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.

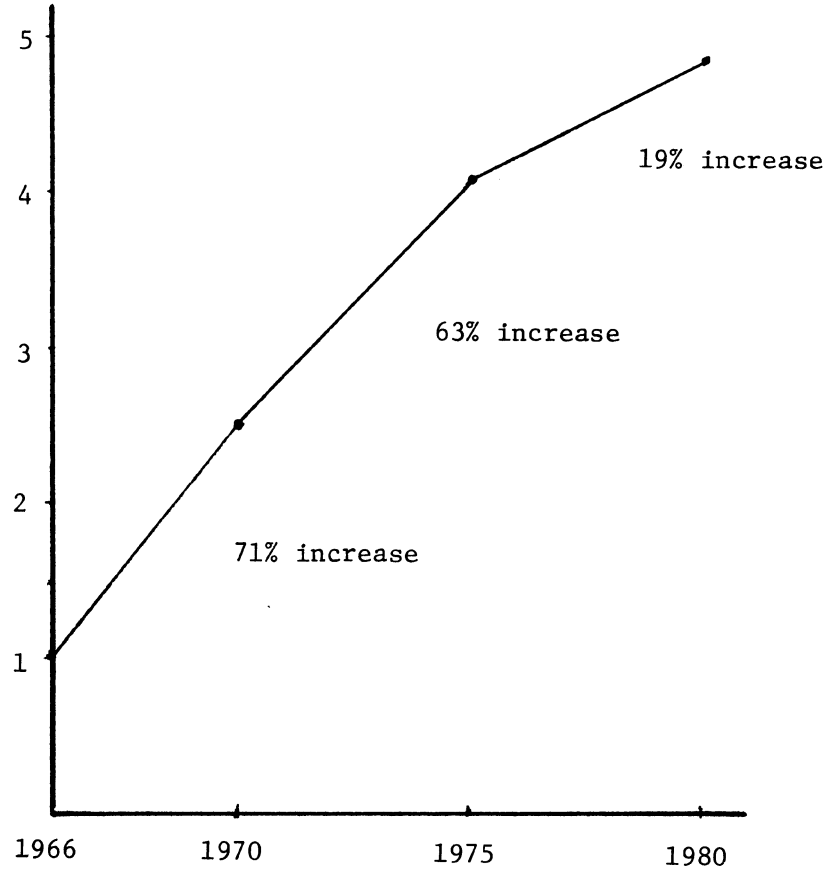
Additional details on trends in course offerings and changes in two-year college teaching environments are given in the following pages.

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)



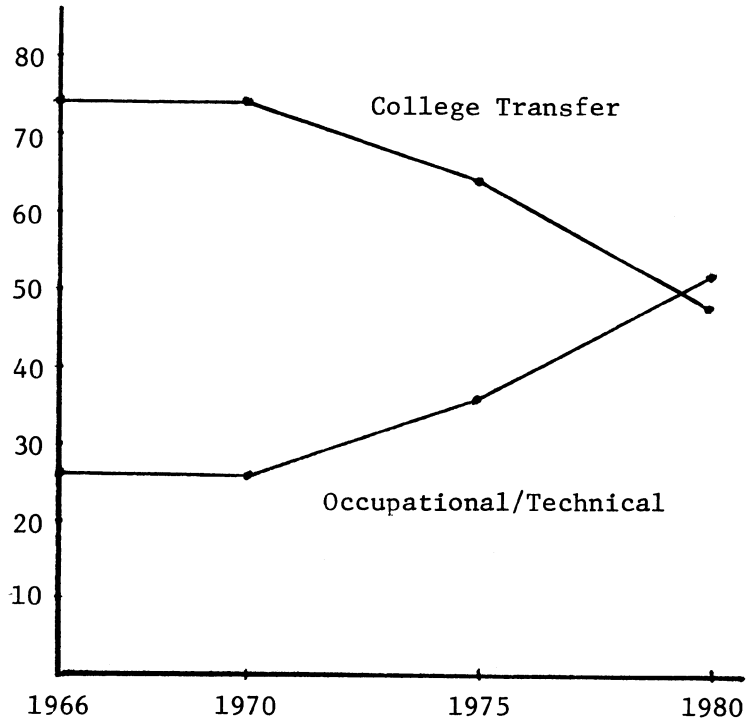
Year	1966	1970	1975	1980
Fall Enrollments	1,464,099	2,499,837	4,069,279	4,825,931

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)



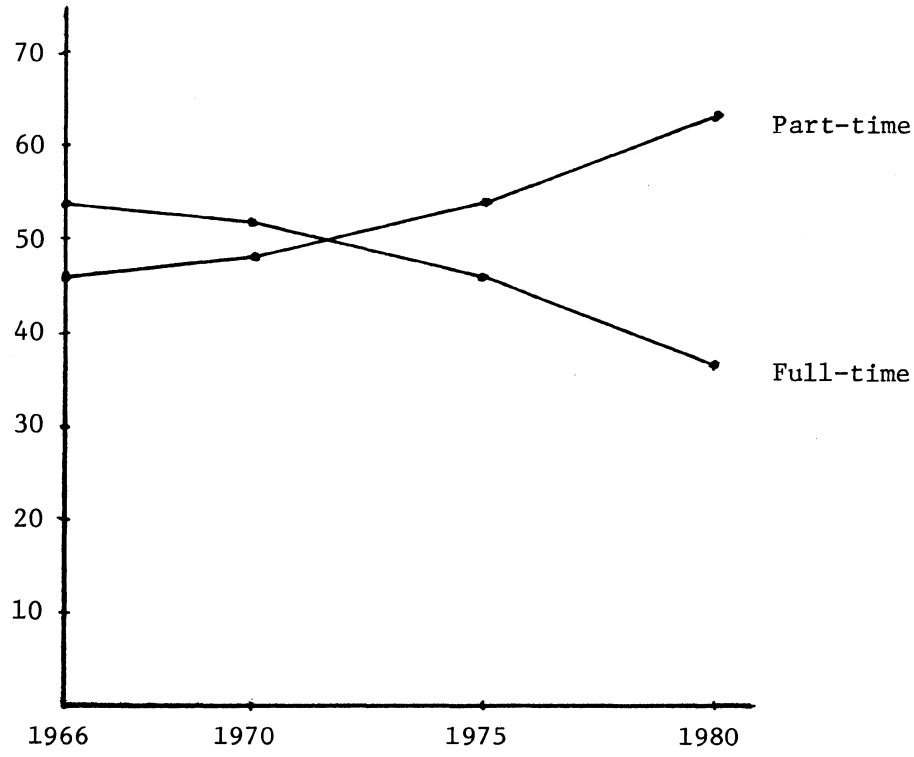
	1966	1970	1975	1980
College Transfer	74%	74%	64%	48%
Occupational/Technical	26%	26%	36%	52%

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.

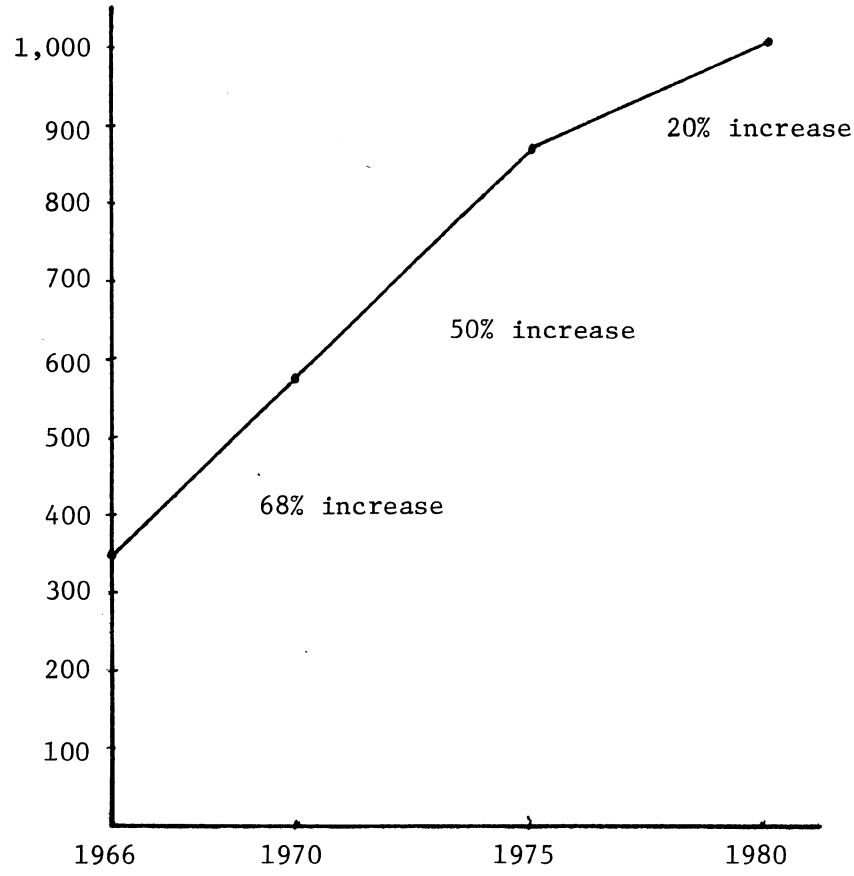
To a great extent, patterns of enrollment growth were accompanied by similar patterns of availability of mathematics courses in two-year colleges.

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

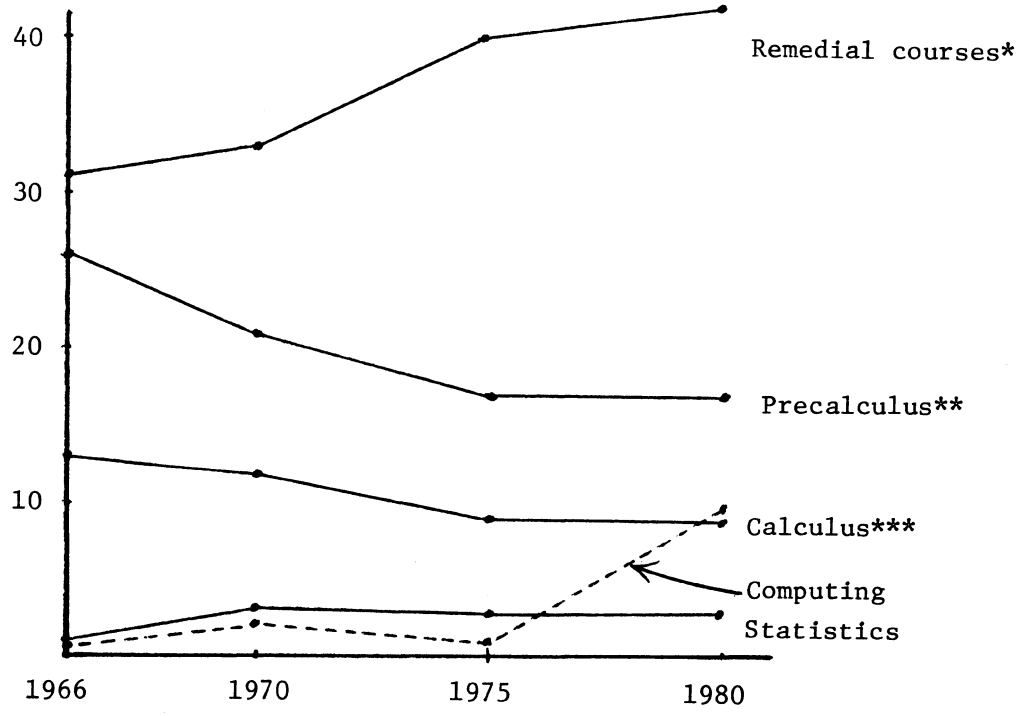
ENROLLMENT TRENDS IN MATHEMATICAL SCIENCE COURSE GROUPS, 1966-1980

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).

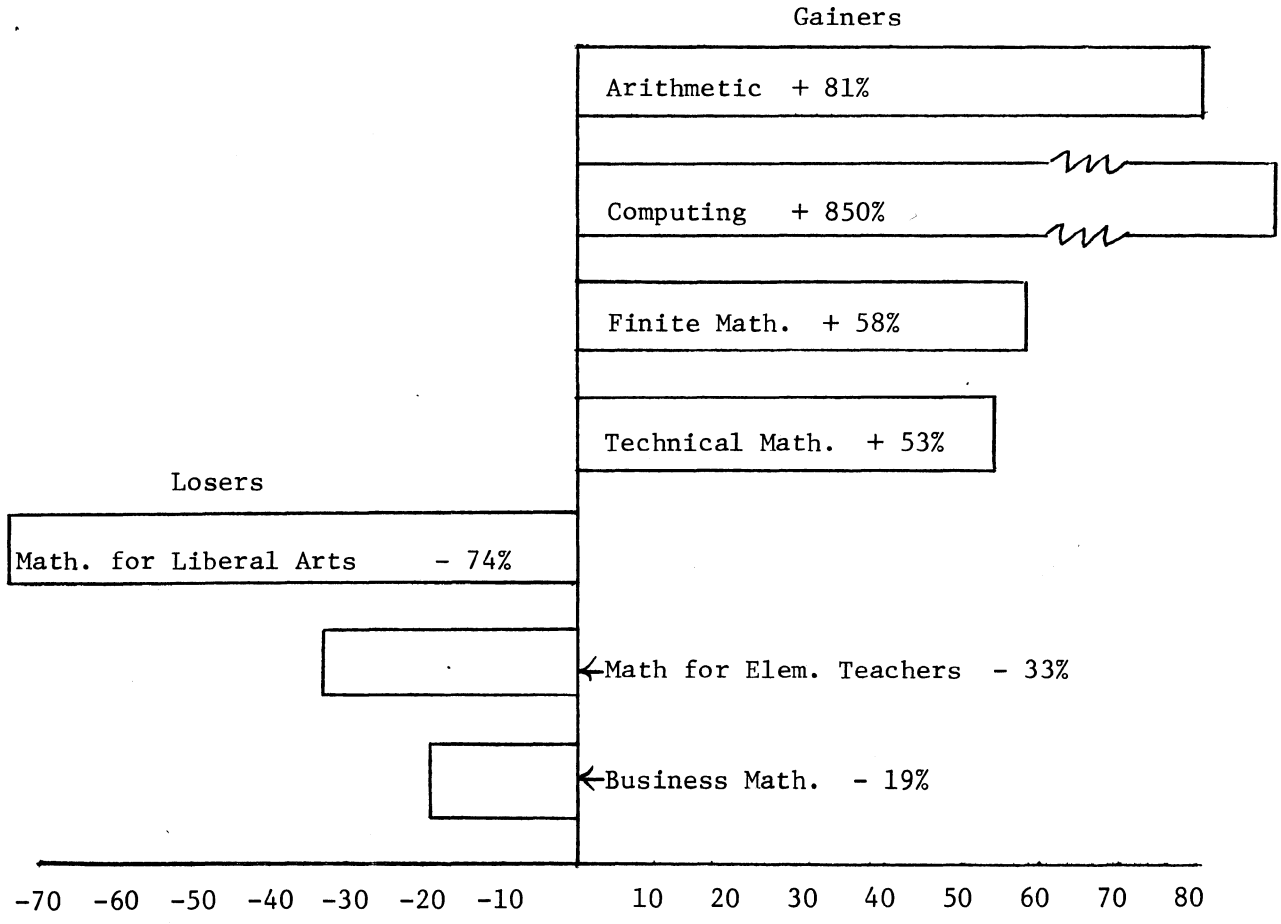
**Precalculus courses include college algebra, college algebra and trigonometry, trigonometry, and elementary functions.

***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.

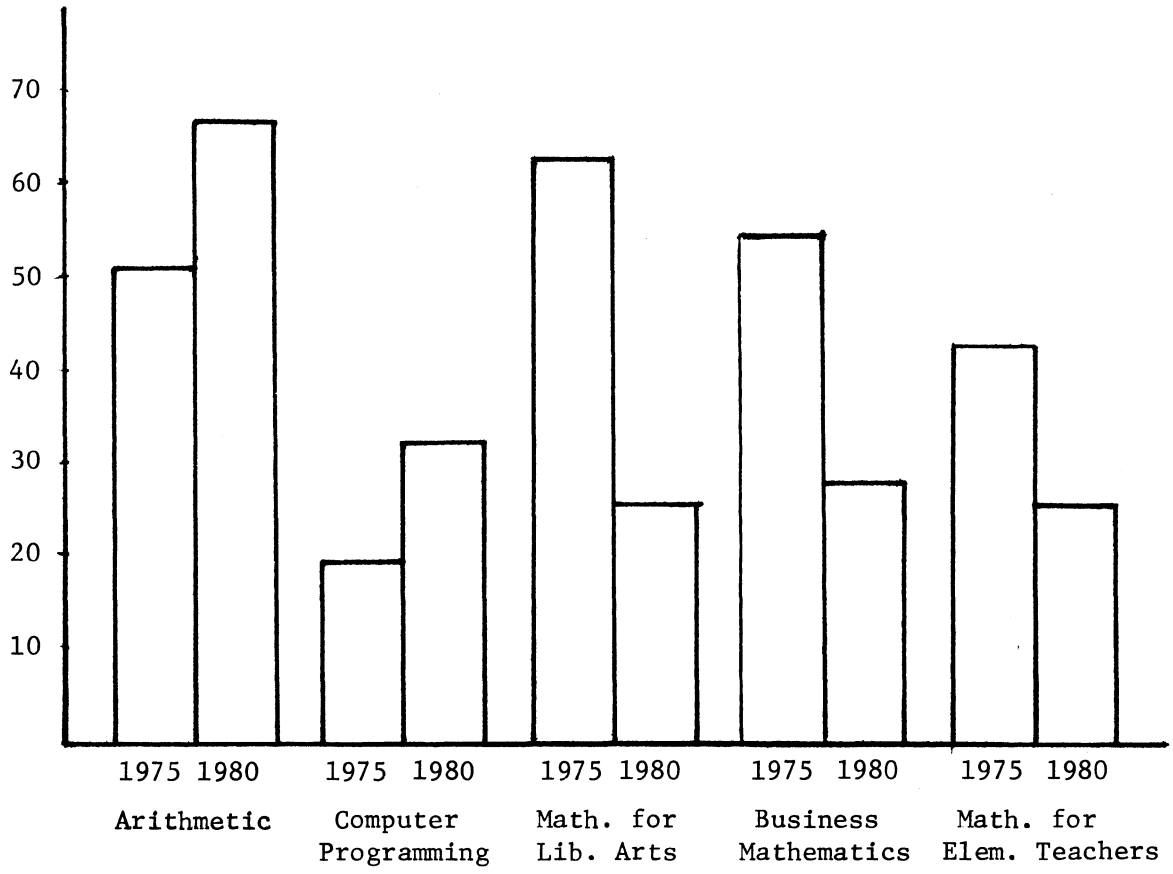
Figure 4.6
(percentage enrollment change, 1975-1980)



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		1970		1975		1980	
	Number	%	Number	%	Number	%	Number	%
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)

Courses	Enrollment in courses given by division specialising in: 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 $\leq$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.