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AUTHOR Sworder, Steve
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ABSTRACT

In 1989, a study was conducted to examine basic mathematics programs in the California community colleges and to produce specific program recommendations for the mathematics curriculum at Saddleback College. The study involved a number of components, including: (1) a review of the literature on developmental education and basic mathematics programs; (2) a survey of all California community colleges to determine the instructional practices used by faculty in basic mathematics or pre-algebra programs; (3) a review of community college catalogs to determine the organizational structure of the basic mathematics programs throughout the state; (4) a comparison of the characteristics of students enrolled in basic mathematics and those enrolled in beginning or intermediate algebra; and (5) a Delphi exercise, involving members of the Saddleback College mathematics faculty, conducted to develop specific recommendations regarding program objectives, organization, and support services for the existing mathematics program. Results of the study led to several conclusions. In light of the diversity of the students enrolled in basic mathematics courses, a variety of instructional styles are warranted, including self-paced instruction, computer-assisted instruction, and faculty and peer tutoring. The focus of the program should be to prepare students for success in algebra. This can best be accomplished by offering two versions of the Arithmetic/Introduction to Algebra course, one focusing on the arithmetic of whole numbers and decimals, the other focusing on the arithmetic of fractions, and both covering traditional arithmetic topics and simple linear equations. In either class, students would have access to a structured self-paced environment and an optional mathematics tutorial laboratory. Delphi exercise results are appended. (JMC)

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Arithmetic in the California Community Colleges

by Steve Sworder

Paper Presented at the AMATYC Fifteenth Annual Convention (15th, Baltimore, MD, October 26-29, 1989). Pages 9-13 have been deleted.

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ARITHMETIC IN THE CALIFORNIA COMMUNITY COLLEGES

Reasons for the Study

OH1

This study of the basic mathematics programs in the California Community Colleges and, more specifically at Saddleback College, was motivated by the changes in the requirements for associate degree applicable courses instituted by the Board of Governors and by my need to find an appropriate researchable topic on which to write an Ed.D. dissertation for the Nova University program in Higher Education.

The Board of Governors mandated, in an attempt to strengthen the associates degree within California, that mathematics courses that could be applied for credit to the associate degree had to be at the beginning algebra level or higher. The lowest level courses that were acceptable were beginning algebra or other courses with the same prerequisite as beginning algebra. At Saddleback College, the arithmetic course had long been available to students for use as a degree applicable course and was taken by many students solely for this purpose. Consequently, it was viewed by many faculty as a terminal consumer mathematics course. Many members of the department felt that there was a need to review the content, objectives, and learning environments

available to the students in this course given that it was now a purely remedial/developmental course rather than an end in itself. It was recognized that the focus of the course would most likely need to be changed to that of preparing students for success in beginning algebra or some other quantitative course at the beginning algebra level.

Procedure

The study involved several distinct components that were integrated to produce specific program recommendations for the mathematics curriculum at Saddleback College. The flow of the research effort is depicted in figure 1.

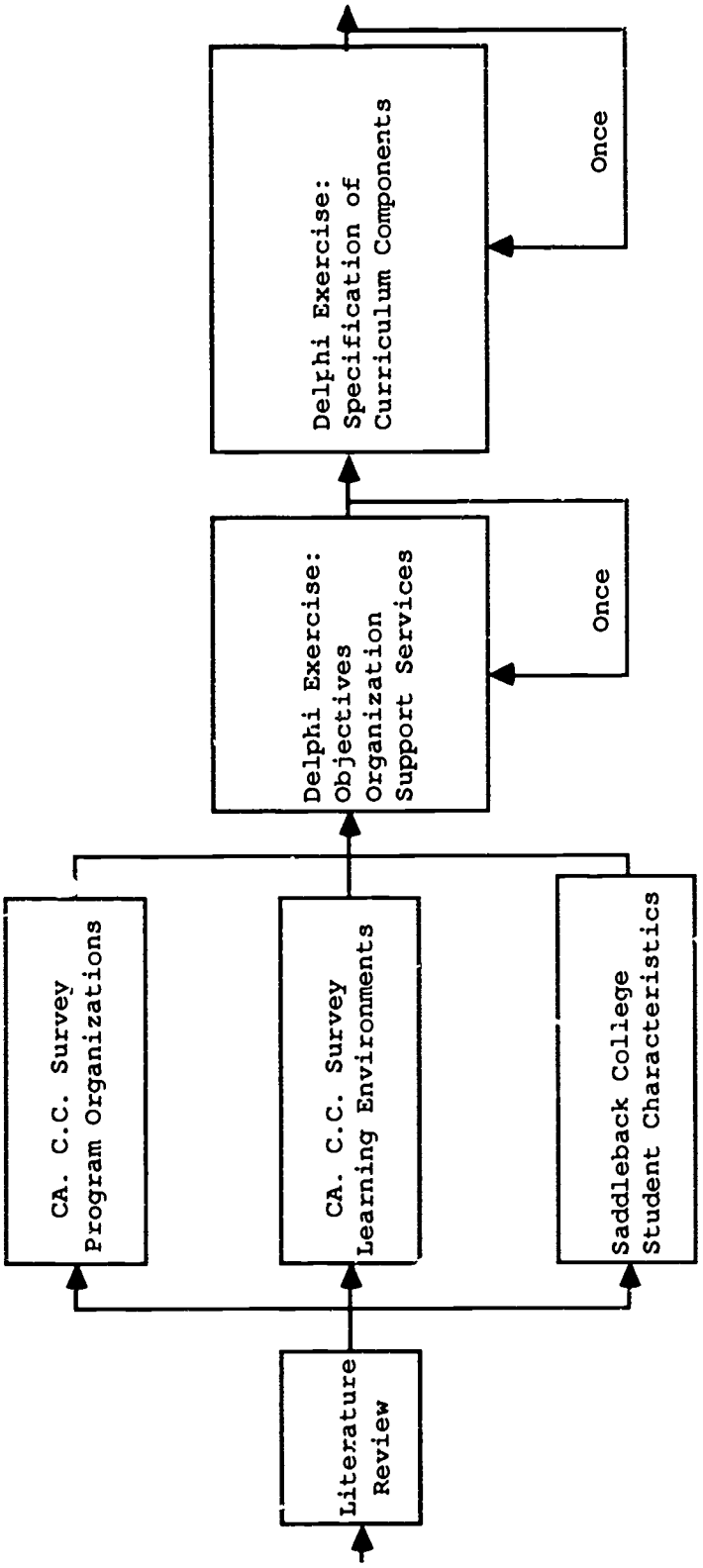

Figure 1
Flow of the Research Effort

Following an extensive review of the literature related to developmental education and basic mathematics programs, a

survey of all of the associate degree granting community colleges in California (N = 105) was conducted to determine the learning environments available to students in the basic mathematic/pre-algebra programs. By reviewing the college catalog for each of these colleges, a detailed view of the organization of the basic mathematics programs throughout the state was constructed. Because the full-time faculty, at Saddleback College, rarely taught the arithmetic course it was felt that the determination of certain demographics would be of value to the faculty members as they designed a program for these students. To this end a comparison of certain characteristics between students enrolled in Basic Mathematics and those enrolled in Beginning or Intermediate Algebra was made. These later courses were chosen as a base because they were often taught by the full-time faculty. A summary of this information was made available to the Saddleback College mathematics faculty. Thirteen of the fourteen full-time faculty members agreed to participate in a four round Delphi Exercise with the objective of defining specific recommendations for changes to the existing basic mathematics program. The Delphi exercise technique was chosen because of the desire of so many members of the department to participate in the activity and impracticality of bringing all of these individuals together for any reasonable length of time to discuss the issues.

Based on the information gathered from the survey components of this study, the first Delphi questionnaire was

constructed. It listed a variety of possible objectives, organizations, and learning environments for the basic mathematics program at Saddleback College. The faculty members were asked to agree or disagree, or rate items as important or unimportant. Further they were allowed to add items to the questionnaire for consideration in the second round. The questionnaires were collected, the mean responses calculated, the items desired for addition incorporated into a second questionnaire. This information was returned to the faculty along with a list of their responses to the first questionnaire. They were asked to reconsider their previous responses and respond to the newly added items. These questionnaires were collected and the mean responses calculated. The items were ranked according the level of importance or agreement. From this list, and knowledge gained from the earlier survey components of the study a questionnaire detailing specific basic mathematics course components including number of courses, course units, course content, available instructional formats, repeatability options etc. was constructed and given to the faculty as Delphi exercise round three. The faculty was asked to agree or disagree with each item. The questionnaires were collected and the responses tallied. These tallies were returned to the faculty along with their own responses. They were asked to reconsider their position. These questionnaires were collected and those items receiving

support form a majority of the faculty were incorporated into the final program recommendations.

Overview of the Review of Literature

OH2

It was clear from the review of the literature that every community college had need for a quality basic mathematics program. For the goal of quality to be achieved, the program had to be flexible. Only in this way did the program respond adequately to the multitude of learning styles students brought with them to the two-year college environment. While some students excelled in individualized self-paced or independent study environments, other students hopelessly floundered with such freedom. Many students needed the structure and group identity provided by a lecture class, but such classes were strengthened by student access to a mathematics learning center or laboratory. These centers often provided tutorial and mediated instructional support services. The key to it all was quality instruction. This was provided, directed, or supported by quality teachers and learning assistance supervisors.

The literature was mixed concerning the administrative organization of the developmental mathematics program. The mathematics literature supported placement under the jurisdiction of the mathematics department. The developmental education authors sought its containment within a separate developmental skills organization. Less

controversy surrounded the content of the program itself. This reaction might have resulted partially from the fact that the literature contained few references in this area. The only significant issues discussed related to the number of courses in the program, the division of subject material between the available courses, and the appropriate number of class contact hours.

Survey Components

OH3

The Community College System

Public higher education in California is divided in to three distinct systems. These components are the University of California (eight general campuses), the California State Universities (nineteen campuses), the California community colleges (the largest such system in the nation with 107 colleges, 70 districts, and enrollment of over 1, 150, 000). The community colleges are governed by locally elected boards of trustees. Although under the jurisdiction of the state Board of Governors, each college district retains a great deal of autonomy from the others and the system as a whole. In figure 2 is displayed the distribution of the community colleges over the state.

Figure 2

Distribution of California Community Colleges

Summary of Program Organizations as Revealed in the Survey of College Catalogs

The review of the basic mathematics programs of the 105 degree granting California community colleges revealed that 102 colleges offered an arithmetic course or courses in the mathematics department. The basic mathematics courses were offered by two colleges in a separate skill development or developmental education department that also housed the remedial reading and writing programs. The third college with a basic mathematics program not part of the mathematics department offered the arithmetic courses through the independent applied computational skills department.

CH6 The courses in the basic mathematics program fell into three basic categories, as shown in figure 5.

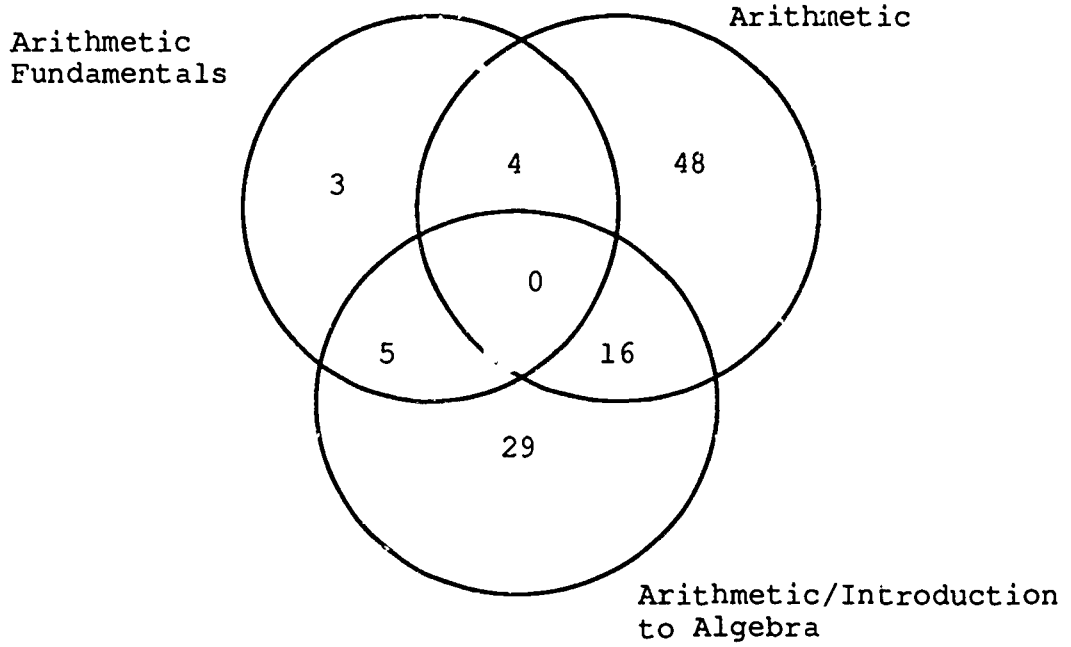

Figure 5

Distribution of the Basic Mathematics Courses Among the California Community Colleges

These categories are: (1) Arithmetic Fundamentals: addition, subtraction, multiplication, and division using whole numbers, fractions, and (usually) decimals; (2) Arithmetic: included the contents of the arithmetic fundamentals course noted above along with the topics of percent, applications, measurement, and (often) applied geometry; (3) Arithmetic/Introduction to Algebra: included the contents of the arithmetic course noted above, along with an introduction to algebra including the solution techniques for simple linear equations. These courses in the basic mathematics program were not always represented in the curriculum by single distinct classes. Occasionally a sequence of courses or course modules were used to complete the material in the categories noted above. These course or module sequences were often organized around the philosophy of mastery learning.

OH7

The arithmetic fundamentals course was offered at twelve colleges. Modular versions of this course were found in four of these colleges. The scheduling format for these courses was placed in Table 1 and Table 2.

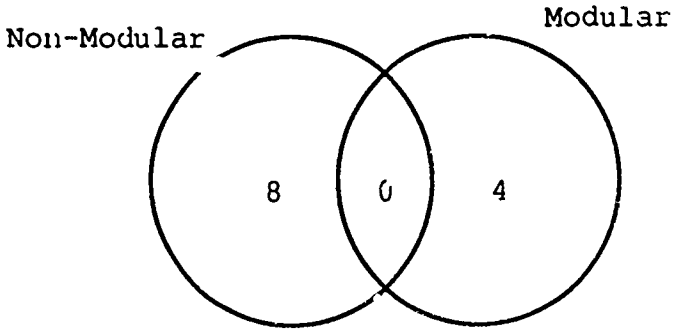

Figure 6

Distribution of Arithmetic Fundamentals Course According to Modularization

Table 1

Arithmetic Fundamentals Scheduling Format for
Non-Modular Courses

Number of Colleges	Lecture Hours	Lect/Lab Hours	Lab Hours	Units
5	3	0	0	3
1	3	0	0	2
1	0	3	0	3
1	1	0	3	2

Table 2

Arithmetic Fundamentals Scheduling Format for
Modular Courses

Number of Colleges	Lecture Hours	Lect/Lab Hours	Lab Hours	Maximum Units
1	3 per 3 units	0	0	6
1	3	0	0	3
1	0	0	2 per 1 unit	4
1	0	2 per 1 unit	0	6

OH8

The arithmetic course was offered at sixty-eight colleges. Non-modular versions of this class were present at fifty-one colleges, twenty-three colleges had modular versions, and six colleges offered both. At nineteen colleges the class was available in more than one scheduling format. The scheduling format for these courses was placed in Table 3 and Table 4.

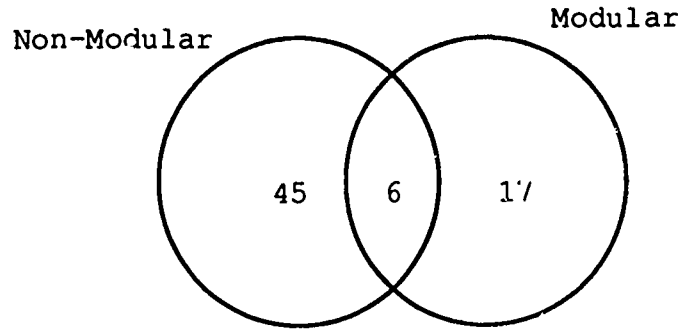

Figure 7

Distribution of the Arithmetic Course
According to Modularization

Table 3

Arithmetic Scheduling Format
Non-Modular Courses

Number of Colleges	Lecture Hours	Lect/Lab Hours	Lab Hours	Units
31	3	0	0	3
4	2	0	0	2
4	3	0	0	2
2	4	0	0	4
1	5	0	0	3
1	5 for 9 weeks	0	0	1
1	4	0	0	1
1	4	0	0	2
1	4	0	1	2
1	4	0	0	3
1*	4 for a quarter	0	0	4Q
1	3	0	1	3
1	3	0	3	4
1	2	0	0	1
1	2	0	3	2
1	2	0	3	3
1	1	0	0	1
1	0	0	8	3

* This college also offered an optional 3 hours CAI laboratory for an additional quarter unit.
Q: Quarter units

OH9

Table 4

Arithmetic Scheduling Format
Modular Courses

Number of Colleges	Lecture Hours	Lect/Lab Hours	Lab Hours	Maximum Units
4	3	0	0	3
3	5 for a quarter	0	0	5Q
3	3	0	2	3
2	0	0	3 per unit	3
2	1 per unit	0	0	3
2	2	0	3	3
1	4	0	0	3
1	4	0	0	4
1	3	0	2	3.5
1	3	0	1 per 3 units	9
1	2	0	3 for 6 weeks	1
1	2	0	1	2
1	1	0	2	2
1	1	0	3	2
1	1	0	3	3
1	1 per 0.5 unit	0	0	3.5
1	1	0	2	8
1	0.5	0	1.5 per unit	4
1	0	0	3	1
1	0	3	0	2
1	0	0	3	3

OH10

The arithmetic/introduction to algebra course was offered at fifty colleges. Non-modular versions of this class were given at forty-two colleges, fourteen colleges offered modular versions, and six colleges offered both. In thirty-nine colleges the only format available was lecture, while eleven offered a laboratory component. In no college was a strictly laboratory course the only option available to students. The scheduling formats used by the fifty colleges that offered the arithmetic/introduction to algebra class were placed in Table 5 and Table 6.

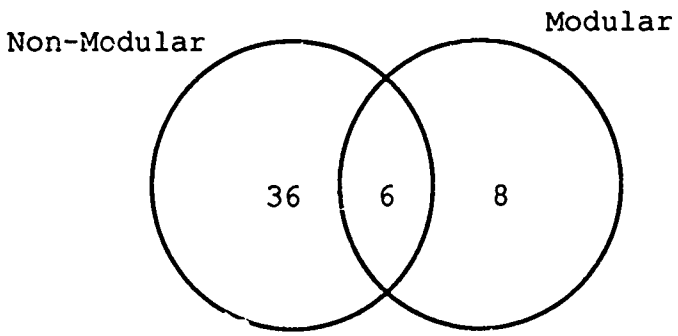

Figure 8

Distribution of the Arithmetic/Introduction to Algebra Course According to Modularization

Table 5

Arithmetic/Introduction to Algebra Scheduling
Format for Non-Modular Courses

Number of Colleges	Lecture Hours	Lect/Lab Hours	Lab Hours	Units
31	3	0	0	3
3	5	0	0	5
2	3	0	0	2
2	5	0	0	4
2	5	0	0	3
2	2	0	2	3
1	4	0	0	4
1	4 for 9 weeks	0	0	2
1	3	0	2	3
1	2	0	0	2
1	2	0	3	2
1	1.5	0	1.5	2
1	1	0	3	2
1	0	3 for a quarter	0	2Q

Q: Quarter units

OH11

Table 6

Arithmetic/Introduction to Algebra Scheduling
Format for Modular Courses

Number of Colleges	Lecture Hours	Lect/Lab Hours	Lab Hours	Maximum Units
2	1 per unit	0	0	4
1	1 per unit for a quarter	0	0	4Q
1	1 to 2	0	0	3
1	3	0	2	2
1	5 for a quarter	0	0	5Q
1	5 per unit	0	0	3
1	4	0	0	4
1	3	0	0	4
1	0	6	0	3
1	0	0	3 per unit	3
1	3	0	1	3
	and 3 for 9 weeks	0	0	1
1	3	0	0	2
	and either of the following:			
	2 for 9 weeks	0	0	1
	or 1 for 9 weeks	0	2	1

Q: Quarter units

OH12

In addition to these basic mathematics courses, twelve colleges had a course in their curriculum designed to provide tutoring assistance for students enrolled in pre-algebra mathematics courses. The complete list of available formats was placed in Table 7.

Table 7

Tutoring Classes Schedule Format

Number of Colleges	Hours	Units
3	2 per week	1
3	3 per week	1
1	2 per week	0
1	3 per week for 9 weeks	0.5
1	24 per semester	0.5
1	27 per semester	0.5
1	1.5 to 9 per week	0.5 to 1.5
1	open lab	0

Survey of the Basic Mathematics Learning Environments Available in the California Community Colleges

The survey of the mathematics faculty in the 105 degree granting California community colleges provided a detailed view of many of the practices used in the instruction of basic mathematics throughout the state. Mathematics faculty members were asked to describe those practices available to students at the basic mathematics level. Faculty at the twenty-five colleges offering more than one category of basic mathematics class were not asked to differentiate practices between specific courses.

The distribution of the types of lecture delivery was placed in figure 9.

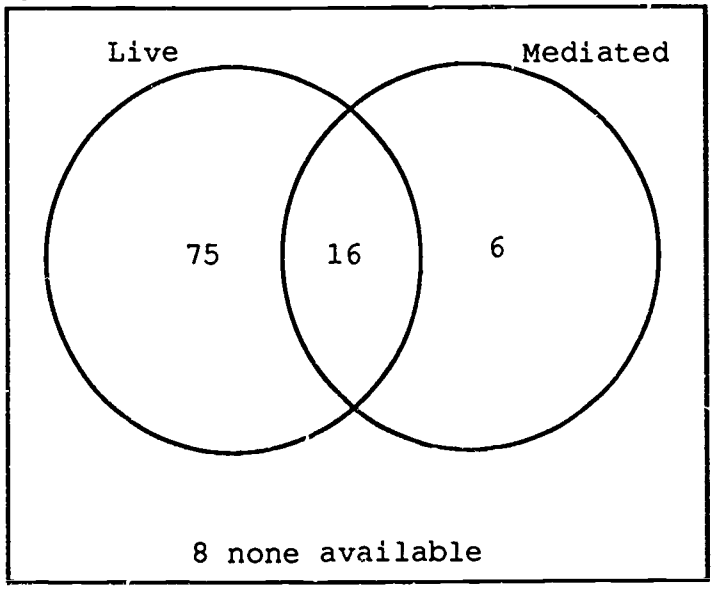

Figure 9

Distribution of Lecture Availability Among the Colleges

Live lecture was an instructional mode available to basic mathematics students at ninety-one colleges. This was the

only lecture delivery system available at seventy-five colleges, while twenty-two had lectures available on video or audio tapes or both, thirty colleges gave the student an option of taking a class where no lecture was given, and eight colleges gave no option of lecture, live or taped, to their students.

QH13 The distribution of media use for basic mathematics programs is shown in figure 10.

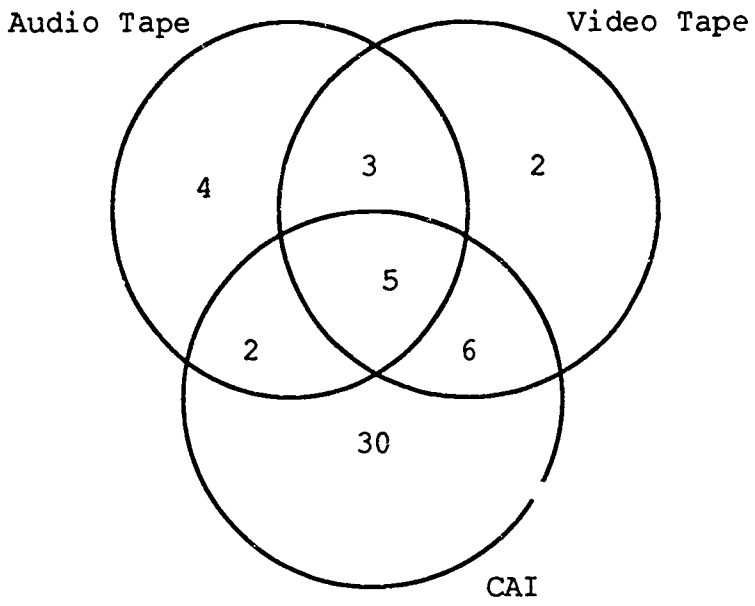

Figure 10

Distribution of Media Used for Basic Mathematics Among the Colleges

Computer-aided instruction was used by forty-three colleges. Stand alone microcomputers were the sole type of machine in use at thirty-four colleges, seven colleges had only mainframe computer systems or microcomputers tied to a central disk, and two colleges had both stand alone and central disk or mainframe capability.

In all, fifty-two colleges used some form of mediated instructional support for the basic mathematics program. Besides the forty-three colleges with CAI available, fourteen had audio tapes, sixteen used video tapes, and five had all three.

The distribution of instructional locations used by the colleges was placed in figure 11.

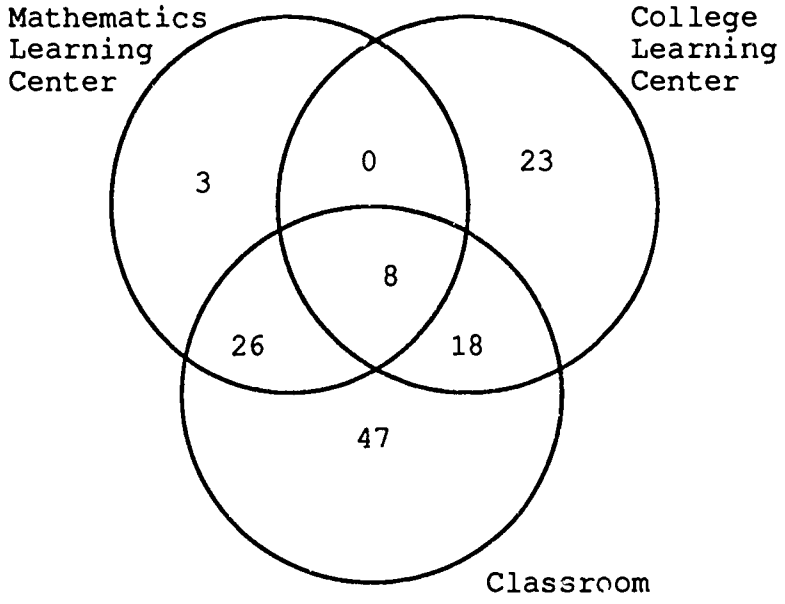

Figure 11

Distribution of Instructional Locations
Among the Colleges

The primary instructional location for basic mathematics was the classroom. This option was available to students at ninety-nine colleges and was the only option in forty-seven. The services of a mathematics learning center were used at thirty-seven colleges for the basic mathematics course, while twenty-nine colleges involved a college learning center in this mathematics program.

OH14

A distribution of the course pacing format was placed in figure 12.

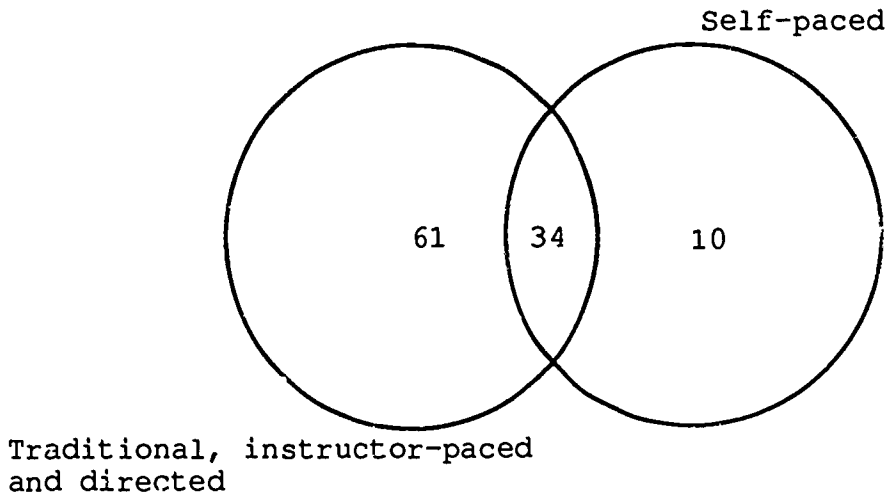

Figure 12

Course Pacing Format

The traditional, instructor-paced and -directed course format was used most often for basic mathematics classes. This format was offered at ninety-five colleges. In sixty-one colleges this was the only format available. A self-paced option occurred at forty-four colleges. Students had no other option than a self-paced instructional format at ten colleges.

Miscellaneous format variations were collected in Table 8.

Table 8

Miscellaneous Format Variations

Number of Colleges	Format Variation
31	Open-entry/Open-exit
41	Mastery Learning
15	Independent Study
29	Variable credit available (amount of credit depended on amount of work completed)
11	"In Progress" grade available (allowed student to extend work into the next semester)

Open-entry/open-exit was available in thirty-one colleges. Of the forty-one colleges that subscribed to the mastery learning format, seven executed it in the context of a traditional, instructor-paced format. Independent study was allowed in fifteen colleges. Twenty-nine colleges gave variable credit depending on the amount of work completed and eleven allowed the students to extend work into the next term by using the "in progress" grade.

OH15

Tutoring was a common support service provided to basic mathematics students in California community colleges. It was present in some form in every college except one non-campus institution. The distribution of tutoring personnel was shown in figure 13.

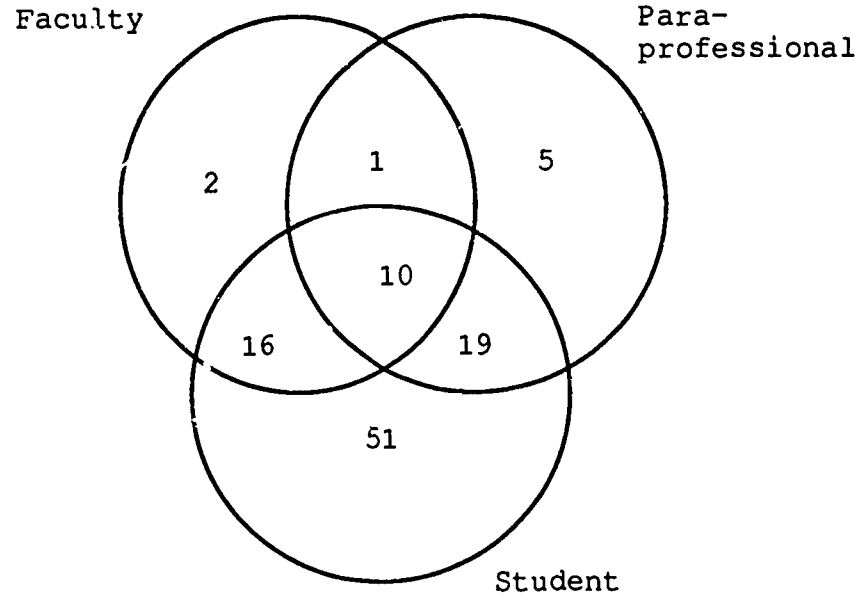

Figure 13

Distribution of Tutoring Personnel
Among the Colleges

Peer or student tutoring was provided at ninety-six colleges, but in only fifty-one colleges was this the sole source of tutoring available. Paraprofessional tutors were employed at thirty-five colleges. In twenty-nine colleges, faculty tutored in addition to their regular office hour assignment.

A learning center was the most frequently noted location for tutoring. The distribution of tutoring locations was shown in figure 14.

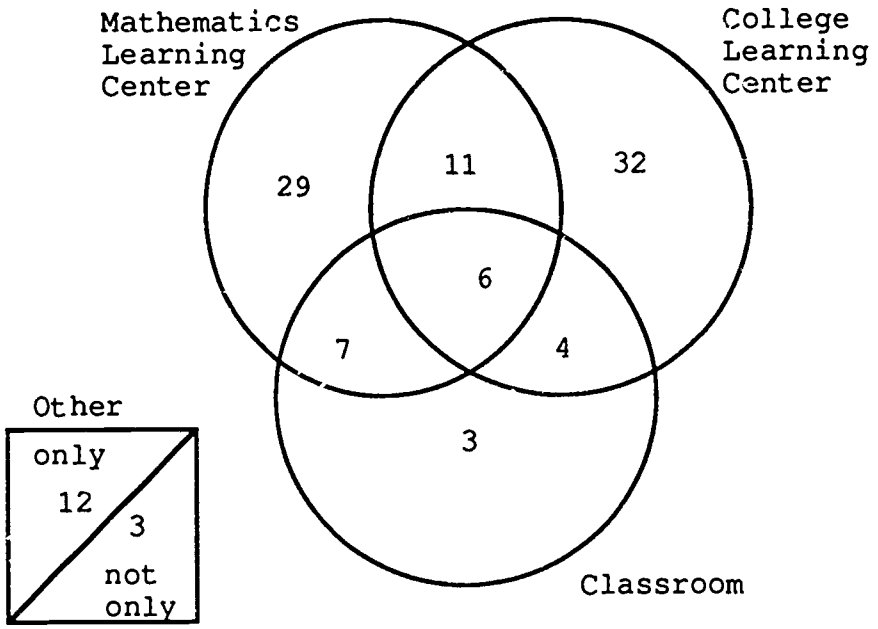

Figure 14

Distribution of Tutoring Locations Among the Colleges

A mathematics learning center was used by fifty-three colleges, a college learning center also by fifty-three, and eighty-nine colleges reported using one or both such facilities. In twenty colleges tutoring took place in a classroom. Facilities other than a classroom or learning center were used for tutoring at fifteen colleges.

OH16

Comparison of Basic Mathematics and Algebra Student Demographics

Several significant differences were found between the population of students enrolled in the developmental mathematics program and those enrolled in the college level algebra courses. These are detailed in Table 9.

Table 9

Differences Between Arithmetic and Algebra Students

1) Arithmetic students are 4.5 years older (mean is 27.5).
2) No differences between the number of units earned or grade point average at the College.
3) Only 7% of the algebra students were new to the College. However, 25% of the arithmetic students were new.
4) While one-half of the algebra students are women, two-thirds of the arithmetic students are women.

It was found that, on the average, basic mathematics students were 27.5 years old and thus 4.5 years older than the algebra students.

For those continuing students enrolled in basic mathematics and algebra, there was no difference between the number of units earned at Saddleback College or the grade point average over those units. However, a significantly

higher proportion of basic mathematics students were new to the college. While only seven percent of algebra students had no units completed at Saddleback College, fully twenty-five percent of the developmental students were new to the college.

Sex distributions of the arithmetic and algebra groups were significantly different. While one-half of the algebra group were women, two-thirds of the arithmetic students were women.

OH17

Recommendations for Improving the Basic Mathematics Program at Saddleback College

Program Objectives, Organization, and Support Services -- Delphi Rounds One and Two

The first two rounds of the Saddleback College mathematics faculty Delphi exercise were focused on defining the appropriate program objectives, organization, and support services for the basic mathematics program at Saddleback College. Those items rated very important (VI), strongly agree (SA), unimportant (UI), or strongly disagree (SD) were placed in Table 10 in rank order. The maximum value for the mean was 4.0 and the minimum value was 1.0. The rank order of all elements was placed in the Appendix.

Table 10

Delphi Round Two Rank Order Responses

Element	value	mean	rank
Objectives:			
B. Prepare the student for success in algebra.	VI	3.77	1
A. Help the student develop good study habits.	VI-	3.62	2
K. Develop "number sense"--the ability to judge whether an answer is reasonable or ridiculous.	VI-	3.62	3
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.			
.			
.			
E. Screen out those students who will not be successful in college level work and dissuade their continuance.	UI	1.23	15
Organization:			
U. Courses in this program should be taught by caring and interested instructors.	SA	3.85	1
C. The arithmetic/pre-algebra program should be offered through the mathematics department.	SA	3.77	2
E. A student enrolled in this program should have a variety of instructional styles from which to choose.	SA-	3.69	3
K. The instructional materials should include the arithmetic of signed numbers.	SA-	3.54	4
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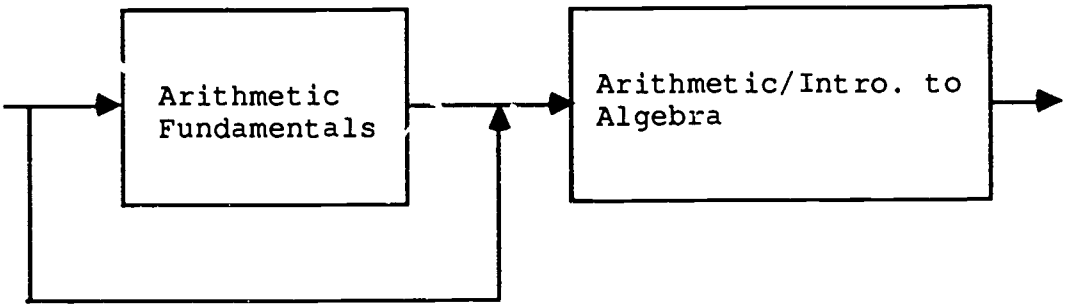
Table 10 (Cont.)

Element	value	mean	rank
J. The instructional materials should not include any topic presented in beginning algebra.	SD-	1.33	24
B. The arithmetic/pre-algebra program should be offered by the College through a special developmental skills department separate from the mathematics department.	SD-	1.31	25
A. No arithmetic/pre-algebra program should exist at Saddleback College	SD	1.23	26
Support Services:			
M. Student assessment/diagnostic testing.	VI	3.92	1
P. Student advisement/counseling.	VI	3.85	2
R. Diagnostic testing with results available to the student and instructor during the first week of class.	VI	3.77	3
V. A math lab that is open as many hours as possible.	VI	3.75	4
D. Live lectures.	VI-	3.62	5
B. Drop-in tutoring outside class.	VI-	3.62	5
L. Convenient student group study areas outside the classroom.	VI-	3.62	5
T. Availability of both peer and faculty tutoring.	VI-	3.54	8
I. A mastery learning environment.	VI-	3.50	9

OH19

It was apparent, following analysis of the questionnaire responses, that there was support for two courses in the basic mathematics program; however, it was not clear whether a sequential model or parallel course model was preferred. These models are depicted in figure 15.

Sequential Model:



Parallel Model:

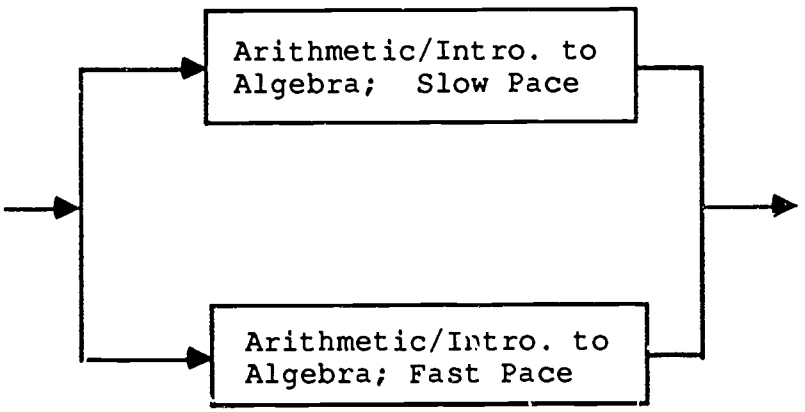


Figure 15

Basic Mathematics Curriculum Options

A sequential model would involve an arithmetic fundamentals course for the particularly weak students. This course would then be followed by an arithmetic/introduction to algebra course that devoted little time to a review of the arithmetic of whole numbers and decimals. A parallel model would involve two arithmetic/introduction to algebra courses, but one would move at a slower pace to allow the weaker students to develop sufficient skills in each topic area. The other course would move more rapidly and would serve students needing only a review or possessing strong arithmetic computational skills.

OH20

Because of the uncertainty as to which program was preferred, all three courses were placed in the candidate program for faculty consideration with the third round Delphi exercise. Included, also, were the options of a variety of instructional styles and an open-entry/open-exit format that the faculty had found to be important. Following two Delphi rounds, curriculum depicted in figure 16 was selected.

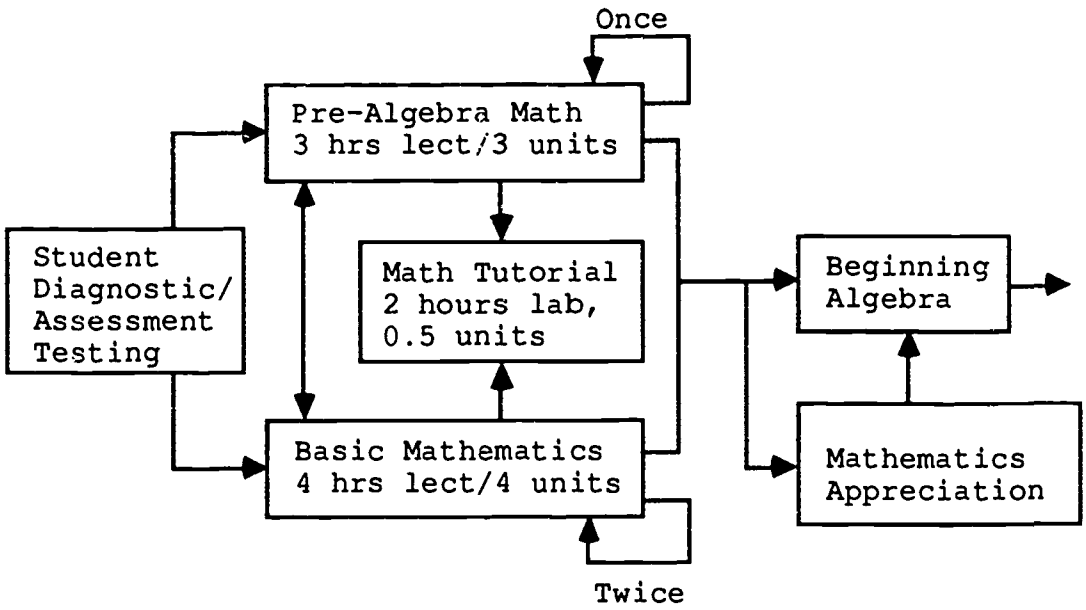


Figure 16

Basic Mathematics Program Flowchart

Faculty Program Recommendations --
Delphi Rounds Three and Four

Consistent with the earlier result that the faculty felt a mathematics learning center provided a very important support service for basic mathematics students, the faculty supported the creation of a laboratory course for these students. This course would offer students a tutorial service and access to computer-aided drill and practice activities. For identification in the study, it was titled Mathematics Tutorial. The student would be scheduled into the laboratory for two hours each week and receive one-half unit. The tutorial course would be repeatable eight times. This high maximum number of repeats would remove student fear that they would be prevented from enrolling if several semesters were needed to complete the basic mathematics program.

OH21

A description of the Pre-Algebra Mathematics course was placed in Table 11.

Table 11

The Pre-Algebra Mathematics Course

Units: 3

Weekly Student Contact: 3 hours

Repeatable: Once

Prerequisite: Satisfactory score on the mathematics assessment examination

Format: Instructor-paced, lecture and
Student self-paced (not independent study)
a) Mediated instruction
b) Mastery learning
c) Open-entry/open-exit

Content: A brief review of the arithmetic of whole numbers and decimals, the arithmetic of fractions and signed numbers, the order of operations, ratios and proportions, percent, scientific notation, calculations involving whole number powers and roots.

Discussion of various geometrical concepts: perimeter, area, volume, the metric system and measurement. Introduction of algebra through the inclusion of the solution techniques for simple linear equations and the manipulation of common formulas.

Problem solving techniques would be developed through the inclusion of material related to the translation of word phrases to mathematical expressions, word problems, the use of calculator and estimation of results.

The Pre-Algebra Mathematics course would carry a unit value of three, meet for three hours each week, and be repeatable once. A satisfactory score on the mathematics assessment examination would be required for admission to the course.

It would be offered both in an instructor-paced, lecture format and a student self-paced format. The self-paced version would take place in a classroom setting and not be an independent study situation. The self-paced version would involve mediated instruction and be organized around a mastery learning philosophy. The class would be open-entry/open-exit and consequently students could enter at any time during the semester and exit immediately after completing the course requirements. In conjunction with both the instructor-paced lecture and student self-paced versions the student would have the opportunity to enroll in the one-half unit mathematics tutorial laboratory course.

The subject content of the Pre-Algebra Mathematics course would be the following: a brief review of the arithmetic of whole numbers and decimals, the arithmetic of fractions and signed numbers, the order of operations, ratios and proportions, percent, scientific notation, calculations involving whole number powers and roots. The content would include consideration of the following geometrical concepts: perimeter, area, volume, the metric system and measurement with an emphasis on the proper use of units. Algebra would be introduced through the inclusion of the solution techniques for simple linear equations and the manipulation of common formulas. Problem solving techniques would be developed through the inclusion of material related to the translation of word phrases to mathematical expressions, word problems, the use of calculators and estimation of results.

OH22

A description of the Basic Mathematics course was placed in Table 12.

Table 12

The Basic Mathematics Course

Units: 4

Weekly Student Contact: 4 hours

Repeatable: Twice

Prerequisite: None

Format: Instructor-paced, lecture and
Student self-paced (not independent study)
a) Mediated instruction
b) Mastery learning
c) Open-entry/open-exit

Content: Consideration of the arithmetic of whole numbers and decimals, the arithmetic of fractions and signed numbers, the order of operations, ratios and proportions, percent, scientific notation, calculations involving whole number powers and roots.

Discussion of various geometrical concepts: perimeter, area, volume, the metric system and measurement. Introduction of algebra through the inclusion of the solution techniques for simple linear equations and the manipulation of common formulas.

Problem solving techniques would be developed through the inclusion of material related to the translation of word phrases to mathematical expressions, word problems, the use of calculator and estimation of results.

The Basic Mathematics course would carry a unit value of four, meet for four hours each week, and be repeatable twice. It would have no prerequisite. It would be offered both in an instructor-paced, lecture format and a student self-paced format. The self-paced version would take place in a

classroom setting and not be an independent study situation. The self-paced version would involve mediated instruction and be organized around a mastery learning philosophy. The class would be open-entry/open-exit and consequently students could enter at any time during the semester and exit immediately after completing the course requirements. In conjunction with both the instructor-paced lecture and student self-paced versions the student would have the opportunity to enroll in the one-half unit mathematics tutorial laboratory course. The subject content of the Basic Mathematics course would be the same as described above for the Pre-Algebra Mathematics course except that the arithmetic of whole numbers and decimals would be treated in some detail.

Evaluation of Program Recommendations

The faculty recommendations resulting from the four round Delphi exercise were evaluated and found to be practical, complete, and consistent in terms of the program objectives, the educational environment at Saddleback College, and the practices of other California community colleges. A basic mathematics program composed of only two parallel arithmetic/introduction to algebra courses of different unit value was the practice previously adopted by six colleges: College of the Siskiyous, Foothill College, Laney College, San Diego City College, San Diego Mesa College, and San Diego Miramar College. The concept of offering the arithmetic/introduction to algebra class in both instructor-paced and student self-paced modes was not a unique concept to Saddleback College. Students at ten California colleges have the option of choosing between these methods. This was the case at Bakersfield College, Cerritos College, Fresno City College, Long Beach City College, College of Marin, Ohlone College, Orange Coast College, Pasadena City College, Solano College, and West Hills College. As has already been discussed and displayed in Table 7, twelve California college now offer a mathematics tutorial course of the type recommended by the Saddleback College mathematics faculty.

Conclusions

Examination of the data generated in this research effort resulted in several conclusions. Students enrolled in community college basic mathematics programs represented a diverse group. At Saddleback College the average age of these students was 27.5 years. Two-thirds were women and twenty-five percent had no units completed at Saddleback College. These students needed access to a wide variety of instructional styles, including instructor-paced classes, a self-paced environment, and the opportunity for a laboratory experience supported by peer and faculty tutoring as well as computer-aided instruction materials.

The focus of the program should be to prepare students for success in algebra. This would best be accomplished by offering two version of the arithmetic/introduction to algebra course. One would meet four hours each week, and include a discussion of the arithmetic of whole numbers and decimals in some detail. The other course would meet three hours each week, and only briefly mention the arithmetic of whole numbers and decimals before beginning a detailed discussion of the arithmetic of fractions. Both courses would cover the traditional arithmetic topics and end with the solution techniques for simple linear equations. Under either class, students should have access to a structured self-paced environment (not independent study). Under either class students should be able to enroll in an

optional mathematics tutorial laboratory that would include computer-aided instruction activities. This laboratory experience would aid their efforts to grasp the principles of arithmetic and an introduction to algebra.

APPENDIX

SECOND ROUND DELPHI EXERCISE RESULTS

RANK ORDER OF BASIC MATHEMATICS PROGRAM
OBJECTIVES, ORGANIZATION, AND SUPPORT SERVICES
Delphi Round Two -- Results

Element	value	mean	rank
Objectives:			
B. Prepare the student for success in algebra.	VI	3.77	1
A. Help the student develop good study habits.	VI-	3.62	2
K. Develop "number sense"--the ability to judge whether an answer is reasonable or ridiculous.	VI-	3.62	3
I. Develop problem solving abilities in the student.	I+	3.46	4
C. Improve the student's self-image.	I+	3.38	5
D. Aide the student to become functional on the job and in day-to-day life.	I+	3.38	5
F. Improve a student's arithmetic skills to whatever level possible even though the student may never succeed at college level work.	I+	3.38	5
L. Develop computational skills.	I	3.23	8
N. Reduce math anxiety.	I	3.23	8
M. Demonstrate a usefulness for math through relevant examples.	I	3.23	8
G. Encourage the full mental, moral, and emotional growth of the student.	I	3.00	11
J. Develop an understanding of the processes of arithmetic (i.e. why the rules work).	I	3.00	11
H. Enrich the life of the student.	I	2.92	13
O. Comprehensive knowledge of course material should be stressed on all exams.	I	2.92	13
E. Screen out those students who will not be successful in college level work and dissuade their continuance.	UI	1.23	15

Element	value	mean	rank
Organization:			
U. Courses in this program should be taught by caring and interested instructors.	SA	3.85	1
C. The basic mathematics program should be offered through the mathematics department.	SA	3.77	2
E. A student enrolled in this program should have a variety of instructional styles from which to choose.	SA-	3.69	3
K. The instructional materials should include the arithmetic of signed numbers.	SA-	3.54	4
R. The instructional materials should provide for a strong foundation in fractions.	A+	3.46	5
S. The instructional materials should include many applied examples	A+	3.31	6
W. The program should be offered in both the instructor paced and self-paced formats.	A+	3.30	7
O. The program should set a work level that requires a collegiate commitment, even if the work is not college level.	A+	3.25	8
H. The instructional materials should begin with counting and operations with whole numbers and then continue with more advanced topics.	A	3.23	9
X. Each assignment should give sufficient practice on new topics to draw out common errors, but each assignment should also have substantial review included.	A	3.18	10
G. The student enrolled in this program should be able to proceed through the instructional materials at their own pace (i.e. the course is student self-paced).	A	3.15	11

Element	value	mean	rank
P. A method for testing for learning disabilities should be provided	A	3.15	11
Z. The program should include the beginning translation of words to math symbols (e.g. Three more than twice a number means 2x+3).	A	3.08	13
Q. Special services should handle those students with identified learning disabilities.	A	3.08	13
T. The program should be structured somewhere between self-paced and instructor-paced.	A	3.00	15
N. The program should include an arithmetic course as well as a pre-algebra course.	A	2.92	16
Y. Cumulative tests at least at the end of each chapter should be given.	A	2.92	16
D. This program should consist of a single one semester course.	A	2.83	18
V. The program should be instructor paced, since human contact is essential and there is need for a more "controlled" environment.	A	2.77	19
L. The instructional materials should include the solution of linear equations.	A	2.76	20
Seven instructors responded A or SA; three instructors responded D or SD.			
I. The instructional materials should begin with common fractions and then continue with more advanced topics.	D+	1.69	21
M. The program materials should include operations with polynomials.	D+	1.75	22
F. The course(s) in this program should be offered only in the lecture/discussion instructor-paced format.	D+	1.54	23
J. The instructional materials should not include any topic presented in beginning algebra.	SD-	1.33	24

Element	value	mean	rank
B. The basic mathematics program should be offered by the College through a special developmental skills department separate from the mathematics department.	SD-	1.31	25
A. No basic mathematics program should exist at Saddleback College	SD	1.23	26
Support Services:			
M. Student assessment/diagnostic testing.	VI	3.92	1
P. Student advisement/counseling.	VI	3.85	2
R. Diagnostic testing with results available to the student and instructor during the first week of class.	VI	3.77	3
V. A math lab that is open as many hours as possible.	VI	3.75	4
D. Live lectures.	VI-	3.62	5
B. Drop-in tutoring outside class.	VI-	3.62	5
L. Convenient student group study areas outside the classroom.	VI-	3.62	5
T. Availability of both peer and faculty tutoring.	VI-	3.54	8
I. A mastery learning environment.	VI-	3.50	9
U. Scheduled tutoring outside class supplemented by a variety of instructional support services.	I+	3.46	10
G. Mediated instruction via programmed text, video tapes, audio tapes, or other media form.	I+	3.31	11
C. Scheduled tutoring outside class.	I+	3.30	12
F. Computer-Aided Instruction.	I	3.23	13
Q. Student advisement/counseling by math faculty, rather than by counselors, through released time assignments.	I	3.17	14
J. An open entry/open exit enrollment option.	I-	3.08	15

Element	value	mean	rank
O. Follow-up research on student success in college level courses.	I	3.00	16
E. Taped lectures.	I	2.77	17
K. Tutoring by mathematics department faculty in addition to their regularly scheduled office hours.	I	2.75	18
S. An open entry/open exit enrollment option with a "satisfactory progress" requirement should exist. The student would be limited to a two semester or one semester plus summer period.	I-	2.62	19
A. Tutoring during regular class time.	SI+	2.33	20
H. Independent study.	SI	2.08	21
N. Regular course testing (first time or make-up) outside of the regular class time.	SI	1.82	22

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