY OF SELECTED MATHEMATICS COURSES IN TYC'S, 1975-1980

The availability trends shown below parallel enrollment trends to a great extent. Arithmetic gained 81% in enrollments during 1975-1980 and is more available; mathematics for liberal arts lost 74% in enrollments and is less available. There are other interesting trends not shown below. Analytic geometry courses have all but vanished from TYC's. Courses in differential equations and in statistics continue to decline in availability.

Figure 4.7
(percent of TYC's offering course)



TEN-YEAR TRENDS IN AVAILABILITY OF MATHEMATICS, 1970-1980

Since 1970, remedial courses have become more widely available. In 1970, courses in arithmetic were taught in one-third of TYC's. In 1980, arithmetic was taught in two-thirds of TYC's. Of the pre-calculus course group, all except college algebra are *less* available than they were in 1970. Calculus courses designed for engineering science, mathematics, and physics are less available than they were in 1970. Part of this drop in availability can be explained by the introduction of new "soft" calculus courses designed for students in the biological, social, and managerial sciences.

Advanced courses such as linear algebra and differential equations are less available than they were in 1970.

Headed for extinction in the two-year colleges are courses in mathematics of finance, analytic geometry, and slide rule. Curiously, courses involving statistics are less available in 1980 than they were in 1970.

Table 4.1 provides additional detail on ten-year trends in availability.

AVAILABILITY OF MATHEMATICS IN TWO-YEAR COLLEGES:
TEN-YEAR TRENDS, 1970-1980

Table 4.1

(% of TYC's offering course)

	Subject	Fall 1970	Fall 1980
1.	Arithmetic	37	67
2.	High School Geometry	24	16
3.	Elementary Algebra (H.S.)	48	62
4.	Intermediate Algebra (H.S.)	56	68
5.	College Algebra	53	72
6.	Trigonometry	64	48
7.	College Algebra and Trigonometry	41	35
8.	Elementary Functions	25	13
9.	Mathematics for Liberal Arts	NA*	26
10.	General Mathematics	20	36
11.	Finite Mathematics	19	23
12.	Mathematics of Finance	13	5
13.	Business Mathematics	38	28
14.	Mathematics for Elementary School Teachers	48	26
15.	Technical Mathematics	41	61
16.	Technical Mathematics (Calculus Level)	19	19
17.	Analytic Geometry	18	6
18.	Analytic Geometry and Calculus	63	51
19.	Calculus (mathematics, physics, and engineering science)	41	33
20.	Calculus (biology, social and management science)	NA	20
21.	Differential Equations	49	17
22.	Linear Algebra	17	6
23.	Differential Equations and Linear Algebra	NA	L**
24.	Elementary Statistics	41	28
25.	Probability (and statistics)	16	14
26.	Programming of Digital Computers	27	32
27.	Other Computer Science Courses	18	28
28.	Use of Hand Calculators	NA	7
29.	Slide Rule	24	L

*NA denotes not available
**L denotes less than 1%

DETAILED FALL ENROLLMENTS IN MATHEMATICAL SCIENCE
COURSES IN TWO-YEAR COLLEGES

Table 4.2

(enrollments in thousands)

	Subject	1966-67	1970-71	1975-76	1980-81
1.	Arithmetic	15	36	67	121
2.	High School Geometry	5	9	9	12
3.	Elementary Algebra (H.S.)	35	65	132	161
4.	Intermediate Algebra (H.S.)	37	60	105	122
5.	College Algebra	52	52	73	87
6.	Trigonometry	18	25	30	33
7.	College Algebra and Trigonometry, combined	15	36	30	41
8.	Elementary Functions	7	11	16	14
9.	Mathematics for Liberal Arts	22	57	72	19
10.	General Mathematics	17	21	33	25
11.	Finite Mathematics	3	12	12	19
12.	Mathematics of Finance	4	5	9	4
13.	Business Mathematics	17	28	70	57
14.	Mathematics for Elementary School Teachers	16	25	12	8
15.	Technical Mathematics	19	26	46	66
16.	Technical Mathematics (calculus level)	1	3	7	14
17.	Analytic Geometry	4	10	3	5
18.	Analytic Geometry and Calculus	32	41	40	45
19.	Calculus (mathematics, physics, and engineering sciences)	8	17	22	28
20.	Calculus (biology, social, and management sciences)	NA	NA	8	9
21.	Differential Equations	2	1	3	4
22.	Linear Algebra	1	1	2	1
23.	Differential Equations and Linear Algebra, combined	NA	NA	L*	L
24.	Elementary Statistics	4	11	23	20
25.	Probability (and statistics)	1	5	4	8
26.	Programming of Digital Computers	3	10	6	58
27.	Other Computer Science Courses	2	3	4	37
28.	Use of Hand Calculators	NA	NA	4	3
29.	Slide Rule	3	9	5	L
30.	Other Courses	5	5	27	27
	Total	348	584	874	1,048

*L denotes enrollment less than 500

FALL ENROLLMENTS IN MATHEMATICAL SCIENCE COURSES
IN TWO-YEAR COLLEGES, BY LEVEL

Since 1966 the share of enrollments in remedial courses and computing has increased. The share of precalculus, calculus, and service courses has declined.

Table 4.3

(in thousands and as % of total)

Level	1966 Number	1966 %	1970 Number	1970 %	1975 Number	1975 %	1980 Number	1980 %
Remedial (Courses 1-4,10)	109	31	191	33	346	40	441	42
Precalculus (5-8)	92	26	124	21	149	17	175	17
Calculus (17-21)	46	13	69	12	76	9	91	9
Statistics (24-25)	5	1	16	3	27	3	28	3
Computing (26-27)	5	1	13	2	10	1	95	9
Service Courses (9,11-16,22,24, 25,28,29)	91	26	182	31	266	30	219	21

4.3 Mathematics Courses Taught Outside of Mathematics Programs

We have previously noted the shift of two-year college enrollments to occupational/technical programs. Many of these programs provide their own mathematics instruction. To get an approximation to the size of such "outside" offerings, we asked for estimates of enrollments in mathematics courses given by other divisions or departments. The estimates are probably not as reliable as other data presented in this report, because respondents did not have direct responsibility for these outside courses.

The majority of outside enrollments are found in computer science courses and business mathematics. The divisions providing most of the outside courses are those whose specialization is in business and occupational/technical programs.

In 1967, Jewett and Lindquist observed that "... the mathematics curriculum in junior colleges seems overwhelmingly designed for transfer students. Outside enrollments have nearly tripled since 1970 and are now equal to 13% of mathematics enrollments. The words of Jewett and Lindquist take on added importance in view of the growth of occupational/technical programs. Hopefully, mathematics faculty will increase their coordination efforts with occupational/technical departments.

At present, nearly half of the mathematics departments in two-year colleges do consult with vocational technical departments on development and/or coordination of offerings. The magnitude and quality of such coordination may be vital to mathematics faculty, given the turn toward occupational/technical programs.

ESTIMATED ENROLLMENTS IN MATHEMATICS COURSES TAUGHT OUTSIDE OF MATHEMATICS PROGRAMS IN TYC'S, ALL TERMS

As in the case of "inside" mathematics enrollments, computer science is the most prominent course in 1980 for "outside" mathematics enrollments. Computer science accounts for 35% of "outside" enrollments and increased by 80% from 1975. "Outside" enrollments in business mathematics have increased by 32% from 1975. This is to be contrasted with "inside" business mathematics enrollments, which decreased by 19%.

Table 4.4

(enrollments in thousands)

Courses	1970	1975	1980
Arithmetic	14	27	18
Business Mathematics	36	53	70
Calculus and Differential Equations	L*	4	8
Computer Science and Programming	21	51	92
Pre-Calculus College Mathematics	6	17	29
Statistics and Probability	6	14	12
Technical Mathematics	NA	NA	25
Other	9	12	10
Total	92	178	264

*L denotes some but less than 500.

DIVISIONS OTHER THAN MATHEMATICS THAT TAUGHT MATHEMATICS COURSES, ALL TERMS, 1980-81

Business and occupational/technical program faculties teach substantial numbers of mathematics courses.

Table 4.5

(enrollments in thousands)

	Enrollment in courses given by division specialising in:					
Courses	Natural Sciences	Occupational Programs	Business	Social Sciences	Other (specify)	Total
Arithmetic	3	8	3	1	3	18
Business Mathematics	1	4	65	0	L*	70
Statistics and Probability	2	4	5	1	L	12
Pre-calculus College Math.	4	16	2	5	2	29
Calculus or Diff. Equations	4	4	0	L	L	8
Computer Science and Programming	3	22	46	6	15	92
Technical Mathematics	0	21	2	0	2	25
Other	0	2	2	0	6	10
Total	17	81	125	13	28	264

*L = some, but less than 500

4.4 Computers and Calculators in Two-Year Colleges

We have already noted the tremendous growth of enrollments in computer science both inside and outside mathematics departments. Not surprisingly, the number of two-year colleges reporting access to computers has risen sharply since 1975 and now amounts to 71% of all TYC's. (In medium- and large-sized TYC's, access is nearly 100%.) Department heads estimate that 59% of the full-time faculty know a computer language. However, the number of faculty making use of computers in their teaching has not grown much since 1975. It is reported that only 21% of full-time faculty give class assignments involving the use of the computer each year (in courses other than computer science). The small impact of computers on mathematics teaching can be seen by noting that less than 2% of all sections of mathematics (excluding computer science) reported the use of computer assignments for students.

The impact of hand calculators on mathematics teaching is substantially larger than that of computers: 62% of all two-year colleges report that calculators are recommended as adjuncts to instruction in *some* of their courses. It is estimated that hand calculators are recommended for use in 29% of all course sections. Usage of calculators is, however, concentrated in a small number of courses. Only courses in college algebra and trigonometry, trigonometry, statistics, and technical mathematics have usage rates in excess of 50%. (That is, the fraction of sections in which hand calculators are recommended exceeds 50%.)

4.5 Instructional Formats For Two-Year College Mathematics

The 1975 CBMS survey of two-year college mathematics noted the emergence of a variety of self-pacing instructional methods. The 1980 responses point to continued growth in use of self-pacing methods. Although the standard lecture-recitation system for classes of 40 or less remains the dominant technique of instruction in 1980, the increasing presence of self-pacing methods indicates that instructional experimentation is alive and well in two-year colleges.

EXTENT OF USE OF VARIOUS INSTRUCTIONAL METHODS

For each of eleven instructional methods, the table below shows the percentage of two-year colleges reporting no use, use by some faculty, or use by most faculty of that instructional method in mathematics courses in 1980. For each of four of these instructional methods -- independent study, programmed instruction, modules, and PSI -- a quarter or slightly more of the responding two-year colleges reported that method used by a substantially larger fraction of the mathematics faculty than five years earlier.

Table 4.6

Instructional Method	Not Being Used	Used by Some Faculty	Used by Most Faculty
Standard lecture-recitation system (Class size ≤ 40)	1%	2%	97%
Large lecture classes (>40) with recitation sections	63%	16%	21%
Large lecture classes (>40) with no recitation	76%	12%	12%
Organized program of independent study	37%	62%	1%
Courses by television (closed-circuit or broadcast)	73%	27%	0%
Courses by film	75%	24%	1%
Courses by programmed instruction	40%	56%	4%
Courses by computer-assisted instruction (CAI)	68%	31%	1%
Modules	42%	54%	4%
Audio-tutorial	55%	43%	2%
PSI (Personalized Systems of Instruction)	51%	46%	3%

USE AND STAFFING OF MATHEMATICS LABORATORIES IN TWO-YEAR COLLEGES

Math labs (math help centers, math tutorial centers) are relatively new adjuncts to mathematics instruction in two-year colleges. They may contain some or all of the following: tutors, calculators, computers, films, film strips, television units for playback of lectures or video cassettes, models, audio-tape units, learning modules, etc. Math labs have been established at a fairly constant rate since 1970 and can now be found in 68% of all two-year colleges. As shown in the table below, personnel of labs come from a variety of sources.

Table 4.7

Source of Personnel	Percent of TYC's Using Source*
Full-time members of math staff	38%
Part-time members of math staff	17%
Members of other departments	13%
Other (paraprofessionals, students)	35%

*A given college might use more than one source of lab staff. Since percents add only to 103%, it appears most colleges use only one source.

Survey respondents were asked to rate on a scale of 1 to 5 the importance of math labs in promoting the mathematics program at their institutions. A summary of responses is given below.

Of No Value		Of Some Value		Of Great Value
1	2	3	4	5
4%	2%	32%	35%	27%

COORDINATION OF COLLEGE-TRANSFER PROGRAMS WITH FOUR-YEAR INSTITUTIONS

For two-year colleges with large degree-credit programs it is important to coordinate program offerings, advisement, and academic standards with the most likely four-year college or university destination of their students. Seventy percent of the responding TYC's reported that their mathematics offerings are subject to state regulations, and thirty-eight percent reported official state-wide coordination of TYC mathematics offerings with those of four-year institutions.

This may help to explain the low level of reported consultation of TYC mathematics departments with four-year college and university departments: less than once a year for forty-two percent, yearly for thirty-five percent, and more than once a year for only twenty-three percent.

Chapter 5

MATHEMATICAL SCIENCE FACULTY IN TWO-YEAR COLLEGES

This chapter describes the number, educational qualifications, professional activities, and selected personal characteristics of two-year college mathematical science faculty. (For two-year colleges, the terms "mathematical science" and "mathematics" describe the same faculty and are used interchangeably in that context.) The chapter includes profiles of the age, sex, and ethnic composition of these faculty and information on mobility into, within, and out of two-year college teaching positions. Also included is a section on the teaching environment of mathematics faculty.

Highlights

- During the period 1975-1980 the full-time mathematical science faculty *decreased* by 5% and the part-time faculty *increased* by 95%.
- The percentage of doctorates among two-year college mathematics faculty increased to 15%.
- The percentage of women among full-time mathematics faculty increased to 25%.
- High schools continue to be the largest supplier of part-time mathematics faculty in two-year colleges.
- Teaching loads are up by 30 students per faculty member since 1970, and nearly half of the full-time faculty are teaching overloads as well.
- Dealing with remediation was identified as the biggest problem facing two-year college mathematics faculty in 1980.

The data in this chapter support and elaborate these and other findings of the 1980 survey.

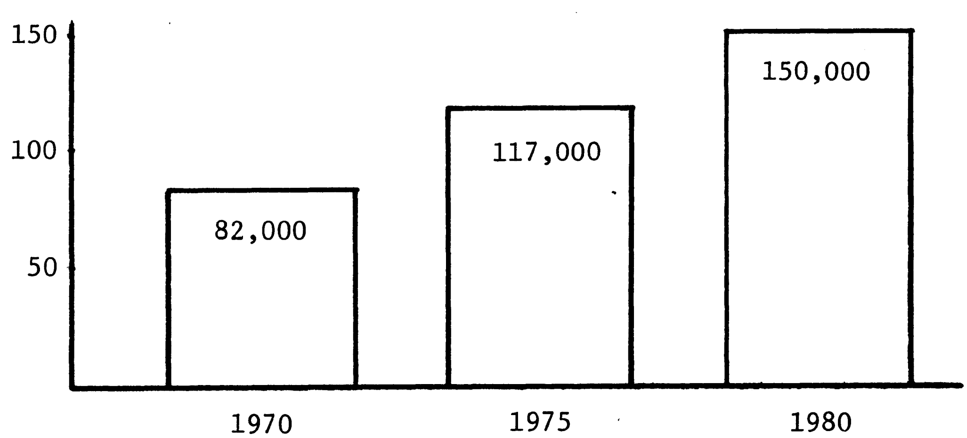
5.1 Number and Educational Qualifications of Two-Year College Faculty

As of fall 1980, two-year colleges employed 105,000 full-time faculty and 134,000 part-time faculty. More than 75% hold a master's degree and 14% hold a doctorate. Since two-year colleges emphasize teaching and not research, two-year college faculty spend significantly more time in the classroom than do faculty in four-year colleges and universities. Most two-year college faculty teach about 15 hours per week.

Since more than 50% of all students enrolled at two-year colleges are taking courses in occupational/technical fields, faculty trained and experienced in such areas as health technologies, business, data processing, and public service fields are currently in greatest demand. Our survey results show, in fact, that the growth of the full-time equivalent (FTE) mathematics faculty was 11%, considerably less than the 28% growth rate of *all* two-year college faculty. This disparity in growth rates is further magnified by the growth of mathematics enrollments (+20%), and has resulted in an average increase of 11 mathematics enrollments per FTE faculty member. The period 1970-75 showed an increase of 19 enrollments per faculty member. Thus, over the last ten years (1970-1980) teaching loads have increased by 30 students per full-time-equivalent faculty member!

Figure 5.1

(numbers of FTE TYC faculty, all fields, in thousands)

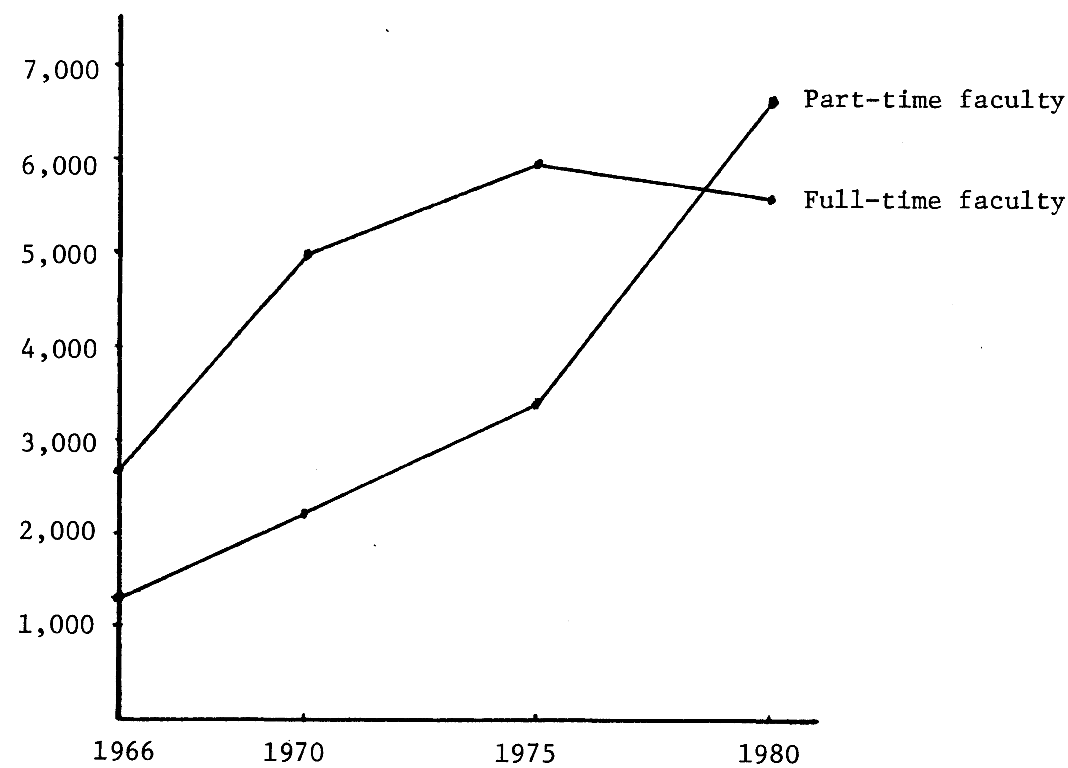


Source: <u>American Association of Community and Junior Colleges Directories</u>, 1971, 1976, 1981.

TRENDS IN NUMBERS OF FULL- AND PART-TIME MATHEMATICS FACULTY

For mathematics in two-year colleges, part-time faculty now outnumber full-time faculty, making up 54% of the total. The part-time component of the mathematics faculty increased by 95% over the period 1970-1975. Equally striking is the *decrease* in the size of the full-time faculty. For *all* fields in TYC's, part-timers constitute 56% of the faculty.

Figure 5.2
(numbers of mathematics faculty)



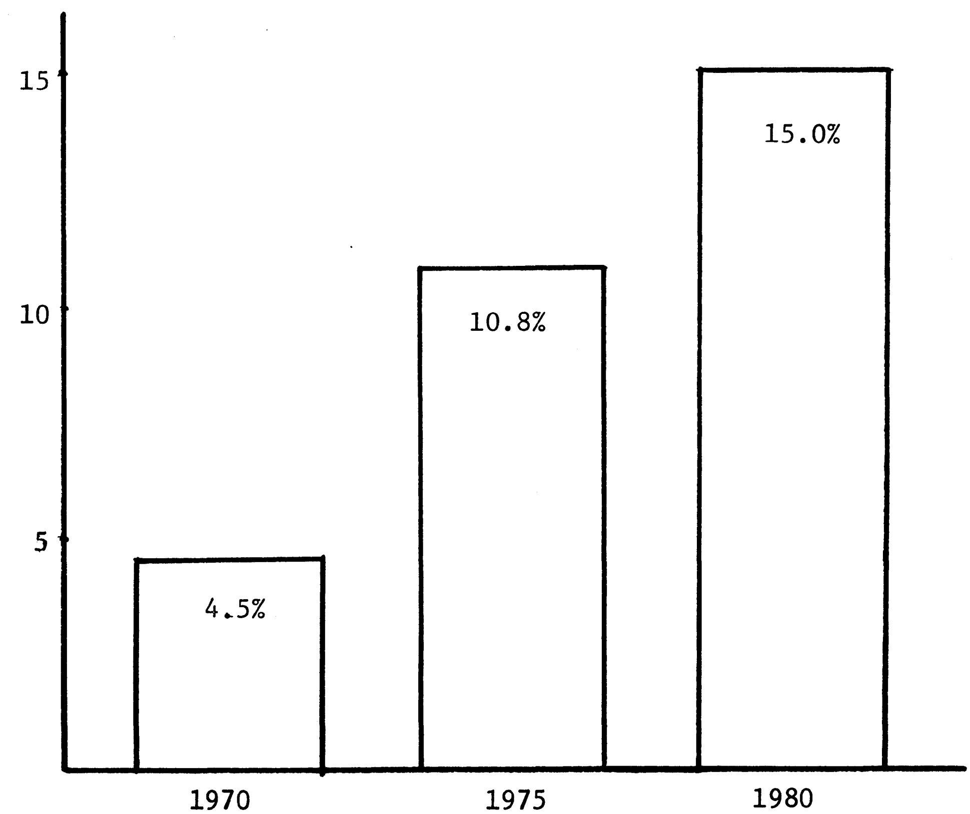
	1966	1970	1975	1980
Full-Time	2677	4879	5944	5623
Part-Time	1318	2213	3411	6661
FTE	3116	5617	7081	7843

TRENDS IN DOCTORATES AMONG FULL-TIME MATHEMATICS FACULTY

The percentage of doctorates among the full-time mathematics faculty in two-year colleges continued to grow at about one percent per year over the period 1975-1980. Department heads reported that 92 two-year college mathematics faculty earned doctorate degrees between 1979 and 1980, mostly in mathematics education and other fields.

Figure 5.3

(doctorates as a percentage of full-time mathematics faculty)



HIGHEST ACADEMIC DEGREES OF FULL-TIME MATHEMATICS FACULTY, 1980*

From 1970 to 1980, the percentage of the two-year college mathematics faculty with doctorates has increased from 5% to 15%, the master's fraction has not changed, and the "master's +1" fraction has decreased from 47% to 38%. The 9% *decrease* in the master's +1 group is nearly equal to the 10% *increase* in the doctorate group.

Table 5.1

	Percent with Highest Degree			
Field	Doctorate	Master's +1	Master's	Bachelor's
Mathematics	6.2%	28.8%	25.5%	3.3%
Statistics	0.3%	0.3%	0.1%	0
Computer Science	0.2%	1.3%	0.7%	0.5%
Mathematics Education	5.1%	4.9%	12.1%	0
Other Fields	3.2%	2.7%	3.9%	1.0%
Totals	15.0%	38.0%	42.3%	4.8%

*Previous CBMS surveys have reported separately on public and private two-year college faculty. Since the private component constitutes approximately 5% of the total faculty, the two components are combined in this report.

5.2 Age, Sex, and Ethnic Composition of Two-Year College Mathematics Faculty

Since 1975 the full-time faculty in mathematis has *decreased* by 5%. This has led to an increase in the average age of the faculty, with fewer in the under 35 range and more in the 35-44 range. There are indications of a substantial number of faculty in the 45-60 year age range leaving two-year college mathematics teaching.

During the five year period 1975-1980, the female fraction of two-year college mathematics faculty has risen from 21% to 25%, and there was an actual increase in the number of female faculty from 1250 in 1975 to 1396 in 1980. It thus appears that most of the overall decrease in the mathematics faculty of two-year colleges is due to an outflow of men.

Ethnic minorities have increased slightly, from 8% of the total faculty in 1975 to 9% in 1980. This percentage increase does not, however, suggest an increase in the number of ethnic minority faculty members.

TRENDS IN AGE DISTRIBUTION OF FULL-TIME MATHEMATICS FACULTY, 1975-1980

As shown in the percentage and number tabulation below, the percentage of full-time mathematics faculty younger than age 35 has decreased over the period 1975-1980, while the percentage in the age range 35-44 has increased correspondingly. Nevertheless, the tabulation of *numbers* of faculty below, suggest that new hires have augmented the group that was under age 35 in 1975. The group that was in the age range 35-44 in 1975 seems to have remained fairly stable, while the group that was over 45 in 1975 has declined in size. The decline may be due to early retirement, "burnout", and moves to employment economically more attractive than teaching.

Table 5.2

	Percent of Full-Time Mathematics Faculty		Number of Full-Time Mathematics Faculty	
Age Range	1975	1980	1975	1980
<30	9	5	535	281
30-34	18	15	1070	843
35-39	20	24	1188	1350
40-44	15	18	892	1012
45-49	13	16	773	900
50-54	13	10	773	562
55-59	8	7	475	394
≥60	4	5	238	281
			5944	5623

AGE DISTRIBUTION OF FULL-TIME MATHEMATICS FACULTY BY SEX AND BY EDUCATIONAL LEVEL, 1980

From 1975 to 1980 the women on full-time mathematics faculties of two-year colleges increased from 21% to 25% of the total. As might be expected, women are more heavily represented in younger age ranges, with nearly one-third less than 35 years of age.

Faculty in the 35-44 year range are more likely to hold doctorates than the other age groups, with 52% of all doctorates held by faculty in that age group.

Table 5.3

	Sex		Highest Degree	
Age Range	Male	Female	Doctorate	Master's
<35	16%	31%	17%	18%
35-44	45%	35%	52%	43%
45-54	27%	24%	19%	27%
≥ 55	12%	10%	12%	12%

ETHNIC GROUPS AMONG FULL-TIME MATHEMATICS FACULTY, 1980

The ethnic-group distribution of the full-time mathematics faculty of two-year colleges in 1980 is shown in the table below. The total minority-group fraction has increased by 1% since 1975.

Table 5.4

Ethnic Group	Percentage of Total*
Caucasian	93
Asian	3
Hispanic	1
Black	3
Amerindian	1

*Percentages do not add to 100% because of rounding.

The age distribution of the ethnic minority part of the full-time mathematics faculty of two-year colleges in 1980 is shown below. It differs from the overall age distribution (Table 5.2) primarily in having a larger fraction under age 35 and a smaller fraction of age 55 or over.

Table 5.5

Age Range	Percent of Total Ethnic Minority Faculty
<35	28
35-44	38
45-54	30
≥55	4

5.3 Part-Time Mathematical Science Faculty in Two-Year Colleges

While the full-time faculty decreased in size over the period 1975-1980, the part-time component increased by nearly 100%. Part-timers now outnumber full-timers by more than 1000, Overall, for all fields, part-timers account for 45% of the two-year college faculty. Mathematics, until the year 1980, used part-timers more sparingly than did other departments. For all intents and purposes, mathematics faculty now have the dubious distinction of being on a par with other departments.

The growth of the part-time sector is often linked to fiscal concerns. Of late, during periods of relatively high inflation, part-timers have been employed at an increasing rate to staff full-time positions that have resulted from deaths, retirements, etc. Until economic conditions improve, given that part-timers cost less, there is little reason to believe that the part-time fraction will decrease. Qualifications of part-time faculty may thus take on added importance in the 80's.

EDUCATIONAL QUALIFICATIONS OF PART-TIME MATHEMATICS FACULTY

As compared with the 1970 figures, the percentages of part-time mathematics faculty in the doctorate or "master's +1" highest degree categories have declined. Given an increase in the number of industrial opportunities for mathematicians, it is not likely that the educational qualifications of part-timers will increase in the near future.

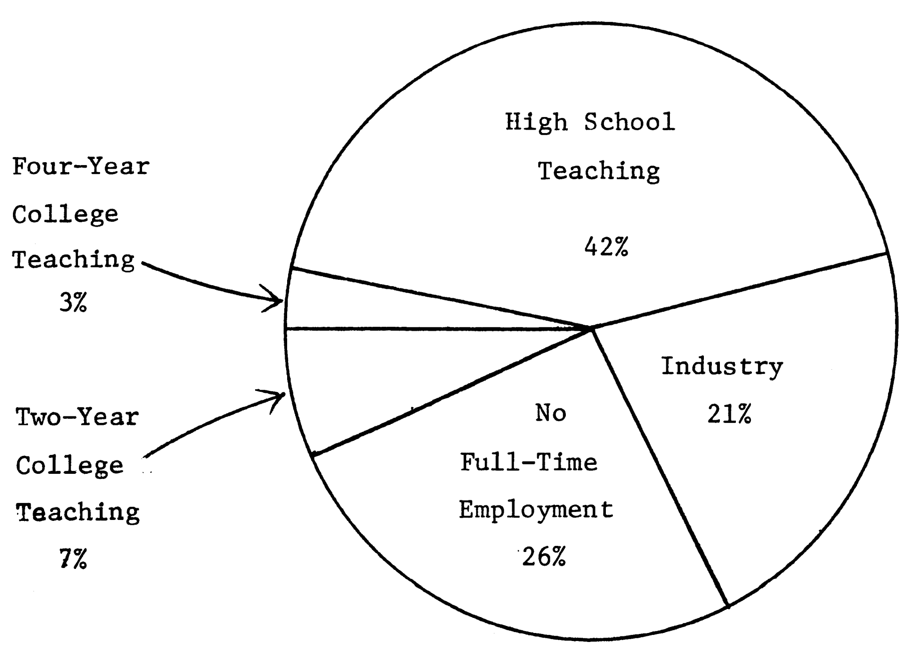
Table 5.6

Highest Degree	1970	1975	1980
Doctorate	9.5%	3.9%	6.7%
Master's + 1 year	31.0%	29.9%	18.1%
Master's	45.5%	49.6%	57.6%
Bachelor's	14.0%	16.6%	17.4%

For 1980, high school teachers constitute the largest source of part-time mathematics faculty in two-year colleges, as shown in the figure below.

Figure 5.4

(percent of part-time faculty from source shown)



HIGHEST ACADEMIC DEGREES OF PART-TIME MATHEMATICS FACULTY, 1980

In general, the highest-degree qualifications of the full-time faculty (Table 5.1) exceed those of the part-time faculty, as would be expected.

Table 5.7

	Percent with Highest Degree			
Field	Doctorate	Master's +1	Master's	Bachelor's
Mathematics	2.9%	10.7%	35.3%	11.2%
Statistics	0	0.4%	0.9%	0.1%
Computer Science	0.2%	0.1%	0.6%	0.2%
Mathematics Education	0.8%	5.0%	13.1%	3.4%
Other Fields	2.8%	1.9%	7.7%	2.5%
Totals*	6.7%	18.1%	57.6%	17.4%

*Totals do not add to 100% because of rounding.

5.4 Faculty Mobility

This section reports our findings regarding flows into and out of the full-time mathematics faculty of two-year colleges in 1980. For those with highest academic degree at the bachelor's level these flows were negligibly small. Mathematics faculty mobility within the two-year college community, that is, faculty moving from one two-year college to another, of course did not contribute to these overall net flows and occurred at only about one-quarter the level of these overall flows.

The primary sources of new full-time mathematics faculty in two-year colleges are, in order, four-year colleges and universities, high schools, and part-timers. In spite of our observed decrease in the size of the full-time faculty from 1975 to 1980, the data for 1980 alone show the number leaving two-year colleges (237) to be less than the number entering (304). Perhaps the decline in size of the full-time faculty is reversing.

SOURCES OF NEW FULL-TIME MATHEMATICS FACULTY IN TWO-YEAR COLLEGES, 1980

One-third of new full-time mathematics faculty in 1980 have previously taught in four-year colleges or universities. Most of the members of that transfer group were holders of master's degrees. High schools continue to be a strong source of new faculty. Overall, over 60% of all mathematics faculty in two-year colleges have previously taught in secondary schools. Teaching part-time in a two-year college also seems a viable path to full-time status.

Table 5.8

	Doctorates		Master's	Total
Source	Mathematics	Mathematics Education		
Graduate school	0	8	21	29
Teaching in a four-year college or university	13	0	88	101
Teaching in a secondary school	0	4	92	96
Part-time employment in institution	10	0	50	60
Non-academic position	6	0	12	18
Other sources, or unemployed	0	0	0	0
Total new TYC faculty	29	12	263	304
Transfers between TYC's	16	6	45	66

FULL-TIME MATHEMATICS FACULTY LEAVING TWO-YEAR COLLEGES, 1980

The "death or retirement" category is consistent with the 1975 age distribution constructed by CBMS. The 1975 age distribution showed 4% of the faculty to be over 60 years of age. That translates to approximately 48 retirements per year.

Table 5.9

	Doctorates		Master's	Total
	Mathematics	Math. Ed.		
Death or retirement	0	0	65	65
Teaching in four-year college or university	13	6	10	29
Non-academic position	6	0	17	23
Secondary school teaching	0	0	20	20
Returned to graduate school	0	0	21	21
Other, or unemployed	0	0	79	79
Total leaving TYC's	19	6	212	237

5.5 The Teaching Environment of Mathematics Faculty in Two-Year Colleges

Two-year colleges have changed rapidly over the last 20 years. Their explosive growth of the sixties, coupled with open-door admission policies, has changed the complexion of these institutions in significant ways. Gone are the days of their nearly exclusive junior college transfer role. Many two-year colleges, particularly in the west and southwest, have greatly expanded their scope to include a host of vocational programs. The great growth in part-time and female enrollments has also changed their clientele in a significant way.

Over the last five years, we have observed changes in two-year colleges which probably relate directly to the economic plight of these institutions:

1. Teaching loads have increased substantially.
2. Nearly half of the faculty are teaching overloads.
3. The part-time faculty has nearly doubled in size since 1975!
4. The full-time faculty has decreased in size!

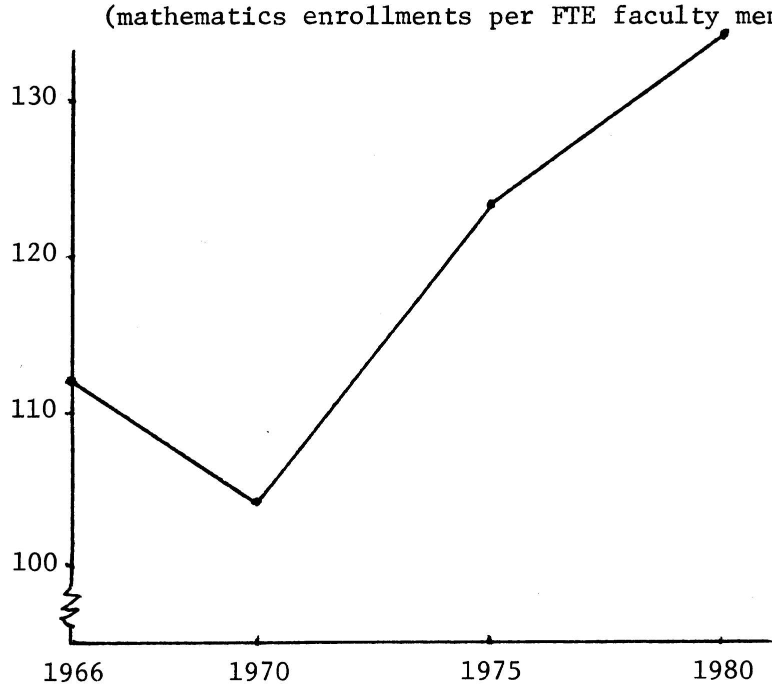
In this section, we report on trends in mathematics teaching loads in two-year colleges, trends in professional activities of full-time mathematics faculty outside the classroom, and problems of the administration of mathematics programs in two-year colleges.

TRENDS IN MATHEMATICS TEACHING LOADS IN TWO-YEAR COLLEGES

Since 1970, teaching loads have increased sharply in TYC mathematics programs, up by 30 students per FTE faculty member. In 1980, mathematics program heads reported that 44% of the full-time faculty were teaching overloads, usually one additional course beyond the standard load of 15 contact hours. While this overload faculty work might mask an undercount of the part-time share in FTE faculty time (and thus overestimate the number of students per FTE faculty member) for the faculty actually teaching the overloads the responsibility means even more students to whom they must provide mathematics instruction. Overload teaching was reported at 88% of responding TYC's.

Figure 5.5

(mathematics enrollments per FTE faculty member)



	1966	1970	1975	1980
Mathematics Enrollments	348,000	584,000	874,000	1,048,000
Full-Time E. Faculty	3,116	5,617	7,081	7,843
Enrollments per FTE	112	104	123	134

PROFESSIONAL ACTIVITIES OF FULL-TIME MATHEMATICS FACULTY

Mathematics program heads in two-year colleges reported an increase in professional activities of the faculty from 1975 to 1980. There is now more participation in conferences and reading of journals. Only textbook writing appears to have declined.

Table 5.10

Activity	Percent of Faculty Engaging in Activity 1975	1980
Attendance at at least one mathematics conference per year	47	59
Taking additional graduate courses during the academic year or summer	21	22
Giving talks on mathematics at conferences	9	13
Giving talks on mathematics education at conferences	9	16
Regular reading of journal articles on mathematics	47	56
Regular reading of journal articles on mathematics education	47	58
Writing journal articles on mathematics	5	5
Writing journal articles on mathematics education	5	6
Writing textbooks	15	10

ADMINISTRATION OF MATHEMATICS PROGRAMS IN TWO-YEAR COLLEGES

The existence of separate mathematics departments in two-year colleges is far from universal: only 38% of TYC's have separate mathematics departments. Another 45% maintain combined mathematics and science units. No departmental structure was reported in 6% of TYC's, and 11% have other types of structures containing mathematics.

Department heads have served in their positions for an average period of 7 years. Rotating department heads can be found in 11% of those TYC's reporting the existence of a department head, with 2 years being the typical length of term. When asked to indicate the most serious problems they faced, the administrators mentioned frequently only "dealing with remediation". More than half the administrators saw no problems concerning the part-time component, increased teaching loads, coordination of vocational-technical programs, continuing education of faculty, losing faculty to industry, and coordination with four-year colleges.*

Table 5.11

Problem	Major and Continuing Problem	Minor Irritant	No Problem
Dealing with remediation	60%	23%	17%
Holding part-time component in check	20%	28%	52%
Maintaining academic standards	19%	52%	29%
Increasing class sizes	16%	42%	42%
Maintaining momentum of faculty	14%	46%	40%
Increasing teaching loads	12%	38%	50%
Coordinating/developing math. for voc./tech. programs	11%	27%	62%
Continuing education of faculty	10%	31%	59%
Coordinating math courses with FTC's and universities	7%	31%	62%
Losing faculty to industry	1%	6%	93%

*Apart from remediation, administration and faculty views of problems of the 80's are largely opposed. See Reference 8 on page 112.

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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	105	8
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 calculated 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.

APPENDIX B
THE UNIVERSITY AND FOUR-YEAR COLLEGE QUESTIONNAIRE

SURVEY OF UNDERGRADUATE PROGRAMS
IN
THE MATHEMATICAL SCIENCES

1980

General Instructions

You are asked to report on programs in the mathematical sciences under the cognizance of your department. If your college or university has on its campus separate departments of mathematics, statistics, applied mathematics, computer science, etc. (as listed in the 1980 Mathematical Sciences Administrative Directory published by the American Mathematical Society), we are sending this same questionnaire to each such department, which is being requested to fill out the entire questionnaire insofar as it is applicable to that department. Do not include data for branches or campuses of your institution that are administratively separate.

Please return completed questionnaire by 1 November 1980 to:

Conference Board of the Mathematical Sciences
1500 Massachusetts Avenue, N.W., Suite 457-8
Washington, D.C. 20005

****

1. Name of your institution: ____________

   Name of your department: ____________

2. Administrative Structure:

   (a) Is your department a part of a larger administrative unit in the mathematical sciences (e.g., a division or school of mathematical sciences)? ______ Yes ______ No

   Name of larger unit ____________

   (b) List other mathematical sciences departments at your institution. (If in doubt be inclusive.)

   Department ____________ Name of Chairman ____________

   Department ____________ Name of Chairman ____________

   Department ____________ Name of Chairman ____________

- 2 -

3. Changes in Administrative Structure:

   (a) Between 1975 and 1980 was your department together with one or more other departments, consolidated into a larger administrative unit (e.g., a Division of Mathematical Sciences or Department of Electrical Engineering and Computer Science)? Yes ____ No ____

   Names of other departments involved in this consolidation ____________

   ____

   Name of larger administrative unit ____________

   (b) Between 1975 and 1980 was your department divided with part of your faculty entering a new department (e.g., a new department of Statistics or Computer Science)? Yes ____ No ____

   Name of new department(s) ____________

   (c) Was your present department created since 1975? Yes ____ No ____

   (d) Other major changes in administrative structure. Please specify:

   ____

   ____

4. Regular Undergraduate Program Courses

Instructions for Question 4:

(a) The undergraduate courses in column (1) in the following table are listed in three groups corresponding roughly to a division into mathematics, statistics, and computer science. Within each group they are listed in approximate "catalog order" for your convenience in locating a listing which is a reasonable approximation to your offerings. Additional blank spaces are provided to permit you to write in names of courses which do not fit reasonably under some listed title.

For the purpose of this survey, consider as a single course, instruction in a particular area of mathematics which you offer as a sequence of two or more parts (e.g., calculus). There is a column for indicating the number of sections of a course.

(b) For each course in column (1) that is being taught in the fall term of 1980 write in column (2) the total number of students who are enrolled in (any part of) the course in this term. Enter in column (3) the total number of sections of the course in the fall term of 1980. If a course is not being taught in the fall term but is expected to be taught during some other term of the current academic year, write L (for later) in column (2).

4. Undergraduate Courses

A. MATHEMATICS

Name of Course (or equivalent) (1)	Total Number of Students Enrolled Fall 1980 (2)	Total Number of Sections (3)	No. of Sections in which Students Use Computers (4)
1. Arithmetic for College Students			
2. General Mathematics (basic skills, operations)			
3. High School Geometry			
4. Elementary Algebra (High School)			
5. Intermediate Algebra (High School)			
6. College Algebra			
7. Trigonometry			
8. College Algebra and Trigonometry, combined			
9. Elementary Functions Precalculus mathematics			
10. Mathematics for Liberal Arts			
11. Finite Mathematics			
12. Mathematics of Finance			
13. Business Mathematics			
14. Mathematics for Elementary School Teachers			
15. Analytic Geometry			
16. Other pre-calculus: specify			
17. Calculus (math., phys., & eng. sciences)			
18. Calculus (biol., social & mgmt. sciences)			
19. Differential Equations			
20. Differential Equations and Linear Algebra			
21. Linear Algebra and/or Matrix Theory			
22. Modern Algebra			

4. Undergraduate Courses

Name of Course (or equivalent) (1)	Total Number of Students Enrolled Fall 1980 (2)	Total Number of Sections (3)	No. of Sections in which Students Use Computers (4)
23. Theory of Numbers			
24. Combinatorics			
25. Foundations of Mathematics			
26. Set Theory			
27. History of Mathematics			
28. Geometry			
29. Math. for Sec. School Teachers (methods, etc.)			
30. Mathematical Logic			
31. Advanced Calculus			
32. Advanced Math for Engineers and Physicists			
33. Vector Analysis			
34. Advanced Differential Equations			
35. Partial Differential Equations			
36. Numerical Analysis			
37. Applied Mathematics Mathematical Modelling			
38. Biomathematics			
39. Operations Research			
40. Complex Variables			
41. Real Analysis			
42. Topology			
43. Senior Seminar in Mathematics			
44. Independent Study in Mathematics			
45. Other Mathematics, Specify			

4. Undergraduate Courses

B. STATISTICS Name of Course (or equivalent) (1)	Total Number of Students Enrolled Fall 1980 (2)	Total Number of Sections (3)	No. of Sections in which Students Use Computers (4)
46. Elementary Statistics (no calculus prereq.)			
47. Probability (& Stat.) (no claculus prereq.)			
48. Mathematical Statistics (Calculus)			
49. Probability (Calculus)			
50. Applied Statistical Analysis			
51. Design & Analysis of Experiments			
52. Regression (and Correlation)			
53. Senior Seminar in Statistics			
54. Independent Study in Statistics			
55. Other Statistics, Specify			

C. COMPUTER SCIENCE			
56. Computer Programming I (CS1)*			
57. Computer Programming II (CS2)			
58. Introduction to Computer Systems (CS3)			
59. Introduction to Discrete Structures			
60. Introduction to Computer Organization (CS4)			
61. Introduction to File Processing (CS5)			
62. Operating Systems and Computer Architecture (CS6)			
63. Data Structures and Algorithm Analysis (CS7)			
64. Organization of Programming Languages (CS8)			

*CS numbers refer to courses described in Curriculum '78, *Communications* of the Association for Computing Machinery, Vol. 22, No. 3 (March 1979) 147-166.

Name of Course (or equivalent)	Total Number of Students Enrolled Fall 1980	Total Number of Sections	No. of Sections in which Students Use Computers
65. Computers and Society (CS9)			
66. Operating Systems and Computer Architecture II (CS10)			
67. Database Management Systems Design (CS11)			
68. Artificial Intelligence (CS12)			
69. Algorithms (CS13)			
70. Software Design and Development (CS14)			
71. Theory of Programming Languages (CS15)			
72. Automata, Computability, and Formal Languages (CS16)			
73. Numerical Mathematics: Analysis (CS17)			
74. Numerical Mathematics: Linear Algebra (CS18)			
75. Senior Seminar in Computer Science			
76. Independent Study in Computer Science			
77. Other Computer Science, Specify			

5. Instructional Format

In the table on the following page are listed five courses from the list of question 4. For each course please enter the number of students taught during the fall term of 1980 in each of the formats listed in column (1). In the last line of the table enter the total enrollment in each of these courses in the fall term of 1980. If a course was not taught by your department during this term, enter zero.

Number of Students Enrolled, Fall 1980

(1)	(2) Finite Math. (11)	(3) Calculus: Math., Eng., Phys. Sci. (17)	(4) Calculus Biol., Soc., Mgmt. Sci. (18)	(5) Computer Programming I (56)	(6) Elementary Statistics (46)
1. Small Class (Less than 40 students)					
2. Large Class (Between 40 and 80 students)					
3. Lecture without recitation or quiz sections (over 80 students)					
4. Lecture with recitation or quiz sections (over 80 students)					
5. Self Paced Instruction					
6. Other Format Specify:					
7. Total enrollment in course in Fall, 1980					

6. Questions on Mathematical Science Faculty (Graduate and Undergraduate). Fall, 1980.

A. Full-time faculty: indicate the number of full-time mathematical science faculty members in your department in the table below, according to their highest degrees and subject fields in which these were earned:

Highest degree	In Math	In Stat.	In Computer Science	In Math Ed.	In another field (specify)
Doctor's degree					
Master's degree					
Bachelor's degree					

B. Part-time faculty, other than graduate students: indicate the numbers of part-time mathematical sciences faculty members in your department in the table below, by highest degrees and subject fields: (If none, check here ______.)

Highest degree	In Math	In Stat.	In Computer Science	In Math Ed.	In another field (specify)
Doctor's degree					
Master's degree					
Bachelor's degree					

C. Other Employment of Part-time Faculty

Of your part-time faculty, how many are:

(a) Employed full-time by some other university or college ______
(b) Employed full-time by a high school ______
(c) Employed full-time but not in education ______
(d) Not employed full-time anywhere ______

D. Teaching Assistants* (If none, check here ______.)

(a) Total number of teaching assistants in Fall, 1980 ______
(b) Number who are graduate students in your department ______
(c) Number who are graduate students in some other mathematical science department ______
(d) Number who are graduate students but not in the mathematical sciences ______
(e) Number who are not graduate students (e.g., who are still undergraduates) ______

E. Use of Teaching Assistants

Indicate the number of teaching assistants by their principal function:

(a) Teaching their own classes ______
(b) Conducting quiz sections or recitation sections ______
(c) Paper grading ______
(d) Providing tutorial or other individual assistance to students ______
(e) Other (please specify) ______

7. Age, Sex and Ethnic Group of Full-time Faculty, Fall 1980.

A. Record the number of full-time faculty members in each category:

Age	Under 30	30-34	35-39	40-44	45-49	50-54	55-59	60 & Over
Tenured, PhD								
Tenured, non-PhD								
Non-tenured, PhD								
Non-tenured, non-PhD								
Men								
Women								
Caucasian								
Asian								
Hispanic								
Black								
Amerindian								

*Graduate or undergraduate students holding instruction-related positions in your department.

B. Were any of your present faculty granted tenure in 1979-80? ______yes ______no
If yes, list the year of receipt of Ph.D. of each (more than once if more than one obtained the Ph.D. in that year). ______________

8. A. What is the expected (or typical) teaching load in credit hours for your full-time faculty (excluding thesis supervision):

	Fall semester or quarter	Spring semester or quarter
(a) Professors		
(b) Associate Professors		
(c) Assistant Professors		
(d) Instructors with PhD		
(e) Instructors without PhD		

B. If there are significant departures from these expected teaching loads for certain classes of individuals, please describe:

9. Does your department have a sabbatical-leave plan under which a faculty member may have leave (one semester at full pay or a year at half pay, every seven years or so, or roughly equivalent)? ______yes ______no

If so, is this leave granted:

(a) automatically (without restriction) ______
(b) only with well-defined research plans ______
(c) other; specify: ______

If there is no regular sabbatical plan as described above, but other provision is made for paid leaves of absence, please comment:

10. Employment and Mobility of Faculty (Graduate and Undergraduate)

A. Are there any new full-time faculty in your department this year? ______yes ______no. If yes, how many were during the previous year 1979-80:

	Ph.D.'s	Non-Ph.D.
(1) enrolled in graduate school		
(2) teaching in a university or four-year college		
(3) teaching in a two-year institution		
(4) holding postdoctoral study/research appointments		
(5) employed in non-academic positions		
(6) otherwise occupied; specify:		

B. Of your full-time faculty last year, are there any who are no longer part of your full-time faculty? ______yes ______no. If yes, how many:

	Ph.D.'s	Non-Ph.D.
(1) died, or retired		
(2) are teaching in a univ. or four-year college		
(3) are teaching in a two-year institution		
(4) left for a non-academic position		
(5) returned to graduate school		
(6) are otherwise occupied; specify:		

C. Of your present full-time Ph.D. faculty members who were also part of your full-time staff in the year 1979-80, how many completed the requirements for their Ph.D. during 1979-80? ______

11. How many bachelor's degrees with major in mathematical sciences were awarded by your department between July 1979 and June 1980?______. Indicate the number of these with each specialty:

Mathematics, general	______	Applied Mathematics	______
Statistics	______	Secondary School Teaching	______
Actuarial Science	______	Operations Research	______
Computer Science	______	Other; Specify	______

If you have found some question(s) difficult to interpret or to secure data for, please supply elucidating comments or suggestions which would be helpful to the Committee in future surveys:

Information supplied by: ______________

Title and Department: ______________

Institution and Campus: ______________

Telephone: ______________ Date ______________

SURVEY OF PROGRAMS IN MATHEMATICS
IN
TWO-YEAR COLLEGES

1980

General Instructions

This questionnaire should be completed by the person who is directly in charge of the mathematics program at your institution.

You are asked to report on all the mathematics courses and faculty in your institution. For some colleges this may involve courses in statistics, applied mathematics, and computers that, although mathematical in nature, are taught outside a mathematics department. Please include data on part-time and evening students and faculty as well as data on occupational and terminal programs. Include non-credit and remedial courses. Do not, however, include data concerning campuses jurisdictionally separate from yours, if such exist.

Please return completed questionnaire by 1 November 1980 to:

Conference Board of the Mathematical Sciences
1500 Massachusetts Avenue, N.W., Suite 457-458
Washington, D.C. 20005

* * * * * * * * *

I. A. Name of institution ____________________

If this two-year institution is part of a larger organization, identify this relationship: ____________________

B. Year institution was established ________

C. How is the mathematics program administered at your institution?

_____ Mathematics department
_____ Mathematics and science department or division
_____ No departmental structure
_____ Other (specify): ____________________

II. Institutional enrollment (approximate):

	College-Transfer Program Full-time Students	College-Transfer Program Part-time Students	Occupational/Technical Full-time Students	Occupational/Technical Part-time Students
Freshman				
Sophomores				
Unclassified or other				
Total				

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III. Courses in the Mathematical Sciences

Instructions for preparing table on this and the following page.

A. The courses in column (1) in the following table are listed with typical course titles (which may not necessarily coincide with the titles you use). They are listed in approximate "catalogue order", beginning with remedial and freshman courses. Additional blank spaces are provided to permit you to write in names of courses which do not fit reasonably under some listed title.

For the purpose of this survey, consider as a single course, instruction in a particular area of mathematics which you offer as a sequence of two or more parts (e.g., calculus).

B. For each course in column (1) that is offered, write in column (2) the total number of students who enrolled in (any part of) the course in the fall term of 1980.

C. In column (3) give the total number of sections of the course.

D. In column (4) give the total number of sections of this course taught by part-time faculty.

E. In column (5) give the total number of sections of this course for which a hand calculator is recommended.

F. In column (6) give the total number of sections of this course in which computer homework assignments are given.

Name of Course (or equivalent) (1)	Total No. of Students Enrolled Fall 1980 (2)	Total No. of Sections (3)	No. Sect. Taught by Part-time Faculty (4)	No. Sect./ Hand Calc. Recommended (5)	No. Sect./ Computer Assignments are Given (6)
1. Arithmetic					
2. High School Geometry					
3. Elementary Algebra (High School)					
4. Intermediate Algebra (High School)					
5. College Algebra					
6. Trigonometry					
7. College Algebra and Trigonometry, combined					
8. Elem. Functions					
9. Math. for Liberal Arts					
10. General Mathematics (basic skills, operations)					

Name of Course (or equivalent) (1)	Total No. of Sections (2)	Total No. of Students Enrolled Fall 1980 (3)	No. Sect. Taught by Part-time Faculty (4)	No. Sect./ Hand Calc. Required (5)	No. Sect./ Computer Assignments are Given (6)
11. Finite Mathematics					
12. Mathematics of Finance					
13. Business Mathematics					
14. Math. for Elementary School Teachers					
15. Technical Mathematics					
16. Technical Mathematics (calculus level)					
17. Analytic Geometry					
18. Analytic Geometry and Calculus					
19. Calculus (math.,phys. & eng. sciences)					
20. Calculus (bio.,soc. & mgt. sciences)					
21. Differential Equations					
22. Linear Algebra					
23. Diff. Equations & Linear Algebra					
24. Elementary Statistics					
25. Probability (and statistics)					
26. Programming of Digital Computers					
27. Other Computer Science Courses					
28. Use of Hand Calculators					
29. Slide Rule					
30. Other: Specify					

IV. To what extent are courses in mathematics taught in division or departments of your institution other than that division or department having primary responsibility for mathematics? If your institution does not have a departmental or divisional structure, consider the group of all mathematics professors to be the "mathematics department" for the purpose of this question. Enter in the relevant boxes an estimate of the total course enrollments for the year. Please consult schedules to give good estimates of numbers of enrollments.

	Enrollment in courses given by division specializing in:				
Courses	Natural Sciences	Occupational Programs	Business	Social Sciences	Other (Specify)
1. Arithmetic					
2. Business Mathematics					
3. Statistics/ Probability					
4. Pre-calculus College Math.					
5. Calculus or Diff. Equations					
6. Computer Science & Programming					
7. Technical Math.					
8. Other: Specify					

V. Questions on Mathematics Faculty

A. Full-time faculty: indicate the numbers of full-time mathematical sciences faculty members in your department in the table below, according to their highest degrees and subject fields in which these were earned:

Highest degree	In math.	In stat.	In computer science	In math. ed.	In another field (specify)
Ph.D.					
Ed.D.					
Dr. Arts					
Master's degree, plus 1 year					
Master's degree					
Master's degree (spec. program) e.g., MAT, MST					
Bachelor's degree					

B. Do you have part-time faculty other than graduate students? ______yes ______no. If yes, indicate in the table below the numbers by highest degrees and subject fields:

Highest degree	In math.	In stat.	In computer science	In math. ed.	In another field (specify)
Ph.D.					
Ed.D.					
Dr. Arts					
Master's degree, plus 1 year					
Master's degree					
Master's degree (spec. program) e.g., MAT, MST					
Bachelor's degree					

C. What is the expected (or typical) teaching load in classroom contact hours for members of you full-time faculty? ________

D. How many full-time faculty teach overloads? ________

E. What is the average overload (in contact hours) for those faculty? ________

F. What is the average teaching load in contact hours of part-time faculty? ________

G. Of your part-time staff, how many were:

Employed Full-time in: High School	Two-year College	Four-year College	Industry or Other	Not Employed Full-time Anywhere	Total No. of Part-time Faculty
a	b	c	d	e	t

NOTE: You should have t = a + b + c + d + e.

VI. Use of Computers and Calculators

A. Does your department have access to a computer or to computer terminal facilities: ______yes ______no

B. How many of your full-time faculty know a computer language? ________

C. How many of your full-time faculty give class assignments involving the use of the computer each year (in courses other than computer sciences)? ________

VII. Instructional Formats

A. In our 1975-76 Survey, the following formats were reported to be in use. At your institution, please indicate the extent to which these formats are employed. Place a check under one of (a) and a check under one of (b).

	(a) Is not Being Used	(a) Is used by Some Faculty	(a) Is used by Most Faculty	(b) Is used by a Substantially Larger % of Faculty than it was Five Years ago	(b) Is used by the Same % of Faculty as it was Five Years ago	(b) Is used by Substantially Smaller % of Faculty than it was Five Years ago
1. Standard lecture - recitation system (Class size ≤40)						
2. Large lecture classes (>40) with recitation sections						
3. Large lecture classes (>40) with no recitation						
4. Organized program of independent study						
5. Courses by television (closed-circuit or broadcast)						
6. Courses by film						
7. Courses by programed instruction						
8. Courses by computer-assisted instruction (CAI)						
9. Modules						
10. Audio-tutorial						
11. PSI (Personalized Systems of Instruction)						
12. Other -- Specify						

B. 1. Does your institution operate a math lab or math help (tutorial) center? ________yes ________no

(If you answered yes in 1, go on to 2 and 3.)

2. Year math lab was established ________

3. Personnel of the math lab are (check all pertinent categories):

_______ Full-time members of the Mathematics staff

_______ Part-time members of the Mathematics staff

_______ Members of another department

_______ Other: please specify ______________________________

4. Importance of Math Labs

On the following scale please circle the number which best indicates your perception of the value of your math lab in promoting the mathematics program at your institution.

1	2	3	4	5
Of no value		Of some value		Of great value

VIII. Coordination of programs:

A. Coordination with vocational/technical departments:

How often does your math staff consult with the voc./tech. departments on development and/or coordination of offerings?

Infrequently	Yearly	More Than Once Per Year

B. Coordination with four-year institutions

1. Are your course offerings and/or curriculum subject to state control or approval? _______yes _______no

2. Is there official state-wide coordination of your mathematical offerings with those of four-year institutions? _______yes _______no

3. How often does your mathematics staff consult with the mathematics department of four-year colleges on course offerings designed for transfer credit?

Less Than Once a Year	Yearly	More Than Once Per Year

4. Are there other coordination activities involving your mathematics staff and mathematics departments of four-year colleges or universities in your area? _______yes _______no

If yes, please describe these:

IX. Faculty Employment and Mobility

A. Were any of your full-time faculty members first employed on a full-time basis this year? ______yes ______no. If yes, how many were during the previous year 1979-80:

	Doctorate (math)	Doctorate (math ed.)	Master's
1. enrolled in graduate school			
2. teaching in a 4-year college or university			
3. teaching in another 2-year institution			
4. teaching in a secondary school			
5. employed by you part-time			
6. employed in non-academic positions			
7. otherwise occupied; specify:			

B. Of the full-time faculty last year, who are no longer part of your full-time faculty, how many:

	Doctorate (math)	Doctorate (math ed.)	Master's
1. died, or retired			
2. are teaching in a 4-year college or univ.			
3. are teaching in a two-year institution			
4. left for a non-academic position			
5. returned to graduate school			
6. left for secondary school teaching			
7. are otherwise occupied; specify:			

8. number of your full-time faculty members who received doctorates between 1979 and 1980 in math ______ in math ed. ______ other ______________?

C. 1. Do you anticipate changes in the number of of mathematics faculty for the coming year? _______yes _______no

If yes, please briefly indicate change and reason for it:

2. Do you anticipate a change in mathematics enrollments for the coming year? _______yes _______no

If yes, please briefly indicate change and reason for it:

X. Age, Sex and Ethnic Group of Full-time Faculty

A. Record the number of full-time faculty members in each category:

Age	Under 30	30-34	35-39	40-44	45-49	50-54	55-59	60 & Over
Bachelors								
Masters								
Doctors								
Men								
Women								
Caucasian								
Asian								
Hispanic								
Black								
Amerindian								

XI. Professional Activities

A. Memberships: for each organization listed, indicate the number of full-time members of your department who belong to:

MAA	AMATYC (State Affiliate)	NCTM	AMS	SIAM	City Org.	State Org.	Other

B. Estimate the number of full-time members of your department who

1. _______ attend at least one mathematics conference per year
2. _______ take additional graduate mathematics courses during the year or summer
3. _______ give talks on mathematics at conferences
4. _______ give talks on mathematics education at conferences
5. _______ regularly read journal articles on mathematics
6. _______ regularly read journal articles on mathematics education
7. _______ write journal articles on mathematics
8. _______ write journal articles on mathematics education
9. _______ write textbooks

XII. Problems of the 80's

Below are some commonly cited problems of some two-year college faculty. Rate each of these problems as follows:

A. This has been a major and continuing problem for me.

B. This is a minor irritant.

C. This is no problem for me.

______ 1. Losing faculty to industry

______ 2. Dealing with remediation

______ 3. Increasing class sizes

______ 4. Increasing teaching loads

______ 5. Maintaining academic standards

______ 6. Continuing education of faculty

______ 7. Maintaining momentum of faculty

______ 8. Holding part-time component in check

______ 9. Coordinating and/or developing math for vocational/technical programs

______ 10. Coordinating math courses with four-year colleges and universities

______ 11. Other: Specify ______________________

Information supplied by: ______________________

Title: ______________________

Date: ______________________

Telephone: ______________________
Area Number Extension

1. How long have you been in charge of the mathematics program? _______ years

2. Is chairmanship rotating? _______ yes _______ no

If yes, what is the frequency of rotation? ______________

3. If you have found any of the above survey questions difficult to interpret or to secure data for, please supply elucidating comments or suggestions which would be helpful to the Committee in future surveys:

APPENDIX D

LIST OF RESPONDENTS TO THE SURVEY

1. Public Universities

University of Akron	Mathematical Sciences
University of Arizona	Mathematics, Computer Science
Ball State University	Mathematical Sciences
University of California, Los Angeles	Mathematics
University of Colorado	Mathematics, Computer Science
University of Delaware	Mathematical Sciences
University of Florida	Mathematics, Statistics, Computer and Information Sciences
University of Illinois	Mathematics
Indiana University	Mathematics, Computer Science
University of Kansas	Mathematics, Computer Science
Kent State University	Mathematics
University of Kentucky	Mathematics, Computer Science
Louisiana State University	Mathematics, Computer Science
University of Louisville	Mathematics, Applied Mathematics and Computer Science
University of Maine	Mathematics, Computer Science
University of Michigan	Mathematics, Statistics
Michigan State University	Mathematics, Statistics and Probability Computer Science
University of Mississippi	Mathematics, Computer Science
Montana State University	Mathematical Sciences
University of Nebraska	Mathematics and Statistics, Computer Science
University of Nevada, Reno	Mathematics
Northern Illinois University	Mathematical Sciences
North Texas State University	Mathematics
Ohio University	Mathematics, Computer Science
Ohio State University	Mathematics, Statistics, Computer and Information Science
Oklahoma State University	Mathematics, Statistics, Computer Science
University of Oregon	Mathematics, Computer and Information Science
Pennsylvania State University	Mathematics, Statistics, Computer Science
University of Pittsburgh	Mathematics and Statistics
Rutgers University	Mathematics, Statistics
University of South Carolina	Mathematics and Statistics
South Dakota State University	Mathematics
Temple University	Mathematics, Statistics, Computer and Information Sciences

1. Public Universities (continued)

University of Tennessee	Mathematics, Computer Science
University of Toledo	Mathematics
University of Utah	Mathematics
University of Virginia	Mathematics, Applied Mathematics and Computer Science
Virginia Commonwealth University	Mathematical Sciences
University of Washington	Mathematics, Computer Science
West Virginia University	Mathematics, Statistics and Computer Science

2. Private Universities

Adelphi University	Mathematics and Computer Science
Baylor University	Mathematics
Boston University	Mathematics
Brandeis University	Mathematics
University of Chicago	Mathematics, Statistics
Duquesne University	Mathematics
Fordham University	Mathematics
Georgetown University	Mathematics, Computer Science
Harvard University	Mathematics, Statistics, Division of Applied Sciences
University of Miami	Mathematics
New York University	Computer Science
Northwestern University	Mathematics
University of Notre Dame	Mathematics
University of Pennsylvania	Statistics, Computer and Information Science
Princeton University	Mathematics, Statistics, Electrical Engineering and Computer Science
University of Santa Clara	Mathematics, Applied Mathematics
Stanford University	Mathematics, Statistics, Computer Science
Texas Christian University	Mathematics
Yale University	Mathematics, Statistics, Computer Science

3. Public Four-Year Colleges

University of Alabama, Birmingham	Mathematics
Baruch College of CUNY	Mathematics
Black Hills State College	Science and Mathematics
Boston State College	Mathematics
Brooklyn College of CUNY	Mathematics, Computer and Information Science

3. Public Four-Year Colleges (continued)

California State University, Fresno	Mathematics
California State University, Fullerton	Mathematics
California State University, Los Angeles	Mathematics and Computer Science
California State Polytechnic University, Pomona	Mathematics, Computer Science
University of California, San Diego	Mathematics
Chicago State University	Mathematics
Chadron State College	Mathematics
Cleveland State University	Mathematics, Computer and Information Science
Clinch Valley College	Mathematics
Concord College	Mathematical Sciences
Coppin State College	Mathematics
Corpus Christi State University	Mathematics and Computer Science
Eastern Kentucky University	Mathematical Sciences
East Tennessee State University	Mathematics, Computer and Information Sciences
East Texas State University	Mathematics
Fitchburg State College	Mathematics
Florida Atlantic University	Mathematics
Florida International University	Mathematical Sciences
Frostburg State College	Mathematics
Georgia College	Mathematics
Georgia State University	Mathematics
Glassboro State College	Mathematics and Computer Science
University of Houston	Applied Mathematical Sciences
Humboldt State University	Mathematics
University of Illinois, Chicago Circle	Mathematics
Indiana University-Purdue University, Indianapolis	Mathematical Sciences
Indiana University at South Bend	Mathematics
Indiana University, Southeast	Mathematics, Computer Science
Indiana University of Pennsylvania	Mathematics, Computer Science
Jackson State University	Computer Science
Kentucky State University	Mathematics-Physics, Computer Science
Kutztown State College	Mathematics
Lamar University	Mathematics
University of Maine at Farmington	Mathematics
University of Maryland, Eastern Shore	Mathematics and Computer Science
Mary Washington College	Mathematical Sciences and Physics
University of Michigan, Flint	Mathematics, Computer Science
Michigan Technological University	Mathematical and Computer Sciences
University of Missouri, Kansas City	Mathematics
University of Missouri, St. Louis	Mathematical Sciences
Montclair State College	Mathematics and Computer Science
Moorhead State University	Mathematics, Computer Science
Morehead State University	Mathematical Sciences

3. Public Four-Year Colleges (continued)

New Jersey Institute of Technology	Mathematics
New Mexico Highlands University	Science and Mathematics
SUNY, College at Oswego	Mathematics, Computer Science
SUNY, College at Plattsburgh	Mathematics
Norfolk State University	Mathematics
University of North Alabama	Mathematics
University of North Carolina at Charlotte	Mathematics
University of North Carolina at Greensboro	Mathematics
University of North Florida	Mathematical Sciences
Northern Arizona University	Mathematics, Computer Science
University of Northern Colorado	Mathematics
Northern Kentucky University	Mathematical Sciences
Old Dominion University	Mathematical Sciences
Peru State College	Mathematics
Portland State University	Mathematics
Ramapo College	Theoretical and Applied Science
San Diego State University	Mathematical Sciences
Southeastern Massachusetts University	Mathematics
Southern Connecticut State College	Mathematics, Computer Science
Southern Illinois University, Edwardsville	Mathematics, Statistics, and Computer Science
University of Southern Mississippi	Mathematics, Computer Science and Statistics
Southern Oregon State College	Mathematics and Computer Science
Stockton State College	Mathematics
University of Texas, Arlington	Mathematics
University of Texas, Dallas	Mathematical Sciences
Towson State University	Mathematics and Computer Science
Trenton State College	Mathematical Sciences
Virginia Military Institute	Mathematics
Virginia State University	Mathematics
Weber State College	Mathematics
Western Illinois University	Mathematics
Western Michigan University	Mathematics
University of Wisconsin, Stevens Point	Mathematics and Computer Science
University of Wisconsin, Stout	Mathematics
Wright State University	Mathematics

4. Private Four-Year Colleges

Amherst College	Mathematics
Assumption College	Natural Science and Mathematics
Bates College	Mathematics
Bellevue College	Mathematics

4. Private Four-Year Colleges (continued)

Belmont College	Mathematics and Physics
University of Bridgeport	Mathematics
Bridgewater College	Mathematics
Carleton College	Mathematics
Carroll College	Mathematics, Computer Science
Coe College	Mathematics
Colorado College	Mathematics
Concordia College, NE	Science and Mathematics
Concordia College, WI	Mathematics
Cooper Union	Mathematics
Dana College	Mathematics
University of Dayton	Mathematics, Computer Science
Dickinson College	Mathematical Sciences
Dominican College, NY	Mathematics and Science
General Motors Institute	Science and Mathematics
Georgian Court College	Mathematics
Gonzaga University	Mathematics and Computer Science
Hanover College	Mathematics
Hardin-Simmons University	Mathematics
University of Hartford	Mathematics and Physics
Harvey Mudd College	Mathematics
Hofstra University	Mathematics
Hollins College	Mathematics
Holy Cross College	Mathematics
Hope College	Mathematics, Computer Science
Illinois Institute of Technology	Mathematics, Computer Science
Illinois Wesleyan University	Mathematics
Incarnate Word College	Mathematics
Indiana Central University	Mathematics and Physics
Indiana Institute of Technology	Computer Science
Iona College	Mathematics, Computer and Informatic Sciences
Juniata College	Mathematics and Computer Science
LeMoyne College	Mathematics, Computer Science
Manhattan College	Mathematics and Computer Science
Marietta College	Mathematics and Computer Science
Mary College	Mathematics
McMurry College	Mathematics
Mercer University	Mathematics
Milwaukee School of Engineering	Mathematics
North Carolina Wesleyan	Mathematics
North Central College	Mathematics
Oklahoma Christian College	Mathematics
Ouachita Baptist University	Mathematics
Pacific Lutheran University	Mathematics and Computer Science
Pepperdine University	Mathematics
Pfeiffer College	Mathematics and Physics

4. Private Four-Year Colleges (continued)

Pine Manor College	Natural and Behavioral Science
Rivier College	Mathematics and Computer Science
Roger Williams College	Mathematics
Rosary College	Mathematics
Russell Sage College	Mathematics and Physical Science
St. Francis College	Mathematics
Samford University	Mathematics, Engineering, and Computer Science
University of San Diego	Mathematics
College of Santa Fe	Science and Mathematics
University of Scranton	Mathematics and Computer Science
Shaw College at Detroit	Natural Science Division
Sioux Falls College	Science Area
Southwest Baptist College	Mathematics
Spelman College	Mathematics
Stevens Institute of Technology	Pure and Applied Mathematics
University of Tampa	Science and Mathematics
Texas Lutheran College	Mathematics
Tift College	Natural Science and Mathematics
Trinity College, Connecticut	Mathematics
Westmont College	Mathematics
Williams College	Mathematical Sciences
William Wood College	Mathematics
York College of Pennsylvania	Physical Science

5. Two-Year Colleges and Technical Institutes

Aiken Technical College
Aims Community College
Allegheny Community College
Anderson College
Anne Arundel Community College
Anoka-Ramsey Community College
Arapahoe Community College
Bakersfield College
Barstow College
Bellevue Community College
Big Bend Community College
Broward Community College
Canada College
Carl Sandburg College
Cazenovia College
Central Piedmont Community College
Central Virginia Community College
Clackamas College

5. Two-Year Colleges and Technical Institutes (continued)

Cleveland Technical College
Columbus Technical Institute
Community College of Allegheny County, Allegheny
Community College of Allegheny County, Boyce
Community College of Denver, North
Consumes River College
Cooke County College
Copiah-Lincoln Junior College
County College of Morris
Crowder College
CUNY-Kingsborough Community College
Cypress College
Delgado Community College
Delta College
Diablo Valley College
Dixie College
Eastern Arizona College
El Reno College
Essex County College
Flathead Valley Community College
Florida Junior College at Jacksonville
Glendale Community College
Hartford Community College
Hartford State Technical College
Highland Community College
Hocking Technical College
Howard Community College
Illinois Central College
Inver Hills Community College
Isothermal Community College
Itawamba Junior College
Jefferson Davis State Junior College
Kent State University, New Philadelphia
Lane Community College
Lee College
Lehigh County Community College
Long Beach City College
Macomb County Community College, Center Campus
McHenry Community College
Metro Technical Community College
Miami University, Hamilton
Mid-State Technical Institute
Mineral Area College
Mississippi Gulf Coast Junior College
Mohave Community College
Montgomery Technical Institute
Mount Ida Junior College

5. Two-Year Colleges and Technical Institutes (continued)

Mount Olive College
Mount Wachusett Community College
Napa College
New York City Technical College
Northeastern Oklahoma A&M College
Oklahoma State University, Technical Institute
Orange Coast College
Pennsylvania State University, York
Piedmont Technical College
Piedmont Virginia Community College
Pima Community College
Portland Community College
Rock Valley College
San Antonio College
Jan Jacinto College, Central
San Jacinto College, North
Jan Joaquin Delta College
San Jose City College
Santa Ana College
Santa Fe Community College
Santa Monica College
Schoolcraft College
Seattle Central Community College
Southeastern Community College, Keokuk
Southwest Mississippi Junior College
Southwest Texas Junior College
St. Philip's College
State Technical Institute, Knoxville
Surry Community College
Tallahassee Community College
Terra Technical College
Tidewater Community College, Frederick Campus
Thornton Community College
Union College Technical Institute
University of Maine, Augusta
Vincennes University
Virginia Western Community College
Volunteer State Community College
Westchester Community College
Wilkes Community College
William Rainey Harper College
Worthington Community College
Wytheville Community College
Yavapai College
Yuba College

APPENDIX E

COURSE BY COURSE ENROLLMENTS IN UNIVERSITIES AND FOUR-YEAR COLLEGES (In Thousands)

Name of Course (or equivalent)	Universities	Public Colleges	Private Colleges	Total*
1. Arithmetic for College Students	2	11	1	14
2. General Mathematics (basic skills, operations)	4	37	8	49
3. High School Geometry	L**	1	L**	1
4. Elementary Algebra (H.S.)	13	54	7	74
5. Intermediate Algebra (H.S.)	44	48	12	104
6. College Algebra	73	62	25	160
7. Trigonometry	18	16	4	38
8. College Algebra and Trigonometry, combined	22	28	11	61
9. Elementary Functions Precalculus mathematics	28	22	22	72
10. Mathematics for Liberal Arts	9	31	24	63
11. Finite Mathematics	34	42	19	95
12. Mathematics of Finance	1	3	L	4
13. Business Mathematics	11	22	11	44
14. Mathematics for Elementary School Teachers	16	22	6	44
15. Analytic Geometry	1	4	3	8
16. Other pre-calculus: specify	1	9	2	13

*Total may differ from sum of columns here due to round-off.
**L means less than 500.

	Name of Course (or equivalent)	Universities	Public Colleges	Private Colleges	Total*
17.	Calculus (math., phys., & eng. sciences)	183	121	101	405
18.	Calculus (biol., social & mgmt. sciences)	63	29	12	104
19.	Differential Equations	17	14	8	39
20.	Differential Equations and Linear Algebra	4	1	0	5
21.	Linear Algebra and/or Matrix Theory	15	10	12	37
22.	Modern Algebra	3	5	3	10
23.	Theory of Numbers	L	L	L	1
24.	Combinatorics	1	L	L	1
25.	Foundations of Mathematics	L	1	L	1
26.	Set Theory	L	1	L	1
27.	History of Mathematics	L	1	1	2
28.	Geometry	1	2	2	4
29.	Math. for Secondary School Teachers (methods, etc.)	L	1	L	1
30.	Mathematical Logic	L	1	1	2
31.	Advanced Calculus	4	3	3	11
32.	Advanced Math. for Engineers and Physicists	3	2	9	14
33.	Vector Analysis	2	1	5	8
34.	Advanced Differential Equations	1	L	0	1
35.	Partial Differential Equations	1	L	L	2

	Name of Course (or equivalent)	Universities	Public Colleges	Private Colleges	Total*
36.	Numerical Analysis	3	3	3	10
37.	Applied Mathematics Mathematical Modelling	1	1	L	2
38.	Biomathematics	L	L	L	L
39.	Operations Research	1	1	L	2
40.	Complex Variables	2	1	1	3
41.	Real Analysis	2	1	1	4
42.	Topology	L	L	L	1
43.	Senior Seminar in Mathematics	L	1	1	2
44.	Independent Study in Mathematics	L	1	1	2
45.	Other Mathematics: specify	3	2	1	6
46.	Elementary Statistics	28	38	21	87
47.	Probability (& Stat.) (no calculus prereq.)	5	10	2	17
48.	Mathematical Statistics (Calculus)	8	5	3	16
49.	Probability (Calculus)	6	4	3	13
50.	Applied Statistical Analysis	6	2	L	8
51.	Design & Analysis of Experiments	2	1	L	2
52.	Regression (and Correlation)	1	L	0	1
53.	Senior Seminar in Statistics	L	0	0	L
54.	Independent Study in Statistics	L	L	0	L

	Name of Course (or equivalent)	Universities	Public Colleges	Private Colleges	Total*
55.	Other Statistics: specify	2	1	L	3
56.	Computer Programming I (CS1)	53	52	49	154
57.	Computer Programming II (CS2)	11	14	7	32
58.	Introduction to Computer Systems (CS3)	5	8	4	16
59.	Introduction to Discrete Structures	3	4	2	9
60.	Introduction to Computer Organization (CS4)	4	4	3	12
61.	Introduction to File Processing (CS5)	3	2	1	7
62.	Operating Systems and Computer Architecture (CS6)	3	3	2	7
63.	Data Structures and Algorithm Analysis (CS7)	5	4	2	12
64.	Organization of Programming Languages (CS8)	3	2	1	6
65.	Computers and Society (CS9)	3	10	3	16
66.	Operating Systems and Computer Architecture II (CS10)	1	1	1	2
67.	Database Management Systems Design (CS11)	2	1	1	4
68.	Artificial Intelligence (CS12)	1	1	L	1
69.	Algorithms (CS13)	2	L	L	2
70.	Software Design and Development (CS14)	1	1	L	2

	Name of Course (or equivalent)	Universities	Public Colleges	Private Colleges	Total*
71.	Theory of Programming Languages (CS15)	L	1	L	1
72.	Automata, Computability, and Formal Languages (CS16)	1	1	L	2
73.	Numerical Mathematics: Analysis (CS17)	2	2	2	5
74.	Numerical Mathematics: Linear Algebra (CS18)	L	1	L	1
75.	Senior Seminar in Computer Science	L	1	L	1
76.	Independent Study in Computer Science	L	L	L	1
77.	Other Computer Science: specify	8	13	7	28

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