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ABSTRACT

One of 12 monographs examining different areas of science education in the two-year college, this report focuses on mathematics education as revealed by a review of the literature, an analysis of the catalogs and class schedules of 175 representative two-year institutions, and a survey of 393 mathematics and computer science instructors. Part I of the report outlines trends in mathematics curricula since 1965 and analyzes study findings as they relate to course offerings in six instructional areas: introductory and intermediate mathematics, advanced mathematics, applied mathematics, mathematics for majors, statistics and probability, and computer science and technology. Part II analyzes instructional practices, noting the predominance of the lecture method in mathematics courses; examining the use of individualized instruction, math labs, and various methods of student evaluation; and presenting catalog study and survey findings as they relate to class size, course level, instructional mode, class format, grading, use of instructional materials, and outcomes desired of students. Part III discusses mathematics faculty members, their educational and employment background, employment status, working conditions, and the assistance available to them. Each of the sections of the report reviews pertinent literature, study methodology and findings, and trends and implications. A bibliography and the questionnaire are included. (JP)

SCIENCE EDUCATION IN TWO-YEAR COLLEGES: MATHEMATICS

by

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PREFACE

This monograph is one of a series of twelve publications dealing with the sciences in two-year colleges. These pieces are concerned with agriculture, biology, chemistry, earth and space sciences, economics, engineering, integrated social sciences and anthropology, integrated natural sciences, mathematics, physics, psychology, and sociology. Except for the monograph dealing with engineering transfer programs, each was written by staff associates of the Center for the Study of Community Colleges under a grant from the National Science Foundation (#SED 77-18477).

In addition to the primary author of this monograph, several people were involved in its execution. Andrew Hill and William Mooney were instrumental in developing some of the procedures used in gathering the data. Others involved in tabulating information were Miriam Beckwith, Jennifer Clark, William Cohen, Sandra Edwards, Jack Friedlander, and Cindy Issacson.

Field Research Corporation in San Francisco, under the direction of Eleanor Murray, did the computer runs in addition to printing the instructor survey employed in that portion of the project dealing with instructional practices. Bonnie Sanchez of the ERIC Clearinghouse for Junior Colleges and Janice Newmark, Administrative Coordinator of the Center for the Study of Community Colleges, prepared the materials for publication. Carmen Mathenge was responsible for manuscript typing. Jennifer Clark did the final compilation of the various bibliographies for each monograph.

Florence B. Brawer coordinated the writing activities and edited each of the pieces. Arthur M. Cohen was responsible for overseeing the entire project.

In addition to these people who provided so much input to the finalization of this product, we wish to thank Ray Hannapel and Bill Aldridge of the National Science Foundation, who were project monitors.

Arthur M. Cohen
Project Director

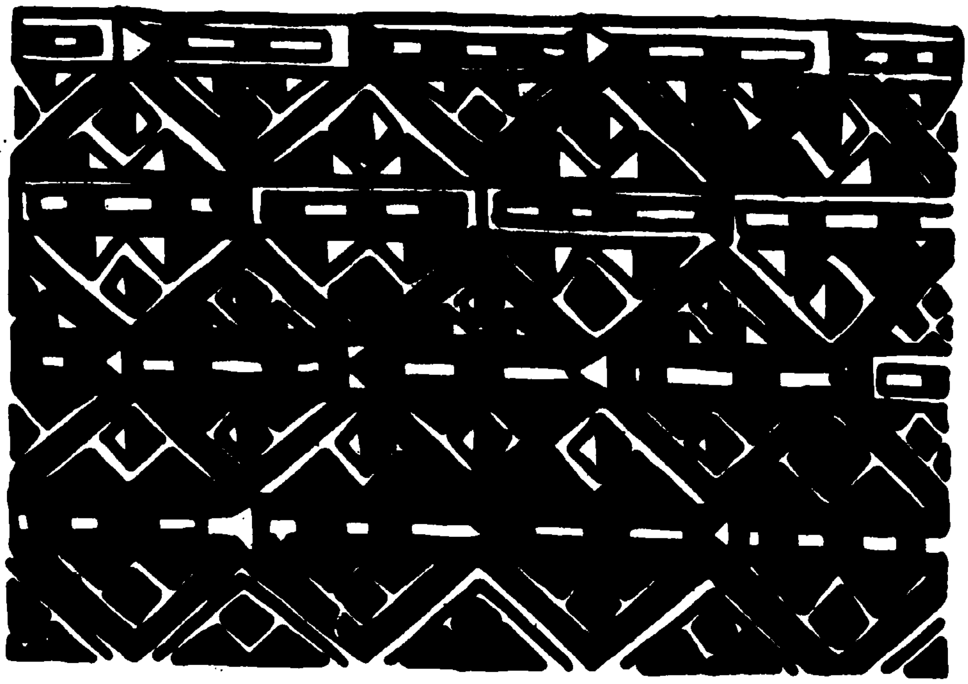
Florence B. Brawer
Publications Coordinator

SCIENCE EDUCATION IN TWO-YEAR COLLEGES: MATHEMATICS

Two-year community and junior colleges enroll more than four million students, one-third of all students in American higher education. Current figures show that 40 percent of all first-time, full-time students are in two-year colleges. Add to this number the people beginning college as part-time students and those attending the two-year college concurrently with or subsequent to enrolling in a senior institution, first-year students taking two-year college courses then approximate two-thirds of all freshmen. These students are enrolled in a wide range of courses--transfer, occupational, remedial, continuing education, community service, and terminal degree. Coming from all walks of life and different cultural and ethnic backgrounds, they represent a wide range of ages.

Under a grant from the National Science Foundation (NSF), the Center for the Study of Community Colleges has been involved in a study of curriculum and instruction in two-year college science and science-related technology programs. Three separate but interrelated activities were involved: a literature search was conducted for each discipline, curriculum data were gathered, and instructors were surveyed to determine instructional practices. These activities were conducted in order to answer questions held by those involved in science education on the institutional, district, state, and national levels and to provide the science education community with a base line of data that may be used by future researchers investigating changes and trends in curriculum and instruction in the sciences in two-year colleges.

This monograph opens with a section on curriculum, followed by an examination of instructional practices and a discussion on the faculty teaching mathematics in the two-year college. Each section will review the pertinent literature and report the data collected by the Center for the Study of Community Colleges. Part IV will discuss the significant implications of the literature and data and offer recommendations for strengthening mathematics education.



PART I

MATHEMATICS CURRICULUM IN THE TWO-YEAR COLLEGE

Any consideration of curriculum must take into account the features that distinguish the comprehensive community college from four-year institutions. The first characteristic concerns the multiple missions of the two-year college. Besides programs for students transferring to four-year colleges, programs are provided for terminal students interested in general education, for students in occupational or vocational fields, for students requiring remedial work to prepare to enter transfer or occupational programs, and for non-degree students desiring cultural, recreational, or community interest courses.

A second distinctive characteristic of the community college is the transformation in its student body. For example, the number of students enrolled in occupational programs has increased from 13 percent in 1965 to 50 percent in 1976 (AACJC, 1976), and Lombardi (1978) even notes that "it is not unusual to find colleges, even entire state systems, where occupational enrollments exceed transfer enrollments" (p. 1). The number of students participating in noncredit courses or programs has increased over 100 percent in one year (1.5 million in 1975 to 3.2 million in 1976). The fact that in 1976 as many students enrolled in noncredit as credit programs (Lombardi, 1978) provides evidence of the phenomenal changes occurring in community colleges' programming.

Changes in the composition of the student population itself include increases in the number of part-time students, students over twenty-five, women returning after extended absence, senior citizens, students from minority groups, and academically "underprepared" students (Knoell, 1973). Traditional full-time students entering the community college from high school account for only 20 percent of the enrollments.

A third distinctive characteristic of the community college concerns the nontraditional course-taking pattern of its students. The community college curriculum no longer reflects the classical, coherent, integrated planned programs; students drop in and stop out, change majors, and begin programs without finishing them (Cohen, 1979).

These characteristics pose dilemmas for planners of mathematics curriculum. Which group should the curriculum serve? Should the sequence of courses parallel those of the transfer institutions or should the sequence be modified for less academically prepared students? Should separate courses be offered for students in different programs or should one course suffice for all students? The literature begins to indicate how these questions and others have been addressed.

THE LITERATURE

The extensive literature in the field reflects both the interest and changes in the math curriculum in the past 15 years. The descriptive studies of math offerings on the state level (Blyler, 1973; Houston & Hoyer, 1975) and on the national level (NSF, 1969; Thornton, 1966), as well as those dealing with specific course types (Baldwin, 1974, 1975; Beal, 1970; Friesen, 1974; Mitchell, 1974), provide one means of charting curricular trends. Another key to curricular emphasis is found in the stated concerns of professional leaders and organizations.

As its major function, the Committee on the Undergraduate Program in Mathematics (CUPM) has been involved in an ongoing examination of undergraduate math curriculum and instruction. The CUPM is both a standing committee of the Mathematics Association of America and one of the eight college commissions in the sciences supported by the National Science Foundation. CUPM has assembled panels of leading authorities in mathematics to review various aspects of curricula, e.g., an overall general curriculum, basic mathematics, applied mathematics, computational mathematics, as well as mathematics for different majors.

Although most of the CUPM reports on curriculum and instruction include material on two-year institutions, three reports were specifically targeted for two-year colleges, A Transfer Curriculum in Mathematics for Two-Year Colleges (1969a), Qualifications for Teaching University Parallel Mathematics Courses in Two-Year Colleges (1969b), and A Basic Library List for Two-Year Colleges (1971a). All of the CUPM reports were intended to be prescriptive rather than descriptive, and, judging from the frequency with which these reports are cited in the literature, they have been widely disseminated and quite influential. The influence has been two-fold. Institutions have undertaken revisions of their curriculum based on directions indicated in the reports and, perhaps even more importantly, these reports have stimulated discussion and provided a reasoned and comprehensive basis from which math educators can examine the curriculum.

Major sources of information on mathematical education are The Mathematics Teacher, Journal for Research in Mathematics Education and American Math Monthly. While the first two are directed more toward high school teachers and the latter to those in four-year institutions, both contain articles useful to two-year college educators. In addition, two journals are specifically designed as a communication forum for those interested and involved in the curricular and pedagogical problems of two-year colleges, the MATYC Journal and the Two-Year College Mathematics Journal.

Mathematics has always constituted a significant portion of the two-year college curriculum, particularly the science curriculum. In the 1969 National Science Foundation-sponsored study of science faculty, mathematics accounted for 24 percent of the two-year college science courses, the highest number of offerings in any discipline falling under the purview of NSF. However, since this study's major focus was on faculty, it provided only limited information on curriculum. The emphasis was clearly on courses with transfer credit (76%), with only one percent of the courses designated as remedial (NSF, 1969).

More specific information on curriculum is provided by Thornton (1966, 1972), who found that the major emphasis was on the traditional calculus and algebra undergraduate sequence for the scientific or engineering student. Three other types of courses were also offered: high school intermediate algebra, plane trigonometry, beginning algebra, and geometry; nontechnical math courses for general education; and refresher courses in arithmetic. Some interesting trends are revealed. Whereas 43 percent of the institutions in Thornton's 1966 sample offered a nontechnical math course and 47 percent offered a refresher course, by 1972 88 percent offered the former and 85 percent offered the latter.

The interval between the Thornton surveys coincides with a period in which educators were forced to confront several important curricular issues. First, it was recognized that in an age of ready availability of calculators and computers, the need for individual paper-and-pencil computations declined. At the same time, there was a concomitant increase in the need for the math curriculum to stress the reasoning behind and the comprehension of math procedures. In line with this shift in emphasis efforts were made to define mathematical literacy (Committee on Basic Mathematical Competencies and Skills, 1972) and then to devise courses that would equip students with the basic skills and competencies they needed to participate in daily life (CUPM, 1971b).

Second, there was a heightened awareness that the traditional math curriculum was heavily oriented toward students in science and engineering and that such an orientation was not sufficiently broad for students preparing for a wider variety of occupations (Carter, 1970; CUPM, 1972a, 1972b; Lawrisuk, 1971; Young, 1970). Consequently, alternative curricula have emerged to fit the needs of greater numbers of students and their occupational programs. Third, the necessity of expanding the type of math offerings was greatly accelerated by a growing number of students who enter two-year institutions with severe deficiencies in mathematical skills. Nowhere was this more strikingly evident than in the CUNY system when, in 1970, the open admission policy went into effect. This policy magnified this problem and propelled remedial classes into the forefront on a scale that was unprecedented elsewhere (see Muir, 1973).

In the past the primary curricular concern centered on the algebra-calculus transfer sequence. Today the curricular issues are much broader. This literature review reflects these expanded concerns.

Transfer Curriculum

The reports emanating from the different panels of the CUPM form the backbone of much of the literature on math curriculum. Panels have formulated curriculums that would be most applicable to various science and engineering majors [see Recommendations for the Undergraduate Mathematics Program for Students in the Life Sciences (1970); Recommendations on the Undergraduate Math Program for Engineers and Physicists (Durst, 1967); Applied Mathematics in the Undergraduate Curriculum (1972a)]. In 1965 the CUPM (Duren) identified a central curriculum that would serve the basic needs of the more specialized programs and majors, and constitute an outline for the core math courses, namely first- and second-year calculus and linear algebra. This report, A General Curriculum in Mathematics for Colleges (GCMC), was reviewed and revised in 1972 in order to "correct deficiencies in the original study and to modify the curriculum in accordance with new conditions in mathematics and mathematics education" (p. 4).

Between the original GCMC and its revision, the CUPM's Panel on Two-Year Colleges addressed some of the deficiencies that were most relevant in the two-year college math curriculum. While recognizing that math for general education and math for technical occupational programs were important areas in need of attention, the panel focused its efforts on the transfer curriculum. The recommendations in their report, A Transfer Curriculum in Mathematics for Two-Year Colleges (1969a), came under four major areas. The first was calculus preparatory in recognition of the need for a greater variety of courses at a precalculus level. Here two courses were proposed--Elementary Functions and Coordinate Geometry, and Elementary Functions and Coordinate Geometry with algebra and trigonometry. In the second area of calculus and linear algebra three courses were proposed: Introductory Calculus, covering the basic concepts of single-variable calculus; Math Analyses, a more rigorous course completing the standard calculus topics; and Linear Algebra, running parallel to, rather than preceding, math analyses and introducing algebra and geometry of R^3 and its extension to R^n. Acknowledging the need of the two-year college to broaden the math curriculum beyond the traditional core so as to meet the needs of students preparing for a variety of careers, the panel proposed two other transfer alternatives. For students in business and social science a course in probability and statistics was suggested, and for those who plan to transfer into teacher training programs, a course in the structure of the number system was designed. Cutting across the curriculum in all four areas was the panel's recommendation to incorporate the use of computers wherever feasible within the various math courses (CUPM, 1969a).

Curriculum planners have paid particular attention to courses for prospective elementary and secondary teachers. A detailed report issued by the CUPM (1971c), Recommendations on Course Content for the Training of Teachers of Mathematics, groups teachers into basic categories--elementary, specialists or coordinators of elementary math programs or middle school teachers, junior high teachers, and high school. Courses relevant to each level are described and recommended.

In a report on articulation within Illinois, Gustafson and Wendt (1970) single out the special course needs for prospective teachers, but fail to recommend specific course content. Houston and Hoyer (1975), examining the transfer courses in Virginia's two-year colleges, found only one major deficiency in the programs--the absence of a course designed to provide a mathematics background for elementary teachers. They recommended that such a course was needed in the two-year college and should include the study of geometry and measurement, elementary number theory, and an elementary introduction to set theory and symbolic logic.

General/Education Mathematics

"Every student at the college level should have a working knowledge and an understanding of the language of mathematics. To be entirely cut off from this medium of communication is to be less than an educated person" (Carlin, 1964, p.65). Such a statement has almost universal acceptance among educators. The problem has been to design a course in which the content is relevant to those students who do not intend to major in math, science, or engineering and who, therefore, do not need the traditional math sequence.

Initially such alternative courses emphasized the role of mathematics from a historical or cultural perspective, and so were readily absorbed into the general education portion of the curriculum. Today general education mathematics is a term applied to a wide variety of courses. One observer catalogued the content of general education mathematics as follows: mathematical systems, introduction to logic, proofs and arguments, sets and operations, sets and logic counting numbers, Cartesian products and functions, probability, and elementary geometry (Starkweather, 1971).

Two studies provide data on the type of courses offered by two-year college math departments under the rubric of general education and the role such courses play in degree requirements. Mitchell (1974) surveyed 212 college catalogs for the period 1970-1973. He found that two-thirds of the math departments offered a course either specifically designated for general education or a course whose content was very similar to the topics listed by Starkweather (1971). Those schools without a general education math offering provided business mathematics, elementary probability, or finite mathematics for business and social science students as an alternative to the calculus-linear algebra sequence. Two-thirds of these courses had no high school prerequisite and two-thirds were one term--rather than a year--in length. Of the schools with the general education offerings, 36 percent had no math requirement; 24 percent had a distribution requirement of which math was a choice, and 39 percent required one or more math courses for the associate degree.

Chairpersons of the mathematics departments in 122 two-year colleges in the North Central Region were surveyed by Friesen (1974) on their general education mathematics programs. A total of 96 questionnaires were returned, but since ten schools did not have a general education program, the findings were based on 86 institutions. One-fourth of the colleges required no math for an associate degree; 41 percent required either a math or science course; and 34 percent required at least one math course.

Friesen approached the issue of what type of math course is considered general education through two different questions. Chairpersons were asked about alternatives available to meet the general education requirement and instructors were asked about topics they considered appropriate to a general education math course. In answer to the first question almost all the math courses offered, except for noncredit arithmetic or basic mathematics, can be applied to meet the requirement. For the mathematics major calculus, linear algebra, and other courses in the usual sequence could be used; for the non-mathematics major arithmetic, algebra or trigonometry met the requirement. A mathematics survey course offered in half of the colleges could also fulfill the requirement. As for the topics that should be included in a general education mathematics course, instructors most frequently reported elementary algebra, graphs, probability and statistics, intuitive geometry, functions, history of mathematics, and number bases.

The profusion of topics within general education mathematics has made it almost impossible to design a single survey course. Math educators are in a situation of having to examine the goals of general education and then balancing those goals against the capabilities of their departments and the needs of their students. One approach that seems to do this is through the use of minicourses.

Barton County Community College began offering minicourses in 1970 as an alternative to the regular college math sequence. These courses are taught for a five-week period, meet 150 minutes each week, and carry one hour of credit. The student, in consultation with his advisor, enrolls in those courses most closely related to his intended major or career choice. The following examples of short course selection show how flexible and individualized such a math curriculum is:

Elementary Education Major
- Geometry
- Finite Systems
- Number Bases
- Logic

Psychology Major
- Probability
- Statistics
- Logic

Electronics Major
- Geometry
- Equation Solving
- Logarithms & Slide Rule
- Practical Trigonometry

Automotive Science
- Equation Solving
- Logarithms & Slide Rule
- College Arithmetic (Carter, 1970).

Moraine Valley Community College instituted a series of unit courses, each of which is defined in terms of behavioral objectives. The intents are to provide the flexibility to meet individual student needs and to increase student success within the classes since students know what is required for each class (Lawrisuk, 1971). In Friesen's study (1974) 22 percent of the institutions were offering minicourses. His data showed a strong relationship between those colleges that had such offerings and the feeling of the chairperson that the needs of the students were being met in the general education math program.

Remedial-Developmental

The literature on remedial-developmental mathematics identifies a number of issues. A major one, especially in developing the procedure for this study, revolves about the courses that are considered remedial. In addition to the definitional issue, there are such issues as placement of students, granting of credit, content of such courses, and instructional practices.

Broader definitions are given by those who describe four- as well as two-year courses. Bittinger (1972) views aritnmetic, elementary algebra, and intermediate algebra as remedial, but he notes that some colleges consider all pre-calculus courses, including trigonometry and elementary functions, in that category. While not using the term remedial, the CUPM considers the broad area below the level of college algebra and trigonometry as basic mathematics. Focusing on the two-year college, Baldwin (1974), Muir (1973), and Pearlman (1977) define remedial courses as those in which arithmetic and elementary algebra are taught.

Several studies provide descriptive data on some of these other issues. In Baldwin's study (1975) involving 104 two- and four-year institutions in 21 states, 91 percent offered developmental math courses. Two other studies, Carter (1975) and Lindberg (1976), report similar figures. Although placement exams are advocated by a number of educators as a means of assessing the level of course for which the student is prepared, exams are far from universally used to determine placement in remedial courses. In a study of remedial math in two-year colleges in New York only 38 percent used a placement exam, but 71 percent of the chairpersons felt an exam should be used. The four placement procedures used, in descending order, were: volunteer 55 percent, teacher referral 50 percent, high school average 45 percent, and, as mentioned above, placement test 38 percent. In Baldwin's nationwide study (1975) students volunteering and high school math grades were the most frequent placement procedures; only 28 percent used a department placement test and 19 percent, a standardized test. Regardless of the placement method used, Baldwin (1975) found that only four percent of the institutions required those students who were determined to be mathematically deficient to take a developmental math course. Another 29 percent strongly recommended such a course but did not require it. Whether placement should be mandatory is a question that is raised within the literature. Zwerling (1977) and Stein (1973), among others, feel that students deficient in mathematics should be advised to take a developmental course, but that final choice should remain with them. On the other hand, Baldwin (1975) and Friesen (1974) feel that a developmental course should be required for all mathematically deficient students.

On the matter of credit, Muir's (1973) study of the eight city colleges of CUNY found that four of the campuses did not offer credit for remedial courses and that credits varied from one to five at the other four. Among two-year institutions in New York state, 44 percent gave no credit for such courses; 43 percent gave credit as an elective; and only 13 percent awarded credit as math (Baldwin, 1974). Nationwide 66 percent of the institutions offered some type of credit (Baldwin, 1975). Muir (1973) raises the question as to whether the attrition rate is higher and the attendance rate lower when there is no credit. Although the above question remains unanswered, Baldwin (1975), Stein (1973), and Zwerling (1977), among others, all advocate granting college credit.

METHOD FOR THE CURRICULUM STUDY

In order that the Center for the Study of Community Colleges could establish a baseline of information regarding curriculum in the sciences in two-year colleges, and, specifically here, information about mathematics and computer sciences, special sampling and data-gathering procedures were established.*

The Sample

The first step was to assemble a representative sample of colleges. The starting point was an earlier study by the Center for the Study of Community Colleges for the National Endowment for the Humanities. This study had already assembled a sample (balanced by college control, region and size) of 178 colleges. Using this sample as the initial

*For a complete report of the procedures used in this study, see Hill and Mooney, 1979.

group, the presidents of these colleges were invited to participate in the current study. Acceptances were received from 144 of these schools.

A matrix was then drawn with cells representing nine college size categories for each of six regions of the country. Using the 1977 Community, Junior, and Technical College Directory (AACJC, 1977), the ideal size-region breakdown for a 175-college sample was calculated. The remaining 31 colleges were selected by arraying all colleges in the underrepresented cells and randomly selecting the possible participants. The sampling technique used in this study produced a balanced sample of 175 two-year colleges. The following table shows how close our sample is to the percentage breakdowns of the nation's two-year colleges. (A regional list of participating colleges is found in Appendix A.)

Procedure

College catalogs and class schedules for the 1977-78 academic year were obtained from each of the 175 colleges participating in this study. For this curriculum phase, a three-level method of classifying courses was employed. First, based upon the catalog course description, each of the science courses was placed into one of six major curriculum areas: Agriculture and Natural Resources, Biological Sciences, Engineering Sciences and Technologies, Mathematics and Computer Sciences, Physical Sciences, and Social and Behavioral Sciences. These areas were chosen because they closely reflect the instructional administrative organization of two-year colleges as well as the organization of national and international professional science organizations and agencies, such as the National Science Foundation.

The second level of classification was based upon the major subject field disciplines within the broad area. The proliferation of course titles in mathematics and the fact that courses are offered not only by the math department but by a number of different departments (e.g., business, engineering, electronics, psychology) made it necessary to form categories that would encompass closely related courses. It should be noted that course inclusion was based upon the catalog description, and not limited to classes offered by the department of mathematics.

Table 1

Percentage of 175-College Sample Compared to National Percentages by Size, Region and Control

	Size								
	1-499	500-999	1,000-1,499	1,500-2,499	2,500-4,999	5,000-7,499	7,500-9,999	10,000-14,999	15,000+
National %	15	18	13	17	17	8	5	5	4
Sample	13	16	13	17	19	9	5	6	4

	Region					
	Northeast	Middle States	South	Midwest	Mountain Plains	West
National %	7	13	32	21	10	17
Sample	6	12	31	22	13	16

	Control	
	Public	Private
National %	84	16
Sample	84	16

Two other features of our classification system need to be pointed out. First we did not delineate a separate category for developmental or remedial courses. Instead, depending on the student for whom intended, such courses formed the first three subcategories of introductory and intermediate mathematics and the pre-algebra subcategory under applied mathematics. Second, rather than adopt the broad category commonly called "general education mathematics," we specified the major for which such courses were designed and formed the category mathematics for majors.

The categories that were formed and the subdivisions within each were:

Introductory and Intermediate Mathematics
- Pre-Algebra
- Introductory Algebra
- Geometry
- Intermediate Algebra & Trigonometry
- College Algebra & Trigonometry

Advanced Level Mathematics
- Analytic Geometry
- First Year Calculus
- Second Year Calculus
- Advanced Topics
- Linear Algebra

Applied Mathematics, Technology Related
- Pre-Algebra
- Algebra through Trigonometry
- Calculus

Mathematics for Majors
- Non-Calculus--Liberal Arts, Education, Social Sciences
- Non-Calculus--Business
- Non-Calculus--Biological Sciences, Allied Health, Agriculture
- Calculus

Statistics and Probability
- Introduction to Probability and Statistics
- Business Statistics
- Statistics for Technological Fields
- Advanced Statistics

Computer Science and Technology
- Non-Science Majors
- Computer Programming
- Math for Computers
- Technical Aspects of Computers
- Calculators and Slide Rules

Independent study courses, courses not carrying college credit, and catalog or schedule entries designated as "math laboratory" or "learning center" without a specific credit course attached to them were omitted from the study.

After all science courses were classified, class schedules for the 1977-1978 academic year were inspected, and the number of sections offered (day, evening, and weekend credit courses) for each term were determined. Prerequisite requirements were also ascertained from the catalogs.

RESULTS

Table 2, developed from the procedure described, presents an overview of the mathematics curriculum offered in two-year colleges for the 1977-1978 academic year. As indicated, 99 percent of the colleges list at least one math course in their catalogs and also offer at least one course at some point in the academic year.

Nearly all colleges offer one or more courses in introductory and intermediate math and math for majors. Courses in these categories also constitute the largest percentage of math courses in the schedule. While more colleges both list and offer a class in statistics and probability than classes in applied math or computer science, this category, as indicated by column 3, constitutes the smallest percentage of the total mathematics offerings.

In addition to an overall view of curriculum we examined differences that existed by region, control, emphasis, and size. Table 3 represents the mathematics curriculum broken down by these four variables. (The states included in each region and the colleges included in each of the groups can be found in Appendix A.)

Table 2

Mathematics and Computer Sciences in the Two-Year Colleges, 1977-78 Academic Year

Type of Course	Percent of Colleges Listing This Type Course in Catalog (n=175)	Percent of Colleges Listing This Type Course in Class Schedule (n=175)	Percent of Total Math & Comp. Sci. Courses Listed on Schedule (n=3,321)	Percent of Total Math & Comp. Sci. Sections Listed on Schedule Lecture (n=16,024)
Introductory and Intermediate	98	97	27	44
Advanced	88	86	18	9
Applied--Technology Related	71	67	15	13
Mathematics for Majors	97	95	21	23
Statistics and Probability	85	75	7	5
Computer Science & Technology	79	71	12	7

Notes. 1. 174 colleges (99% of sample) list one or more mathematics and computer sciences courses in the college catalog.

2. 174 colleges (99% of sample) list one or more mathematics and computer sciences courses in schedules of classes.

Table 3

Course Offerings by College Region, Control, Emphasis and Size (in Percent)

	Total Sample (175)	Region						Control		Emphasis			Size		
		North-east (11)	Middle States (21)	South (54)	Mid-west (39)	Mt/ Plains (22)	West (28)	Public (147)	Private (28)	Comp (142)	Lib Arts (15)	Tech (18)	Small 1499 (72)	Medium 1500-7499 (73)	Large 7500 (25)
Introductory and Intermediate Mathematics	98	82	90	91	90	77	93	89	75	91	100	78	85	88	100
Advanced Mathematics	88	64	90	85	87	86	100	93	61	98	66	28	69	97	100
Applied Math-Technology Related	71	36	67	57	74	64	86	78	7	70	7	94	44	77	100
Mathematics for Majors	97	82	95	98	95	91	96	98	79	95	93	100	92	96	100
Statistics and Probability	85	91	90	61	77	64	93	81	46	82	33	55	53	90	96
Computer Science and Technology	79	64	71	63	82	68	75	77	36	76	33	67	44	86	96

Few notable differences pertain to the regional breakdown. Colleges in the Northeast are least likely to offer advanced math courses, applied, and computer sciences. Southern and Mountain Plains institutions also tend not to offer the last two categories as well as not to have statistics. Midwest institutions are the most likely to offer computer science. Colleges in the West tend to offer all math courses. However, this is probably related to college size since 52 percent of the large schools are in the West.

The private colleges are less likely to offer all the categories than are the public colleges. This is particularly marked in the more specialized areas--applied math, statistics and computer science. However, the variable of control is not only influenced by college size but by emphasis. Of the private colleges, 89 percent are in the small (less than 1,499 students) category and 43 percent have a liberal arts orientation. Individually and, especially, in consort, these factors would severely limit the number of offerings that would be included in their curriculum.

Table 3 clearly shows the relationship between college emphasis and curricular offerings. Whereas technical colleges favor applied math--technology related and mathematics for majors--and de-emphasize advanced mathematics, comprehensive institutions are much more likely to offer courses in all categories. Again, as with the variable of control, the offerings in liberal arts colleges are a reflection not merely of emphasis but of size (of the colleges with a liberal arts emphasis all but one are in the small college category, less than 1,499 students). Thus the finding that almost none of these colleges included applied math and that only a third have courses in statistics and computer science is as much a function of size as it is of emphasis. It is important to note that only two-thirds of these colleges include advanced mathematics in their curriculum. Does this reflect an insufficient student pool and/or insufficient facilities and resources, including, of course, faculty?

The college size naturally influences the variety of courses offered. However, the differences here are not as great as one might imagine--particularly between medium and large institutions. The fact that nearly all large colleges have offerings in all categories is related to a sufficient student pool, a larger teaching staff, and adequate facilities and resources to accommodate more diversified offerings. In addition, the fact that large colleges are also public colleges influences the curricular pattern. On the whole, there appears to be a diversity of curriculum nationwide as institutions attempt to meet the needs of a diverse and rapidly changing student population.

Prerequisites

One of the best indicators of the linearity of the curriculum is the use of prerequisites as entry level blocks on course enrollments. Our data point to the fact that the math curriculum is highly structured (see Table 4). Over 50 percent of the introductory, intermediate, and mathematics for majors courses have a prerequisite, and the prerequisites become even more stringent for the more advanced courses (97% of these having a prerequisite).

The other issue explored in our data is the form of the prerequisite. In introductory and intermediate courses the most frequent prerequisites are high school math or algebra and college or intermediate algebra. These are usually listed separately. Interestingly, the use of placement exams is quite limited. The advanced math curriculum is both the most structured and the most sequential. Trigonometry and college algebra usually precede the calculus series whereas analytic geometry either precedes the series or is included in it. It is important to note that most of the colleges offering advanced math courses offer the entire sequence so students are able to complete a math program that parallels the four-year college math curriculum. In applied math the first course either has no prerequisite or requires high school math or algebra. However, the succeeding courses require the previous course in the series underlining how sequential this dimension of the math curriculum has become.

While a third of the math for majors courses require high school math or algebra, a placement exam to assess math skills is again

Table 4

Prerequisites

	Number of Courses	Percent of This Type of Course with Prerequisite	High School Math or High School Algebra (also called Developmental Math)	Plane Geometry	Placement Test	Previous Course in Series	College Algebra/ Intermediate Algebra	Analytic Geometry/ Trigonometry	College Calculus Series	Business or Technical Math	Other	Consent of Inst.
Introductory and Intermediate Math	892	57	37	10	12	15	36	6			3	3
Advanced Math	587	97	2	1	1		17	53	55		1	*
Applied Math-Technology Related	513	66	20	4	5	55	4	3	1	3	3	1
Mathematics for Majors	696	57	34	6	10	25	19	6		3	2	2
Statistics and Probability	226	74	16		3		40	9		7	10	4
Computer Science and Technology	407	63	13		*	20	13	7	5	5	24**	4

*Indicates less than one percent.

**83% of the "other" in computer science and technology was an electronics course.

utilized very infrequently. The role of course sequences is again evident here since 25 percent of the courses in this category have as their prerequisite a previous course in the series. College algebra/intermediate algebra is the most prevalent prerequisite for statistics and probability courses. Because these courses are offered by departments other than the math department (e.g., psychology), a prior course within the discipline is sometimes listed as the prerequisite and is included in Table 4 under "other." Prerequisites for computer science and technology reflect the needs of this specialization. Most of the courses under "other" are electronics courses, and the course sequences involve a series of computer courses rather than mathematics courses.

Catalog-Schedule Discrepancy

From our data we observed that nearly all the colleges listing a course in their catalog actually schedule it. The greatest discrepancies occurred in statistics and probability (where 11 percent of the colleges with such courses in their catalogs did not schedule them during the 1977-78 academic year) and in computer science and technology (where 10 percent of the colleges did not actually schedule such courses). Although listed in the catalogs of the 175 colleges, a total of 756 courses did not appear in the schedule of classes. Since 3,321 courses were actually offered, our findings indicate that approximately one out of every five mathematics and computer science courses listed in college catalogs were not offered to the students. The largest number not offered are in computer science (27%) followed by applied mathematics-technology related (24%). On the other hand, the catalog accurately reflects the offerings in introductory and intermediate math and is a fairly accurate guide to the advanced mathematical offerings.

PART II

INSTRUCTIONAL PRACTICES

Information about instructional practices in two-year colleges is historically fragmented and disparate. Math instruction is not atypical. Studies on modules, programmed instruction, math laboratories, audio-tutorials, and small group instruction abound. But most of the research tends to be localized and purely descriptive, reflecting the necessity for colleges to make determinations about instructional methods based on their own student populations. The really basic questions regarding the types of instructional methods that are most effective with various students and certain types of instructors are infrequently asked, and even more rarely arswered. To do so a more systematic approach and a national perspective are needed.

THE LITERATURE

The traditional mode of instruction has been the lecture method and because it has prevailed for so long, it is the method against which all others are measured. Despite dissatisfaction with the method and despite various innovative alternatives, the literature indicates that the lecture remains the most commonly used method. Friesen (1974) found that 95 percent of the colleges used this method in general education math courses, and 55 percent of the institutions surveyed by Baldwin (1975) reported that it best described their developmental math courses. In the CUPM's report, Suggestions on the Teaching of College Mathematics (1972c), the lecture approach is the only method that is discussed. True, the report was geared to instruction in both two- and four-year institutions. It is also true that this report emphasized the need to keep lectures short, to allocate time for discussion, to ask frequent questions of students, and to encourage as much class participation as possible. However, for the CUPM not even to mention other instructional approaches indicates how strongly entrenched the lecture is within math instruction.

Still, the continued reliance on the lecture is only part of the picture. For a complete picture one must look at the tremendous amount of experimentation, particularly in individualizing instruction, that is going on. In Friesen's sample (1974) over one-half of the colleges used the following: individualized instruction--51 percent; programmed instruction--31 percent; laboratory--29 percent; independent study--22 percent; audio-tutorial--18 percent. A significant correlation was found to exist between the number of nonlecture teaching techniques employed in the general education mathematics courses and the feelings that the students' needs were being met in these courses. The developmental math courses surveyed by Baldwin (1975) indicated that the following instructional methods were used: programmed books--54 percent; supplemental tutoring--37 percent; open laboratories--26 percent; audio-tutorial method--24 percent; and the Keller Plan--13 percent.

Many of the individualized programs are based on the Personalized System of Instruction (PSI) (Keller, 1968). Despite a proliferation in the names of such courses, they share several important characteristics. First they are based on a specific set of behavioral objectives. Second, the content to be learned is divided into small modules or units. Tests are devised for each unit, sometimes pre- and post-tests, and students must pass with a mastery grade before preceding to the next unit. If students do not reach mastery, they must restudy then take another version of the quiz. Thus a third characteristic is retesting. Fourth, although some programs feature audio-tutorial or video materials and some continue to use the lecture, printed materials are relied upon heavily. Lastly, the teacher's role is that of manager, record keeper, and individual tutor. To assist the teacher in these functions and to provide sufficient opportunities for one-to-one learning, many of these courses use student proctors.

Claims about the success or failure of individualized programs in comparison to the more traditional lecture method vary widely. While some researchers attest to higher test scores (Emery, 1970; Grindler, 1977; Zwerling, 1977), in most studies the comparative mean scores are not statistically significant (Morman, 1973; Nott, 1971; Perry, 1971). The measures of student attitude are also mixed. Lial (1970), Orman (1977), Perry (1971), and Pond (1973), among others, found that students in individualized courses had more favorable attitudes toward math in general and/or the instructional approach than did students in lecture classes. However, Bazik (1972) and Klopfenstein (1977) found no difference in attitude. In terms of student attitude a source of invalidity works in favor of the individualized program--namely, the Hawthorne effect. Since the individualized approach was new for most students, the novelty of being in an experimental or different type class can temporarily inflate the results. While it is impossible to know what, if any, effect this had on the outcomes, it certainly did not work against the individualized approaches.

Few longitudinal studies are available to determine the success of students from individualized courses in later math and science courses. This, of course, needs to be considered when discussing success and failure. One study (Corn & Behr, 1975) provides some evidence that students taught conventionally in a remedial math course tend to do better in future credit courses that are taught conventionally. However, at the University of Arizona when students from a PSI type algebra course and students from a lecture algebra course were followed in subsequent math courses taught by the lecture method, the students from the individualized course were more successful (Thompson, 1977). Obviously, more follow-up studies are needed.

Although a number of studies report a lower rate of attrition in individualized courses (Mattila, 1974; Orman, 1977; Zwerling, 1977), in other courses attrition remains a problem (Klopfenstein, 1977; Spangler, 1971; Turney, 1977). Two major factors contribute to attrition in such courses. The first is that nontraditional systems with self pacing often place more responsibility on the student than do traditional methods. Many students lack the motivation and study skills to keep themselves going, and thus procrastination deters the effectiveness of such programs. The second is that the reading level of some students (particularly those in the developmental individualized courses) is low and thus they have difficulty with programmed materials. With the above factors in mind it is interesting to note that Greenwood (1977) found that the more successful individualized programs utilized external or teacher determined pacing, as opposed to self pacing, and teacher supplementation by lecture of the programmed materials. The use of teacher supplementation appears to be a stronger element in program success than external pacing.

Math Labs

The literature indicates that math labs are used in different ways. They may be a required component of a lecture course--for instance, two hours of lecture/two hours of lab. They may be an optional aspect of a number of courses, both in math and in science. This approach gives students the opportunity to utilize the additional tutoring, audio-visual study aids, and computer programs as needed. Labs may also be both the setting for and the approach to an entire course (Mattila, 1974; Spangler, 1971; Zwerling, 1977). When used in the latter two ways, these labs or learning centers generally are open either all day or days and some evenings to accommodate the varied schedules of students. They also have one or more regular instructors and, frequently, several student assistants to provide immediate tutoring, to administer and score quizzes and exams, and to provide constant feedback on students' progress.

Although the use of mathematics laboratories or learning centers is not limited to remedial courses, it appears from the literature that they are both needed most and utilized most in those courses. When respondents in New York state were asked to rank the facilities needed in a remedial math program, study labs were ranked first (Baldwin, 1974). In the nationwide study Baldwin (1975) found that 37 percent of the institutions had laboratories for their development courses and 32 percent used them as a replacement for a regular classroom. Lindberg (1976) found that 38 percent of the remedial programs met in a math center.

Student Evaluation

Many of the individualized courses rely on mastery testing for each unit, with an achievement required between 70-90 percent (Horner, 1974; Mattila, 1974; Perry, 1971), and the use of retests if mastery is not initially achieved (Haver, 1978; Orman, 1977; Spangler, 1971). However, the way retests are handled varies considerably. Some instructors use only the first grade; others use a C for the second chance, and still others replace the original score with the retest score. As in traditional lecture courses, final exam grades constitute a portion of the course grade in a number of the individualized classes.

Letter grades prevail in math courses regardless of the instructional approach. Even in remedial courses where opinion is divided as to the appropriateness of grades, Baldwin (1975) found that 66 percent of such courses had letter grades. There is a tendency for the non-lecture courses--particularly those that are remedial or lower level college math--to utilize a greater variation of incomplete/partial credit grades so as to avoid actually failing students. In Baldwin's sample 14 percent of the institutions had an incomplete grade and 14 percent had some variation of pass/incomplete.

The literature indicates that there is some experimentation with contract grades (Miller, 1974; Perry, 1971; Stein, 1973). In addition, primarily amongst the proponents of the small group approach, alternatives to a grading system which competitively sets students against each other are discussed. The small group approach features cooperative work among students to solve problems and to master the course material and Kipps (1970), Maxfield (1974), and Stein (1973) feel that traditional evaluation is inappropriate with such a technique.

METHOD FOR THE STUDY OF INSTRUCTION

The first step in assessing instructional practices in the sciences was to establish a random sample of colleges. The procedures used in putting this sample (n=175) together are described in the first section on curriculum. Briefly, each college president who agreed to participate in the study was asked to name a contact person at the school, who was given the title "on-campus facilitator." All communication and correspondence between the Center for the Study of Community Colleges and the sample colleges was conducted through the 175 on-campus facilitators.

Once the college catalogs were obtained from each school, Center staff read each course description in the catalog and put courses in the appropriate category according to the course classification system that had been developed (see Part I). The next step involved counting the science course offerings in the Fall 1977 day and evening schedules of classes. A list was developed for each college showing the courses offered and the number of sections of the course that were listed in the schedule of classes.

The selection of individual class sections was done by drawing every thirteenth section in each of the six major science areas. After randomly selecting the first college, the system was automatically self-randomizing.

Using this procedure, every thirteenth section was pulled off the schedule of classes and recorded on a checklist for the facilitator at each school. This checklist included the name of the instructor listed as teaching the section, the course title, section number, and the days and time the class met. A copy of this checklist was kept at the Center to tally the surveys as they were received.

A survey form for each instructor was mailed to the campus facilitator (Appendix B), together with instructions for completing the questionnaire and a return envelope addressed to the same facilitator. The return envelope had the instructor's name listed as the return address and was clearly marked "Confidential." This enabled the on-campus facilitator to keep an exact record of who had responded without opening the envelope. This technique guaranteed confidentiality to the respondent while also enabling the facilitator to follow up on the retrieval of surveys from nonrespondents.

Questionnaires were mailed between February 20 and April 10, 1978, to 1,683 instructors. Since this was after the completion of the fall term, 114 surveys were not deliverable due to faculty dismissal, retirement, death, etc. An additional 77 sections were cancelled. Of the 1,492 deliverable surveys, 1,275 were returned. This established an overall response rate of 85.5 percent. Questionnaires were retrieved from 100 percent of the faculty sampled at nearly 69 percent of the colleges. Table 5 shows the relationship between completed surveys in the different disciplines and the percent of the total number of science class sections offered in these disciplines in the 1977-78 academic year.

Of these 1,275 responses, approximately a third (393) were from instructors of mathematics and computer science. This group was further divided into a group of 128 instructors who used the designation remedial, either by itself or in conjunction with one or more of the other categories, to describe their course, and the remaining 265 instructors, who did not so designate. Most of the findings reported here are based on the responses from the total group of math instructors. However, on the major issues raised within the literature the data are reported separately for the group who described their course as remedial or having a remedial component and those who did not.

Table 5

Percent of Survey Responses and Total Sections by Discipline

Discipline	Returns on the Instruction Survey --% of Total (n=1,275)	77-78 Academic Year --% of Total Lecture Sections (n=49,275)
Agriculture	3.0	3.0
Biology	12.5	10.5
Engineering	11.3	11.0
Math/Computer Science	30.8	32.5
Chemistry	6.4	5.1
Earth/Space	3.6	3.6
Physics	3.5	3.2
Interdisciplinary Natural Science	2.3	2.7
Anthropology & Interdisciplinary Social Science	2.4	3.0
Psychology	11.2	11.6
Sociology	7.4	8.1
Economics	5.4	5.6

Students

While the average initial class enrollment in all the science disciplines surveyed was 32, mathematics course sections averaged 28. This figure is higher than the median class size of 18 in the National Science Foundation (NSF) study of the 1966-1967 academic year (NSF, 1969). Although the average class size has increased, it remains below 30. The latter figure was considered to be the maximum class size from an educational point of view by the mathematics faculty in Miller's study (1973) on class size. The completion rate for math courses is the lowest of all the disciplines surveyed, 72 percent compared to an overall average in science courses of 79 percent. Attrition in remedial classes is higher. There are more male students (16.1) than female students (11.6) in the average mathematics course; however, female students have a slightly higher completion rate (73%) than do male students (71%).

Whereas in the NSF study (1969) 76 percent of the math courses were designed for transfer students, our findings indicate that the curriculum is now designed for a much more diversified group of students. In the present study 55 percent of the math instructors compared to 68 percent of all the science instructors indicated that their course paralleled a lower division four-year college course, with 31 percent indicating the course was targeted for transfer students majoring in the physical or biological sciences and 29 percent indicating the course was for non-science transfer students. Another 29 percent said their course was designed for occupational students in science technology. Most striking is the fact that one-third of the instructors indicated that their course was directed at those students who need to make up high school math requirements or for those students needing remedial work in math skills. While this figure is certainly in line with estimates on the number of mathematically underprepared students in the community colleges (Baldwin, 1975; Beal, 1970), it represents an enormous change from the 1969 NSF study in which only one percent of the courses were considered remedial.

Instructional Mode

One mode of instruction for each of the classifications was determined from descriptions in the college catalogs (see Table 6). Classes designated as lecture only were those that did not have a separate but required lab. Lecture-lab classes were those that required a set number of laboratory hours in addition to the lecture hours. Individualized instruction were those courses that were entirely self paced and where content was based on the needs of each student. The category "other" referred to courses that were offered by means of closed circuit T.V. on campus or those that were offered via open television channels.

Table 6
Percent of Courses in Each Category
by Instructional Mode

	Lec Only	Lec-Lab	Indiv. Instruc.	Other
Introductory and Intermediate	84	2	12	1
Advanced	97	2	2	
Applied--Technology Related	92	6	3	
Mathematics for Majors	95	3	1	1
Statistics and Probability	92	5	1	
Computer Science & Technology	45	48		7

Table 6 does not corroborate the variety of instructional modes that the literature describes. True, these data were obtained from catalogs that may not list all the nontraditional modes utilized within classes--particularly in developmental classes. However, except for the computer science and technology classes, the lecture format clearly dominates.

The Instructor Survey delved deeper into the use of instructional techniques. The faculty were asked what percent of class time they devoted to certain activities. Table 7 shows the percentage allotment of class time in remedial math classes and in regular math classes, and compares these allotments to those in all the science courses.

Table 7

Amount of Class Time Devoted to Activities

	Remedial Math Classes (n=128)	Regular Math Classes (n=265)	Total Science Classes (n=1275)
Lecture	36%	49%	45%
Class Discussion	16	19	15
Quizzes/Examinations	17	12	10
Student Verbal Presentations	2	3	3
Viewing and/or Listening to Film or Taped Media	2	*	4
Lecture/Demonstration Experiments	2	3	3
Lab Experiments by Students	*	3	11
Lab Practical Exams	*	2	2
Other	23	5	5

*Indicates less than one percent

Note: Because of rounding these columns do not total 100%

Under the open-ended term "other," instructors indicated a number of activities and techniques primarily designed to individualize instruction (e.g., computer instruction, tutoring, self study with programmed text).

As one would expect, there was much less use of laboratory experiments by students in mathematics classes than in many of the other science disciplines. Aside from this difference, instructional activities in regular math classes are very similar to those in other science classes. The real cleavage is between remedial math classes and regular math classes--particularly in terms of the time alloted to lecturing, testing, and using "other" instructional approaches.

Aside from the allotment of class time, we also looked at the percentage of faculty utilizing these different activities. As one would expect, most instructors lecture. However, only 80 percent of the instructors in remedial classes do so, compared to 93 percent of their colleagues who teach regular math and 94 percent of all science instructors. Remedial math instructors are also strikingly different in that 45 percent of them used an instructional activity classified as "other" in contrast to 16 percent of the regular math faculty and 13 percent of all science instructors. The instructors who checked the "other" category also specified the technique used. A` the activities listed were designed to individualize instruction and to promote a greater degree of flexibility and self pacing.

Regardless of the type of math course, math instructors are distinguished from their colleagues in the other science disciplines by the small number who use instructional media in their classes. Only 13 percent, the lowest percentage in any discipline surveyed, reported that class time was spent in viewing or listening to media. The aforementioned figure contrasts with 46 percent of all the respondents who indicated that some class time was used for viewing and/or listening to media. Of the various forms of media listed, only overhead transparencies and charts/illustrations/displays were used frequently by at least 10 percent of the math faculty.

Instructional Materials

The choice of reading materials, amount of reading required, and the level of faculty satisfaction with the materials used are all important topics to explore when considering instructional practices. The most widely used reading material was the textbook, which was utilized by 93 percent of the math respondents. Not surprisingly, the number of pages that math instructors expect students to read is low (237) in comparison to the reading assignments in other science courses, which averaged 307 pages. About half of the instructors used syllabi and handouts. The only other materials used by more than 10 percent of all the math respondents were workbooks (19%) and problem books (13%). However, 15 percent of the instructors of remedial courses indicated that they used some other type of instructional material. Again instructors were asked to specify what other materials were used, and the responses (e.g., student tutors, modules, programmed texts, audio tapes, staff prepared materials) indicate materials that would be suitable for individualized instruction.

Our respondents were also asked to indicate the extent to which they participated in the selection of the instructional materials used in their courses. Only 21 percent of the math instructors had "total say" in the selection of textbooks, the lowest figure for all the disciplines surveyed, and over a third (35%) had no involvement. The lack of participation in choosing textbooks may, in part, account for an increased dissatisfaction with textbooks. Whereas in 1967, 82 percent of the math instructors were satisfied with their textbook (NSF, 1969), in our study the number reporting satisfaction declined to 61 percent. In view of the fact that the textbook appears to be the primary instructional material used in math classes, this lack of control in selection and the concomitant level of dissatisfaction with them take on an added importance.

Grading Practices

While the standard letter grade system prevailed in regular math courses, the grading practices in remedial courses were less traditional (see Table 8). The "other" category included such things as In Progress, Satisfactory/Unsatisfactory, Pass/Retake, Withdraw, Re-Enroll, and Incomplete.

We also surveyed the instructors to determine the basis of their grade assignments. There were very few differences between remedial math instructors and instructors of regular classes as to which activities were included in grading and the emphasis given them. Objective tests were

Table 8

Grading Practices

	Remedial Math Classes (n=128)	Regular Math Classes (n=265)	Total Science Classes (n=1,275)
ABCDF	52.3	75.8	73.6
ABCD/No Credit	12.5	15.1	15.3
ABC/No Credit	9.4	6.0	5.6
Pass/Fail	5.5	<1	1.4
Pass/No Credit	10.9	1.1	2.8
Other	14.8	3.4	4.9

Note. Some courses employ multiple grading options; therefore these columns may total over 100%.

the most prevalent means of evaluation, followed by essay exams. Over half the math instructors (54%) counted the former as 25 percent or more of the grade and 40 percent gave the latter the same emphasis. Forty percent said that homework was considered as part of the grade but it counted less than 25 percent, and about one-fourth also counted regular class attendance, participation in class discussions, and problem sets as less than 25 percent. Problem sets were included in evaluation by more of the instructors in regular classes. Other activities--e.g., papers written in or out of class, workbook completion, nonwritten projects--were very seldom included as part of the grade.

Since tests are the primary means of evaluating students, it is important to understand what student abilities instructors considered most important. The emphasis is clearly on mastery of a skill, with 88 percent of the math instructors indicating that this is "very important," the highest percentage among faculty from any science discipline.

The next most important is to demonstrate an acquaintance with concepts of the discipline; 77 percent indicated that this was "very important." The recall of specific information is "very important" to close to half (43%) of these faculty. Understanding the relationship of mathematical concepts to students' values is least important, with over half (56%) reporting it as "not important." The latter result typifies the physical sciences and engineering and contrasts with the importance assigned this ability by faculty in the social sciences.

Nearly all (93%) of the instructors use tests where students must show the work used to solve the problems. The next most frequent type of question (used by one-third) is one in which students are asked to construct graphs, diagrams, or equations. Multiple response, completion, and essay questions are used by only a few.

Course Goals

Related to the issue of abilities that students should be able to demonstrate are the course goals held by instructors. Table 9 presents the responses of instructors of remedial math classes, of regular math classes, and of the other sciences. Instructors were asked to select one quality from each set of four that they most wanted their students to achieve. The most noticeable differences between the two math groups are in Set 3. Clearly, the goal of remedial classes is to prepare students for further education, particularly college level math courses, and this goal is evident in the instructors' responses. Since much of the work in the remedial classes is devoted to improving arithmetic skills and mastering the basics, the ability to think critically does not figure as prominently as it does in many other math courses. The greatest cleavage between math and the sciences as a whole is in Set 1. The emphasis in math on applying course material to solve problems is to be expected, and the fact that instructors had to select one goal probably accounts for the disparity between math and the total sample on understanding the interrelationship of science and society. Certainly this aspect of math education is stressed in the literature in terms of the need for basic math competencies for all citizens and in the philosophical underpinning of general education math.

Table 9

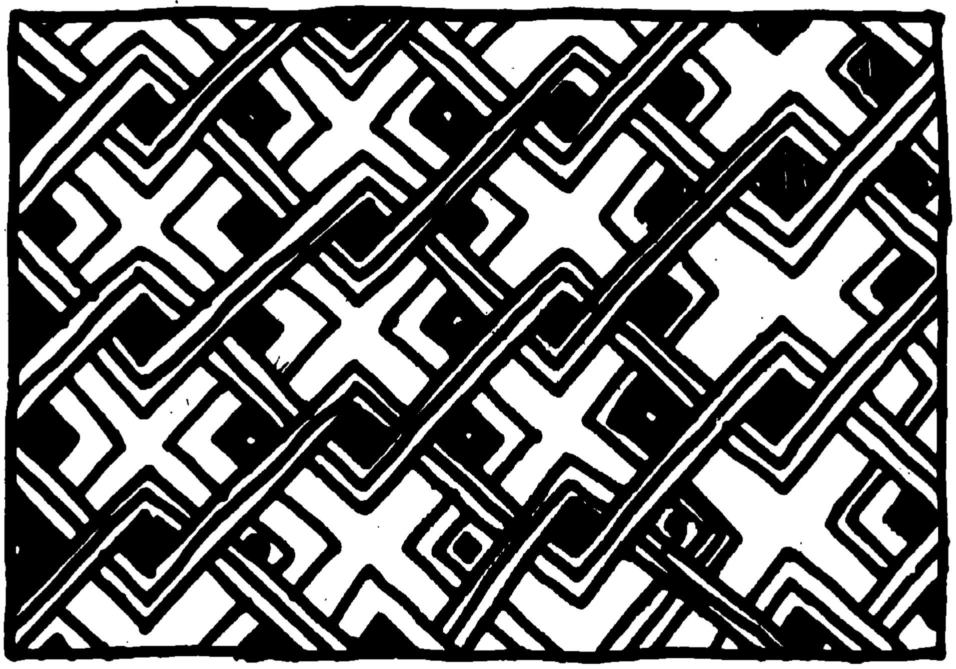
Desired Qualities for Students (in Percent)

		Remedial Math Classes (n=128)	Regular Math Classes (n=265)	Total Science Classes (n=1275)
Set 1	Understand/appreciate interrelationships of science & technology with society	1.6	7.9	26.9
	Be able to understand scientific research literature	*	*	1.5
	Apply principles learned in course to solve qualitative and/or quantitative problems	89.8	84.5	61.4
	Develop proficiency in laboratory methods and techniques of the discipline	7.8	4.9	8.3
Set 2	Relate knowledge acquired in class to real world systems and problems	36.7	40.4	48.2
	Understand the principles, concepts and terminology of the discipline	60.2	50.2	42.6
	Develop appreciation/understanding of scientific method	1.6	2.3	2.2
	Gain "hands-on" or field experience in applied practice	1.6	6.0	6.1
Set 3	Learn to use tools of research in the sciences	6.3	12.5	8.6
	Gain qualities of mind useful in further education	61.7	33.6	32.9
	Understand self	1.6	*	9.4
	Develop the ability to think critically	26.6	51.7	46.6

*Indicates less than one percent

Out-of-Class Activities

In addition to classroom activities and course goals, instructors were asked to note which, if any, out-of-class activities were required or recommended. The list of activities included on-campus educational films, other films, field trips, television programs, museum attendance, volunteer service, outside lectures, and tutoring. None of these were required or recommended by more than two percent of the math faculty except for tutoring, which was recommended by 58 percent of the remedial and 46 percent of the regular instructors. Both of these figures are high when compared to instructors in other disciplines and to the 39 percent of the total science sample who recommended tutoring.



PART III

THE FACULTY

Because teaching is frequently stated as being the raison d'etre of two-year colleges, much of the attention in two-year college research would seemingly be directed towards the faculty. Unfortunately, whereas little is known about effective instructional methodologies, even less is known about what makes a good teacher. Until educational research begins to uncover some of the attributes that make an individual an effective instructor, data on faculty will continue to be primarily descriptive. Therefore, it is not surprising that the literature on mathematics instructors in two-year colleges tends to focus on degree attainment and the related matter of faculty training programs.

THE LITERATURE

The issue of whether the traditional doctorate degree is suitable training for a community college teaching job is debatable. Among others, Colvin (1971), Laible (1970), and Tolle (1970) advocate a specialized master's degree which includes a supervised teaching internship at the community college level. Others feel that a Doctor of Arts program, again with an internship, may be a better solution.

While educators will undoubtedly continue to debate faculty training, the fact is that the number of math instructors with doctorates is steadily growing. In the NSF study (1969) 13 percent of the math instructors had a B.A., 82 percent had an M.A., and 3 percent had a Ph.D. McKelvey et al. (1979) found that the number with only a B.A. had decreased to 6 percent and that doctorates among full-time two-year college mathematics teachers had grown at more than one percent per year from four and one-half percent in 1970 to 14 percent in their study. Doctorates included both those with the Ph.D. and the Ed.D. degree; interestingly many of the doctorates in their study are long-time faculty members who have been steadily upgrading their education.

Faculty attitudes have not been given much attention. However, the study by McKelvey et al. begins to look at this critical area. With one important exception, faculty with the doctorate feel more secure about teaching the two-year college curriculum than faculty who have a master's or the sizeable group (58%) who have a master's plus at least one year of additional course work. The important exception is that they were not more secure when it came to teaching remedial courses such as arithmetic. Faculty with a master's plus one year are the most secure about teaching these courses. Teaching unmotivated students is the outstanding problem for these instructors. Interrelated with the aforementioned is the second biggest problem--having to cover much more material than students can absorb.

METHOD

The Center's Instructor Survey received 1,275 responses from science instructors. Of these, 393 mathematics and computer science instructors responded to questions on faculty demographics and working conditions. The development and distribution of the Instructor Survey are described in the preceding section on Instructional Practices.

RESULTS

Degree Attainment

Eight percent of the math instructors have an earned doctorate and the same number hold the bachelor's. Since the 1969 NSF study, the number of math instructors whose highest degree is the bachelor's has declined by five percent and there has been a corresponding increase in the number with the doctorate. Aside from the engineering faculty, this is the lowest percentage of doctorates among any of the faculty surveyed. These figures differ from those reported by McKelvey et al. (1979) who found 14 percent of the math instructors with the doctorate and six percent with the bachelor's. However, while our sample included both full- and part-time instructors, all of the McKelvey et al. respondents were full-time faculty. Since past research has shown that there are more doctorates among the full-time faculty (Cohen & Brawer, 1977), this would help to explain the discrepancy in the findings of the two studies.

Teaching Experience

Over half the math faculty respondents had been teaching at the community college level between three and ten years, and one-fourth had taught over ten years. There are, however, differences in the experiential level of instructors of regular classes and those of remedial classes. The latter group is less experienced than their counterparts who teach regular courses and the total science sample (see Table 10). Again this difference is in part related to the higher percentage of part-timers teaching remedial courses since past studies have found that part-timers have less teaching experience (Cohen & Brawer, 1977; Lombardi, 1975).

Table 10

Percentage of Teachers at Each Level of Degree Attainment, Employment Status, and Teaching Experience

	Remedial Math (n=128)	Regular Math (n=265)	Total Science (n=1275)
Degree Attainment			
bachelor's	4.7	9.8	8.3
Master's	89.1	78.5	74.3
Doctorate	5.5	9.1	14.5
Employment Status			
Full-time	72.7	77.4	78.7
Part-time	16.0	25.8	18.5
Chairperson/Administrator	3.1	4.9	8.4
Teaching Experience			
0-2 years	19.6	10.9	12.7
3-10 years	59.3	56.6	55.6
Over 10 years	21.1	31.7	31.7

Support Services

It would seem that the availability and faculty use of support services influence instructional practices. Certainly remedial math instructors both have access to and make use of tutors and paraprofessionals to a much greater extent than either instructors of regular math courses or science instructors in general (see Table 11). The limited use of test scoring facilities is probably related to the findings on testing indicating that most instructors use tests that require students to show their work and only a few rely on multiple response exams. Although library assistance was available to nearly half of all the math faculty, very few actually take advantage of this fact. The use of media production assistance was also low. Further investigation would be necessary to determine if the available library and media production assistance were appropriate for faculty needs; however, the discrepancy between the availability and the utilization of these services indicates that they may not be entirely suitable.

Working Conditions

The faculty were also asked what they felt they needed to make their course even more effective. Table 12 lists the responses to this question for all the math respondents, instructors of remedial math, instructors of regular math, and the total sample. The most frequently expressed need of all the science faculty was that students should be better prepared to handle the course material. Math instructors share this concern. There is, however, a considerable difference in the way the instructors of the two types of math courses perceive this issue, with 59.2 percent of those teaching regular classes stating that it is their primary need compared to 45.3 percent of those teaching remedial courses. Again there is a disagreement among math instructors on the need for stricter prerequisites. Quite understandably instructors teaching regular classes rank it higher than do their colleagues teaching remedial courses; the former indicated that it was their second greatest concern while the latter ranked it after the need for smaller classes.

Table 11

Availability and Use of Support Services

Type of Service	Assistance Available			Assistance Utilized		
	Remedial Math (n=128)	Regular Math (n=265)	Total Science (n=1275)	Remedial Math (n=128)	Regular Math (n=265)	Total Science (n=1275)
Clerical Help	78.1	76.2	81.9	63.3	60.8	69.1
Test-Scoring Facility	55.5	40.8	53.3	22.7	12.8	25.1
Tutors	72.7	57.7	50.7	60.2	47.2	35.9
Readers	9.4	6.8	10.7	6.3	4.5	5.4
Paraprofessionals	32.0	16.2	18.4	27.3	11.7	13.6
Media Prod.	57.8	52.8	56.1	22.7	20.4	37.9
Library/Bibl. Assistance	46.9	47.2	64.4	8.6	12.8	34.4
Laboratory Assistance	10.9	10.9	24.5	6.3	8.3	19.9

Table 12

Factors Desired by Faculty to Increase Course Effectiveness

	Total Math (n=393)	Remedial Math (n=128)	Regular Math (n=295)	Total Sample (n=1275)
Students better prepared to handle course material	54.7	45.3	59.2	53.0
Stricter prerequisites	36.9	29.7	40.4	30.5
Smaller classes	29.8	35.2	27.2	28.9
Instructor release time to develop course and material	26.5	25.0	27.2	38.0
Availability of more media or instructional material	22.1	17.2	24.5	35.9
More interaction with colleagues or administrators	16.8	18.0	16.2	18.0
More clerical assistance	13.0	12.5	13.2	17.2
Professional development opportunities	12.7	11.7	13.2	24.5
More readers/paraprofessionals	12.5	19.5	9.1	13.3
Better lab facilities	11.2	14.1	9.8	21.2

Less than 10 percent selected the following:
- More freedom to choose materials
- Less interference from colleagues/administrators
- Larger classes
- Changed course description
- Different goals and objectives

Math instructors differed from their colleagues in the other disciplines on certain items within this question. For example, they did not feel as strong a need for more release time or for more professional development as did the other scientists. As a group the math faculty, but particularly those teaching remedial math, were not as concerned over the availability of instructional materials as were instructors in other disciplines.

PART IV

CONCLUSION

This section will include a summary of the most important findings concerning mathematics from the Center for the Study of Community Colleges study of science curriculum and instruction. Several recommendations will also be made that bear on the implications of the data.

SUMMARY

The Center for the Study of Community Colleges undertook its study of science education in the two-year colleges to document the current curricular structure and instructional practices in the various fields of study. Data were obtained through a curriculum study that analyzed courses offered in the 1977-1978 academic year and included a classification scheme and data on frequency of course offerings, course prerequisites, and instructional modes. In addition, an Instructor Survey was conducted to determine the types of instructional methodology and materials utilized by two-year college math instructors.

Mathematics constitutes a significant portion of the two-year college science curriculum. Offerings in mathematics accounted for 33 percent of all the science courses considered in the study. Virtually every two-year college offers at least one course in mathematics regardless of college emphasis. The most frequently offered courses are introductory and intermediate math and mathematics for majors, while statistics and probability are the least frequent.

The Math Curriculum

An important question emerges in considering the state of mathematics curriculum in the two-year college. Does the curriculum respond to the unique characteristics of the community college? At the outset of this monograph the distinctive features of the two-year college were identified as the diversity of college missions, the heterogeneity of the student population, and the nontraditional student course-taking patterns.

Some of the findings indicate that the mathematics curriculum has taken steps to keep pace with the community college's movement away from its predominate role as a transfer institution providing an academic program directed at traditional college students. One-third of the instructors surveyed indicated that their course was remedial in nature or had a remedial component. This is an enormous change from the 1966-1967 NSF survey (1969) in which only one percent of the courses were designated as remedial. Over a quarter replied that their course was designed for an occupational student in a science technology, and 15 percent of all the math courses offered during 1977-78 were intended for students in engineering and science-related technologies. These data demonstrate the impact that the two-year college's open-door policy and the emphasis on occupational programs has had on the math curriculum.

However, the major thrust remains on the degree-oriented student and the transfer curriculum. Over half of the instructors (55%) maintain that their course parallels a lower division course at a transfer institution. Our curriculum findings revealed that the introductory and intermediate math course is available in virtually all colleges, and that the algebra through calculus sequence continues to be important.

There has been a steady increase in the number of colleges offering courses that are outside the traditional sequence but still meet AA degree requirements. In 1966, 43 percent of the institutions listed nontechnical/general education math courses in their catalogs (Thornton, 1966). Although two studies in the early 1970s report different figures, the number of schools with such offerings had clearly grown. Mitchell (1974) reported 66 percent of his sample of 200 colleges had such courses while Thornton (1972) found that 88 percent of his sample of 40 institutions so indicated. Our study revealed that 97 percent of the colleges listed such a course in the catalog and 95 percent actually scheduled one. The large number of courses offered under the heading Mathematics for Majors attests to the need for and the expansion of these courses.

In addition, a number of these courses, as well as courses in statistics and probability, are targeted for students in social sciences and business. A change along these lines was recommended by the CUPM (1971b, 1971c). However, despite the need noted in the literature for courses specifically designed for prospective teachers, the curriculum has not expanded in this direction.

Proponents of the minicourse praise its utility in meeting the curriculum needs of a highly diversified student population (Carter, 1970; Friesen, 1974; Lawrisuk, 1971). However, our analysis of college catalogs and schedules revealed almost no evidence of this approach. It is true that minicourses may be subsumed under a single course title and thus the specialized topics remain unidentified. But more likely this curricular movement of the early 1970s has faded, and colleges have replaced this flexible and individualized approach with the more standard semester or quarter course designed for students in a number of majors.

There were no major regional differences in curriculum. Rather size, particularly in conjunction with the variables of control and emphasis, seems to be a greater factor in influencing curriculum. Medium and especially large public comprehensive institutions have the most diversified curriculum; thus they are better able to meet the needs of a varied student clientele. Our data suggest that small private liberal arts institutions do not have the breadth of offerings to respond to a heterogeneous student body. However, such colleges may attract a more homogeneous student population and, accordingly, may not need to offer as wide a range of courses.

The fact that the math curriculum is highly structured with many courses requiring a prerequisite again reflects its traditional transfer orientation. Colleges do have some latitude in sequencing the curriculum to fit their individual programs and students, but the basic curricular structures have not been adjusted to accommodate a changed student population. A major barrier to nontraditional community college students may be found in the number of course sequences within the curriculum. This was particularly evident in the area of applied math - technology related courses where over half with a prerequisite required a previous course in the series. Such structure does not seem to accommodate the unorthodox course-taking patterns of many of today's community college students, which consist of "dropping in" and "stopping out."

What was surprising in regards to prerequisites was the minimal use of placement exams, particularly for the basic skills or remedial courses, which were included in our classification system under Introductory/Intermediate and Applied Math. Since placement exams are not widely used, an important issue is: how can the two-year college accurately assess the math background and skill level of its entering students? Math educators are recognizing that the high school diploma is no longer a valid assurance that a student is ready for a college-level math course. Similarly the increased number of "nontraditional students" who either graduated or left high school years before and whose math skills are either deficient and/or rusty make a math literacy evaluation a pressing need. A more stringent method of placing students might also reduce the high attrition that is common within math classes. Since more than a fourth of the students (28%) fail to complete courses, the curriculum does not appear to be meeting their needs.

Instructional Practices

The catalog descriptions of math courses do not suggest that math faculty utilize a variety of instructional modes. Except for the large number of computer science courses using a lecture-lab approach, most math courses are conducted on a lecture basis. However, the responses on the Instructor Survey revealed that different instructional approaches are being used--particularly in remedial courses. Nearly half (45%) of the instructors of these classes reported using an activity designed to individualize instruction, and nearly one-fourth of the class time was spent on these activities. Both of these figures are much higher than those reported for any of the other science disciplines surveyed. This finding certainly indicates an attempt by these instructors to address the different learning styles and needs of the students in remedial classes. On the other hand, regular math classes are taught much like classes in the other science disciplines with the primary means of instruction being the lecture.

Textbooks are the most widely used instructional material, but there is considerable dissatisfaction with them. This dissatisfaction may result from a combination of factors. First, there is the nationwide decline in student reading scores; the impact of this is very strong at the two-year college level and may in effect make many of the college texts unsuitable. Second, the available texts may presuppose a math background that is no longer valid, given today's heterogeneous student clientele. Third, the texts may not be appropriate for many of the new math courses which are targeted for students in specific majors.

What is important is that despite their dissatisfaction, few instructors use other instructional materials. The only important supplement to the text are syllabi and handouts. In addition, most math instructors eschew using instructional media in their classes. It is true that various forms of instructional media are housed and used in math labs or math learning centers, and our sampling did not include math labs that were not associated with specific credit courses. However, the absence of instructional media in the classroom may indicate a lack of awareness of varied instructional methodologies or an unwillingness to employ them in order to more effectively reach a diversified group of students.

Community college math instructors are also very traditional in their emphasis on skill mastery in their course goals and in the activities included in grading. There was some experimentation with the standard letter grade system among instructors of remedial classes. In order to avoid actually failing students, these instructors have instituted options that allow students to complete or retake the course without a penalty.

The completion rate for math courses is the lowest for all the disciplines surveyed. In fact, remedial courses have a lower completion rate than do regular courses, which throws into question the usefulness of some of the individualized approaches with the less apt student. Although the various individualized programs have generated great enthusiasm among their adherents, there is debate about whether such programs are more successful than traditional methods and about the meaning of successful (Schoen, 1976; Stein, 1973; Willcox, 1977). Our data would seem to indicate that the learning needs of at least some of the students in the community college are not being met by current instructional practices--be they the traditional lecture method or the more individualized approaches.

Faculty

Math instructors were asked about the conditions that would improve their courses. The two items considered most important are critical in assessing how these instructors perceive the mission of the community college and the needs of a diverse student clientele. Over half of the math instructors wanted "students better prepared to handle course," and over a third wanted "stricter prerequisites." Not surprisingly, more instructors of regular classes checked these items than did instructors of remedial courses (see Table 12). What these findings indicate is that faculty expectations have not fully adjusted to an "open door philosophy" and a predominately non-transfer-oriented group of students.

Most math instructors do not feel a need for more release time to develop courses and/or material, and even fewer wanted professional development opportunities. These responses are quite different from those of instructors in the other science disciplines. Also curious was the finding that while many of these instructors have little involvement in the selection of the textbooks for their courses, only nine percent felt their course would be improved if they had more freedom in choosing materials. The above findings may be related to the high percentage of part-time math instructors. Previous research has shown that part-time faculty have less participation in and are less concerned with issues of curriculum and instruction (Cohen & Brawer, 1977; Guichard, Mangham, & Gallery, 1975).

A profile of two-year college mathematics emerges from the Center's study. The curriculum has responded to student diversity and the multiple missions of the community college by moving from almost a complete emphasis on the traditional algebra-calculus transfer sequence to a curriculum that has a large number of remedial courses and courses related to different majors and occupational programs. However, the number of courses that require a prerequisite or are part of a sequence are not compatible with many of today's community college students or their course-taking patterns. Except for remedial courses where various forms of individualized instruction are used, instructional practices in most courses follow traditional patterns. Lectures are used to communicate information; textbooks are the primary instructional material; and the emphasis is on skill mastery as demonstrated through tests. There is a noticeable lack of alternative materials or instructional media, and a reluctance on the part of instructors to develop these. Two-year college math educators need to take steps to combat the high attrition rate in their classes. The combination of the community college setting, the changing curricular needs of students, and the necessity of devising instructional methods for students with non-traditional backgrounds and learning styles will make this a formidable task.

RECOMMENDATIONS

In light of the findings of the Center's study the following recommendations are put forth for college administrators, curriculum planners, counselors, and policy makers to support the faculty course developer in addressing two-year college students' needs for mathematical education.

- Placement exams should be instituted in all colleges so as to accurately assess the mathematical skills and background of entering students.

- Improved counseling is needed to guide students to math courses that are better suited to their abilities and their educational needs. This in combination with placement exams may reduce the high rate of attrition.
- Further research is needed on instructional materials suitable to different learning approaches and to students who are academically deficient.
- Textbook publishers need to produce materials more consistent with the community college student's competencies and educational objectives.
- The minicourse concept or instructional module directed towards different student groups should be re-examined and perhaps utilized on a wider scale.
- Noncredit courses can serve as a means of presenting topics in mathematics that would be of interest to groups within the community. Although some of the remedial/developmental courses are offered on noncredit basis, they were not considered in our study. However, in light of the enormous growth in this area in the community college, math educators should consider a greater use of noncredit programs.
- The need for structure and linearity within the curriculum is not open to question. However, the use of prerequisites and courses in a sequence needs to be explored in light of the students for whom they are intended and their course-taking patterns.
- Remedial math courses are growing in number, and student success in them is critical to their success in other areas of the math curriculum. Therefore, rather than simply assigning these courses to part-timers because that is where instructors are needed, these courses need to be taught by instructors who understand and accept the academically deficient student and who have the experience and interest to work with him.
- The factors that contribute to faculty meeting the needs and objectives of two-year college students include a combination of relevant preservice, pedagogical training, professional development

opportunities, and faculty initiative, The college administration can encourage the latter two through offering faculty fellowships, instructional development grants, release time, and professional leaves.

- Greater efforts should be made to involve part-time instructors in issues related to curriculum and instruction. Toward that end administrators need to institute policies that will allow part-timers to participate in the incentive programs mentioned above.

Recommendations, such as those listed here, are often ignored because of fiscal constraints. Yet the centrality of mathematics in the two-year college science curriculum demands creative attempts to improve its offerings.

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APPENDIX A

Region 1 NORTHEAST

Connecticut

Greater Hartford
Mitchell
Quinebaug

Massachusetts

Bay Path
Bunker Hill
Mt. Wachusett

Maine

University of Maine/
Augusta

New Hampshire

New Hampshire Tech.
White Pines

New York

Cayuga County
Genesee
Hudson Valley
North Country

Vermont

Champlain
Vermont Col. of
Norwich U.

Region 2 MIDDLE STATES

Delaware

Delaware Tech. & C.C./
Terry Campus
Goldey Beacom

Maryland

Dundalk
Hagerstown
Harford
Howard
Villa Julie

New Jersey

Atlantic
Middlesex County

Pennsylvania

Allegheny County/Boyce Campus
Delaware County
Harcum
Keystone
Northampton County
Northeastern Christian

West Virginia

West Virginia Northern
Potomac State

Region 3 SOUTH

Alabama

James Faulkner State
John C. Calhoun State
Lurleen B. Wallace State
Northwest Alabama State

Arkansas

Central Baptist
Mississippi County
Westark

Florida

Brevard
Edison
Florida
Palm Beach
Seminole
Valencia

Georgia

Atlanta
Bainbridge
Clayton
Floyd
Georgia Military
Middle Georgia
South Georgia

Kentucky

Southeast

Mississippi

Itawamba
Mary Holmes
Mississippi Gulf Coast/
 Jefferson Davis Campus
Pearl River
Southwest Mississippi
Wood

North Carolina

Chowan College
Coastal Carolina
Edgecombe Tech.
Halifax City Tech.
Lenoir
Richmond Tech.
Roanoke-Chowan Tech.
Wake Tech.

South Carolina

Greenville Tech.
Univ. of South Carolina/
 Lancaster

Tennessee

Jackson State
Martin
Morristown
Shelby State

Texas

Angelina
Lamar University/Orange Branch
San Antonio
Vernon Regional
Weatherford

Virginia

Central Virginia
Northern Va./Alexandria
New River
Southern Seminary
Tidewater
Thomas Nelson
Wytheville

Region 4 MIDWEST

Illinois

Central YMCA
Danville
Highland
Kishwaukee
Lincoln Land
Oakton
Waubonsee
William Rainey Harper

Iowa

Clinton
Hawkeye Institute of Technology
Indian Hills
Iowa Lakes
Marshalltown
Southeastern

Michigan

Bay de Noc
Delta
Kalamazoo Valley
Kirtland
Monroe County
Oakland
Suomi

Minnesota

Austin
North Hennepin
Northland
University of Minnesota Tech.
Willmar

Missouri

St. Paul's
Three Rivers

Nebraska

Metropolitan Tech.
Platte Tech.

Ohio

Edison State
Lorain County
Northwest Tech.
Shawnee State
Sinclair
University of Toledo
 Comm. & Tech.

Wisconsin

District One Tech.
Lakeshore Tech.
Milwaukee Area Tech.
University Center System/Sheboygan
Western Wisconsin Tech.

Region 5 MOUNTAIN PLAIN

Colorado

Arapahoe
Community College of Denver
 Auraria Campus
Morgan
Northeastern

Kansas

Barton County
Central
Coffeyville
Hesston
St. John's

Montana

Miles

North Dakota

North Dakota St. Sch. of Science

Oklahoma

Connors State
Hillsdale Free Will Baptist
Northern Oklahoma
South Oklahoma City
St. Gregory's

South Dakota

Presentation

Utah

College of Eastern Utah
Utah Tech.

Wyoming

Central Wyoming

Region 6 WEST

Alaska

Ketchikan

Arizona

Cochise
Pima

California

American River
Butte
Citrus
College of San Mateo
College of the Desert
College of the Sequoias
Fresno City College
Hartnell
Lassen
Los Angeles Pierce
Mendocino
Merced
Mt. San Jacinto
Saddleback
San Bernardino Valley
San Diego Mesa
Santa Rosa

Nevada

Clark County

Oregon

Chemeketa
Mt. Hood
Umpqua

Washington

Green River
Lower Columbia
Peninsula
South Seattle

Center for the Study of Community Colleges

INSTRUCTOR SURVEY

Your college is participating in a nationwide study conducted by the Center for the Study of Community Colleges under a grant from the National Science Foundation. The study is concerned with the role of the sciences and technologies in two-year colleges — curriculum, instructional practices and course activities.

The survey asks questions about one of your classes offered last fall. The information gathered will help inform groups making policy affecting the sciences. All information gathered is treated as confidential and at no time will your answers be singled out. Our concern is with aggregate instructional practices as discerned in a national sample.

We recognize that the survey is time-consuming and we appreciate your efforts in completing it. Thank you very much.

1a. Your college's class schedule indicated that in Fall, 1977 you were teaching:

____________________ 11-13 ____________________
(Course) (Section)

If this class was assigned to a different instructor, please return this survey to your campus facilitator to give to the person who taught this class.

If the class was not taught, please give us the reason why, and then return the uncompleted survey form in the accompanying envelope.

b. Class was not taught because: (explain briefly) ____________________

____

____

Please answer the questions in relation to the specified class.

2. Approximately how many students were initially enrolled in this class?

Males ________ 14-16

Females ________ 17-19

3. Approximately how many students completed this course and received grades? (Do not include withdrawals or incompletes.)

Males ________ 20-22

Females ________ 23-25

4. **Check <u>each</u> of the items below that you believe properly describes this course:**

a. Parallel or equivalent to a lower division college level course at transfer institutions . . . . ☐ 1 26

b. Designed for transfer students majoring in one of the natural resources fields (e.g., agriculture, forestry) or an allied health field (e.g., nursing, dental hygiene, etc.) . . . . ☐ 2

c. Designed for transfer students majoring in one of the physical or biological sciences, engineering, mathematics, or the health sciences (e.g., pre-medicine, pre-dentistry) . . . . ☐ 3

d. Designed for transfer students majoring in a non-science area . . . ☐ 4

e. Designed for occupational students in an allied health area . . . . ☐ 5

f. Designed for occupational students in a science technology or engineering technology area . . . . ☐ 6

g. Designed as a high school make up or remedial course . . . . . . ☐ 7

h. Designed as a general education course for non-transfer and non-occupational students . . . . ☐ 8

i. Designed for further education or personal upgrading of adult students . . . . ☐ 9

j. Other *(please specify)*: ______________________________ ☐ 0

5a. **Instructors may desire many qualities for their students. Please select the <u>one</u> quality in the following list of four that you most wanted your students to achieve in the specified course.**

1) Understand/appreciate interrelationships of science and technology with society . . . . ☐ 1 27

2) Be able to understand scientific research literature . . . . ☐ 2

3) Apply principles learned in course to solve qualitative and/or quantitative problems . . . . ☐ 3

4) Develop proficiency in laboratory methods and techniques of the discipline . . . . ☐ 4

b. **Of the four qualities listed below, which <u>one</u> did you most want your students to achieve?**

1) Relate knowledge acquired in class to real world systems and problems . . . . ☐ 1 28

2) Understand the principles, concepts, and terminology of the discipline . ☐ 2

3) Develop appreciation/understanding of scientific method . . . . . ☐ 3

4) Gain "hands-on" or field experience in applied practice . . . . . . ☐ 4

c. **And from this list, which <u>one</u> did you most want your students to achieve in the specified class.**

1) Learn to use tools of research in the sciences . . . . ☐ 1 29

2) Gain qualities of mind useful in further education . . . . ☐ 2

3) Understand self . . . . ☐ 3

4) Develop the ability to think critically . . . . ☐ 4

6a. **Were there prerequisite requirements for this course?** Yes ☐ 1 No ☐ 2 30

b. **IF YES: Which of the following were required? (CHECK AS MANY AS APPLY)**

1) Prior course in the same discipline taken in high school ☐ 1 . . college ☐ 7 31

2) Prior course in any science taken in high school ☐ 2 . . college ☐ 8

3) Prior course in mathematics taken in high school ☐ 3 . . college ☐ 9

4) Declared science or technology major . . . . . ☐ 4

5) Achieved a specified score on entrance examination . ☐ 5

6) Other *(please specify)*: ______________________ ☐ 6

7. **Over the entire term, what percentage of class time is devoted to each of the following:**

a. Your own lectures	______%	32/33
b. Guest lecturers	______%	34/35
c. Student verbal presentations	______%	36/37
d. Class discussion	______%	38/39
e. Viewing and/or listening to film or taped media	______%	40/41
f. Simulation/gaming	______%	42/43
g. Quizzes/examinations	______%	44/45
h. Field trips	______%	46/47
i. Lecture/demonstration experiments	______%	48/49
j. Laboratory experiments by students	______%	50/51
k. Laboratory practical examinations and quizzes	______%	52/53
l. Other *(please specify)*: ______	______%	54/55

Please add percentages to make sure they agree with total

TOTAL: 100 %

8. **How frequently were each of the following instructional media used in this class?**

Also check last box if you or any member of your faculty developed any of the designated media for this course.

	Frequently used	Occasionally used	Never used	Developed by self or other faculty member	
a. Films	☐ 1	☐ 2	☐ 3	☐ 4	56
b. Single concept film loops	☐ 1	☐ 2	☐ 3	☐ 4	57
c. Filmstrips	☐ 1	☐ 2	☐ 3	☐ 4	58
d. Slides	☐ 1	☐ 2	☐ 3	☐ 4	59
e. Audiotape/slide/film combinations	☐ 1	☐ 2	☐ 3	☐ 4	60
f. Overhead projected transparencies	☐ 1	☐ 2	☐ 3	☐ 4	61
g. Audiotapes, cassettes, records	☐ 1	☐ 2	☐ 3	☐ 4	62
h. Videotapes	☐ 1	☐ 2	☐ 3	☐ 4	63
i. Television (broadcast/closed circuit)	☐ 1	☐ 2	☐ 3	☐ 4	64
j. Maps, charts, illustrations, displays	☐ 1	☐ 2	☐ 3	☐ 4	65
k. Three dimensional models	☐ 1	☐ 2	☐ 3	☐ 4	66
l. Scientific instruments	☐ 1	☐ 2	☐ 3	☐ 4	67
m. Natural preserved or living specimens	☐ 1	☐ 2	☐ 3	☐ 4	68
n. Lecture or demonstration experiments involving chemical reagents or physical apparatus	☐ 1	☐ 2	☐ 3	☐ 4	69
o. Other *(please specify)*: ______	☐ 1	☐ 2	☐ 3	☐ 4	70

9. **Which of the following materials were used in this class? CHECK EACH TYPE USED. THEN, FOR EACH TYPE USED, PLEASE ANSWER ITEMS A-D.**

	A.	B.			C.		D.			
		How satisfied were you with these materials?			Did you prepare these materials?		How much say did you have in the selection of these materials?			
Check Materials Used	How many pages in total were students required to read?	Well-satisfied	Would like to change them	Definitely intend changing them	Yes	No	Total say	Selected them but had to verify with a chairperson or administrator	Was member of a group that selected them	Someone else selected them
☐ 1 Textbooks	____ 13-15	16 ☐ 1	☐ 2	☐ 3	17 ☐ 1	☐ 2	18 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 2 Laboratory materials and work-books	____ 19-21	22 ☐ 1	☐ 2	☐ 3	23 ☐ 1	☐ 2	24 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 3 Collections of readings	____ 25-27	28 ☐ 1	☐ 2	☐ 3	29 ☐ 1	☐ 2	30 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 4 Reference books	____ 31-33	34 ☐ 1	☐ 2	☐ 3	35 ☐ 1	☐ 2	36 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 5 Journal and/or magazine articles	____ 37-39	40 ☐ 1	☐ 2	☐ 3	41 ☐ 1	☐ 2	42 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 6 Newspapers	____ 43-45	46 ☐ 1	☐ 2	☐ 3	47 ☐ 1	☐ 2	48 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 7 Syllabi and handout materials	____ 49-51	52 ☐ 1	☐ 2	☐ 3	53 ☐ 1	☐ 2	54 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 8 Problem books	____ 55-57	58 ☐ 1	☐ 2	☐ 3	59 ☐ 1	☐ 2	60 ☐ 1	☐ 2	☐ 3	☐ 4
☐ 9 Other *(please specify)* ____	____ 61-63	64 ☐ 1	☐ 2	☐ 3	65 ☐ 1	☐ 2	66 ☐ 1	☐ 2	☐ 3	☐ 4

10. **Please indicate the emphasis given to each of the following student activities in this class.**

	Not included in determining student's grade	Included but counted less than 25% toward grade	Counted 25% or more toward grade	
a. Papers written outside of class	☐ 1	☐ 2	☐ 3	67
b. Papers written in class	☐ 1	☐ 2	☐ 3	68
c. Quick-score/objective tests/exams	☐ 1	☐ 2	☐ 3	69
d. Essay tests/exams	☐ 1	☐ 2	☐ 3	70
e. Field reports	☐ 1	☐ 2	☐ 3	71
f. Oral recitations	☐ 1	☐ 2	☐ 3	72
g. Workbook completion	☐ 1	☐ 2	☐ 3	73
h. Regular class attendance	☐ 1	☐ 2	☐ 3	74
i. Participation in class discussions	☐ 1	☐ 2	☐ 3	75
j. Individual discussions with instructor	☐ 1	☐ 2	☐ 3	76
k. Research reports	☐ 1	☐ 2	☐ 3	77
l. Non-written projects	☐ 1	☐ 2	☐ 3	78
m. Homework	☐ 1	☐ 2	☐ 3	79
n. Laboratory reports	☐ 1	☐ 2	☐ 3	80
o. Laboratory unknowns and/or practical exams (quantitative and qualitative)	☐ 1	☐ 2	☐ 3	12
p. Problem sets	☐ 1	☐ 2	☐ 3	13
q. Other *(please specify)*: ________	☐ 1	☐ 2	☐ 3	14

11. **Examinations or quizzes given to students may ask them to demonstrate various abilities. Please indicate the importance of each of these abilities in the tests you gave in this course. (CHECK ONE BOX FOR EACH ITEM)**

	Very important	Somewhat important	Not important	
a. Mastery of a skill	☐ 1	☐ 2	☐ 3	15
b. Acquaintance with concepts of the discipline	☐ 1	☐ 2	☐ 3	16
c. Recall of specific information	☐ 1	☐ 2	☐ 3	17
d. Understanding the significance of certain works, events, phenomena, and experiments	☐ 1	☐ 2	☐ 3	18
e. Ability to synthesize course content	☐ 1	☐ 2	☐ 3	19
f. Relationship of concepts to student's own values	☐ 1	☐ 2	☐ 3	20
g. Other *(please specify)*: ________	☐ 1	☐ 2	☐ 3	21

12. **What was the relative emphasis given to each type of question in written quizzes and examinations? (PLEASE RESPOND BY CHECKING ONE OF THE THREE BOXES FOR EACH ITEM.)**

	Frequently used	Seldom used	Never used	
a. Multiple response (including multiple choice and true/false)	☐ 1	☐ 2	☐ 3	22
b. Completion	☐ 1	☐ 2	☐ 3	23
c. Essay	☐ 1	☐ 2	☐ 3	24
d. Solution of mathematical type problems where the work must be shown	☐ 1	☐ 2	☐ 3	25
e. Construction of graphs, diagrams, chemical type equations, etc.	☐ 1	☐ 2	☐ 3	26
f. Derivation of a mathematical relationship	☐ 1	☐ 2	☐ 3	27
g. Other *(please specify)*: ________	☐ 1	☐ 2	☐ 3	28

13. What grading practice did you employ in this class? 29

ABCDF	☐ 1	29
ABCD/No credit	☐ 2	
ABC/No credit	☐ 3	
Pass/Fail	☐ 4	
Pass/No credit	☐ 5	
No grades issued	☐ 6	
Other ____________ *(please specify)*	☐ 7	

14. For each of the following out-of-class activities, please indicate if attendance was required, recommended or neither.

	Attendance required for course credit	Attendance recommended but not required	Neither required nor recommended	
a. On-campus educational type films	☐ 1	☐ 2	☐ 3	30
b. Other films	☐ 1	☐ 2	☐ 3	31
c. Field trips to industrial plants, research laboratories	☐ 1	☐ 2	☐ 3	32
d. Television programs	☐ 1	☐ 2	☐ 3	33
e. Museums/exhibits/zoos/arboretums	☐ 1	☐ 2	☐ 3	34
f. Volunteer service on an environmental project	☐ 1	☐ 2	☐ 3	35
g. Outside lectures	☐ 1	☐ 2	☐ 3	36
h. Field trips to natural formation or ecological area	☐ 1	☐ 2	☐ 3	37
i. Volunteer service on education/ community project	☐ 1	☐ 2	☐ 3	38
j. Tutoring	☐ 1	☐ 2	☐ 3	39
k. Other *(please specify)*: ____________	☐ 1	☐ 2	☐ 3	40

15a. Was this class conducted as an interdisciplinary course?

Yes	☐ 1	41
No	☐ 2	

b. IF YES: Which other disciplines were involved? ________________________________
(please specify)

____

____ 42-43-

16. Were instructors from other disciplines involved ...

	YES	NO	
...in course planning?	☐ 1	☐ 2	44
...in team teaching?	☐ 1	☐ 2	45
...in offering guest lectures?	☐ 1	☐ 2	46

17a. Which of these types of assistance were available to you last term? CHECK AS MANY AS APPLY.

b. Which did you utilize? CHECK AS MANY AS APPLY.

	a. Assistance was available to me in the following areas	b. Utilized
a. Clerical help	47- ☐ 1	48- ☐ 1
b. Test-scoring facilities	☐ 2	☐ 2
c. Tutors	☐ 3	☐ 3
d. Readers	☐ 4	☐ 4
e. Paraprofessional aides/instructional assistants	☐ 5	☐ 5
f. Media production facilities/assistance	☐ 6	☐ 6
g. Library/bibliographical assistance	☐ 7	☐ 7
h. Laboratory assistants	☐ 8	☐ 8
i. Other *(please specify)*: ______________	☐ 9	☐ 9

18. Although this course may have been very effective, what would it take to have made it better? CHECK AS MANY AS APPLY.

a. More freedom to choose materials	☐ 1	49
b. More interaction with colleagues or administrators	☐ 2	
c. Less interference from colleagues or administrators	☐ 3	
d. Larger class (more students)	☐ 4	
e. Smaller class	☐ 5	
f. More reader/paraprofessional aides	☐ 6	
g. More clerical assistance	☐ 7	
h. Availability of more media or instructional materials	☐ 8	
i. Stricter prerequisites for admission to class	☐ 9	
j. Fewer or no prerequisites for admission to class	☐ 1	50
k. Changed course description	☐ 2	
l. Instructor release time to develop course and/ or material	☐ 3	
m. Different goals and objectives	☐ 4	
n. Professional development opportunities for instructors	☐ 5	
o. Better laboratory facilities	☐ 6	
p. Students better prepared to handle course requirements	☐ 7	
q. Other *(please specify)*: ______________	☐ 8	

Now, just a few questions about you . . .

19. How many years have you taught in any two-year college?

a. Less than one year . . . . ☐ 1 51
b. 1-2 years . . . . ☐ 2
c. 3-4 years . . . . ☐ 3
d. 5-10 years . . . . ☐ 4
e. 11-20 years . . . . ☐ 5
f. Over 20 years . . . . ☐ 6

20. At this college are you considered to be a:

a. Full-time faculty member . . . . ☐ 1 52
b. Part-time faculty member . . . . ☐ 2
c. Department or division chairperson . . . ☐ 3
d. Administrator . . . . ☐ 4
e. Other *(please specify):*
_________________________ . . . ☐ 5

21a. Are you currently employed in a research or industrial position directly related to the discipline of this course?

Yes ☐ 1 53
No ☐ 2

b. IF YES: For how many years?________________ 54/55

c. If previously you had been employed in a related industry or research organization, please indicate the number of years:________________ 56/57

22. What is the highest degree you presently hold?

a. Bachelor's . . . . ☐ 1 58
b. Master's . . . . ☐ 2
c. Doctorate . . . . ☐ 3

IMPORTANT INSTRUCTIONS

Thank you for taking the time to complete this survey. Please seal the completed questionnaire in the envelope which is addressed to the project facilitator on your campus and return it to that person. After collecting the forms from all participants, the facilitator will forward the sealed envelopes to the Center.

We appreciate your prompt attention and participation in this important survey for the National Science Foundation.

Arthur M. Cohen
Principal Investigator

Florence B. Brawer
Research Director

80