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ABSTRACT

This report contains the complete statewide results of the California Assessment Program, including some features that have become standard and some that are new this year: detailed findings for reading, written language, mathematics, and specific skill areas within each major area; national comparisons; expert opinions of the results; comparable results from previous years; subgroup analyses; Scholastic Aptitude Test (SAT) scores; characteristics of effective schools in terms of available time for learning, and mathematics and science courses taken by California students; and results concerning the knowledge and attitudes that 6th and 12th grade students hold about computers. Major findings include: grade 3 test scores improved for the 16th consecutive year; grade 6 scores imporved for the 6th year in written language and mathematics, and declined slightly in reading; and grade 12 scores declined in reading and written language and remained constant in spelling and mathematics. (BW)

Student Achievement in California Schools

1982-83 Annual Report

California Assessment Program

CALIFORNIA STATE DEPARTMENT OF EDUCATION Bill Honig—Superintendent of Public Instruction Sacramento, 1983

California Assessment Program

Student Achievement in California Schools

1982-83 Annual Report

Prepared Under the Direction of
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Research Division

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I. Summ:ary of Findings

- o Grade three test scores improved in 1982-83 for the sixteenth consecutive year.

- o Grade six scores improved for the sixth year in two content areas and declined slightly in one.

- o Grade twelve scores declined in two content areas and remained constant in two.

During the 1982-83 school year, all third, sixth, and twelfth grade students in California public schools were tested in the basic skills of reading, written language, and mathematics. T following paragraphs provide a summary of the main findings.

Grade Three Results

Reading test scores for third grade pupils have been improving steadily since statewide testing in that grade began in 1967, using the Survey of Basic Skills: Grade 3. This trend has continued through 1982-83. A summary of the test results is presented in Table 1. The overall gain in 1982-83 was five scaled score points (see Chapter II for an explanation). The areas of written language and mathematics have been tested for only four years in grade three. The scores this year were up by six points in both areas.

Special equating studies were conducted to determine the relationship of the current performance of California pupils to the performance of a sample of students across the nation. In comparison with previous estimates of national norms (1973), California students are well above these national averages; however, in comparison with more recent estimates of national averages (1981 and 1982), California students fall only slightly above or even below the national average, depending on the test and content area being considered.

Grade Six Results

All students in grade six took the Survey of Basic Skills: Grade 6, another test developed specifically for the California Assessment Program. The scores of California's sixth grade students improved in two of the content areas tested--written language and mathematics (see Table 1)--but declined slightly in reading for the first time in several years.

Several equating studies provide a basis for comparing the performance of California's students with that of sixth grade students across the nation. According to all comparisons, some recent and some not so recent, California students are at or above the national averages.

Grade Twelve Results

All students in grade twelve took the same test that had been administered since 1975-76--the Survey of Basic Skills: Grade 12. In 1980-81 scores were up in all content areas for the first time. In 1981-82 the scores went up in two areas and down in two areas. In 1982-83 the scores in reading and written language declined slightly, and the results in spelling and mathematics remained constant (see Table 1).

Table 1

Numbers of Students Tested and Average Test Score, by Grade Level and Content Area, from 1979-80 Through 1982-83
California Assessment Program

Grade level and content area (number tested)	Average test score				Difference		
	1979-80	1980-81	1981-82	1982-83	1979-80 to 1980-81	1980-81 to 1981-82	1981-82 to 1982-83
Grade 3 (278,837)							
Reading	250	254	258	263	+4	+4	+5
Written Language	250	255	260	266	+5	+5	+6
Mathematics	250	254	261	267	+4	+7	+6
Grade 6 (299,609)							
Reading	250	252	254	253	+2	+2	-1
Written Language	250	253	257	259	+3	+4	+2
Mathematics	250	253	258	260	+3	+5	+2
Grade 12 (213,500)							
Reading	63.1	63.4	63.2	63.1	+0.3	-0.2	-0.1
Written Language	62.4	63.1	63.2	63.0	+0.7	+0.1	-0.2
Spelling	68.8	69.0	69.5	69.5	+0.2	+0.5	0
Mathematics	66.8	68.0	67.7	67.7	+1.2	-0.3	0

Note: The scores for grade three and grade six are reported in scaled score units. These scores range from approximately 100 to 400 with a statewide average of 250 in 1980, the base year. The scores for grade twelve continue to represent the percentage of questions answered correctly.

Special equating studies provide a basis for comparing the performance of California's twelfth graders with that of national test publishers' norm samples tested in 1962, 1970, and 1978. On the basis of the 1962 norms, the median twelfth grade student in California remained in 1982-83 at the 41st percentile rank in reading, the 34th percentile rank in written expression, and the 46th percentile rank in mathematics.

Comparisons with two other tests with 1970 norms placed California's twelfth grade students somewhat lower: at the 32nd and 34th percentiles in reading, at the 28th and 30th percentiles in written expression, and at the 44th and 47th percentiles in mathematics.

On the basis of more recent norms (1978) for these tests, California's performance has generally improved relative to the nation. The median California student is now in the forties (percentile rank) on most of the tests and above the 50th percentile on two of the comparisons. The results on the Scholastic Aptitude Test (SAT) support those findings; on the SAT the averages for California college-bound seniors are comparable to the national averages, and California students are relatively better in mathematics than in verbal skills.

Other Findings in the Annual Report

This report also contains additional information about the achievement of California students, including:

- Detailed analyses of the specific strengths and weaknesses of California students and school instructional programs in reading, written expression, and mathematics (in Chapters III, IV, and V)
- The results of a pilot study of the knowledge and attitudes of sixth and twelfth grade students about computers (Chapter VII)
- Analyses of the time available for learning in California schools and how California compares with national averages (The focus of these analyses is on science and mathematics at the high school level [Chapter VIII].)

II. Introduction to the Report

This report contains the complete statewide results of the California Assessment Program, including some features that have become standard and some that are new this year:

- Detailed findings. Information is presented not only for the major content areas of reading, written language, and mathematics but also for a variety of specific skill areas within each major area.

- National comparisons. Although the tests were developed to correspond specifically to the skills and concepts being taught in California schools, special studies have been conducted to show how the performance of California students compares to that of samples of students from throughout the nation.

- Expert opinions. Recognized authorities in each professional field present their interpretation of the results for each of the content areas by identifying skill areas of relatively impressive student performance and other skill areas that need attention.

- Comparable results. All test results in this report are comparable to those of previous years, either because the tests have not been changed or, where new tests have been introduced, the results from the old and new tests have been placed on a common scale.

- Subgroup analyses. With the stability of the tests, it has become possible and appropriate to examine the differences in the rate of progress achieved by various subgroups of students.

- Scholastic Aptitude Test (SAT) scores. Although the *Scholastic Aptitude Test* is not a part of the California Assessment Program, the latest results for California's college-bound seniors and their counterparts throughout the nation are included in this report so these results can be compared conveniently to the basic skill test results for all California public high school seniors.

- School characteristics. The California Assessment Program is mandated to provide information about the characteristics of effective schools and the factors related to the quality of their programs. Last year's report focused on findings concerning the issue of available time for learning in California schools, both at the elementary and secondary levels. This year's effort extends those findings with new information on the specific mathematics and science courses taken by California students.

- Computer studies. The knowledge and attitudes that sixth and twelfth grade students hold about computers were assessed in 1982-83 as part of a test development effort in the areas of computer literacy and computer science. The results reported here can serve as a useful baseline for monitoring statewide efforts in developing computer liter... skills.

Development of the California Assessment Program

The California Assessment Program was first fully implemented in 1974-75. In design, development, and procedures, it is unique in the nation. The assessment program was designed with several criteria in mind: (1) it must be relevant to California schools; (2) it must cover the full range of instructional objectives; (3) it must provide program-diagnostic information at local and state levels; and (4) it must take only a minimum of testing time. This section describes the process of developing such a program.

Background and Assumptions

The state assessment program had its foundation in two legislative acts: (1) the California School Testing Act of 1969, a revision of a 1961 law which first required an achievement testing program in the public schools; and (2) the Miller-Unruh Basic Reading Act, which originally required reading tests in grades one, two, and three.

The testing program was revised by 1972 legislation, and major changes were made in the program as a result of that legislation. The changes in the statewide testing program were based on the principle that an efficient state testing program has to be limited in scope--that is, limited primarily to the task of furnishing useful information to state-level policymakers and decision makers. It was assumed that the program could not meet all of the many information needs of local school district personnel and that assessment information needed at the classroom level could best be collected by local school personnel.

In spite of this assumption, the program was designed to report as much information as possible to school personnel. Since all students at a grade level in all schools were tested, it was possible to provide very detailed analytical reports for each school to supplement locally obtained information. In fact, the results of a survey of all districts in California showed that most districts have found this unique information very useful in evaluating and revising programs. Board members and other local citizens have relied heavily on statewide results in making judgments about local needs and accomplishments, primarily because of the uniform and comparable nature of the information provided.

Reasons for Revising the Testing Program

Two major problems were addressed through the revision of the statewide testing program:

- Test relevancy and breadth. The incomplete match between the relatively narrow range of skills measured by any one published standardized test, on the one hand, and the variety of instructional programs in California schools, on the other, made it difficult to assess the skills of California students or the effectiveness of the programs with any degree of assurance of fairness. Furthermore, it was not possible to assess the relative strengths and weaknesses of California students in order to have an indication of how instructional programs should be redirected, since the standardized tests being used yielded only total scores.

- Testing time. Previous testing instruments required an inordinate amount of a student's time for the testing process--inordinate, at least, in relation to the usefulness of the results. The use of a new testing technique called matrix sampling has now reduced the amount of testing time at certain grade levels from as much as three and one-half hours to 30 minutes. Under this sampling method all students at the specified grade levels in all schools are tested, but each student takes only a portion of the total test. Results for an individual student cannot be obtained, but quite accurate estimates of the overall performance of groups of students can be computed.

The National Norm Dilemma

From 1962, the first year of statewide testing in California, until CAP began using its own tests, all tests adopted for use had been commercially published instruments with "national" norms. The new tests described in this report were constructed specifically for use in California schools. The decision to develop tests rather than use commercial "off-the-shelf" tests with national norms was not made casually. Comparisons to national averages are not only interesting but are also useful as a basis for judging the overall relative effectiveness of California's instructional programs. Furthermore, California law (Education Code sections 60640 and 60663) requires that such information be made available.

A real dilemma, one with both philosophical and technical aspects, faces anyone who would measure the basic skills of California students: to choose a test which has national norms but fails to address all the skills taught in California schools or to develop a relevant test which does not allow easy and immediate national comparisons. Assessment programs in other states are about equally divided between these two approaches. After 11 years of using tests with national norms but less than satisfactory coverage of the skills being taught in California schools and after observing the difficulties faced by other states in interpreting the results from their own tests without national norms, the course to be followed was obvious: Develop a test which fits the instructional programs of most California schools and then find a way to compare the results of that test to national norms.

A plan which could accomplish this (allow one to have one's cake and eat it, too) had to overcome two main problems with the national norms associated with published standardized tests:

1. No single test is given to all students in the country. Of necessity, a publisher's norm is, therefore, only an estimate of what the distribution of scores would be like if, in fact, the test had been taken by all students in the United States. For this reason, norms vary from publisher to publisher, sometimes in the extreme. In California's own recent history, the Stanford Reading Test was administered to all second grade students in the 1969-70 school year, and the median California student scored at the 38th percentile of that publisher's norms. In the following year the Cooperative Primary Reading Test was administered to all second grade students. The median California student scored at the 50th percentile of that publisher's norms. The different result was clearly a reflection more of the difference in norms than of the difference in reading achievement.

2. A second problem with norms i .hat they are not updated very often. For instance, the Cooperative Primary Reading Test was normed during the 1965-66 school year. As a result, when those norms are referred to, it must be clearly understood that the comparisons being made are to the publisher's estimate of what scores on that test would have been if administered to all students in the country at that time. Because reading scores for the nation have dropped continuously since 1965-66, an "average" score on those norms for California students might, in fact, reflect achievement far above current nationwide averages.

The plan that was decided on is straightforward and efficient. It involves the equating of the California tests to standardized tests with national norms and updating those comparisons as new norms or new tests become available. The equating process requires that a sample of students take both the California test and one of the other tests. The effect of the statistical analyses following the testing is to show how California students would have scored if they had all taken the standardized test. Therefore, students' progress on the California test can be translated into the appropriate national percentile ranks--against the year in which the publisher's test was normed, of course, not against the national performance for that year. The latter would be the most useful information, but it is simply not obtainable.

This solution has several advantages: (1) the national comparisons are more timely since they can be updated as new norms become available; (2) the estimates are more stable since they do not depend on the representativeness of a single publisher's sample; and (3) it allows California's students to be assessed with a test which fits the objectives of California's instructional program and simultaneously, with almost no additional testing, allows their performance to be compared to national norms.

Essential Information About the Numbers Used in This Report

The Percent Correct Score

A statistic used in this report to indicate the achievement levels of California students is the "average percent correct score." For a given set of test questions, this number is the percentage of correct test responses, with one response being equal to the answer of one student to one question and the total number of responses being equal to the number of students multiplied by the number of items on the test. For example, if three students took a test with ten questions and if each of the three answered five of the ten questions correctly, the total number of responses would be 30, the total number correct would be 15, and the average percent correct score would be 50. It can also be said that the average student answered 50 percent of the questions correctly; or that, on the average, 50 percent of the questions were answered correctly.

The average percent correct score and the simultaneous presentation of illustrative test questions or exercises are designed to add to the clarity and usefulness of the findings. It should be easier, as a result, to see what California students are able to do. Unfortunately, this method is so new in educational evaluation and assessment that guidelines and benchmarks are not available. Each reader will have to evaluate the adequacy of the results. The emphasis is on establishing realistic and necessary levels of competence rather than on the traditional comparing of results to a national norm.

How High Is High?

Most of the average percent correct scores hover around the 60s and 70s; however, some are down in the 30s, and some are up in the 90s. Two points must be kept in mind in interpreting these figures:

1. The major reason that the average scores are in the 60s and 70s, rather than the 90s, is that the aims of the instructional programs at each level in California schools go beyond the basic, minimal levels of performance expected of all students. In reading, for example, those skills which are mastered by most students by the end of the third grade are not even tested in the sixth grade. Testing time is too valuable and the scoring and processing too expensive to justify gathering information which does not add to what is already known about California students.

2. It should be obvious that high scores in particular skill areas do not necessarily indicate effective programs; or low scores, the opposite. Some tasks are inherently more difficult. In reading, for example, it is not considered outstanding that by the end of grade three, nearly all students can immediately recognize and read certain short words; and it is not at all disappointing that only about 67 percent can answer certain questions requiring a student to recognize cause-and-effect relationships among sentences.

Development of a New Reporting System

The need. For many years the results of the California Assessment Program have been reported in this volume in terms of the percent of questions answered correctly. School district personnel have also received their results in this form. Test results, of course, can also be compared to the scores of other schools and districts, using the percentile rank tables prepared annually.

Although the percent correct score has the advantages described in the preceding section and will continue to be the basis for most of the interpretations and recommendations proposed in this report, it has certain disadvantages, some of which are outlined below:

1. When a new test is introduced, as in grade three in 1979-80, the scores from the new test cannot be compared directly to those of the old test. The new test in grade three, for example, is more difficult than the old test. A simple comparison of the scores would make it appear as if all schools had declined, when in reality the average score for 1980 went up slightly. The relationship of the scores on both tests must be determined through an "equating" study. The progress of a school or district can then be followed when the scores for both tests are put on a common scale.

2. The percent correct scores do not easily facilitate comparisons across content areas (e.g., reading with mathematics) or across grade levels. This is not really a problem at the state level, since the focus is primarily on the actual performance of students; i.e., the proportion of them who can answer given types of questions correctly. School personnel, however, often wish to compare the relative performance of their students in different content areas; for example, reading performance with mathematics performance. It can be seen that the rationale for and process of developing the tests militates against this simple comparison.

   The California Assessment Program tests were expressly designed to measure the wide array of skills taught in a good instructional program rather than to make an easy test by focusing on simple skills or an extremely difficult test by covering only the complex or advanced skills. Statewide advisory committees designated the proportion of the test to be devoted to the various skill areas on the basis of their importance, rather than their relative easiness or difficulty. Therefore, there is no reason to expect a 70 percent correct score in reading to be equal to a 70 percent score in mathematics, or a 65 percent correct score on the third grade mathematics test to equal a 65 percent correct score on the sixth grade mathematics test.

The solution. After three years of developmental effort, the Department of Education has implemented a scaled score system for reporting the results of the California Assessment Program tests. It was introduced first in 1980 at the third grade level in conjunction with the new Survey of Basic Skills: Grade 3 and in 1982 at grade six. The power of this new scaled score methodology is best realized with a test that is specifically designed to capitalize on its strengths.

The new scaled scores range from approximately 100 to 400. However, relatively few of the district-level scores go below 150 or over 350. This particular range of numbers was selected to avoid decimals, negative numbers, and confusion with percent correct scores and percentile ranks. Otherwise, the scale is quite arbitrary; any particular score--for example, a score of 320--has no obvious meaning that would allow an immediate judgment about a school's program. Scores do not indicate the percent of questions answered correctly or the percentage of schools which score higher or lower--although both of these pieces of information can be obtained from tables which are provided to all school districts. In fact, it is this detached, objective quality which makes these scores most valuable. They are not tied to any particular test in any particular year. They are designed to be a baseline measure which can reflect the progress of a school or a school district (or the state) over a period of years--irrespective of changes to the test or the progress of other schools or districts. Unlike percentile ranks, which are calculated annually, this scale has the same meaning in terms of relative achievement each year. A school or district can monitor its progress without being affected by the achievement of other schools or districts.

The achievement for the average (mean) third grade student and sixth grade student in California has been set to a scaled score of 250 for 1979-80. Bearing some similarity to the more familiar Consumer Price Index, the score of 250, although arbitrary, becomes a useful point of reference for monitoring change.

Since the scores for the content areas of reading, language, and mathematics are all on the same scale, it is possible to compare the performance of a school in reading to its performance in mathematics without making any translation into normative scores, such as percentile ranks.

Furthermore, in comparison to other scores, the units on the scale (100 to 400) represent more nearly equal intervals. The differences between different percentile rank points, for example, are particularly uneven; the distance between a school at the 50th percentile and one at the 55th percentile is very small in comparison to the distance between a school at the 90th percentile and one at the 95th. These uneven intervals make it very difficult to compare the progress of a school at the 50th percentile with that of one at the 90th. Such comparisons are greatly facilitated by scaled scores.

In summary, the scaled scores now in use in grades three and six have the following characteristics and features:

- Scaled scores range from approximately 100 to 400, with the statewide average student achievement in 1980 set at 250.
- Scores can be compared over years, independent of test changes or amount of statewide progress.
- Scores can be compared among content areas.
- More equal intervals between scaled scores allow better assessment of the progress of high- or low-scoring schools and school districts.
- Scores can be compared directly across grade levels.

III. Reading Achievement for Grades Three, Six, and Twelve

Synopsis of Findings

- o Grade three reading scores improved for the sixteenth consecutive year; gains were shown in all 27 skill areas.
- o Grade six reading scores declined by 0.2 percent correct, marking the first time in six years that sixth grade reading scores failed to improve.
- o Twelfth grade reading scores declined slightly (0.1 percent correct) from 1981-82 to 1982-83, yielding an overall decline of 1.0 percent correct since 1975-76. Twelfth grade reading scores have declined for six of the last seven years.
- o The median twelfth grade student in California is now scoring at the 41st percentile on national norms in reading; the median sixth grader is at the 52nd percentile; and the median third grader is at the 45th percentile (see Chapter VI, "Comparisons with National Norms").

Committee's Recommendations

After reviewing the data from the reading achievement tests for grades three, six, and twelve, the Reading Assessment Advisory Committee (members' names are listed in the Appendix) offered the following recommendations:

Policy Recommendations

1. Resources that have traditionally supported reading programs at grades one, two, and three should be extended and intensified at grades four, five, and six.
2. More time, especially actively engaged instructional time, should be provided for reading in all curricular areas at the upper elementary level.
3. Systematic statewide efforts should be made to find more effective ways for content area teachers to teach students to learn from text in all curricular areas in junior and senior high schools. Such efforts might include identifying strong teaching models at the school site level, providing in-service training to meet the needs of content area teachers, and/or hiring qualified reading specialists at the secondary level.
4. Every school principal should provide strong instructional leadership and staff development activities by stimulating effective instruction in vocabulary, higher-level comprehension, and writing in all disciplines across the curriculum.

5. District program leaders should seek ways to encourage more effective teaching and learning in the content areas at the secondary level (such as identifying strong teaching models at the school site) and to stimulate higher levels of creative thinking by involving students in applications, analysis, synthesis, and evaluation.

Instructional Recommendations

1. All higher-level reading and thinking skills and vocabulary development should receive high priority in all grades and in all content areas across the curriculum. Teachers should explore the reasons for students' mistakes in an attempt to discover the thinking strategies students are using.

2. Teachers should have actual dialogue with students and provide multiple opportunities for writing instead of overreliance on assigning and correcting workbooks and worksheets. (Research shows that students learn more and retain information longer when such active strategies are employed.)

3. Teachers should help their students discover the enjoyment of reading by reading aloud to them at all grade levels to "immerse" them in the sound of spoken literature and by setting aside class time for sustained silent reading, during which all teachers, acting as role models, read silently along with the students.

4. Every classroom should include numerous opportunities for oral language practice through discussions, reporting, and question-and-answer sessions in support of comprehension development.

5. Every reading program should involve students in the reading and discussion of high-quality literature.

6. Activities should be sponsored to increase the amount of time students spend reading outside school.

Recommendations to Parents

Parents should help their children discover the value and enjoyment of reading. Research shows that habits such as the following can support higher reading achievement:

1. Spending time reading daily and encouraging children to do the same

2. Reading aloud to children

3. Setting aside definite times for reading

4. Using television to stimulate reading and thinking through family discussions

5. Developing the ability in children to ask their own questions before and after they read (as well as answering questions others ask them)

Scope and Foundations of the Grade Three Test

The reading section of the Survey of Basic Skills: Grade 3 contains 270 questions covering five broad skill areas: (1) word identification; (2) vocabulary, (3) literal comprehension; (4) inferential comprehension; and (5) study-locational skills. These skill areas reflect the emphases in the Reading Framework for California Public Schools: Kindergarten Through Grade Twelve (Sacramento: California State Department of Education, 1980), the county superintendents' Course of Study, and state-adopted reading textbooks commonly used at the third grade level.

Decisions about the emphasis and breadth of content for each of these skill areas were made by the Reading Assessment Advisory Committee, a group of reading specialists representing a cross section of geographical regions, institutions, instructional levels, and professional groups throughout California (listed in the Appendix). In making these decisions, the committee members considered information from broad field reviews of preliminary test content specifications. The results indicated the degree of emphasis placed on each skill area and whether or not the skill should be assessed on the Survey. These field reviews reflected the points of view of the districts, schools, and teachers.

After examining the Reading Framework and field review information, the reading committee decided that the area of comprehension should receive the greatest emphasis on the reading section of the Survey. This decision is also consistent with the state-adopted Handbook for Planning an Effective Reading Program (Sacramento: California State Department of Education, 1983), which includes the following statement: "Comprehension is the central goal of reading" (page 7). Thus, most of the reading questions are literal or inferential comprehension items, and, of course, the vocabulary items involve comprehension as well. All the reading questions, except the study-locational items, are based on reading selections so that pupils are never asked to deal with reading skills apart from the context of a passage.

The emphasis assigned to each of the reading skill areas in the Survey is illustrated graphically in Figure 1. For illustrations of all reading skill areas and the underlying rationale, see Survey of Basic Skills: Grade 3--Rationale and Content (Sacramento: California State Department of Education, 1980).

Reading Results for Grade Three

The Survey of Basic Skills: Grade 3 was administered for the fourth successive year in 1982-83. The results of the third grade performance on the reading section of this test are shown in Table 2. Year-to-year changes in overall performance and in skill area performance are also shown in the table. The following observations are evident from the data in Table 2:

- The reading score for California's third grade students improved by 1.2 percent correct since 1981-82 and 2.7 percent correct from 1979-80, when the test was first administered.

- The gains in reading have increased systematically over the past three years (from 0.6 to 0.9 to 1.2 percent correct).

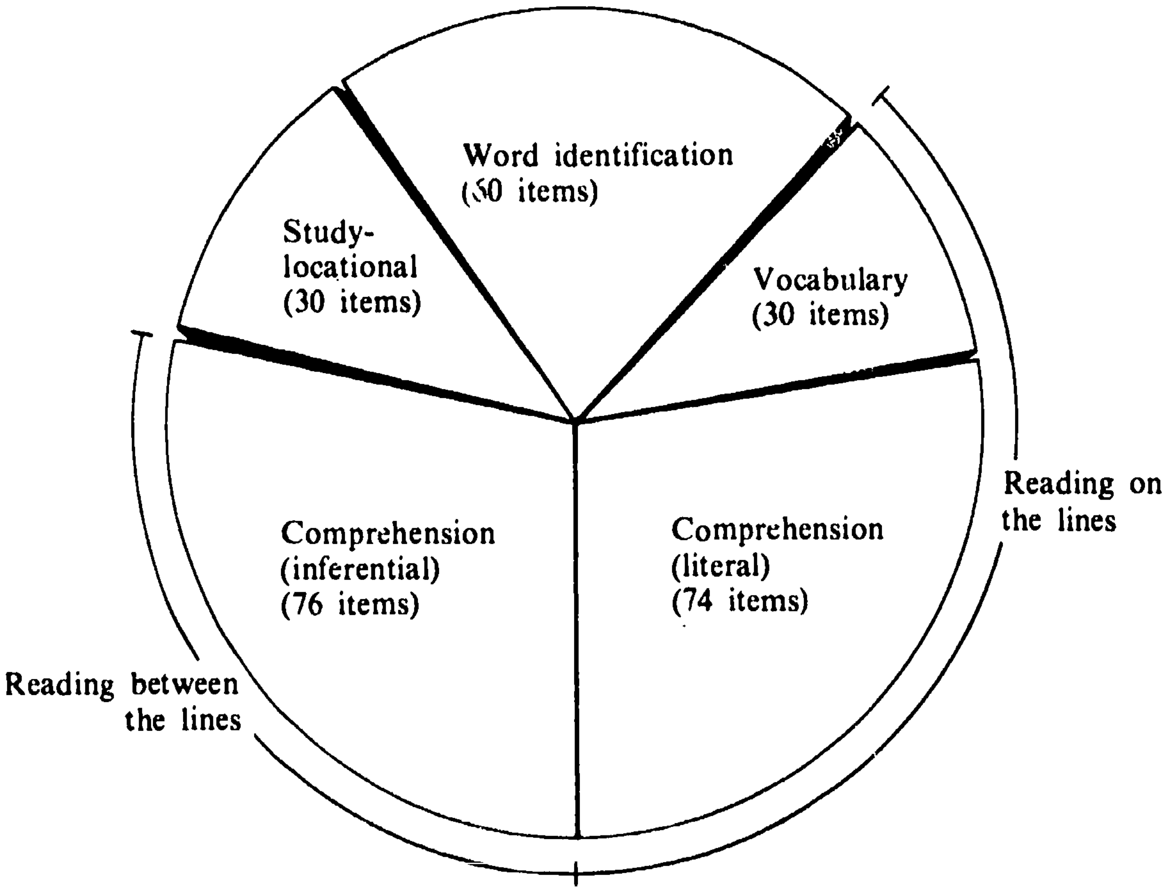

Fig. 1. Number of questions, by skill area, in the reading portion of the *Survey of Basic Skills: Grade 3*

- Gains of over 1.0 percent correct appeared in all comprehension skill areas from 1981-82 to 1982-83 and in four word identification skill areas, recognizing word meanings, and table of contents as well

- The largest gain in the comprehension skill areas over the three-year period from 1979-80 to 1982-83 was in the area of main ideas (3.0 percent correct). Structural analysis and study-locational skill areas also showed substantial gains (3.4 and 3.0 percent correct, respectively).

- The smallest gains over the three-year period from 1979-80 to 1982-83 were in the areas of using context clues (1.9 percent correct) and drawing conclusions from details (1.5 percent correct).

Table 2

Reading Scores of California Third Grade Students on the Survey of Basic Skills: Grade 3, 1979-80 Through 1982-83

Skill area	Number of questions	Average percent correct score				Change in score			Total
		1979-80	1980-81	1981-82	1982-83	1979-80 to 1980-81	1980-81 to 1981-82	1981-82 to 1982-83	1979-80 to 1982-83
TOTAL READING	270	70.0	70.6	71.5	72.7	+0.6	+0.9	+1.2	+2.7
Word identification	60	76.5	77.3	78.2	79.4	+0.8	+0.9	+1.2	+2.9
Phonics	30	78.9	79.6	80.3	81.2	+0.7	+0.7	+0.9	+2.3
Vowels	15	77.7	78.4	79.0	80.0	+0.7	+0.6	+1.0	+2.3
Consonants	15	80.1	80.8	81.6	82.3	+0.7	+0.8	+0.7	+2.2
Structural analysis	30	74.2	75.0	76.2	77.6	+0.8	+1.2	+1.4	+3.4
Prefixes, suffixes, roots	18	69.0	69.7	71.0	72.4	+0.7	+1.3	+1.4	+3.4
Contractions and compounds	12	82.1	82.8	84.0	85.4	+0.7	+1.2	+1.4	+3.3
Vocabulary	30	62.5	62.8	64.0	64.9	+0.3	+1.2	+0.9	+2.4
Recognizing word meanings	16	68.5	68.8	70.1	71.2	+0.3	+1.3	+1.1	+2.7
Using context with multiple-meaning words	14	55.7	55.9	57.1	57.6	+0.2	+1.2	+0.5	+1.9
Comprehension	150	65.8	66.2	67.0	68.3	+0.4	+0.8	+1.3	+2.5
Literal	74	65.2	65.7	66.4	67.8	+0.5	+0.7	+1.4	+2.6
Details	37	63.5	64.0	64.6	65.9	+0.5	+0.6	+1.3	+2.4
--from single sentence	20	63.7	64.1	64.9	66.3	+0.4	+0.8	+1.4	+2.6
--from two or three sentences	17	63.1	63.9	64.3	65.5	+0.8	+0.4	+1.2	+2.4
Pronoun references	18	70.9	71.1	72.0	73.3	+0.2	+0.9	+1.3	+2.4
Sequence	19	63.2	63.9	64.6	66.1	+0.7	+0.7	+1.5	+2.9
Inferential	76	66.3	66.8	67.5	68.7	+0.5	+0.7	+1.2	+2.4
Main idea	19	69.5	70.1	71.3	72.5	+0.6	+1.2	+1.2	+3.0
Cause and effect	20	66.8	67.1	67.9	69.3	+0.3	+0.8	+1.4	+2.5
Drawing conclusions	37	64.3	64.9	65.4	66.5	+0.6	+0.5	+1.1	+2.2
--about characters	15	70.5	71.0	72.1	73.2	+0.5	+1.1	+1.1	+2.7
--from details	12	56.5	56.9	57.0	58.0	+0.4	+0.1	+1.0	+1.5
--from overall meaning	10	64.4	65.2	65.4	66.8	+0.8	+0.2	+1.4	+2.4
Study-locational	30	85.9	86.7	87.8	88.9	+0.8	+1.1	+1.1	+3.0
Alphabetizing	15	82.2	83.1	84.0	85.3	+0.9	+0.9	+1.3	+3.1
Table of contents	15	89.5	90.3	91.6	92.5	+0.8	+1.3	+0.9	+3.0

Interpretation of Skill Area Results, Grade Three

The members of the Reading Assessment Advisory Committee, a panel of distinguished California educators with recognized expertise in reading instruction and assessment, analyzed, interpreted, and evaluated the 1982-83 reading results for grade three. In this process they examined the changes in skill area performance in light of the philosophy underlying the CAP reading tests. This philosophy is stated generally in the Reading Framework for California Public Schools and more specifically in Survey of Basic Skills: Grade 3--Rationale and Content.

The members of the assessment advisory committee were pleased to see the continued increasing gains in reading scores at grade three. This year marks the sixteenth consecutive year of improvement for third grade reading scores in California (a fact that is determined through equating studies with other tests). The committee members speculated that the concentration of resources supporting primary reading instructional programs is paying off in terms of test score gains at the grade three level.

The members of the committee were also pleased with the consistent gains shown on all vocabulary and literal comprehension skills. They also noted that the cluster of literal sequence questions registered the largest gain (1.5 percent correct) among all reading skill areas from 1981-82 to 1982-83. The smallest gain from 1981-82 to 1982-83 was registered for using context clues in defining multiple-meaning words, which continues to be one of the most difficult areas on the third grade reading test. The same kind of context questions appear on the Survey of Basic Skills: Grade 6; yet, sixth graders apparently handle them with ease, since percent correct scores are quite high at that level. Apparently instruction, experience, and maturation during grades four, five, and six serve to overcome students' apparent weakness in using context clues in grade three. Although third grade students' ability to use context increased, committee members concluded that continuing instructional emphasis is needed in all aspects of vocabulary, given the central role that knowledge of word meanings plays in comprehension.

The members of the Reading Assessment Advisory Committee applauded the schools for the consistent increases shown in inferential comprehension, which requires students to read "between the lines." Research shows that such higher-level reading and thinking skills can be taught if teachers choose to address them and know how to phrase questions that require students to think and imagine. The committee members were pleased that scores in the skill of finding main ideas increased 3.0 percent correct over the past three years. This increase may reflect the current emphasis in reading instruction in the primary grades.

The reading skill area showing the least gain was drawing conclusions from details, which has been a consistent weakness at all grade levels in previous years. The difficulty in this area is not surprising since the questions involve multiple-step processes, including reading carefully for details and drawing a conclusion from the appropriate detail. The members of the committee recommended continuing emphasis on important higher-level comprehension skills, such as main ideas, cause and effect, and drawing conclusions from details--especially in view of the still higher gains registered in the more mechanical skills, such as structural analysis.

Instructional Recommendations

The members of the Reading Assessment Advisory Committee concluded their analysis of grade three test results by offering four instructional recommendations:

1. Research shows that students learn more and retain it longer when they have dialogue with the teacher and have many opportunities to write. Such teaching strategies should be employed much more frequently than assigning and correcting worksheets and workbooks.

2. Comprehension, especially the higher-level thinking skills and vocabulary, should be stressed in the primary grades without undue emphasis on the mechanics of word identification.

3. Every classroom should include numerous opportunities for oral language practice through discussions, reporting, and question-and-answer sessions.

4. Teachers should explore reasons for students' mistakes in an attempt to discover the thinking strategies the students are using.

Scope and Foundations of the Grade Six Test

In 1982-83 the Survey of Basic Skills: Grade 6 was administered for the second year. The reading section of the Survey of Basic Skills: Grade 6 contains questions from six broad skill areas: (1) vocabulary; (2) literal comprehension; (3) inferential comprehension; (4) interpretive comprehension; (5) critical/applicative comprehension; and (6) study-locational skills. These skill areas reflect the emphases in the Reading Framework for California Public Schools, the Handbook for Planning an Effective Reading Program, and state-adopted reading textbooks commonly used at the sixth grade level.

Decisions about the emphasis and breadth of content for each of these skill areas were made by the Reading Assessment Advisory Committee. In making these decisions, the committee members considered information from field reviews of preliminary test content specifications. The results were used to determine the emphasis placed on each skill area and whether the skill should be assessed on the Survey. These field reviews reflected the points of view of district and school personnel.

The reading committee decided that the area of comprehension should receive the greatest emphasis in the reading section of the Survey. This decision is also consistent with the state-adopted Handbook for Planning an Effective Reading Program, which includes the following statement: "Comprehension is the central goal of reading" (page 7). Thus, approximately 75 percent of the reading questions are comprehension items.

The two major features of the reading section of the Survey of Basic Skills: Grade 6 are:

- The test reflects the new Reading Framework for California Public Schools, which emphasizes comprehension development, higher-level thinking, and reading in the content areas.

- Content area reporting is a major feature of the revised Survey. Comprehension and vocabulary scores are reported for science, social studies, and literature.

The emphasis assigned to each of the reading skill areas in the Survey is presented graphically in Figure 2. For an illustrated description of all reading skill areas and underlying rationale, see Survey of Basic Skills: Grade 6--Rationale and Content (Sacramento: California State Department of Education, 1982).

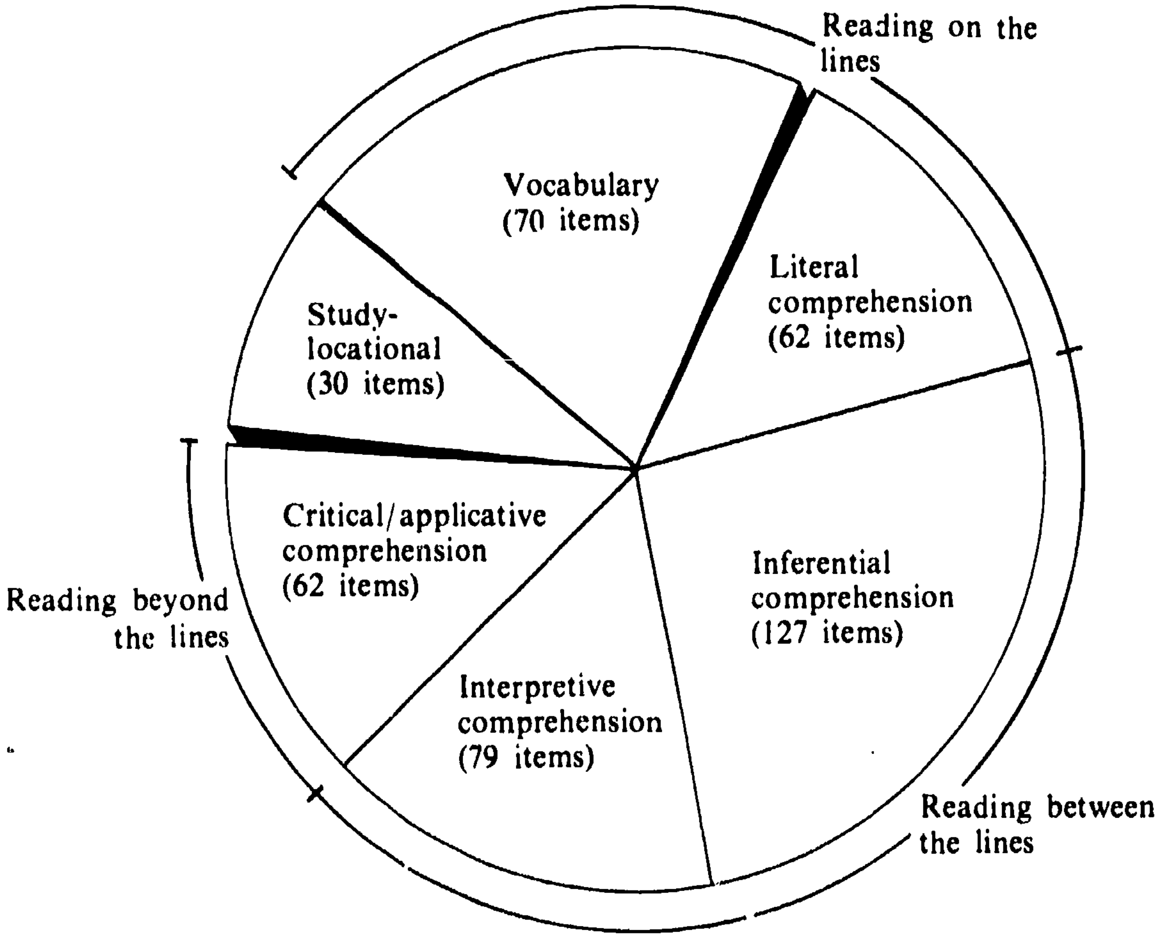

Fig. 2. Number of questions, by skill area, in the reading portion of the *Survey of Basic Skills: Grade 6*

Reading Results for Grade Six

The results of sixth graders' performance on the reading section of the Survey are shown in Table 3. The following observations are evident from the data in Table 3:

- The overall sixth grade reading score declined from 71.5 percent correct in 1981-82 to 71.3 percent correct in 1982-83, a decline of 0.2 percent correct.

- Of the 27 reading skill area elements assessed, scores declined in 17.

- The gains that did occur appeared in the higher-level areas beyond literal comprehension. Increases were registered in four inferential comprehension skill areas, one interpretive skill area, two critical/applicative skills, and one study-locational skill area.

- The reaggregation of reading scores by content areas (science, social studies, and literature) revealed a pattern of decreases or no change. Exceptions to this pattern occurred under word meanings for science and social studies, both of which showed slight gains (+0.2 and +0.1 percent correct, respectively) and for literal and critical/applicative comprehension of science passages, both of which increased by 0.1 percent correct.

Interpretation of Skill Area Results, Grade Six

The members of the Reading Assessment Advisory Committee analyzed, interpreted, and evaluated the 1981-82 reading results for grade six. In this process they examined the scores in the reading skill areas in light of the philosophy underlying the CAP reading tests. This philosophy is stated generally in the Reading Framework for California Public Schools and more specifically in Survey of Basic Skills: Grade 6--Rationale and Content.

Members of the Reading Assessment Advisory Committee were concerned about the decline in grade six reading scores. Equating studies between the new Survey of Basic Skills: Grade 6 and tests used previously reveal that 1982-83 is the first time in six years that sixth grade reading scores have failed to improve. The committee suggested that the decline in sixth grade reading scores may reflect the decline in resources supporting intermediate reading programs since the advent of Proposition 13 and the concentration of existing resources at grade three.

Given the well-documented emphasis of most elementary classroom instruction on literal-level responses, members of the committee were surprised at the decline in the literal skill areas but not unduly alarmed considering the relatively strong showing in literal comprehension (76.4 percent correct).

Table 3

Reading Scores of California Sixth Grade Students on the Survey of Basic Skills: Grade 6, 1981-82 Through 1982-83

Skill area	Number of questions	Average percent correct score		Change in average percent correct score
		1981-82	1982-83	
TOTAL READING	430	71.5	71.3	-0.2
Vocabulary	70	70.1	69.9	-0.2
Prefixes, roots, and suffixes	16	67.0	66.8	-0.2
Recognizing word meanings	37	67.7	67.7	-0-
Using context with multiple-meaning words	17	78.1	77.6	-0.5
Comprehension	330	71.2	71.0	-0.2
Literal	62	76.7	76.4	-0.3
Details	31	80.1	79.9	-0.2
--from single sentence	14	80.2	79.8	-0.4
--from two or three sentences	17	80.0	79.9	-0.1
Pronoun references	16	74.3	73.9	-0.4
Sequence	15	72.4	72.0	-0.4
Inferential	127	67.3	67.2	-0.1
Main idea	16	73.4	73.6	+0.2
Cause and effect	15	75.6	75.5	-0.1
Following organization	16	58.0	58.2	+0.2
Putting information together	15	62.5	62.1	-0.4
Predicting outcomes	18	69.3	68.7	-0.6
Making comparisons and contrasts	17	60.6	60.7	+0.1
Drawing conclusions from details	16	65.1	65.2	+0.1
Drawing conclusions from overall meaning	14	75.3	74.8	-0.5
Interpretive	79	74.9	74.6	-0.3
Analyzing characters	18	75.6	75.4	-0.2
Understanding setting	12	78.4	77.9	-0.5
Summarizing plot	13	73.4	73.2	-0.2
Understanding dialogue	12	77.2	77.3	+0.1
Sensing mood	12	67.1	66.4	-0.7
Understanding figurative language	12	77.4	77.1	-0.3
Critical/applicative comprehension	62	68.7	68.8	+0.1
Detecting author and author's attitude	12	66.1	66.2	+0.1
Detecting author's purpose	19	72.7	72.7	-0-
Separating fact from opinion	16	66.8	67.1	+0.3
Applications to a different context	15	67.9	67.6	-0.3
Study-locational skills	30	78.1	78.1	-0-
Reference materials and parts of a book	15	81.8	81.5	-0.3
Maps, graphs, and charts	15	74.2	74.6	+0.4
Reading in the content areas				
Vocabulary--word meanings	37	67.7	67.7	-0-
In reading and literature	13	71.2	71.0	-0.2
In science	11	71.1	71.3	+0.2
In social studies	13	61.3	61.4	+0.1
Comprehension of literature passages	117	74.3	74.0	-0.3
Literal	17	79.5	78.7	-0.8
Inferential	29	72.0	71.9	-0.1
Interpretive	61	74.7	74.4	-0.3
Critical/applicative	10	69.9	69.8	-0.1
Comprehension of science passages	103	68.0	68.0	-0-
Literal	17	76.5	76.6	+0.1
Inferential	58	65.4	65.2	-0.2
Critical/applicative	28	68.4	68.5	+0.1
Comprehension of social studies passages	107	70.8	70.7	-0.1
Literal	28	75.2	75.0	-0.2
Inferential	40	66.7	66.6	-0.1
Interpretive	15	77.0	77.0	-0-
Critical/applicative	24	68.7	68.7	-0-

The committee members observed that, under vocabulary, losses were registered for prefixes, roots, and suffixes (-0.2 percent correct), using context (-0.5 percent correct), and general vocabulary (-0.2 percent correct), while gains were shown for science terms (+0.2 percent correct) and social studies terms (+0.1 percent correct). The committee members were pleased with the gains shown in content area vocabulary, but the uneven performance in the other vocabulary skill areas led them to conclude that more emphasis is needed in vocabulary development. This may be done through oral language activities, broad and varied reading, discussion, and direct instruction.

In the area of inferential comprehension, high scores were registered for skills requiring students to infer the primary message of the material, skills such as drawing conclusions from overall meaning (74.8 percent correct), and identifying main ideas (73.6 percent correct). The most difficult inferential comprehension skills for sixth graders proved to be drawing conclusions from details (65.2 percent correct), putting information together (62.1 percent correct), making comparisons and contrasts (60.[illegible] percent correct), and following organization (58.2 percent correct).

The members of the committee were very pleased to observe increases for some of the most difficult inferential comprehension skill areas, specifically for following organization (+0.2 percent correct), making comparisons and contrasts (+0.1 percent correct), and drawing conclusions from details (+0.1 percent correct) as well as for the easier skill area of finding main ideas (+0.2 percent correct).

As is apparent from the list of skills in the interpretive comprehension category, most of the interpretive skills are associated with the study of literature. All of these skill areas registered a decline except understanding dialogue, which gained 0.1 percent correct. The skill area showing the largest decline was sensing mood (-0.7 percent correct), which was also the most difficult interpretive comprehension skill area for sixth graders. These questions require students to interpret the prevailing feeling or tone of a selection. As the members of the English Language Assessment Advisory Committee have repeatedly insisted, students need focused instruction that will sensitize them to the emotional connotations of language.

Members of the reading committee were especially pleased to see an overall gain (+0.1 percent correct) for critical/applicative comprehension and increases in two critical skill areas: detecting author and author's attitude (+0.1 percent correct) and separating fact from opinion (+0.3 percent correct). Noting that the ability to make applications to another context is of paramount importance to reading in all areas of the curriculum, the committee expressed particular concern over the decline in this skill area (-0.3 percent correct).

After examining the breakout of reading scores according to the content areas of literature, science, and social studies, members of the committee expressed particular concern over the decline (-0.3 percent correct) in the comprehension of literature passages. The committee concluded that involvement in good literature is an important indicator of a high-quality reading program and that increased emphasis is needed in this area.

Instructional Recommendations

After completing their analyses of the data from the Survey of Basic Skills: Grade 6, the members of the committee offered the following recommendations:

1. Resources that have traditionally supported primary grade reading programs should be extended and intensified at the intermediate levels.

2. More time, especially actively engaged instructional time, is needed for reading in all curricular areas at the upper elementary level. Reading in and out of school time should be actively encouraged through rewards, discussions, and assigned readings.

3. Every reading program should regularly involve children in high-quality literature.

4. All higher-level reading and thinking skills and vocabulary development should receive high priority in all content areas across the curriculum.

5. Reading, including comprehension and thinking in all disciplines across the curriculum, must be taught actively and creatively and must go beyond merely assigning and correcting worksheets.

6. In the development of the higher-level reading and thinking skills, there is a need for discussion and composition to improve students' ability to think, thereby enabling them to draw comparisons and contrasts, infer new conclusions, make applications to different contexts, and integrate new ideas into their experiences.

7. The study of vocabulary should be intensified through oral language development, broad and varied reading, and direct instruction. Such instruction should include strategies for increasing students' awareness of the emotional connotations of words.

Scope and Foundations of the Grade Twelve Test

The reading section of the Survey of Basic Skills: Grade 12 consists of 141 questions. The items were designed to assess students' attainment of a wide range of objectives discussed broadly in Framework in Reading for the Elementary and Secondary Schools of California (since updated as Reading Framework for California Public Schools: Kindergarten Through Grade Twelve) and specified, with the help of the Reading Assessment Advisory Committee, in Test Content Specifications, State Reading Tests, Grades Two, Three, Six, and Twelve (Sacramento: California State Department of Education, 1975). As shown in Figure 3, both the objectives and the questions used to assess the achievement of the objectives fall into one of four reading skill areas: vocabulary, literal comprehension, interpretive/critical comprehension, and study-locational skills. Figure 3 is also an illustration of the emphasis placed on each of the reading skill areas in the Survey of Basic Skills: Grade 12.

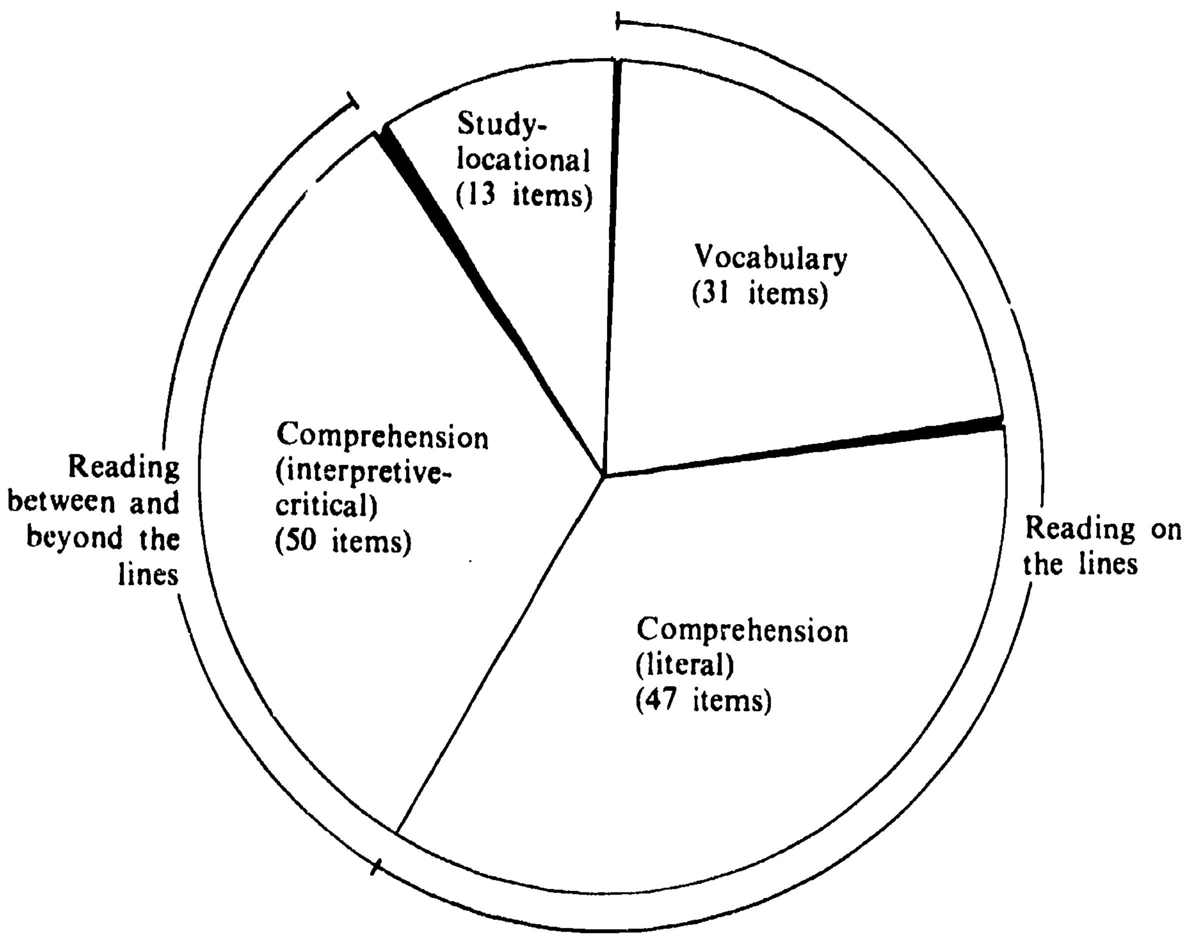

Fig. 3. Number of questions, by skill area, in the reading portion of the *Survey of Basic Skills: Grade 12*

Reading Results for Grade Twelve

For the eighth consecutive year, the Survey of Basic Skills: Grade 12 was administered to all California twelfth grade students. The reading achievement results from this test are shown in Table 4. Year-to-year changes in overall reading performance and in each of the reading skill areas are also shown in the table. The following observations are evident from the data in Table 4:

- In six of the last seven years, since the Survey of Basic Skills: Grade 12 was first administered in California, twelfth grade reading scores have declined. This generally downward trend continued from 1981-82 to 1982-83 with a slight decline of 0.1 percent correct, yielding an overall decline of 1.0 percent correct since 1975-76.

- All reading skill areas registered slight declines from 1981-82 to 1982-83 except for the study-locational skill area, which showed a small gain (+0.1 percent correct).

- Over the eight-year period from 1975-76 to 1982-83, vocabulary and interpretive/critical comprehension showed the largest declines (-1.3 and -1.4 percent correct, respectively); the smallest decline (-0.1 percent correct) was registered for study-locational skills.

Table 4

Reading Scores of California Twelfth Grade Students on the Survey of Basic Skills: Grade 12, 1975-76 Through 1982-83

	Skill area					
				Comprehension		
	Total reading	Vocabulary	Comprehension	Literal	Interpretive/ critical	Study-locational
Number of questions	141	31	97	47	50	13
	Average percent correct score					
1975-76	64.1	61.3	64.5	69.2	60.1	68.4
1976-77	63.6	60.9	63.9	68.9	59.3	67.2
1977-78	63.3	60.5	63.7	68.5	59.2	67.3
1978-79	63.2	60.2	63.7	68.6	59.0	67.4
1979-80	63.1	60.0	63.5	68.5	58.9	67.4
1980-81	63.4	60.2	63.8	68.8	59.1	68.4
1981-82	63.2	60.1	63.5	68.6	58.8	68.2
1982-83	63.1	60.0	63.4	68.3	58.7	68.3
	Change in average percent correct score					
1975-76 to 1976-77	-0.5	-0.4	-0.6	-0.3	-0.8	-1.2
1976-77 to 1977-78	-0.3	-0.4	-0.2	-0.4	-0.1	+0.1
1977-78 to 1978-79	-0.1	-0.3	-0-	+0.1	-0.2	+0.1
1978-79 to 1979-80	-0.1	-0.2	-0.2	-0.1	-0.1	-0-
1979-80 to 1980-81	+0.3	+0.2	+0.3	+0.3	+0.2	+1.0
1980-81 to 1981-82	-0.2	-0.1	-0.3	-0.2	-0.3	-0.2
1981-82 to 1982-83	-0.1	-0.1	-0.1	-0.3	-0.1	+0.1
Total change, 1975-76 to 1982-83	-1.0	-1.3	-1.1	-0.9	-1.4	-0.1

Interpretation of Skill Area Results, Grade Twelve

The members of the Reading Assessment Advisory Committee analyzed, interpreted, and evaluated the 1982-83 reading results for grade twelve. In this process they examined the changes in skill area performance in light of the philosophy underlying the CAP reading tests, which is stated in the Reading Framework for California Public Schools.

Members of the committee were extremely concerned that twelfth grade reading scores have declined for six of the last seven years. The committee members speculated that in many senior high schools, teachers of content areas (such as science and social studies) feel that the teaching of reading is not their responsibility. They also commented that sometimes students with reading difficulties spend too much time in reading labs filling out workbooks, a process that can result in less time spent reading. Because of distractions of television and social activities, out-of-school time is rarely spent reading. Also expressed was the fear that proficiency testing may be actually downgrading the curriculum in certain areas. The committee concluded that there is a need for more qualified reading experts at the high school level.

Because there have been consistent declines in performance in all reading areas at the twelfth grade, the members of the committee expressed concern that reading and thinking skills be emphasized in all curricular areas at the secondary level. They also noted the special importance of vocabulary in this process. As stated in the Reading Framework (page 15):

> Some skills are common to all of the content areas, including the ability to (1) set purposes for reading; (2) survey materials; (3) understand graphic and illustrative materials; and (4) locate, comprehend, and combine information from several sources.
>
> Each content area subject presents unique problems for the reader. If students are to comprehend the materials used in a content area subject, they must learn the vocabulary of the subject.

The members of the Reading Assessment Advisory Committee observed that interpretive/critical comprehension is not only the most difficult reading skill area on the Survey of Basic Skills: Grade 12, but it is also the area showing the greatest overall decline (-1.4 percent correct) since the test was first administered. Thus, the committee again insisted that the higher-level reading and thinking skills receive greater emphasis at the secondary level across the curriculum. The following statement from the Reading Framework (p. 15) succinctly expresses the committee's position on this issue:

> In order for students to comprehend written materials used in the content areas of the curriculum, they should receive instruction in the reading-thinking skills required in these areas. . . .
>
> The students who learn to generalize, to make judgments, to use problem solving techniques, and to reach conclusions have much greater assurance of experiencing success in the content areas than those who have not learned those skills.

The decline in the performance of California's twelfth grade students in interpretive/critical comprehension has paralleled that of similar students nationwide. In a report by the National Assessment of Educational Progress (NAEP), it was disclosed that, nationally, the performance level of seventeen-year-olds had declined significantly (-2.1 percent) in inferential comprehension.

In a 1981 publication by NAEP, Reading, Thinking, and Writing, it was reported that students are not adept at supporting their own multiple-choice selections, analyzing materials to deepen understanding, or evaluating the materials they read. NAEP also found that boys and girls who never read in their spare time or who read only nonfiction scored below national levels. Experts called in by NAEP to interpret the results concluded that students who do not read or who read only nonfiction deprive themselves of those literary materials that appear critical to the building of imagination and to higher-level reading skills.

Instructional Recommendations

The members of the Reading Assessment Advisory Committee concluded their analysis with the following recommendations:

1. Systematic attention should be devoted to finding more effective ways for content area teachers to teach students to learn from text in the various content areas. Such efforts might include identifying strong teaching models at the school site level, providing in-service training to meet the needs of content area teachers, and/or hiring qualified reading specialists at the secondary level.

2. All higher-level reading and thinking skills, including interpretive, inferential, and critical/applicative comprehension skills (or, more informally, "reading between the lines" and "reading beyond the lines") should receive high priority in all content areas across the curriculum.

3. In the development of the higher-level reading and thinking skills, discussion is necessary to improve students' thinking and thereby enable them to put information together, draw comparisons and contrasts, infer new conclusions, make applications to different contexts, and integrate new ideas into their experiences.

4. Reading, including comprehension and thinking in all disciplines across the curriculum, must be taught actively and creatively and must go beyond merely assigning and correcting worksheets.

5. The study of vocabulary should be intensified through oral language development, broad and varied reading, and direct instruction. Such instruction should include strategies for increasing student awareness of the emotional connotations of words.

6. Activities are needed which will encourage and require students to spend more time reading outside the classroom.

IV. Written Language Achievement for Grades Three, Six, and Twelve

Synopsis of Findings

- Grade three written language scores improved by 1.1 percent correct between 1981-82 and 1982-83. Scores improved in all but one of the 34 skill areas. This is the third consecutive year that scores improved in written language at grade three, yielding an overall gain of 2.9 percent correct from 1979-80 to 1982-83.

- Grade six written language scores for 1982-83 improved by 0.4 percent correct over the score of the previous year, when this edition of the Survey of Basic Skills: Grade 6 was first administered. Gains were shown in 29 of the 39 skill areas.

- For the first time in five years, twelfth grade written expression scores declined (-0.2 percent correct); losses occurred in three of the seven skill areas.

- The median twelfth grade student in California is now scoring at the 34th percentile on national norms in written language; the median sixth grader is at the 49th percentile; and the median third grader is at the 42nd percentile. (See Chapter VI, "Comparisons with National Norms.")

Committee's Recommendations

After reviewing the data presented in the following three sections, the English Language Assessment Advisory Committee (see the Appendix for members' names) offered the following recommendations:

Policy Recommendations

1. Statewide efforts are needed to increase the amount of quality instructional time for composition.

2. High school students should be required to take four years of high school English. The committee supports any efforts that will increase the number of hours students spend in the English classroom.

3. Additional resources are needed at the classroom level to support and assist those responsible for the teaching of writing.

4. Efforts are needed to ensure that those teaching language, composition, and literature are well qualified in these areas.

5. Districts should conduct annual schoolwide assessments of writing (including writing samples) as an integral part of the writing program.

6. The State Department of Education should include writing samples at various grade levels as part of the California Assessment Program.

Instructional Recommendations--Grade Three

1. Primary grade teachers should nurture fluency in students' own writing. A concern for correctness in language should not interfere with the major objective of nurturing this fluency.

2. More emphasis is needed in the area of language choices, which would offer primary grade children numerous opportunities to learn to use specifics and sensory detail in their writing.

3. Efforts to develop sentence and paragraph sense in primary grade children should be continued through a wide variety of oral and written activities in which the children's active use of language is central.

4. The focus of instruction should be whole units of thought rather than fragmented pieces of language isolated from context.

Instructional Recommendations--Grades Six and Twelve

1. Writing instruction should include more writing, more teaching of writing, a greater variety of writing assignments, and adherence to the principles set forth in the Handbook for Planning an Effective Writing Program (Sacramento: California State Department of Education, 1983).

2. Writing should be integrated with the teaching of reading in all the content areas. In language arts instruction, writing should be integrated with the teaching of literature.

3. While students are engaged in the act of writing, only the process skills of writing should be emphasized. Later, during the act of editing, the supporting skills of writing should be emphasized as the need arises and should not be neglected.

4. Teachers should do more writing themselves, especially in the classroom with their students and on the topics they assign.

5. Various types of writing activities and events (such as writing celebrations, writing showcases, write-athons, writing fairs, and writing olympics) should be planned and conducted to emphasize the importance of writing and to provide out-of-classroom audiences for students' writing.

6. The California Assessment Program results as well as direct assessments of students' writing should be used for analyzing programmatic strengths and weaknesses and for setting goals.

Scope and Foundations of the Grade Three Test

The written language section of the Survey of Basic Skills: Grade 3 contains questions from eight skill areas that are divided into two main categories. The first is "Writing Process Skills," which deals primarily with matters of judgment in writing. The skills included in this category are (1) paragraphs; (2) sentence recognition; and (3) language choices. The other category, "Supporting Skills," also a necessary part of writing instruction, includes the following skills: (4) standard usage; (5) word forms; (6) spelling; (7) punctuation; and (8) capitalization. These skills reflect the goals and objectives stated in the English Language Framework for California Public Schools: Kindergarten Through Grade Twelve (Sacramento: California State Department of Education, 1976) and the Handbook for Planning an Effective Writing Program as well as the major written language skills covered in state-adopted language textbooks commonly used in California's third grade classrooms.

Decisions concerning emphasis and breadth of context for each of the eight skill areas were made by the English Language Assessment Advisory Committee, which is composed of language arts experts representing a cross section of instructional levels and institutions from across the state.

The committee members considered the following sources of information during the test development process:

1. Content analyses of commonly used third grade language textbooks adopted by the State Board of Education

2. Field reviews of skill area compilations in which teachers and curriculum specialists indicated the degree of emphasis they assigned to each skill area and whether or not the skill in question should be assessed on the Survey

3. Reviews in which teachers judged each language item as to the degree of instructional emphasis placed on that particular skill and whether the item should be retained, modified, or omitted.

The language items were written to simulate actual production of written language as closely as possible within the restrictions of a multiple-choice testing format. Consequently, almost all the language items require pupils to select needed letters, words, or sentences for a blank in a word, sentence, or paragraph.

The emphasis assigned to each of the written language skill areas within the two broad areas on the Survey of Basic Skills: Grade 3 is precented graphically in Figure 4.

Written Language Results for Grade Three

The Survey of Basic Skills: Grade 3 was administered for the fourth successive year in 1982-83. The results of third grade performance on the language section of this test are shown in Table 5. Year-to-year changes in overall performance and in skill area performance are also shown in the table. The following observations are evident from the data in Table 5:

- The written language score for California's third grade students increased by 1.1 percent correct from 1981-82 to 1982-83, and gains were made in 33 of the 34 skill areas assessed. This marked the third consecutive year that gains were achieved in written language at grade three, yielding an overall gain of 2.9 percent correct from 1979-80 to 1982-83.

- The largest gain from 1981-82 to 1982-83 was in supplying subjects (+2.8 percent correct) in the category of sentence recognition. The only skill area that declined in the past year was also within sentence recognition. Scores in the supplying verbs area declined by 0.5 percent correct.

- The largest gains over the three-year period from 1979-80 to 1982-83 were registered for commas (+5.3 percent correct), supplying subjects (+4.8 percent correct), periods and questions (+4.8 percent correct), apostrophes (+4.4 percent correct), specific words (+4.2 percent correct), and contractions (+4.1 percent correct).

- The smallest gain over this same three-year period occurred for irregular noun plurals (+0.6 percent correct).

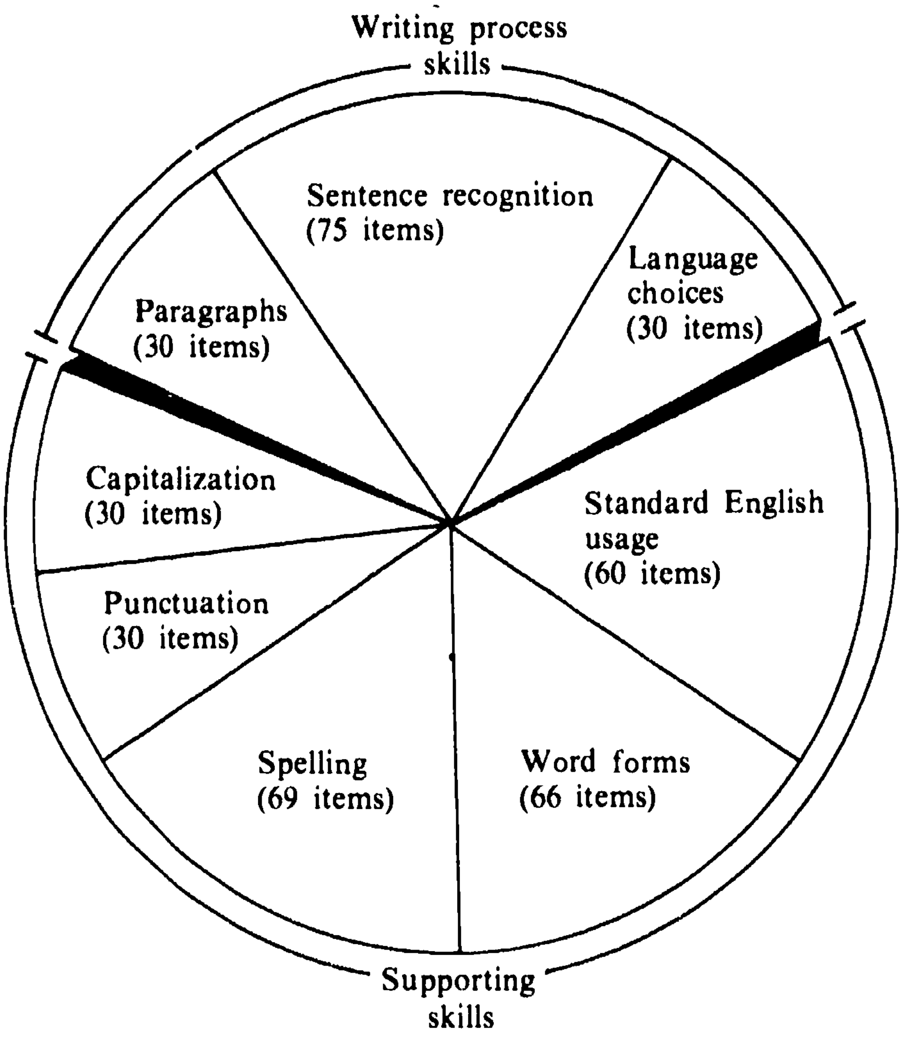

Fig. 4. Number of questions, by skill area, in the written language portion of the *Survey of Basic Skills: Grade 3*

Table 5

Written Language Scores of California Third Grade Students on the Survey of Basic Skills: Grade 3, 1979-80 Through 1982-83

Skill area	Number of questions	Average percent correct score 1979-80	1980-81	1981-82	1982-83	Change 1979-80 to 1980-81	1980-81 to 1981-82	1981-82 to 1982-83	Total change 1979-80 to 1982-83
TOTAL WRITTEN LANGUAGE	390	74.8	75.4	76.6	77.7	+0.6	+1.2	+1.1	+2.9
Writing Process Skills									
1. Paragraphs	30	69.6	70.0	71.3	72.5	+0.4	+1.3	+1.2	+2.9
- Topic sentence	15	68.4	68.8	70.1	71.3	+0.4	+1.3	+1.2	+2.9
- Details and sequence	15	70.9	71.3	72.5	73.7	+0.4	+1.2	+1.2	+2.8
2. Sentence recognition	75	78.4	79.1	80.5	81.8	+0.7	+1.4	+1.3	+3.4
- Statements and questions	15	74.1	74.9	76.1	77.6	+0.8	+1.2	+1.5	+3.5
- Complete sentences	60	79.5	80.2	81.7	82.8	+0.7	+1.5	+1.1	+3.3
- Supplying subjects	30	78.8	79.5	80.8	83.6	+0.7	+1.3	+2.8	+4.8
- Supplying verbs	30	80.3	80.9	82.5	82.0	+0.6	+1.6	-0.5	+1.7
3. Language choices	30	66.1	67.0	68.6	69.9	+0.9	+1.6	+1.3	+3.8
- Sensory words	15	72.1	73.0	74.1	75.4	+0.9	+1.1	+1.3	+3.3
- Specific words	15	60.2	61.0	63.1	64.4	+0.8	+2.1	+1.3	+4.2
Supporting Skills									
4. Standard usage	60	74.2	74.4	75.1	76.0	+0.2	+0.7	+0.9	+1.8
- Irregular verbs	15	76.7	76.6	77.3	78.1	-0.1	+0.7	+0.8	+1.4
- Pronouns	15	73.5	73.8	74.4	75.3	+0.3	+0.6	+0.9	+1.8
- Subject-verb agreement	16	69.3	69.5	70.4	71.1	+0.2	+0.9	+0.7	+1.8
- Noun determiners	14	78.0	78.5	78.9	80.0	+0.5	+0.4	+1.1	+2.0
5. Word forms	66	74.9	75.2	76.0	77.1	+0.3	+0.8	+1.1	+2.2
- Prefix	14	79.1	79.4	79.9	80.9	+0.3	+0.5	+1.0	+1.8
- Inflectional suffix	12	76.3	76.6	78.0	79.1	+0.3	+1.4	+1.1	+2.8
- Derivational suffix	11	76.3	76.8	77.3	78.1	+0.5	+0.5	+0.8	+1.8
- Irregular noun plural	14	65.1	64.8	65.2	65.7	-0.3	+0.4	+0.5	+0.6
- Contractions	15	77.8	78.9	80.0	81.9	+1.1	+1.1	+1.9	+4.1
6. Spelling	69	73.0	73.5	74.6	75.8	+0.5	+1.1	+1.2	+2.8
- Predictables	39	80.4	80.7	81.7	82.8	+0.3	+1.0	+1.1	+2.4
- Words with suffixes	16	55.5	56.3	57.5	58.9	+0.8	+1.2	+1.4	+3.4
- Demons and homophones	14	72.4	73.2	74.3	75.7	+0.8	+1.1	+1.4	+3.3
7. Punctuation	30	72.0	73.3	74.9	76.8	+1.3	+1.6	+1.9	+4.8
- Periods and questions	10	77.8	79.0	80.8	82.6	+1.2	+1.8	+1.8	+4.8
- Commas	10	62.4	63.7	65.2	67.7	+1.3	+1.5	+2.5	+5.3
- Apostrophes	10	75.7	77.1	78.7	80.1	+1.4	+1.6	+1.4	+4.4
8. Capitalization	30	88.1	89.2	90.1	91.1	+1.1	+0.9	+1.0	+3.0
- Persons	10	90.9	91.6	92.4	93.2	+0.7	+0.8	+0.8	+2.3
- Places	10	87.3	88.5	89.4	90.4	+1.2	+0.9	+1.0	+3.1
- Days/months	10	86.0	87.5	88.5	89.7	+1.5	+1.0	+1.2	+3.7

Interpretation of Skill Area Results, Grade Three

The members of the English Language Assessment Advisory Committee analyzed, interpreted, and evaluated the 1982-83 written language results for grade three. In this process they examined the changes in skill area performance in light of the rationale underlying the CAP reading tests, which is stated generally in the English Language Framework for California Public Schools and more specifically in Survey of Basic Skills: Grade 3--Rationale and Content.

The members of the committee were very happy to see a third consecutive year of gains in written expression at grade three. They were especially pleased to observe that gains of over 1.0 percent correct occurred in most of the skill areas and that many of these gains were in the writing process skills of language choices, sentence recognition, and paragraphs.

In spite of the unexpected decline from 1981-82 to 1982-83 in supplying verbs, members of the committee were pleased with the high scores and overall gains in the important area of sentence recognition. Performance on these questions reflects children's intuitive sensitivity to the sentence. (The committee's view of the importance of sentence recognition is reflected by the fact that the grade three written language test contains more sentence recognition items than any other type of question.)

The committee members were especially gratified to observe the sizable increases in the language choice areas, particularly specific words (with a 4.2 percent correct cumulative increase), because these skill areas were designated by the committee in previous years for special instructional attention. They observed, however, that of the various writing process skills, the specific words skill area of language choices continues to be by far the most difficult area for third graders. Given this fact, the committee agreed that continuing instructional efforts are needed at the intermediate levels to help children develop a firm grasp of levels of abstraction in language that can help them learn to make better use of detail in their writing.

The committee observed that, after specific word choices, the area of greatest difficulty among writing process skills for third graders was that of topic sentences within paragraphs (71.3 percent correct). The topic sentence questions require third graders to select a sentence that provides a topic for a partial paragraph presented in the item stem. The relatively weak third grade showing in this area led the committee to stress that primary grade teachers need to deal consistently with whole units of thought as much as possible and avoid fragmenting and isolating language elements from meaningful context.

The members of the committee were very pleased with the gains shown for all supporting skills. They noted that the following supporting skill areas were particularly difficult for third graders: spelling words with suffixes (58.9 percent correct), irregular noun plurals (65.7 percent correct), and punctuation with commas (67.7 percent correct). The subskills that were strikingly easy for California's third graders were all within the area of capitalization--names of persons (93.2 percent correct), places (90.4 percent correct), and days/months (89.7 percent correct)--followed by spelling of predictable words (82.8 percent correct), punctuation with periods and question marks (82.6 percent correct), and contractions (81.9 percent correct). The committee commented that the third grade pattern of strengths and weaknesses should be useful for planning in both the intermediate grades (and especially fourth grade) and the primary grades.

The committee observed that the supporting skill areas showing the greatest overall increases since 1979-80 are not necessarily the easiest areas for pupils: punctuation with commas (+5.3 percent correct) and spelling words with suffixes (+3.4 percent correct). The committee members were pleased to see such consistent progress in all supporting skills, especially in the more troublesome areas of spelling and punctuation.

The areas that the committee found to be of least and greatest difficulty are listed in Table 6 for both supporting and writing process skills. The committee's instructional recommendations follow the table.

Table 6

Areas of Weakest and Strongest Achievement in Grade Three Written Language Test for Supporting Skills and Writing Process Skills

Category	Skill areas showing strongest performance	Skill areas showing weakest performance
Writing process skills	Supplying verbs to form complete sentences Supplying subjects to form complete sentences	Selecting specific words for precise language choices Supplying paragraphs with topic sentences
Supporting skills	Capitalization Persons Places Days/months Spelling predictables Punctuation with periods and question marks Contractions	Spelling words with suffixes Irregular noun plurals Punctuation with commas

Instructional Recommendations

The members of the English Language Assessment Advisory Committee concluded their analysis of grade three test results by offering four instructional recommendations:

1. Primary grade teachers should nurture fluency in students' own writing; a concern for correctness in language should not interfere with the major objective of nurturing this fluency.

2. More emphasis is needed in the area of language choices, which would offer primary grade children numerous opportunities to learn to use specific and sensory detail in their writing.

3. Efforts to develop sentence and paragraph sense in primary grade children should be continued through a wide variety of oral and written activities in which active use of language is central.

4. The focus of instruction should be whole units of thought rather than fragmented pieces of language isolated from context.

Scope and Foundations of the Grade Six Test

In 1981-82 a new sixth grade test, the Survey of Basic Skills: Grade 6, was administered for the first time. The written language section of the Survey of Basic Skills: Grade 6 contains questions from nine skill areas that are divided into two main categories. The first is "writing process skills," which deals primarily with matters of judgment in effective writing. The skills included in this category are (1) judging student writing; (2) paragraphs; (3) sentence combining; (4) sentence recognition; and (5) language choices. The other category, "supporting skills," also a necessary part of writing instruction, includes the following skills: (6) standard usage; (7) word forms; (8) spelling; and (9) capitalization and punctuation. These skills reflect the goals and objectives stated in the English Language Framework for California Public Schools: Kindergarten Through Grade Twelve and the Handbook for Planning an Effective Writing Program as well as the major written language skills covered in state-adopted language textbooks commonly used in California's sixth grade classrooms.

Decisions concerning emphasis and breadth of content for each of the nine skill areas were made by the English Language Assessment Advisory Committee, which is composed of language arts experts representing a cross section of instructional levels and educational institutions across the state. The committee members considered the following sources of information during the test development process:

1. Content analyses of commonly used sixth grade language textbooks adopted by the State Board of Education

2. Field reviews of skill area compilations in which teachers and curriculum specialists indicated the degree of emphasis they assigned to each skill area

3. Reviews in which teachers judged each language item as to the degree of instructional emphasis placed on that particular skill and whether the item should be retained, modified, or omitted

The emphasis assigned to each of the written language skill areas in the Survey is presented graphically in Figure 5. For an illustrated description of all reading skill areas and underlying rationale, see Survey of Basic Skills: Grade 6--Rationale and Content.

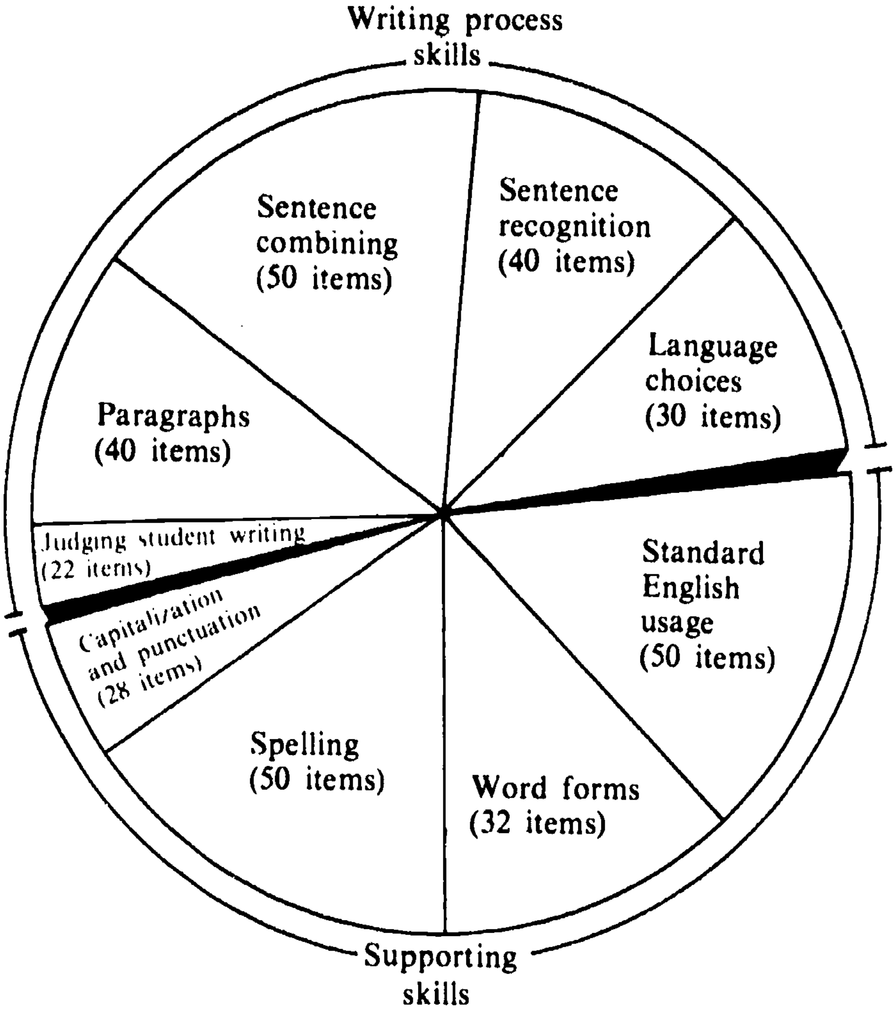

Fig. 5. Number of questions, by skill area, in the written language portion of the *Survey of Basic Skills: Grade 6*

Written Language Results for Grade Six

The Survey of Basic Skills: Grade 6 was administered for the first time in 1981-82. The results of the written language section of this test are shown in Table 7. The following observations are evident from the data in Table 7:

- The total written expression score for California's sixth grade students improved by 0.4 percent correct from the 1981-82 school year to 1982-83.

- Gains were registered in 21 of the 29 skill area elements assessed. The largest gains were shown for simple sentences with modification (+1.6 percent correct), compound sentences and sentence parts (+1.5 percent correct), complex sentences (+1.3 percent correct), forming complete sentences (+1.2 percent correct), using pronouns (+1.0 percent correct), and punctuation (+1.2 percent correct).

Table 7

Written Language Scores of California Sixth Grade Students on the Survey of Basic Skills: Grade 6, 1981-82 Through 1982-83

Skill area	Number of ques- tions	Average percent correct score		Change in average percent correct score, 1981-82 to 1982-83
		1981-82	1982-83	
TOTAL WRITTEN LANGUAGE	342	73.3	73.7	+0.4
Writing Process Skills	182	72.6	73.0	+0.4
1. Judging student writing	22	71.4	71.7	+0.3
2. Paragraphs	40	76.1	76.3	+0.2
- Topic sentences	10	74.2	74.7	+0.5
- Details and sequence	10	77.0	77.6	+0.6
- Outlines for organization	10	71.7	72.1	+0.4
- Consistency of verb and pronoun	10	81.6	81.0	-0.6
3. Sentence combining	50	66.8	67.9	+1.1
- Simple sentences with modification	13	52.0	53.6	+1.6
- Compound sentences and sentence parts	13	66.0	67.5	+1.5
- Complex sentences	14	68.9	70.2	+1.3
- Conjunctions	10	84.3	83.8	-0.5
4. Sentence recognition	40	75.2	75.6	+0.4
- Supplying subjects	13	90.5	90.5	-0-
- Supplying verbs	13	84.7	84.8	+0.1
- Forming complete sentences	14	52.1	53.3	+1.2
5. Language choices	30	75.0	74.7	-0.3
- Sensory words	10	75.8	75.9	+0.1
- Specific words and sentences	10	67.1	67.0	-0.1
- Achieving tone through word choices	10	82.0	81.3	-0.7
Supporting Skills	160	74.1	74.5	+0.4
6. Standard usage	50	78.2	78.3	+0.1
- Irregular verbs	10	77.5	77.7	+0.2
- Pronouns	10	66.7	67.7	+1.0
- Subject-verb agreement	10	72.4	72.2	-0.2
- Noun determiners	10	91.2	90.8	-0.4
- Double negatives	10	83.0	82.8	-0.2
7. Word forms	32	74.6	74.9	+0.3
- Suffixes	10	79.6	79.4	-0.2
- Irregular noun plurals	10	71.3	71.5	+0.2
- Contractions	12	73.2	74.0	+0.8
8. Spelling	50	71.2	71.7	+0.5
- Predictable words	15	73.2	74.0	+0.8
- Words with suffixes	15	64.4	64.8	+0.4
- Demons	10	76.8	77.1	+0.3
- Homophones	10	72.9	73.2	+0.3
9. Capitalization and punctuation	28	71.5	72.3	+0.8
- Capitalization	14	70.6	71.1	+0.5
- Punctuation	14	72.4	73.6	+1.2

- Declines were shown for the following writing process skill areas: consistency of verb and pronoun usage within paragraphs (-0.6 percent correct), using conjunctions (-0.5 percent correct), using specific words and sentences (-0.1 percent correct), and achieving tone through word choices (-0.7 percent correct).

- Among the supporting skills, declines were shown for achieving subject-verb agreement (-0.2 percent correct), using noun determiners (-0.4 percent correct), avoiding double negatives (-0.2 percent correct), and using suffixes (-0.2 percent correct).

Interpretation of Skill Area Results, Grade Six

The members of the English Language Assessment Advisory Committee analyzed, interpreted, and evaluated the 1982-83 written language results for grade six. In this process they reviewed the scores in the written language skill areas in light of the philosophy underlying the CAP written language tests. This philosophy is stated generally in the English Language Framework and more specifically in Survey of Basic Skills: Grade 6--Rationale and Content.

The members of the English Language Assessment Advisory Committee were pleased with the gains for most of the written expression skill areas. They observed that, as with the third graders, supplying subjects and supplying verbs to form complete sentences were the easiest writing process skills for sixth graders. They also noted with pleasure the gains on items requiring students to judge student writing, because this evaluative skill is one of the most important language skills assessed at grade six. The writing process skills that presented the greatest degrees of difficulty for sixth graders continue to be in the areas of (1) sentence combining; (2) sentence recognition; and (3) language choices.

The sentence-combining exercises require students to select the most effective way to combine several numbered sentences presented in the item stem. The correct answer is typically a simple sentence with an appositive, a compound sentence, or a complex sentence. The members of the committee observed that the syntax of these items tends to be difficult for most sixth graders but that as native readers of English, most should be able to determine the correct choice by eliminating the exceedingly awkward distractors. Given the complexity of most of the sentence-combining items, members of the committee were extremely pleased to see the substantial gains (+1.6, +1.5, and +1.3 percent correct) made in these areas.

The second area of greatest difficulty, forming complete sentences, is a skill that is introduced in the sixth grade but that involves considerable experience at the upper grade levels before mastery can be expected. While sixth graders demonstrated understanding of the need for a subject and verb in most sentences, as evidenced by the high scores in the other sentence recognition subskills, they are still displaying a great deal of confusion when required to discriminate between complete sentences, sentence fragments, and run-on sentences. Noting the difficulty of this aspect of the skill, members of the committee were extremely pleased to see the large gain (+1.2 percent correct) in forming complete sentences from 1981-82 to 1982-83.

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In the area of language choices, the subskill in which the students showed the weakest performance was a cluster of items requiring students to select the most detailed information for a given audience. Students at both grades three and six continue to exhibit considerable confusion when dealing with levels of abstraction (choices between vague, general statements and more specific ones) and the use of detailed information needed by a particular audience. The advisory committee has consistently stressed the importance of this skill area; understanding the information needs of a particular audience is fundamental to the writing process. Given the declines in two of the language choices skill areas, members of the committee again underscored the need for instructional emphasis in using specific language choices and achieving tone through word choices. Related to achieving tone through word choices is one of the interpretive/comprehension skill areas on the reading test, namely that of sensing mood. It is noteworthy that one of the most difficult reading skill areas for sixth graders is the ability to sense mood (66.4 percent correct) and that this area also registered a decline (-0.7 percent correct) from 1981-82 to 1982-83. As members of both the English and reading assessment advisory committees have previously pointed out, children need specific instruction in understanding the emotional connotations of words as part of a foundation in learning to think critically.

The areas showing the weakest and strongest achievement in grade six are presented in Table 8 for both supporting and writing process skills. The committee's instructional recommendations for grade six follow the table.

Table 8

Areas of Weakest and Strongest Achievement in Grade Six Written Language for Supporting Skills and Writing Process Skills

Category	Skill areas in which students showed strongest performance	Skill areas in which students showed weakest performance
Writing process skills	Supplying subjects to form complete sentences Supplying verbs to form complete sentences Using conjunctions	Sentence combining (to produce simple, compound, and complex sentences) Forming complete sentences (and avoiding fragments and run-ons) Using specific words and sentences to provide sufficient information and detail for a given audience
Supporting skills	Using noun determiners Avoiding double negatives	Spelling words with suffixes Using pronouns

Instructional Recommendations

After reviewing the results of the grade six test, the committee recommended the following:

1. Writing instruction should include more writing, more teaching of writing, a greater variety of writing assignments, and adherence to the principles set forth in the Handbook for Planning an Effective Writing Program.

2. California Assessment Program results, as well as assessments of students' writing, should be used for analyzing strengths and weaknesses in students' writing and for setting goals.

3. Writing should be integrated with the teaching of reading in all content areas. In language arts instruction, writing should be integrated with the teaching of literature.

4. While students are engaged in the act of writing, only the process skills of writing should be emphasized. Later, during the act of editing, the supporting skills of writing should be emphasized as the need arises and should not be neglected.

5. More emphasis is needed in the areas of language choices, vocabulary development, and sentence combining in the intermediate grades as well as throughout junior high school.

Scope and Foundations of the Grade Twelve Test

The written expression section of the Survey of Basic Skills: Grade 12 consists of 142 questions. The items were selected to assess the students' attainment of a wide variety of objectives compiled by the English Language Assessment Advisory Committee and published in Test Content Specifications, Basic Skills, Grades 6, 12, Written Expression, Spelling (Sacramento: California State Department of Education, 1975). Both the objectives and the items used to assess achievement of the objectives fall into one of six major skill areas: paragraphs; sentence manipulation; sentence recognition; language choices; word forms; and capitalization and punctuation. Spelling is tested separately on the test. The emphasis placed on each of the written expression skill areas in the Survey of Basic Skills: Grade 12 is shown in Figure 6.

Written Language Results for Grade Twelve

The results of twelfth grade performance on the total written expression test and in each of the skill areas for 1975-76 through 1982-83 are presented in Table 9. Year-to-year changes in overall performance and in skill performance are also shown in the table. The following observations are apparent from the data in Table 9:

- For the first time in five years, twelfth grade written expression scores declined (-0.2 percent correct). During the past five years, twelfth grade scores in this area have shown either slight gains or no change.

- Of the six skill areas assessed on the written expression section of the Survey of Basic Skills: Grade 12, declines were shown in word forms (-0.6 percent correct), language choices (-0.6 percent correct), and paragraphs (-0.2 percent correct). No changes were registered for spelling, sentence recognition, and sentence manipulation. Capitalization and punctuation was the only area showing a gain (+0.4 percent correct).

- Over the seven-year period from 1975-76 to 1982-83, written expression has shown an overall gain of 0.7 percent correct. The skill areas registering the largest gains over this period are sentence recognition (+2.8 percent correct) and capitalization and punctuation (+2.6 percent correct). The only skill areas to show an overall decline are word forms (-1.1 percent correct) and language choices (-0.6 percent correct).

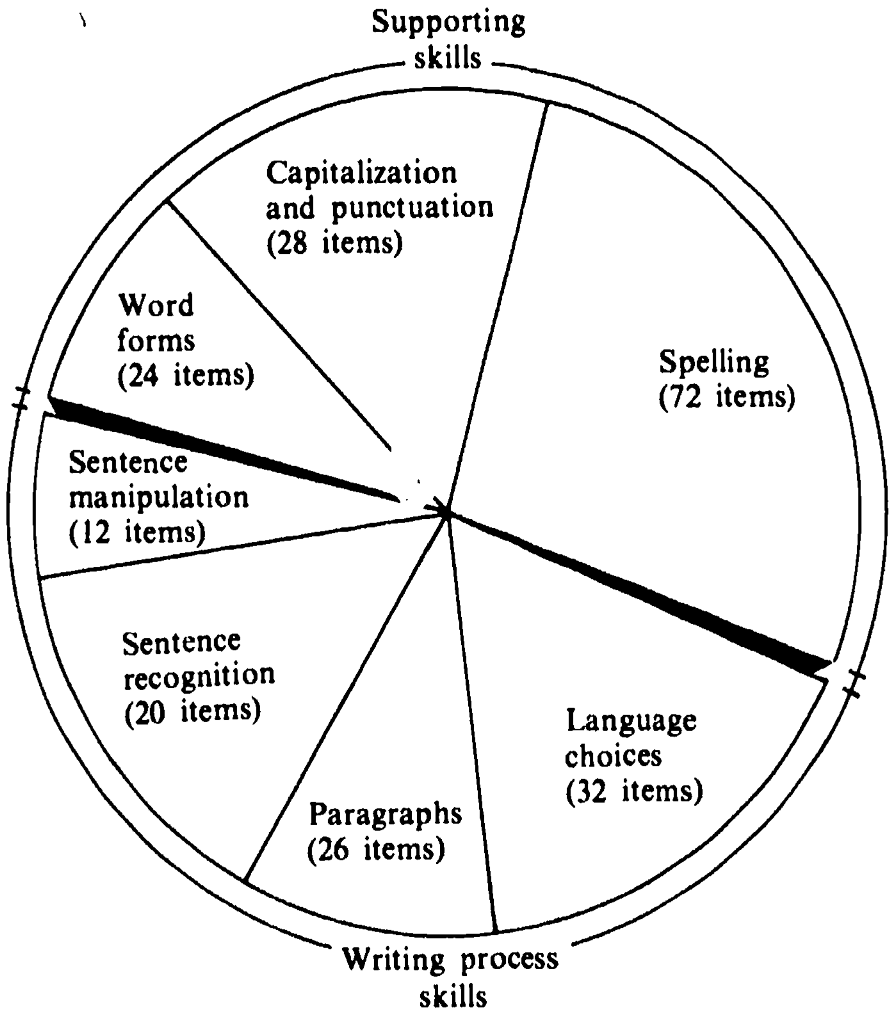


Fig. 6. Number of questions, by skill area, in the written language portion of the *Survey of Basic Skills: Grade 12*

Table 9

Written Expression Scores of California Twelfth Grade Students on the *Survey of Basic Skills: Grade 12*, 1975-76 Through 1982-83

	Total written expression	Writing process skills				Supporting skills		
		Paragraphs	Sentence manipulation	Sentence recognition	Language choices	Word forms	Capitalization/ punctuation	Spelling
Number of questions	142	26	12	20	32	24	28	72
Average percent correct score								
1975-76	62.3	59.9	42.9	67.3	66.9	72.6	54.6	68.0
1976-77	61.9	59.1	42.9	67.7	66.7	72.1	54.3	67.9
1977-78	62.1	59.3	43.4	68.4	66.6	72.1	54.7	68.4
1978-79	62.4	59.7	43.7	68.8	66.6	71.9	55.4	68.4
1979-80	62.4	59.7	43.7	69.0	66.3	72.2	55.4	68.8
1980-81	63.1	60.2	44.3	70.1	66.7	72.5	56.6	69.0
1981-82	63.2	60.5	44.6	70.1	66.9	72.1	56.8	69.5
1982-83	63.0	60.3	44.6	70.1	66.3	71.5	57.2	69.5
Change in average percent correct score								
1975-76 to 1976-77	-0.4	-0.8	-0-	+0.4	-0.2	-0.5	-0.3	-0.1
1976-77 to 1977-78	+0.2	+0.2	+0.5	+0.7	-0.1	-0-	+0.4	+0.5
1977-78 to 1978-79	+0.3	+0.4	+0.3	+0.4	-0-	-0.2	+0.7	-0-
1978-79 to 1979-80	-0-	-0-	-0-	+0.2	-0.3	+0.3	-0-	+0.4
1979-80 to 1980-81	+0.7	+0.5	+0.6	+1.1	+0.4	+0.3	+1.2	+0.2
1980-81 to 1981-82	+0.1	+0.3	+0.3	-0-	+0.2	-0.4	+0.2	+0.5
1981-82 to 1982-83	-0.2	-0.2	-0-	-0-	-0.6	-0.6	+0.4	-0-
Total change, 1975-76 to 1982-83	+0.7	+0.4	+1.7	+2.8	-0.[illegible]	-1.1	+2.6	+1.5

Interpretation of Skill Area Results, Grade Twelve

The members of the English Language Assessment Advisory Committee analyzed, interpreted, and evaluated the 1982-83 written language results for grade twelve. In this process they examined the changes in skill area performance in light of the *Handbook for Planning an Effective Writing Program*, which includes standards for assessing the quality of a school's writing program. The philosophy stated in the handbook is that writing should be a major component across the curriculum, with skills instruction in a supporting capacity.

The members of the committee expressed concern over the reversal of the upward trend in twelfth grade written expression indicated by the overall decline of 0.2 percent correct from last year's score. While the skill area declines appeared to be slight, members of the committee judged that the losses were in important areas, especially language choices (-0.6 percent correct) and paragraphs (-0.2 percent correct). The committee members were puzzled by the continuing decline in word forms, which is the easiest skill area on the Survey of Basic Skills: Grade 12. They suggested that perhaps this particular skill area is so basic that little instructional time is being dev..ed to it in most high schools.

As noted above, the skill areas showing the greatest total increases over the years are sentence recognition (+2.8 percent correct) and capitalization and punctuation (+2.6 percent correct). This pattern may reflect common instructional practices, especially in light of the current emphasis on the basic skills. That is, the greater improvement in sentence recognition and capitalization and punctuation may reflect the "back to basics" emphasis and concern for conventions and correctness resulting from district proficiency testing. The members of the advisory committee concluded that while such skills as usage, word forms, and capitalization are important supporting skills, greater attention should be devoted to the writing process skills--language choices, sentence manipulation, and paragraphs. The committee stressed that skills instruction should not be overemphasized at the expense of the total writing process and that skills should be taught as needed in support of writing (taking care not to neglect them).

Given the slight but unexpected decline in twelfth grade written expression scores, members of the English Language Assessment Advisory Committee stressed that they are in support of any effort to increase the amount of quality instructional time for composition. This need has been publicized by a recent report from the Carnegie Foundation (E. L. Boyer, High School: A Report on Secondary Education in America, New York: Harper and Row, 1983), which states:

> Language defines our humanity. It is the means by which we cope socially and succeed educationally. The advent of the information age raises to new levels of urgency the need for all students to be effective in their use of the written and spoken word. The mastery of English is the first and most essential goal of education.
>
> Writing should be taught in every class. Clear writing leads to clear thinking; clear thinking is the basis of clear writing. Perhaps more than any other form of communication, writing holds us responsible for our words and ultimately makes us more thoughtful human beings.

The committee also expressed concerns about the need for resources to support the teaching of writing, the need to ensure the qualifications of those teaching English courses, and the importance of both local and statewide writing assessments. These concerns are formulated below as the committee's policy recommendations and are followed by the committee's instructional recommendations for grade twelve.

Policy Recommendations

1. Statewide efforts are needed to increase the amount of quality instructional time for composition.

2. High school students should be required to take four years of high school English. The committee supports any efforts which will increase the number of hours students spend in the English classroom.

3. Additional resources are needed at the classroom level to support and assist those responsible for the teaching of writing.

4. Efforts are needed to ensure that those teaching language, composition, and literature are well qualified in these areas.

5. Districts should conduct annual schoolwide assessments of writing (including writing samples) as an integral part of the writing program.

6. The Department of Education should include writing samples at various grade levels as part of the California Assessment Program.

Instructional Recommendations

1. Writing instruction should include more writing, more teaching of writing, a greater variety of writing assignments, and adherence to the principles set forth in the Handbook for Planning an Effective Writing Program.

2. Writing should be integrated with the teaching of reading in all content areas. In English instruction writing should be integrated with the teaching of literature.

3. While students are engaged in the act of writing, only the process skills of writing should be emphasized. Later, during the act of editing, the supporting skills of writing should be emphasized as the need arises and should not be neglected.

4. Teachers should do more writing themselves, especially in the classroom with their students, on the topics they assign.

5. Various types of writing activities and events (such as writing celebrations, writing showcases, write-athons, writing fairs, and writing olympics) should be planned and conducted to emphasize the importance of writing and to provide out-of-classroom audiences for the students' writing.

6. The California Assessment Program's results, as well as assessment of students' writing, should be used for analyzing strengths and weaknesses in students' writing and for setting goals.

V. Mathematics Achievement for Grades Three, Six, and Twelve

Synopsis of Findings

- On the 1981 norms for the Comprehensive Tests of Basic Skills (CTBS), the typical California third grade student ranks at the 50th percentile, and on the Stanford Achievement Test, 1982 norms, at the 53rd percentile.

  Since the introduction of the mathematics Survey in the third grade in 1979-80, students have made impressive gains each year. From 1981-82 to 1982-83, the scores improved in 21 of the 22 skill areas assessed in mathematics.

- On the CTBS, 1981 norms, the typical California sixth grade student ranks at the 60th percentile and on the Stanford, 1982 norms, at the 52nd percentile.

  This year marks the eighth consecutive year in which the scores of sixth grade students improved in mathematics. From 1981-82 to 1982-83, the scores improved in 25 of the 34 skill areas assessed in mathematics.

- On the Iowa Tests of Educational Development (ITED), 1978 norms, the typical California twelfth grade student now ranks at the 45th percentile. The same student ranks at the 55th percentile on the Sequential Tests of Educational Progress (STEP), 1978 norms. From 1981-82 to 1982-83, the overall mathematics score of twelfth grade students remained unchanged.

Committee's Recommendations

After reviewing the results presented in the following three sections, the Mathematics Assessment Advisory Committee (members' names and affiliations appear in the Appendix) concluded that schools are doing a good job of teaching tasks requiring computation and recognition. However, increases were relatively small on problem-solving and application questions, which require students to think. This weaker growth pattern led the committee to believe that such skills are not being reinforced in classrooms. Simply teaching students lower-level knowledge and skills is unlikely to improve substantially higher-level cognitive skills and understanding. Improvements in higher cognitive skills will occur only when higher-level problem solving becomes a curricular and instructional focus.

The committee made the following recommendations aimed at education policymakers, textbook publishers, curriculum developers, school administrators, and classroom teachers:

- Since the growth in scores for application and problem-solving questions is much lower than the growth in computational questions, at all grade levels, more instructional time should be spent on problem solving and applications. Although drill and practice on basic computational skills remain important, such techniques should be balanced with the development of skills in problem solving.

- The use of manipulatives and models should be increased to facilitate students' understanding of place value concepts and to help them develop visualization skills in two and three dimensions.

- Teachers and developers of instructional materials should strive to use materials that help students at all ability levels to develop skills in problem analysis and modeling (as recommended in the Mathematics Framework and the 1980 Addendum for California Public Schools, published by the California State Department of Education in 1982). This kind of instructional emphasis will not detract from the development of other skills but, in fact, should improve computation and application skills by giving students a clearer understanding of the mathematical processes involved in problem solving.

- Teachers should be provided with in-service training and with instructional materials that will aid them in helping students model and solve multiple-step problems. Teachers' guides should include practical examples or suggestions that will help teachers involve students in classroom activities that lead to opportunities for students to create and solve "real" multiple-step problems.

- It is important that teachers and curriculum personnel avoid imbalances in the curriculum. Some of the questions that might be asked in the planning of a strong mathematics curriculum are the following:

  - Are the needs of advanced students in algebra, geometry, trigonometry, and calculus being met, as well as the needs of students who require additional instruction in basic mathematics?

  - Are "end-of-the-book" topics systematically included and articulated across grade levels?

  - Are new textbooks being chosen that offer a variety of problem analysis techniques at all levels?

  - Is problem solving used for motivation and integration of mathematics into "daily-life mathematics" skills?

  - Is problem-solving instruction integrated with skill instruction rather than being delayed until complete student mastery is attained in computational skill?

  - Does instruction in measurement include actual situations in which all students participate actively in taking measurements?

  - Does the curriculum include the use of calculators and computers?

Scope of the Grade Three Mathematics Test

The Survey of Basic Skills: Grade 3 was developed to assess the levels of mathematics skills of third grade students in California. The 360 items on the Survey were designed to assess students' skills in the area of arithmetic (counting and place value, nature of numbers and properties, and operations), geometry, measurement, patterns and graphs, and problem analysis and models. In each area, with the exception of problem analysis and models, the test items include computational skills and knowledge of terminology as well as word problems. Figure 7 illustrates the emphasis placed on each skill area in the total test.

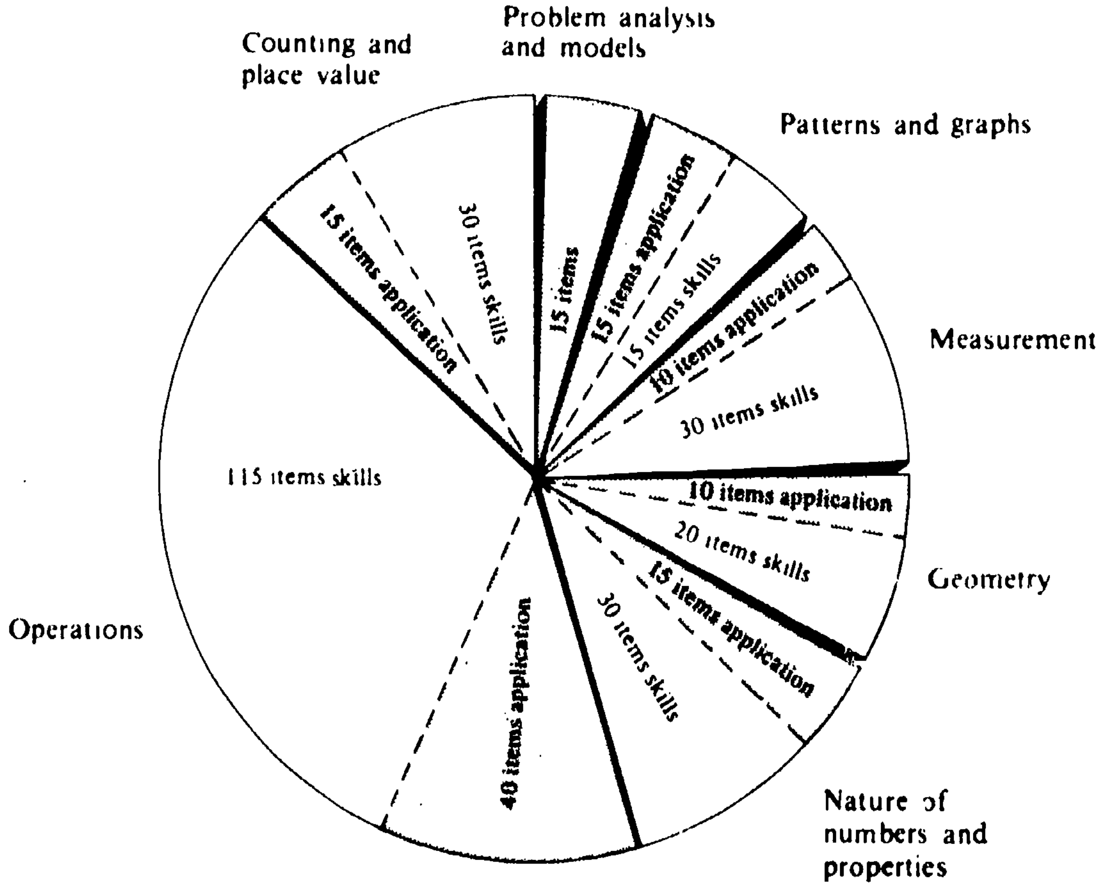


Fig. 7. Number of questions, by skill area, in the mathematics portion of the *Survey of Basic Skills: Grade 3*

The emphasis on each skill area in the third grade Survey is consistent with the mathematics curricula of most California schools and additionally reflects the "umbrella" concept of problem solving/applications emphasized in the Mathematics Framework and the 1980 Addendum for California Public Schools: Kindergarten Through Grade Twelve. In the new framework, problem solving/application skills, rather than being a separate strand, is now "positioned" to receive equal emphasis with each of the other strands of mathematics. Figure 8 shows the major content categories of mathematics recommended in the 1980 addendum, including the problem solving/application skills. The third grade Survey assesses all the skills proposed in the addendum at the third grade level except the calculator/computer skills. A detailed description of the skills assessed in the third grade Survey is given in Survey of Basic Skills: Grade 6--Rationale and Content.

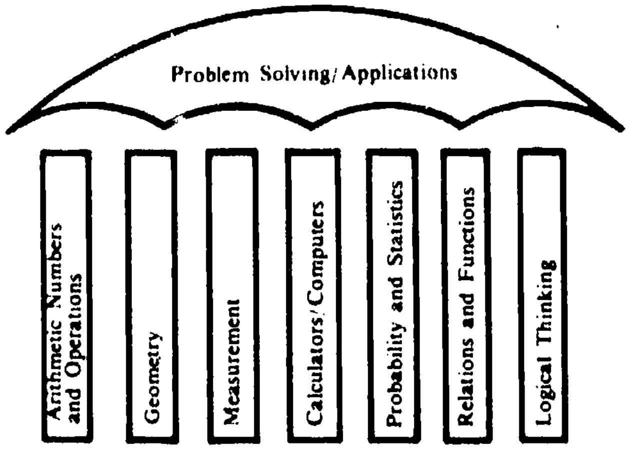


Fig. 8. Problem solving/applications, the umbrella for all strands in mathematics

Mathematics Results for Grade Three

The results of the third grade mathematics assessment for 1982-83 are shown in Table 10. This was the fourth year of the assessment in mathematics in grade three. Longitudinal comparisons are also given in Table 10 for the four-year period (1979-80 through 1982-83).

As shown in Table 10, the average California third grade student in 1982-83 correctly answered 77.7 percent of the questions in arithmetic skills; 77.1 percent in geometry; 75.3 percent in measurement; 76.8 percent in patterns and graphs; 72.5 percent in problem analysis and models; and 74.4 percent in problem solving/applications. Overall, the average third grade student correctly answered 77.1 percent of the mathematics questions.

The following conclusions can be drawn about the 1982-83 mathemacics performance of California third grade students:

- The typical third grade student in California was able to answer over three-fourths of the test questions correctly.
- The average percent correct scores increased in all but one major subskill areas over those recorded in 1981-82.
- The highest percent correct score was in operations using basic facts (88.4 percent correct), followed closely by applications with graphs (87.4 percent correct), addition operations (86.0 percent correct), and money and fraction problems (83.4 percent correct).

Summary of the Committee's Conclusions

The members of the Mathematics Assessment Advisory Committee reviewed the results of the third grade students by skill areas and by items within each skill area. The committee members made the following general remarks about the performance of third grade students in California public schools:

Table 10

Mathematics Scores of California Third Grade Students and Changes in Mean Scores on the Survey of Basic Skills: Grade 3, 1979-80 Through 1982-83

Skill area	No. of ques- tions	Mean score 1979-80	1980-81	1981-82	1982-83	Change 1979-80 to 1980-81	1980-81 to 1981-82	1981-82 to 1982-83
MATHEMATICS, TOTAL	360	74.1	74.7	76.0	77.1	+0.6	+1.3	+1.1
Arithmetic	245	74.5	75.1	76.4	77.7	+0.6	+1.3	+1.3
Count and place value	45	79.3	79.9	81.3	82.3	+0.6	+1.4	+1.0
Skills	30	79.7	80.3	81.9	82.7	+0.6	+1.6	+0.8
Applications	15	78.5	79.1	80.3	81.5	+0.6	+1.2	+1.2
Operations	155	72.7	73.3	74.8	76.3	+0.6	+1.5	+1.5
Basic facts	25	85.9	86.3	87.5	88.4	+0.4	+1.2	+0.9
Addition	30	82.6	83.4	84.7	86.0	+0.8	+1.3	+1.3
Subtraction	30	69.9	71.0	73.1	75.3	+1.1	+2.1	+2.2
Multiplication	30	63.7	64.5	66.7	68.6	+0.8	+2.2	+1.9
Application	40	65.7	65.9	66.7	67.9	+0.2	+0.8	+1.2
Basic facts	13	68.0	67.9	68.6	69.8	-0.1	+0.7	+1.2
Addition/subtraction	15	75.0	76.0	77.4	79.0	+1.0	+1.4	+1.6
Multiplication	12	51.4	51.2	51.2	52.1	-0.2	0	+0.9
Nature of numbers and properties	45	75.8	76.3	77.4	77.9	+0.5	+1.1	+0.5
Properties and relationships	15	76.0	76.4	77.5	77.1	+0.4	+1.1	-0.4
Money and fractions	15	80.2	81.1	82.4	83.4	+0.9	+1.3	+1.0
Applications	15	71.1	71.5	72.2	73.2	+0.4	+0.7	+1.0
Geometry	30	74.9	75.1	76.6	77.1	+0.2	+1.5	+0.5
Skills	20	76.3	76.3	77.7	78.3	0	+1.4	+0.6
Applications	10	72.0	72.8	74.3	74.8	+0.8	+1.5	+0.5
Measurement	40	73.4	74.0	74.6	75.3	+0.6	+0.6	+0.7
Linear measures	15	69.7	70.6	72.0	72.3	+0.9	+1.4	+0.3
Other measures	15	78.4	78.6	78.3	79.1	+0.2	-0.3	+0.8
Applications	10	71.4	72.2	72.8	74.2	+0.8	+0.6	+1.4
Patterns and graphs	30	73.8	74.6	75.9	76.8	+0.8	+1.3	+0.9
Skills	15	63.5	64.1	65.7	66.2	+0.6	+1.6	+0.5
Applications	15	84.1	85.0	86.2	87.4	+0.9	+1.2	+1.2
Problem analysis and models	15	70.1	70.5	71.2	72.5	+0.4	+0.7	+1.3
Problem solving/applications*	120	71.5	72.3	73.2	74.4	+0.8	+0.9	+1.2

*Questions in this category are an aggregate of 105 application questions and 15 questions in problem analysis and models.

- The performance of the third grade students was commendable, especially the pattern of growth in mathematics scores from 1979-80 through 1982-83.

- Teachers and students should be particularly commended for the strong performance and growth shown in mathematics scores over the four-year period.

- The strong performance in all major skill areas indicated to the committee members that a strong, comprehensive mathematics instructional program exists in kindergarten through grade three in California public schools.

The committee members also identified areas of strength or improvement and areas in need of improvement. The areas of strength included skills in which students achieved at the committee's level of expectation. The areas in need of improvement included the skills that the committee believes need more emphasis in California classrooms.

Areas of Strength or Improvement

- Identifying ordinal positions (e.g., second, third, and so on) of familiar objects.
- Counting by 1s, 2s, 5s, and 10s
- Identification of the place value of a given digit in a numeral
- Identification of the digit of a given place value in a numeral
- Recognition of numerical values of written numerals
- Addition, subtraction, multiplication, and division facts
- Word problems involving money
- Recognition of geometric terms and concepts
- Recognition of simple geometric figures
- Location of points on a coordinate grid
- Measures of time (clock and calendar)
- Measures of temperature
- Reading of a bar graph
- Reading of a pictograph (especially those involving coins)
- Applications involving reading of graphs
- Problem analysis
- Recognition of a function rule

Areas in Need of Improvement

- Vocabulary development
- Identification of odd or even numbers
- Subtraction of whole numbers, especially with renaming
- Knowledge of the metric system
- Correct use of linear measures
- Recognition of the correct unit of measure
- Recognition of geometric patterns
- Applications involving multiplication of whole numbers

The Committee's Recommendations

The members of the Mathematics Assessment Advisory Committee made the following recommendations for the improvement of mathematics skills in the third grade.

- The current emphasis in place value should be continued, because this concept is the key to the understanding of arithmetic operations.

- Students should be given more practice in reading and discussing mathematical problems.

- Students should be given opportunities to develop the vocabulary and mathematical notation needed to discuss mathematical concepts.

- Open classroom discussions and small group activities should replace some of the individual paper-and-pencil activities.

- Teachers should give students concrete experiences to help them discriminate between standard units of length, volume, mass, and temperature and to know when to apply them in the measurement of common objects or quantities. At the third grade level, all measurement concepts should be developed using activities with concrete materials.

- In subtraction the most common error made by students was subtracting the smaller digit from the larger digit, regardless of the positions of the two digits in the problem. Instructional emphasis should be given to developing the understanding of the subtraction algorithm, with renaming, through the use of manipulative materials. A better understanding of place value is needed to improve the understanding of this algorithm.

- In application questions the most common error made by students was to add the numbers in the problem even though the operation called for was either subtraction or multiplication. Students should be confronted with many sets of application problems that randomly involve any of the four basic operations and emphasize the selection and use of the correct operation or operations.

- Teachers should emphasize the use of multiplication skills in real-life situations.

- The current test results indicate that teachers now offer a comprehensive instructional program in mathematics in kindergarten through grade three. This broad instructional emphasis should be continued to ensure steady improvement in all mathematical skills and concepts.

Some Examples and Ideas for Classroom Teachers

- Introduce new concepts with concrete manipulative materials.

- Present computational problems in other than just the vertical format.

- Introduce completed problems with portions missing to force students to think about arithmetic algorithms.

- Ask students to discuss together the steps involved in solving a variety of problems.

- Give students completed problem sets, with errors present, and ask for identification and explanation of the errors.

- Give students experiences, oral and written, using "100 more than," "100 less than," and similar phrases for other decimal values.

- Provide students with opportunities to identify incorrect answers and to tell why they are wrong, especially positional errors.

- Provide students with many activities using concrete manipulative materials to develop geometric spatial concepts.

- Use place value boards and other similar manipulatives.

- Use calculators to develop and use estimation, rounding, and place value skills.

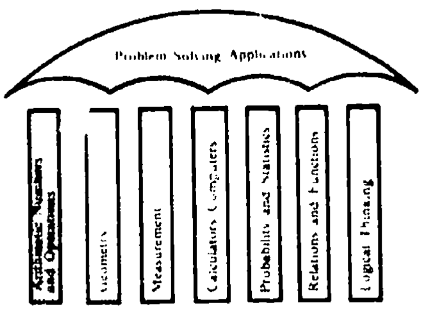
The Committee's Analysis of Skill Area Results

The members of the Mathematics Assessment Advisory Committee reviewed the scores of the third grade students by skill area and by items within each skill area. The committee members judged the adequacy of student performance in light of the difficulty levels of the questions and the instructional emphasis of each skill in the typical classroom.

The results of the committee's analysis are summarized below in two categories--computational skills and problem solving/application skills. The computational skills are described under two headings--"Arithmetic, Numbers, and Operations" and "Geometry, Measurement, and Patterns and Graphs." In the following discussions only the areas of special strengths or weaknesses are described; no attempt is made to discuss each skill tested on the *Survey*. The purpose of the illustrative examples is to indicate the relative stength or weakness in the skills; hence, students' performance on illustrative items should not be taken as indicative of their performance in the entire skill area.

Arithmetic, Numbers, and Operations

The main skills included under this category are counting and place value, nature of numbers and properties, and operations. The subskills include the following: ordinal positions; counting by 1s, 2s, 5s, 10s, or 100s; reading and writing numbers; finding place values; using commutative and associative properties; multiplying a number by zero; using symbols for greater than, less than, and equal to; recognizing even and odd numbers; knowing basic facts; and performing operations of addition, subtraction, and multiplication on whole numbers.



As shown in Table 10, third grade students continued to show improvement in the arithmetic skills of counting and place value, nature of numbers, and operations. Not only was the total average percent correct for arithmetic higher in 1982-83, but also the score for every item increased, except for properties and relationships. Of the 155 operations items in arithmetic, the scores on all items increased. Third grade students scored highest in basic facts (88.4 percent correct) and lowest in multiplication (68.6 percent correct); however, third grade students' greatest improvement (+2.2 percent correct) from 1981-82 to 1982-83 was in subtraction.

In counting and place value skills, the committee felt that students have a good understanding of the concepts in general. On items that directly test understanding of place value, such as pictorial representation, expanded notation, and identification of digits in the ones, tens, and hundreds place, students showed good improvement. However, the committee members expressed a need for stronger reinforcement of skills in place value for all students at this grade level, because this concept is the key to understanding arithmetic operations, especially renaming, as students progress in their mathematics curricula. The following example illustrates that 19 percent of the students were unable to identify the place value of the digits in 345:

345 =

15 ○ 3 + 4 + 5
2 ○ 400 + 30 + 5
2 ○ 400 + 50 + 3
81 ● 300 + 40 + 5

Although students showed improvement over previous years for all items asking for "100 more than" or "100 less than," the committee noted that one out of five students chose to juxtapose 506 and 100 and selected the answer "50600" when asked, "Which number is 100 more than 506?" On other items in this category, about one out of every ten students added when subtraction was required. The idea of more than and less than does not appear to be a concept that is clear to most third graders.

Which number is 100 more than 506?

18 ○ 50600
71 ● 606
6 ○ 516
5 ○ 406

About 90 percent of the students were able to interpret a pictorial representation of expanded notation, but that percentage drops to 72 percent when numbers were used. The typical incorrect answer was the fourth choice in the illustration below.

603 =

8 ○ 600 + 30
2 ○ 300 + 6
72 ● 600 + 3
18 ○ 60 + 3

When asked to complete statements in the form of "the number 3 is in the ______ place" or "the number ___ is in the ones place," the students scored uniformly better than in 1981-82. Some students (about 10 percent) seemed confused by terminology, identifying "1" as the number in the ones place of 2163. Another 12 percent selected "2" as the ones place. This and other similar responses indicated the possibility of developmental reversals between the beginning place value and the final place value of the ones place.

2163

The number ___ is in the ones place.

9	○	1
12	○	2
72	●	3
7	○	6

About 15 percent or one in six failed to complete correctly an addition problem with renaming, compared with a success rate of about 95 percent when renaming is not involved. Error patterns varied, with some students renaming once but not twice, others not maintaining place value for the renamed ten or hundred. The example shows that many students perhaps assume that if no renaming is needed between the ones and tens, no renaming is needed between tens and hundreds.

$$\begin{array}{r} 252 \\ +\,176 \\ \hline \end{array}$$

10	○	328
83	●	428
4	○	438
3	○	4128

The committee members also found evidence that place value concept continued to be a weakness for some students at the sixth grade level (see the place value section for grade six).

In operations, the committee members observed that students appear to understand both the horizontal and vertical forms of addition, subtraction, and multiplication facts. Also, they felt that division facts are being taught and learned by the end of the third grade, though the recognition of the use of the division symbol (÷) is still weak.

In operations skills the committee members recognized that addition and subtraction skills are considered to be at the mastery level, and multiplication is considered to be at the developmental level. The mean scores reflected these facts, showing that good instruction is being provided in these areas and student learning is adequate.

The students showed improvement in one- and two-digit addition problems, but they need more understanding and skill where carrying applies to more than one column.

		264
		+578
5	O	732
6	O	742
7	O	832
82	●	842

In subtraction problems involving renaming, some students simply subtracted the smaller digit from the larger digit regardless of their positions in the problem. Twenty-six percent of the students chose the second answer on the following problem:

		210
		−162
10	O	158
26	O	152
9	O	58
55	●	48

In operations with decimals (the only problems tested in the third grade are those involving money), students showed gains over the previous years, an average gain of 4.3 percent correct per year from 1979-80 to 1982-83.

In the example below, 11 percent of the students placed the decimal point in an incorrect position, while another 13 percent ignored the decimal point completely:

		$1.31
		+ .25
11	O	$15.6
3	O	$1.55
13	O	$156
73	●	$1.56

The following example shows students' performance in a multiplication problem. The pattern of errors shows a lack of understanding of place value by a large number of students:

$$\begin{array}{r} 67 \\ \times\ 3 \\ \hline \end{array}$$

12	○	81
15	○	181
62	●	201
11	○	1821

On items involving multiplication by 10 or 100, the most common error made by students was adding rather than multiplying. The committee suspected that this error was due to the fact that some students have been told to add zeros to find the answer to multiplication problems involving 10 or 100.

The following two examples show the performance of third grade students on two division problems presented in different formats.

$9 \div 3 =$

19	○	27
5	○	12
6	○	6
70	●	3

$2\overline{)6}$

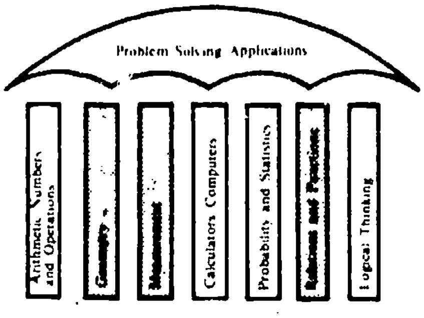
75	●	3
4	○	4
5	○	8
16	○	12

Of the two division formats, the linear form ($9 \div 3$) was more difficult; almost one in five students chose to multiply. Multiplication was the most powerful distractor; multiplication was also a powerful distractor for problems in the format of $2\overline{)6}$.

It is apparent from the data that all students are not able to identify correctly the divisor and dividend in a division problem. With the increasing use of calculators, it is important that students understand the linear format from an early grade.

Geometry, Measurement, and Patterns and Graphs

The questions in geometry cover skills in identifying basic geometrical shapes, parallel lines, line segments, right angles, diagonals of quadrilaterals, diameters of circles, and congruent figures. The questions in measurement deal with skills in measuring objects, converting units, finding appropriate units, and determining the perimeter and area of a polygon. The skills also include identifying correct time, order of days of the week, and months of the year; reading a calendar and thermometer; determining volume; and finding the heavier of two measures. The questions in patterns and graphs require skills in identifying the function rule, completing a function table, and identifying a geometric or number pattern.



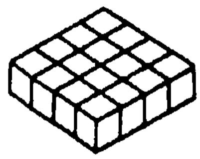
From Table 10, it is apparent that from 1981-82 to 1982-83, scores increased in all skills under geometry, measurement, and patterns and graphs.

In geometry the committee felt that students were doing an excellent job of recognizing and selecting common two-dimensional geometric figures. The committee, however, observed that students seemed to have difficulty recognizing and/or identifying the geometric concepts of parallel lines, diagonals, right angles, and diameters.

In measurement the committee members noted that students continue to have greater difficulty with the metric system than with the U.S. Customary system of measurement. The members surmised that instruction in measurement skills is perhaps not too well developed at the third grade level; however, the scores do indicate that more and more instructional programs include metrics. In questions involving spatial concepts, the students were unable to visualize a three-dimensional object in a two-dimensional drawing. The following item on counting cubes is an example. Most errors resulted from students' counting the visible faces of a cube rather than the cube as a whole. Twenty-seven percent of the students chose the first answer.

How many cubes?

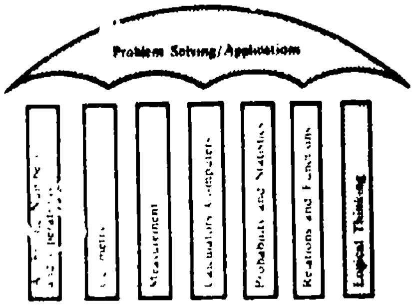
27 ○ 24
70 ● 16
1 ○ 9
2 ○ 4



With regard to scores on items on temperature, volume, or mass, the committee felt that the level of performance of third grade students was adequate. The committee recommended that continued instructional emphasis be given to teaching students to discriminate between standard units of length, volume, mass, and temperature and to know when to apply them.

Problem Solving/Application

The third grade Survey includes word problems or application questions in all the skills of counting and place value, nature of numbers and properties, operations, geometry, measurement, and patterns and graphs. The application questions require the use of skills to solve word problems presented in the context of daily life. The test also includes questions in analysis and models (problem solving). In these questions the emphasis is not on finding a correct numerical solution; rather the emphasis is on analyzing a word problem and finding given facts, missing information, or the question being asked. Some questions require students to match a picture model with a mathematical sentence or statement.



Applications

In application questions involving basic facts and addition, the committee felt that students had good understanding of these skills. The committee noted some areas of difficulty, however. In application problems, students often chose an addition answer when subtraction or multiplication was the indicated operation. In a question on subtraction facts, 92.2 percent of the students knew that 15 - 8 = 7, but only 76.1 percent were able to use this fact correctly in an application problem. The answer found by adding together the numbers in the problem was selected by 14.5 percent of the students.

In the construction of the third grade Survey, 33 application items were designed to be paired with computation or concept items. These application items involve the same numbers and the same operations as the paired skill items. The average percent correct on the skills items in 1982-83 was 79.4, while the average percent correct on the paired application items was 71.1. The two examples below show matched skills and application items involving multiplication. The percent of students who chose to add was about five times as great in the application item as in the skill item.

$$\begin{array}{r} 23 \\ \times\ 3 \\ \hline \end{array}$$

3 ○ 20
9 ○ 26
3 ○ 68
85 ● 69

Brown School had 3 rooms
Each room had 23 students.

How many students were at the school?

5 ○ 20
39 ○ 26
4 ○ 68
52 ● 69

Although the committee members noted growth in multiplication applications, they felt that scores in multiplication applications seriously lag the scores in other areas. The average percent correct for this skill was 52.1, the lowest score on the entire test. The committee recommended that instructional emphasis be placed on relating multiplication skills to real-life applications as early as possible in the instructional program.

Problem Solving

The third grade Survey includes 15 questions in analysis and models. The average percent correct score in 1982-83 was 72.5, which was an increase of 1.3 percent correct over the 1981-82 score. This one-year increase was as large as the increase reported in the previous two years combined. The increase in problem analysis and models is slightly higher than the increase on the whole test. Some typical items in this category are:

5 3 - 2

Which matches the problem above?

- 5 ○ Jan had 3 apples She got 5 more apples How many in all?
- 5 ○ Jan had 3 apples Each apple had 5 seeds. How many seeds in all?
- 12 ○ Jan had 5 apples She ate 2 apples. How many were left?
- 78 ● Jan had 5 apples She ate 3 apples How many were left?

Kim had 4 apples.
She ate 3.
How many were left?

Which question is asked?

- 18 ○ Did Kim have 4 apples?
- 64 ● How many were left?
- 11 ○ How many apples did Kim eat?
- 7 ○ Did Kim have 3 apples left?

There were 7 boys.
Each boy had 3 cookies.
How many cookies were there?

How can you find the answer?

- 4 ○ $10 - 7 = 3$
- 26 ○ $7 + 3 = 10$
- 62 ● $7 \times 3 = 21$
- 8 ○ $7 - 3 = 4$

The committee members strongly recommended that more instruction be given to students of all ability levels in the skills of problem analysis and modeling. This instructional emphasis should not detract from the development of other skills but, in fact, should help improve application and computation skills by giving students a clearer understanding of the mathematical processes involved in problem solving.

Scope of the Grade Six Mathematics Test

The new Survey of Basic Skills: Grade 6 was developed to replace the grade six Survey first given in 1975-76. It assesses the levels of mathematical skills of sixth grade students in California on a more comprehensive set of subskills and is similar in breadth to the new Survey of Basic Skills: Grade 3, which was first used in 1979-80. The development and review process that spanned a period of two and a half years included a large number of California teachers, students, and schools. The result of this process was a comprehensive set of test specifications and the 480 items that appear on the Survey.

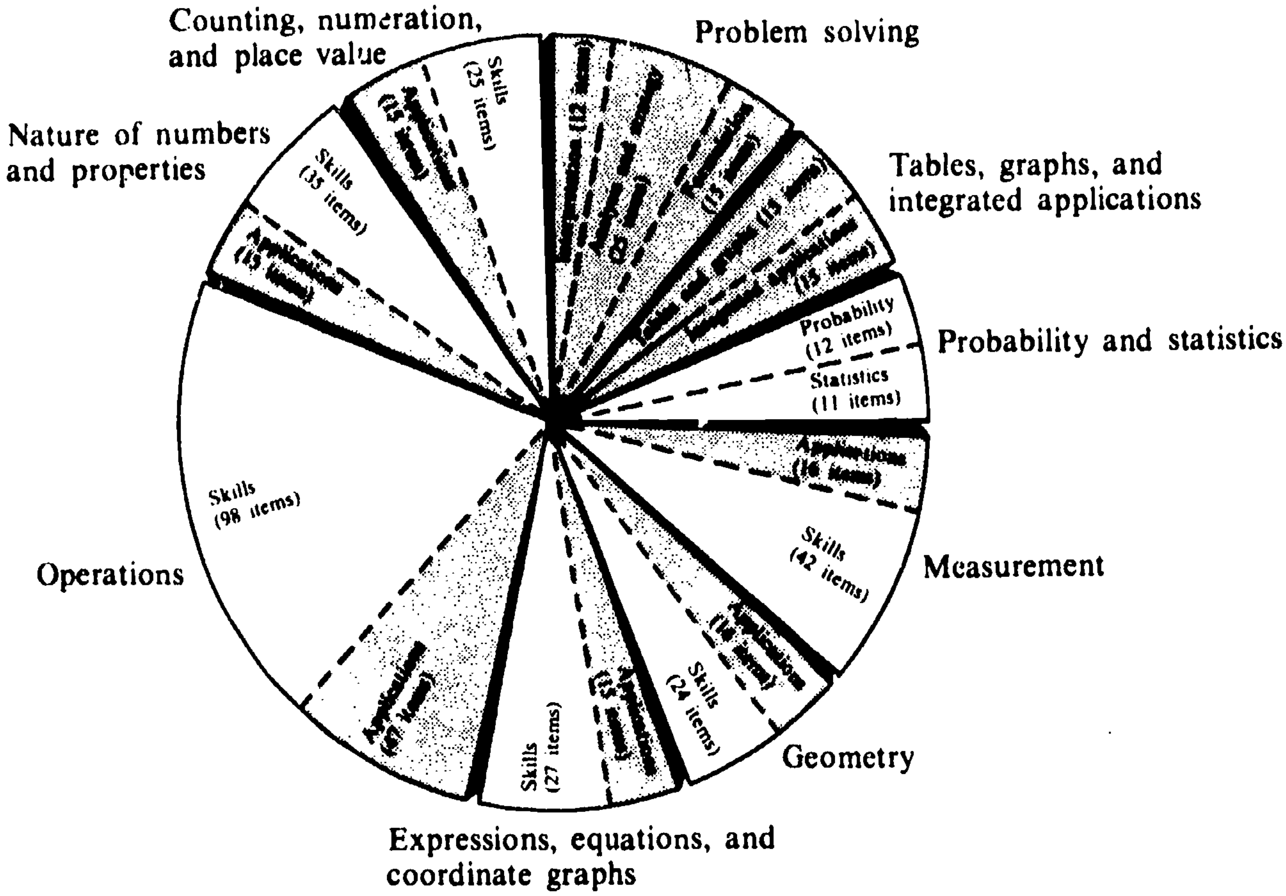


Fig. 9. Number of questions, by skill area, in the mathematics portion of the *Survey of Basic Skills: Grade 6*

The 480 items on the Survey were designed to assess students' skills in the area of counting, numeration, and place value; nature of numbers and properties; operations; expressions, equations, and coordinate graphs; geometry; measurement; probability and statistics; tables, graphs, and integrated applications; and problem solving. Figure 9 illustrates the emphasis placed on each skill area in the total test. The emphasis on each skill area in the test is consistent with the mathematics curricula of most California public schools and additionally reflects the "umbrella" concept of problem solving/applications emphasized in the Mathematics Framework and the 1980 Addendum for California Public Schools: Kindergarten Through Grade Twelve. In the new framework problem solving/application skills, rather than being a separate strand, receives equal emphasis with each of the other strands of mathematics. Figure 10 shows the major content categories of mathematics recommended in the 1980 addendum and the "positioning" of the problem solving/application skills. The sixth grade Survey assesses all the skills proposed in the addendum, except for the calculator/computer skills. A detailed description of the skills assessed in the sixth grade Survey is given in Survey of Basic Skills: Grade 6--Rationale and Content.

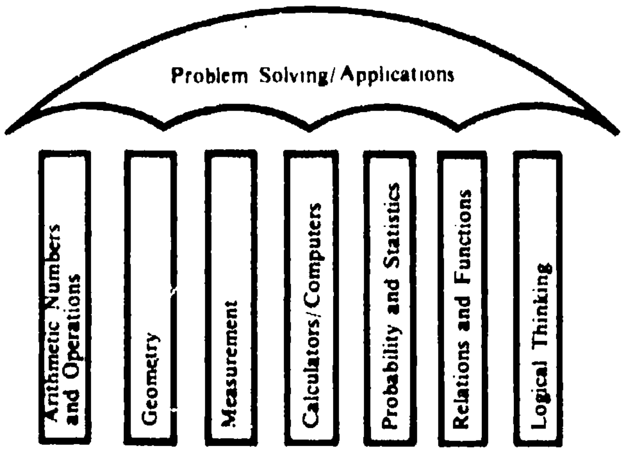


Fig. 10. Problem solving/applications, the umbrella for all strands in mathematics

Mathematics Results for Grade Six

The results of the new sixth grade mathematics assessment for 1982-83 are shown in Table 11. Overall, the percent correct increased 0.5 from 1981-82 to 1982-83.

Table 11 shows that in 1982-83 California sixth grade students had an average percent correct score of 63.2 on the 480 questions in the total test. The skill-by-skill results were: 66.6 percent correct in counting, numeration, and place value; 61.5 percent correct in nature of numbers and properties; 63.1 percent correct in operations; 63.9 percent correct in expressions, equations, and coordinate graphs; 63.5 percent correct in geometry; 61.0 percent correct in measurement; 59.8 percent correct in probability and statistics; 67.5 percent correct in tables, graphs, and integrated applications; and 63.5 percent correct in problem solving. From Table 11, the following conclusions are apparent:

- Sixth grade students scored highest in addition/subtraction of whole numbers, with an average percent correct score of 79.4. The next highest subskill scores were 78.9 percent correct in multiplication of whole numbers and 73.6 percent correct in division of whole numbers.

- Sixth grade students typically scored higher on skill questions than on application questions. However, for nature of numbers and properties; expressions, equations, and coordinate graphs; and geometry, students' scores on application questions exceeded their scores on skill questions.

- In operation applications sixth grade students scored 68.9 percent correct in one-step problems involving whole numbers and 53.3 percent correct in one-step problems involving rational numbers. They scored lowest in application problems of two or more steps involving whole and rational numbers, with an average percent correct score of 48.4.

Table 11

Mathematics Scores of California Sixth Grade Students
on the Survey of Basic Skills: Grade 6, 1981-82 Through 1982-83

Skill area	No. of questions	Average percent correct 1981-82	Average percent correct 1982-83	Change 1981-82 to 1982-83
MATHEMATICS, TOTAL	480	62.7	63.2	+0.5
Counting, numeration, and place value	40	64.7	66.6	+0.9
Skills	25	66.2	68.2	+2.0
Count and numeration	15	67.4	68.6	+1.2
Place value	10	64.5	67.6	+3.1
Applications	15	62.1	64.0	+1.9
Nature of numbers and properties	50	61.6	61.5	-0.1
Skills	35	61.4	61.3	-0.1
Ordering and properties	15	67.1	67.0	-0.1
Classification of numbers	20	57.1	57.0	-0.1
Applications	15	62.1	62.0	-0.1
Operations	145	62.3	63.1	+0.8
Skills	98	65.6	66.6	+1.0
Addition/subtraction of whole numbers	15	79.2	79.4	+0.2
Multiplication of whole numbers	14	78.9	79.9	+1.0
Division of whole numbers	15	72.1	73.6	+1.5
Addition/subtraction of decimals	14	56.3	56.9	+0.6
Multiplication/division of decimals	12	54.0	57.5	+3.5
Operations on fractions	16	53.6	53.4	-0.2
Percents and equivalent fractions/decimals	12	63.6	63.9	+0.3
Applications	47	55.4	55.8	+0.4
One-step problems involving whole numbers	12	68.5	68.9	+0.4
One-step problems involving rational numbers	20	52.9	53.3	+0.4
Two- (or more) step problems	15	48.4	48.8	+0.4
Expressions, equations, and coordinate graphs	42	63.1	63.9	+0.8
Skills	27	62.5	63.4	+0.9
Expressions and equations	15	66.3	66.1	-0.2
Graphs and function tables	12	57.8	59.9	+2.1
Applications	15	64.0	64.9	+0.9
Geometry	40	62.8	63.5	+0.7
Skills	24	63.0	64.1	+1.1
Shapes and terminology	12	64.9	65.4	+0.5
Relationships	12	61.1	62.7	+1.6
Applications	16	62.4	62.6	+0.2
Measurement	58	60.8	61.0	+0.2
Skills	42	62.1	62.4	+0.3
Metric units	20	59.2	60.0	+0.8
U.S. Customary units	10	74.7	74.5	-0.2
Length, area, and volume	12	56.4	56.2	-0.2
Applications	16	57.6	57.3	-0.3
Probability and statistics	23	60.1	59.8	-0.3
Probability	12	53.5	52.3	-1.2
Statistics	11	67.2	68.0	+0.8
Tables, graphs, and integrated applications	30	67.1	67.5	+0.4
Tables and graphs	15	68.3	69.0	+0.7
Integrated applications	15	65.8	65.9	+0.1
Problem solving	52	63.3	63.5	+0.2
Formulation	15	70.1	70.1	0
Analysis and strategy	25	65.7	66.0	+0.3
Interpretation	12	49.9	50.0	+0.1
Total, applications problems	154	60.7	61.2	+0.5

- In measurement sixth grade students scored higher on questions in U.S. Customary units than on the questions in metric units.
- Among the four basic operations, students have most facility with addition, subtraction, and multiplication of whole numbers, followed by division of whole numbers and operations on decimals. Students have the greatest difficulty with operations involving fractions.

The committee members also identified the areas of strength or improvement and the areas in need of improvement. The areas of strength included those skills in which students achieved at or above the committee's expectations or the skills in which the scores are below the committee's expectations but are improving. The areas in need of improvement included the skills that the committee members would like to have particularly emphasized in the mathematics instructional programs.

Areas of Strength or Improvement:

Identification of rational numbers in word form, given the fraction form
Identification of the place value of a given digit in a whole number
Identification of numerals for whole numbers given in expanded notation
Identification of order symbols
Identification of order relations for a given set of decimals
Identification of odd or even numbers
Identification of multiples of given whole numbers
Application of the order relation using whole numbers
Addition, subtraction, and multiplication of whole numbers
Understanding of the multiplication algorithm for whole numbers
Reduction of fractions to the lowest terms
Applications, one-step problems, using addition of whole numbers
Evaluation of simple expressions involving addition, subtraction, or multiplication
Identification of appropriate linear units of measure
Calculation of perimeters of common geometric figures
Identification of the mode of a given list of data
Interpretation of data given in the form of a table
Identification of relevant mathematical problems for given situations
Identification of facts, questions, or unknowns in given problems

Areas in Need or Improvement

Understanding of the exponential form of a number
Identification of prime numbers and prime factors
Identification of the least common multiple and greatest common factor for whole numbers
Division of decimals
Addition and subtraction of fractions with unlike denominators
Multiplication and division of fractions
Applications, one-step problems, involving multiplication or division of fractions
Applications, one-step problems, involving division of decimals
Applications, two-step problems, involving fractions

Estimation of nonlinear measures of familiar objects (metric units)
Calculation of areas and volumes of common geometric figures
Calculation of probabilities of simple events
Interpretation of data given in the form of a circle graph
Selection of appropriate operations to solve given problems that involve division
Checking a given answer in a problem
Recognition of a sensible answer to a given problem
Identification of fraction/decimal/percent equivalents

Committee's Recommendations

- The instructional emphasis should be on the development of problem-solving skills, particularly estimation and checking skills, and on recognition '. sensible answers.

- The committee members cautioned against the tendency to develop a narrow, computational, minimum proficiency-based mathematics curriculum in grades four, five, and six. They felt that all students need a broad, comprehensive instructional program in these grades, covering all objectives in the Mathematics Framework. Concern was expressed that a substantial number of students are being trapped in a repetitive cycle of arithmetic computation instruction and are not being exposed to any other mathematical concepts or skills throughout their school years. Most of these activities do little to develop "number sense" in students.

- The use of appropriate mathematical terminology should be increased.

- Increased instructional emphasis should be given to understanding the concept of place value when used in problems and applications, particularly with decimal fractions.

- The representations of division expressions should be varied so that students are aware of the different forms used.

- Increased instructional emphasis on the understanding and reading of Cartesian coordinate graphs through the use of paper-and-pencil games and computer-assisted activities is recommended.

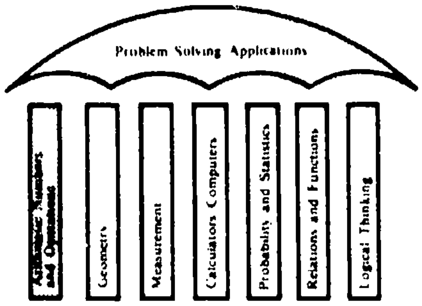
- Continued instructional emphasis in the use and understanding of metric units is recommended.

The Committee's Analysis of Skill Area Results

The results of the committee's analysis are summarized below, by major skill area. The main purpose of this analysis was to point out areas of strength and weakness that may form the basis for improving instruction in California classrooms. Illustrative examples indicating students' actual performance are provided to indicate special strengths or weaknesses; however, these examples should not be taken as indicative of the typical student performance in an entire skill area.

Arithmetic Numbers and Operations

The skills included under arithmetic numbers and operations are counting, numeration, and place value; identifying relational symbols and phrases; identifying the least or greatest whole number, decimal, or fraction from among several numbers, using the commutative, associative, and distributive properties and the properties of one and zero; identifying factors, multiple, least common multiple, greatest common factor; and the basic operations of addition, subtraction, multiplication, and division on whole numbers, decimals, and fractions.



The committee members felt that, in general, students performed well on addition, subtraction, and multiplication problems with whole numbers. The committee members noted that students performed well on most operation problems with whole numbers, even those with a number of renamings. Notable success was achieved on a subtraction problem that included three renamings and a double zero in the minuend. This problem was correctly solved by 86 percent of the students.

$$\begin{array}{r} 4003 \\ -\ 209 \\ \hline \end{array}$$

5 ○ 4794
2 ○ 3806
7 ○ 3804
86 ● 3794

Students, however, have more difficulty on test problems with common fractions and decimal fractions. Many students seem to get "locked into" an algorithmic process and use it even when it is inappropriate. For example, in problems involving addition of fractions, the students tend to add numerators and denominators using an algorithm similar to the one used to multiply fractions.

$\frac{1}{5} + \frac{3}{4} =$

42 ○ $\frac{4}{9}$
41 ● $\frac{19}{20}$
9 ○ $\frac{4}{20}$
8 ○ $\frac{3}{20}$

When subtracting a mixed number from a whole number, students "bring down" the fraction (as in the addition algorithm) without recognizing the need for regrouping.

$$\begin{array}{r} 8 \\ -\ 6\frac{1}{4} \\ \hline \end{array}$$

9 ○ $2\frac{3}{4}$	37 ● $1\frac{3}{4}$
50 ○ $2\frac{1}{4}$	4 ○ $1\frac{1}{4}$

The committee believes that the reason for many of these errors is a lack of conceptual understanding. They recommend the use of concrete materials such as "fraction strips" and "pies" to develop fraction concepts, including the operations with fractions. This lack of understanding becomes very apparent in problems involving fraction, decimal, and percent equivalences. Students do extremely poorly on even the most simple, everyday examples.

Ken's calculator shows $\boxed{143.5}$

Which shows an equal number?

44 ○ $143\frac{1}{5}$
31 ● $143\frac{1}{2}$
19 ○ $143\frac{5}{1}$
6 ○ $143\frac{1}{50}$

The committee believes that concepts such as those illustrated by these examples are fundamental and should be thoroughly internalized by students. All students should recognize without computation, the fraction, decimal, and percent equivalences for the commonly used fractions such as 1/2, 1/4, 1/10, etc. These concepts should be introduced naturally as they are used in real life. Students should know that 50 cents is a half dollar and that if they get 100 percent on a test, they got all of the problems correct. The principle of teaching that needs to be applied here is starting with the familiar before developing the abstract. It appears that students are focusing on symbolic manipulations rather than trying to make sense of the problems they are doing.

Of the several areas in which students had difficulty, two areas drew particular attention from the committee members--mathematical vocabulary and understanding of place value.

Mathematical vocabulary. Students have some difficulty understanding and using the vocabulary of arithmetic. On the following item, 23 percent of the students did not know that "finding the difference" involves subtraction. Six percent of the students selected addition, and 12 percent chose division for their answers.

> To find the difference between 83 and 18, you
>
> 6 ○ add
> 77 ● subtract
> 5 ○ multiply
> 12 ○ divide

Similarly, for multiplication only 46 percent of the students correctly identified the "product" of 8 and 2. Twenty-two percent chose 4 as the product, and 27 percent chose 10. Although division vocabulary was not tested as such, the results on the following item indicate that students have some difficulty:

> Kim played her radio 3 hours every day. The battery lasted about 54 hours. Which of the following could be used to find the number of days Kim played her radio?
>
> 7 ○ $54 - 3 = n$
> 42 ● $54 \div 3 = n$
> 33 ○ $3 \div 54 = n$
> 18 ○ $3 \times 54 = n$

The California Assessment Program test assesses students' understanding of such words and terms as factor, product, addend, sum, even, odd, prime number, prime factor, divisible by, multiple, least common multiple, greatest common factor, and common divisor. During the test development phase, 95 percent of the teachers who responded on a statewide survey indicated that they considered the terminology for addition, subtraction, multiplication, and division at the mastery or developmental level; however, corresponding percentages for prime number, greatest common factor, and lowest common multiple were 45 to 49 percent.

The committee members expressed concern over the low scores in terminology and related concepts, especially because of their conviction that mathematical terminology and symbols constitute the "grammar" of mathematics. In learning a foreign language, students study vocabulary and grammar. It is as important for students of mathematics to understand and use mathematical terms as it is to learn the syntax of a foreign language. The committee members emphasized that learning the language of mathematics should begin in the early grades and should continue throughout a school's mathematics program.

Place value. Student performance on certain place value skill items improved this year. This improvement was in those items that required reading of numerals (including decimals), identifying the place value of a digit, and rounding numerals. However, sixth grade students still show a lack of understanding when they are required to apply or interpret some of the place value skills. Student responses on the following examples are almost identical to the responses on the 1981-82 test.

100 less than 32,013 is

4	○	32,913
9	○	32,113
66	●	31,913
21	○	31,013

Lack of understanding of place value concepts is particularly apparent when students calculate with decimal fractions. In the following example, students ignored the place value of the whole number 2:

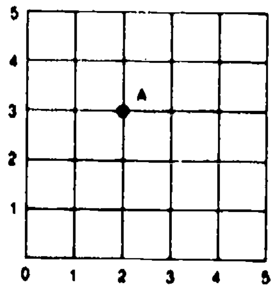
$2 + 1.24 =$

61	○	1.26
2	○	1.44
6	○	2.48
31	●	3.24

<u>Expressions, equations, and coordinate graphs</u>. The questions in this part of the *Survey* involve translation of algebraic expressions into English phrases, evaluating simple algebraic expressions, locating points on a coordinate graph, and identifying either the rule or a missing number in a function table.

There has been very little change in the scores in this content area from those on last year's test. The committee feels that these skills are basic skills that need to be learned before students take higher-level courses such as algebra or geometry.

Among the items on coordinate graphs and function rules and skills, the committee observed that the scores were consistently low only in the subskill of identifying points on the coordinate plane. A closer look at the student responses indicated that most of the errors that occurred involved reversing the order of the coordinates (see the following example).



What ordered pair gives the location of Point A?

2 ○ (3, 3)
45 ○ (3, 2)
1 ○ (3, 4)
52 ● (2, 3)

The committee members indicated a need to emphasize "convéntions," such as in ordered pairs, in the classroom.

Geometry. The questions in this part of the test involve identifying two- and three-dimensional geometric shapes, recognizing line segments, rays, radii, diameters, type of angles and triangles, parallel and perpendicular lines, and similar and congruent figures. The questions also pertain to lines of symmetry, measurement of angles with the help of a protractor, and recognition of spatial relationships.

The students scored 65.4 percent correct on shapes and terminology and 62.7 percent correct on relationship questions. The committee's review of these items revealed that students had some difficulty with the perpendicularity relationship in particular, and with spatial relationships in general. Students were especially strong in identifying angles and congruent figures.

Measurement. The questions in this part of the Survey include subskills on estimating length, area, volume, and mass; choosing appropriate units for measuring an object of a given length, area, volume, or mass; and converting from one unit to another within a particular system. The questions include items on both metric and U.S. Customary units, with a predominance of the questions dealing with metric units.

Student performance in items using metric units improved this year and declined slightly on items using U.S. Customary units. However, students still seem to be more knowledgeable about U.S. Customary units than metric units. Students' performance is not strong when they are asked to use measurement skills, particularly for area and volume. The committee recommends more hands-on measurement activities for students, with increased emphasis on the use of metric units.

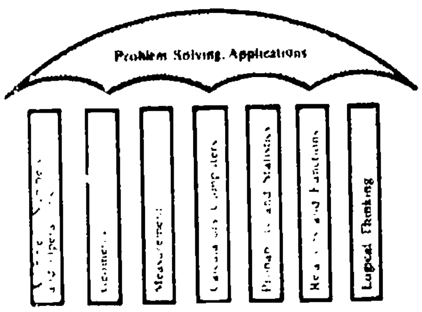
Probability and statistics. The questions on probability require students to select the probability of an event or the complement of an event, identify the probability for an event certain to occur or not to occur, and find probability associated with, for example, the tossing of a coin or the stopping of a pointer of a spinner. The questions on statistics include items on finding the mean, median, mode, and range of a given set of numbers. All questions in this category are presented in simple application format involving real-life situations.

The committee members recommended greater instructional emphasis on probability and statistics in classrooms. The basis for their recommendation was the broad general usage of these concepts in the everyday lives of our citizens and the importance of these skills in preparing for business and technology.

The committee recognized that many instructional materials include minimal suggestions for teaching probability and statistics. Yet, because this strand is so necessary for functioning in our society, the committee recommended that teachers supplement textbooks to ensure that their students develop a good understanding of these skills and concepts.

Problem Solving/Applications

In order to assess student performance in problem solving/application skills, the committee incorporated several unique design features into the new Survey. First, the test contains questions on skills as well as applications for each major strand of mathematics. Second, it includes matched questions such that a computational question has its parallel in a word problem involving the same computations. Third, several application questions are designed to assess student achievement in one- and multi-step word problems. Fourth, problem-solving questions unique to CAP were written by committee members to assess achievement in problem formulation, analysis and strategies, and problem interpretation. Fifth, integrated applications, also unique to CAP, are intended to assess skills involving knowledge in two or more math skills in a practical situation. Whereas skill questions assess student achievement in computational skills, the one-step problems assess achievement in the identification of correct operations, and multi-step problems assess ability in critical thinking in a problem situation. On problem-solving questions, students are required to think about the situation in which the answer is not simply the result of an arithmetic computation.



One-step applications. A one-step application problem is a word problem that is reduced to a one-step computation--adding, subtracting, multiplying, or dividing. The problems on the test involve both whole numbers and rationals (decimals and fractions).

The average score on one-step problems involving whole numbers was 68.9 percent correct as compared to 52.3 percent correct for similar problems involving rationals. The difference in student performance on whole number and rational number applications is primarily the result of students' not having mastered computational skills in decimals (57.5 percent correct on multiplication and division and 56.9 percent correct on addition and subtraction) or fractions (53.4 percent correct) to the same degree that they have mastered computations with whole numbers (79.4 percent correct in addition and subtraction, 78.9 in multiplication, and 73.6 in division). In one-step problems the context of the problem is relatively unimportant except to identify the choice of the operation. The following examples illustrate student performance in one-step whole number application and in one-step decimal applications:

The phone book has 17,751 listings of businesses and homes 2,686 are for businesses How many are for homes?

74 ● 15,065
5 ○ 15,135
6 ○ 15,165
15 ○ 20,437

A paper clip weighs 0.5 gram. A piece of paper weighs 0.03 gram. How much would the paper and the paper clip weigh?

13 ○ 0.008 gram
8 ○ 0.015 gram
34 ○ 0.08 gram
45 ● 0.53 gram

When the same numbers were given as whole number or decimal computations, 92.1 percent of the students correctly answered the whole number question, and 61.0 percent correctly answered the decimal question. Student responses revealed that most of the students knew the correct operations; however, many made errors in aligning the decimals or place values of numbers. About one-half (46 percent) of the sixth graders chose the wrong answer because they aligned the right most digits of two decimal numbers without regard to the decimal position.

Multi-step applications. The word problems in this category involve two or more steps or operations. The percent correct for multi-step problems was 48.4, which was not only lower than the score for one-step problems involving whole or rational numbers but also the lowest score on the Survey. In contrast to one-step problems, in which the context of the story is unimportant, in two- (or more) step problems, the context of the story becomes important for correct solution. The example below illustrates the performance of sixth grade students on a two-step problem that involves identifying the features that are significant to the central problem.

It is 1.3 kilometers from Sharon's house to school She rides her bicycle to and from school every day How far does she ride in 5 days?

6 ○ 6.3 kilometers
67 ○ 6.5 kilometers
5 ○ 10 kilometers
22 ● 13 kilometers

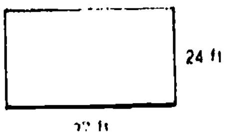
In the above question the predominant error (made by 67 percent of the students) resulted from students' ignoring "to-and-fro" parts of the question and answering simply 1.3 x 5 = 6.5. The correct solution requires additional multiplication: 2 x 6.5 = 13. In multi-step problems a general error was to respond as if only one step were required. The committee members noted that questions such as these have been used infrequently in commonly used grade six textbooks. They recommended that teachers spend more time in developing critical thinking skills through class discussions and homework assignments using concrete problem situations. Since computation is not the critical skill to develop thinking skills, the committee members emphasized the use of calculators in conjunction with class discussion and homework assignments for such problems.

Applications in expressions, equations, geometry, measurement, graphs, and integrated applications. The application questions in these categories involve applications of skills in practical situations. From Table 11 it is apparent that the percent correct for applications was lower than the percent correct for skills except for the area of expressions and equations. Of the nine major categories on the Survey, the highest score was 67.5 percent correct for tables, graphs, and integrated applications.

The committee's review indicated that generally where students are weak in applications, they are also weak in skills. On measurement computation questions students were able to find perimeters of figures when measurements are given on the figure, but in most application problems, they seem to apply the given numbers in a random fashion without regard to their meaning in the problem (see the following example).

Jim and Judy wanted to put a rail fence around their rectangular lot They wanted the posts to be spaced eight feet apart

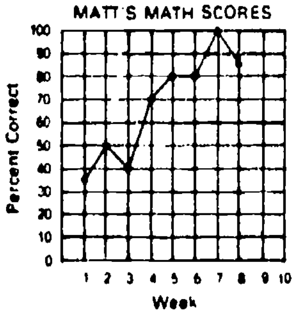
How many posts will they need?



23 ○ 12
41 ● 14
19 ○ 16
17 ○ 18

The students in the sixth grade were also weak in interpreting data from circle graphs and line graphs. The examples that follow illustrate their performance on representative items:

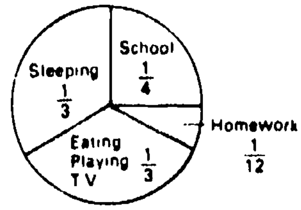
Read the graph to answer the question



The biggest change in Matt's math scores took place between weeks

3 ○ 1 and 2
4 ○ 2 and 3
50 ● 3 and 4
43 ○ 6 and 7

What part of Sam's day is spent eating, playing, watching TV, and sleeping?

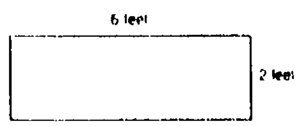


39 ○ $\frac{1}{3}$
3 ○ $\frac{1}{2}$
12 ○ $\frac{7}{12}$
46 ● $\frac{2}{3}$

Student scores were strong, however, in interpretation of data from tables and from bar graphs. In general, students did better on items where they simply had to read a table or graph than on items that required them to interpret information or do some computation with the data.

Problem solving. Of the three types of questions in this category, problem formulation, analysis and strategy, and interpretation, students scored highest (70.1 percent correct) on problem formulation questions and lowest (50.0 percent correct) on interpretation questions. Except for the multi-step application problems, items involving interpretation were the most difficult.

The skills in problem formulation include identifying problems or situations that can be represented by given mathematical models, such as number sentences, equations, diagrams, tables, and graphs. The following example illustrates the performance of sixth grade students on a question in problem formulation:



Which problem is suggested by the above diagram?

14 ○ What is the diameter of a 6-foot circle?
71 ● What is the area of the floor?
11 ○ How much will it cost for 8 items?
4 ○ How many halves are there in 6 apples?

The committee members noted that students were able to match a word problem to a given number sentence when the numbers in the problem were dollars and cents, but noted that students found a similar problem involving decimals more difficult. In all cases where a drawing or diagram was presented, the students had some difficulty applying it to a correct problem situation. In the example above, only 71 percent responded correctly, while approximately 25 percent chose either the first or third response.

Analysis and strategy problems involve identifying the significant features of the central problem and planning strategies to deal with them. Planning might involve guessing, estimating, drawing diagrams, creating concrete models, listing similar elements, or breaking the problem into manageable parts. A critical step in problem analysis is translation of the problem into mathematical symbols, because it demands an explicit definition of the problem and selection of an appropriate strategy for solving it. The step also demands risk taking. The following example is from the questions on identifying given facts, unknowns, or questions (significant features) in a given problem:

> 36 children are in the room. 4 children are sitting at each table. How many tables are being used by the children?
>
> . . . . . .
>
> What are you asked to find out?
>
> 3 ○ The number of children in the room
> 77 ● The number of tables being used
> 16 ○ The number of children at each table
> 4 ○ The number of children in 4 rooms

Although about 77 percent of the students answered questions similar to the above example correctly, the responses of the students on other questions indicated that they were not reading discriminately. The students were not paying attention to specific details in the prose or the specific question asked. The next example is an illustrative question requiring an appropriate operation that will lead to the solution of a given problem:

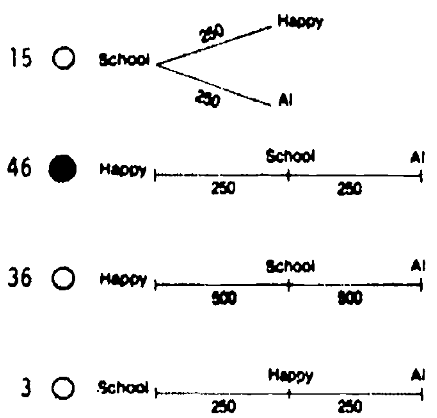
> Mr. Higgins made 2 hamburgers for each child at the picnic. In all, he made 32 hamburgers. How many children were at the picnic?
>
> . . . . . .
>
> Which expression will help you solve the problem?
>
> 20 ○ 32 × 2
> 6 ○ 32 + 2
> 45 ● 32 ÷ 2
> 29 ○ 2 ÷ 32

The committee members noticed that students had some difficulty knowing when to multiply or divide, and the larger the number in the problem, the more difficulty they had in selecting the appropriate operation. Students also seemed to have difficulty relating a division problem with its horizontal form. In the example just presented, 74 percent of the students knew that division was the appropriate operation, but only 45 percent selected the correct response.

The example below is an illustration from questions on identifying mathematical models, such as number sentences, charts, tables, and diagrams for a given problem. The example was answered correctly by less than half the students.

Happy and Al lived the same distance from the school, but in opposite directions. They found that they lived 500 meters apart.

Which drawing shows this?



In general, student performance on these items suggests that many students have had little experience drawing or interpreting diagrams or other models of mathematical situations.

The following example is an illustration from questions on identifying missing or extraneous information in a given problem:

> The 130 students from Marie Curie School are going on a picnic in Carson Park. Carson Park is 12 miles from the school. Each bus holds 50 passengers. How many buses are needed?

Which numbers are needed to solve this problem?

9 ○ 130 and 12
66 ● 130 and 50
11 ○ 12 and 50
14 ○ 130, 12, and 50

The committee members noted that such problems are relatively new to most math programs and textbooks. Yet it is imperative that, in real-life situations, students be able to sort through the information they have (or identify information they do not have) and select the relevant data. Only 63 percent of the students were able to select the relevant numbers in the example just given.

The example below is an illustration from questions on using guess and check strategies to solve problems. Guessing and checking, or trial and error, is an appropriate starting point when a method to solve a problem is not immediately apparent.

$\square \times \square = 1849$

The number in each box is the same

2 ○ The number is between 0-10
32 ● The number is between 11-50
35 ○ The number is between 51-100
31 ○ The number is larger than 100

This approach, which is used frequently by adults in everyday situations, seems to be almost unknown to sixth grade students. In the example above the last three responses were chosen almost equally by the students.

The ensuing example is an illustration from questions on estimation to predict reasonable solutions and identification of problem-solving tactics needed to solve a given problem:

Yolanda bought groceries that cost $3.65, $1.25, $4.99, $27.95, and $0.15

Which of these is the best estimate of her total cost?

15 ○ $4 + $2 + $5 + $28 + $1
22 ○ $3 + $1 + $4 + $27 + $0
56 ● $4 + $1 + $5 + $28 + $0
7 ○ $4 + $1 + $5 + $27 + $0

The committee members remarked that rounding and estimation are frequently used in everyday life, whether one is shopping for groceries, determining cooking time for a dinner, or determining whether an answer to a problem worked on a calculator is reasonable. Yet most students get very little practice in estimating. In the example, only simple rounding skills are necessary to determine the solution; yet only 56 percent of the students answered this item correctly.

Interpretation skills require students to review the problems and answers, judge the validity of their translations into mathematical symbols, and check the accuracy of their use of mathematical rules. The example below requires students to check their solutions in the context of the original problem. The committee members remarked that students are accustomed to using arithmetic to solve word problems and that they have "learned" that the answer to their arithmetic is the "correct" answer to the word problem.

> The 130 students from Marie Curie School are going on a picnic. Each school bus holds 50 passengers. How many buses will they need?
>
> Rose worked the following problem.
>
> $$\begin{array}{r} 2 \\ 50\overline{)130} \\ \underline{100} \\ 30 \end{array}$$
>
> Look back at the question in the problem. Which answers it?
>
> 5 ○ 2   10 ○ $2\frac{3}{5}$
>
> 50 ○ 2 R30   35 ● 3

They need to have more experience in "making sense" out of the answer. In the example above there are several "correct" answers to the arithmetic problem, but there is only one "sensible" answer to the question in the word problem.

Even on problems where there was only one sensible choice, many students selected unrealistic answers. In the following examples almost 50 percent of the students made unrealistic choices for their answers.

> A hand is used to measure the height of a horse. The hand is 4 inches long. How tall is a horse that measures $15\frac{1}{2}$ hands?
>
> Which answer makes the most sense?
>
> 16 ○ $15\frac{1}{2}$ inches
>
> 54 ● about 5 feet
>
> 16 ○ about 62 feet
>
> 14 ○ $15\frac{1}{2}$ feet

88

The next example is an illustration from questions that require students to draw reasonable conclusions by analyzing or interpreting given information:

> Anna is cutting a whole pizza into pieces of about the same size. Which sentence below is true?
>
> 4 ○ The larger each piece is, the more pieces there are
>
> 5 ○ The smaller each piece is, the fewer pieces there are
>
> 68 ● The larger each piece is, the fewer pieces there are
>
> 23 ○ The size of each piece has nothing to do with the number of pieces.

The committee members noted that many students had some difficulty interpreting information and relating it to their experiences. In the example above nearly one-fourth of the students stated that the size of the pieces in a pizza was not related to the number of pieces cut. Even in a relatively straightforward computation problem (see the example that follows), less than 60 percent of the students were able to draw a reasonable conclusion from the given information.

> A new school building has 40 classrooms. The school ordered 28 new desks for each classroom. 1200 desks were delivered.
>
> Which of these is true?
>
> 10 ○ The correct number of desks was delivered.
>
> 57 ● Too many desks were delivered.
>
> 28 ○ Not enough desks were delivered.
>
> 5 ○ The school needed 200 more desks.

Scope of the Grade Twelve Mathematics Test

The Survey of Basic Skills: Grade 12 was developed to assess the degree to which students have acquired "basic" mathematics skills by the end of the twelfth grade. A statewide committee compiled objectives and reviewed questions for inclusion in the test. The 196 questions on the Survey were designed to assess students' skills in the areas of arithmetic, algebra, geometry, measurement, and probability and statistics. Figure 11 is an illustration of the emphasis given to each skill area in the total test. In the figure the skill area of arithmetic is subdivided into the areas of number concepts, whole numbers, fractions, and decimals. A complete description of the skills assessed on the Survey is given in Test Content Specifications, Survey of Basic Skills, Grades 6, 12, Mathematics (Sacramento: California State Department of Education, 1975).

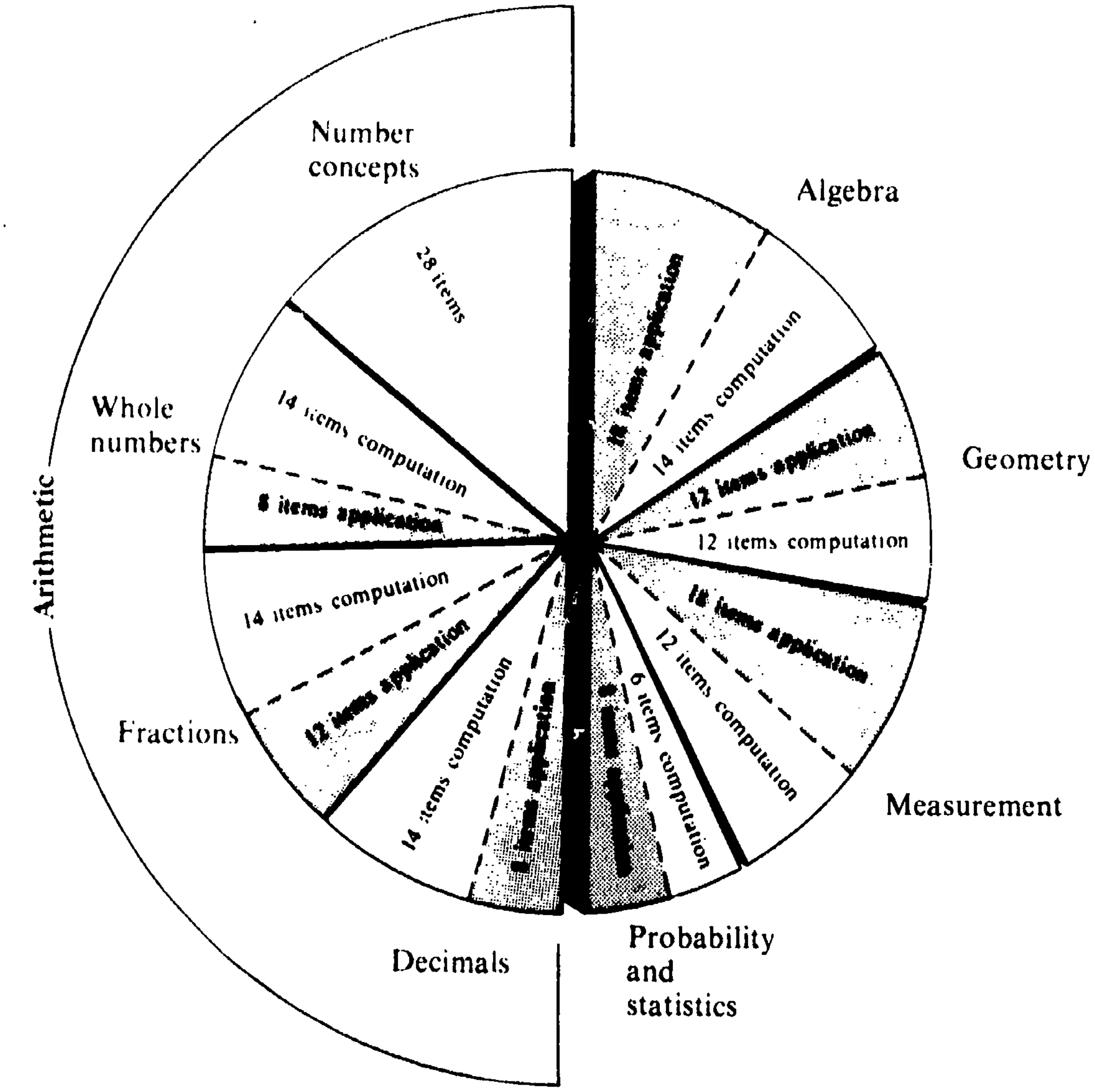


Fig. 11. Number of questions, by skill area, in the mathematics portion of the *Survey of Basic Skills: Grade 12*

Mathematics Results for Grade Twelve

Table 12 contains the twelfth grade Survey results for the total test and for the five major content categories assessed on the Survey--arithmetic, algebra, geometry, measurement, and probability and statistics. The results are presented for the computation and application portions of each skill category. Additionally, the results are presented for the category of problem solving, which is an aggregation of application questions in arithmetic, algebra, and measurement. Table 12 shows the scores for 1975-76 through 1982-83 and the changes in scores over the same eight-year period. The following overall conclusions are apparent from the data in Table 12.

- The overall mathematics achievement of California twelfth grade students did not change from 1981-82 to 1982-83.

- The 1981-82 and 1982-83 scores of 67.7 percent correct were the second highest scores for the eight years of testing, being surpassed only by the 1980-81 score of 68.0 percent correct.

Table 12

Mathematics Scores of California Twelfth Grade Students and Changes in Scores on the Survey of Basic Skills: Grade 12, 1975-76 Through 1982-83

Skill area	No. of questions	Average percent correct score								Change in average percent correct score						
		1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1975-76 to 1976-77	1976-77 to 1977-78	1977-78 to 1978-79	1978-79 to 1979-80	1979-80 to 1980-81	1980-81 to 1981-82	1981-82 to 1982-83
MATHEMATICS, TOTAL	198	67.0	66.3	66.3	66.5	66.8	68.0	67.7	67.7	-0.7	-0-	+0.2	+0.3	+1.2	-0.3	-0-
Arithmetic	98	72.9	72.1	72.2	72.7	73.1	74.5	74.3	74.4	-0.8	+0.1	+0.5	+0.4	+1.4	-0.2	+0.1
Number concepts	28	74.3	73.5	73.6	73.9	74.1	75.4	75.0	75.2	-0.8	+0.1	+0.3	+0.2	+1.3	-0.4	+0.2
Number and numeration	14	71.0	70.1	69.9	70.1	70.6	72.1	72.1	72.6	-0.9	-0.2	+0.2	+0.5	+1.5	-0-	+0.5
Number theory	8	76.2	75.9	76.4	76.9	76.7	77.7	76.9	76.7	-0.3	+0.5	+0.5	-0.2	+1.0	-0.8	-0.2
Number properties	6	79.6	78.5	78.6	78.8	78.7	79.8	79.1	79.3	-1.1	+0.1	+0.2	-0.1	+1.1	-0.7	+0.2
Whole numbers	22	80.1	80.1	80.1	80.6	81.0	81.7	81.6	81.6	-0-	-0-	+0.5	+0.4	+0.7	-0.1	-0-
Computation	14	80.9	81.0	81.2	81.9	82.4	83.5	83.6	83.8	+0.1	+0.2	+0.7	+0.5	+1.1	+0.1	+0.2
Application	8	78.7	78.5	78.2	78.3	78.4	78.6	78.0	77.7	-0.2	-0.3	+0.1	+0.1	+0.2	-0.6	-0.3
Fractions	26	66.0	64.5	64.3	64.7	65.0	66.3	66.1	65.9	-1.5	-0.2	+0.4	+0.3	+1.3	-0.2	-0.2
Computation	14	70.4	68.3	68.4	69.0	69.6	71.5	71.5	71.2	-2.1	+0.1	+0.6	+0.6	+1.9	-0-	-0.3
Application	12	60.9	60.0	59.5	59.6	59.7	60.2	59.9	59.7	-0.9	-0.5	+0.1	+0.1	+0.5	-0.3	-0.2
Decimals	22	71.8	71.2	72.0	72.9	73.7	75.8	75.8	76.3	-0.6	+0.8	+0.9	+0.8	+2.1	-0-	+0.5
Computation	14	74.1	73.8	74.8	75.8	76.7	79.1	79.2	80.0	-0.3	+1.0	+1.0	+0.9	+2.4	+0.1	+0.8
Application	8	67.8	66.6	67.2	67.7	68.3	70.1	69.9	69.8	-1.2	+0.6	+0.5	+0.6	+1.8	-0.2	-0.1
Algebra	32	62.9	62.1	61.8	62.1	62.3	63.5	63.2	63.3	-0.8	-0.3	+0.3	+0.2	+1.2	-0.3	+0.1
Computation	14	66.4	65.9	65.5	66.0	66.4	67.6	67.5	67.7	-0.5	-0.4	+0.5	+0.4	+1.2	-0.1	+0.2
Application	18	60.1	59.2	58.8	59.1	59.1	60.2	59.9	60.0	-0.9	-0.4	+0.3	-0-	+1.1	-0.3	+0.1
Geometry	24	62.7	62.1	61.8	61.8	62.0	62.4	62.4	62.1	-0.6	-0.3	-0-	+0.2	+0.4	-0-	-0.3
Knowledge of facts	12	75.2	75.5	75.5	75.4	75.5	76.0	76.0	75.6	+0.3	-0-	-0.1	+0.1	+0.5	-0-	-0.4
Application	12	50.1	48.7	48.1	48.3	48.4	48.8	48.8	48.6	-1.4	-0.6	+0.2	+0.1	+0.4	-0-	-0.2
Measurement	30	60.5	59.5	59.4	59.0	59.2	60.0	59.3	59.0	-1.0	-0.1	-0.4	+0.2	+0.8	-0.7	-0.3
Knowledge of facts	12	71.6	70.5	70.1	69.7	69.6	70.8	69.7	69.1	-1.1	-0.4	-0.4	-0.1	+1.2	-1.1	[illegible]
Application	18	53.1	52.2	52.2	51.9	52.2	52.9	52.4	52.3	-0.9	-0-	-0.3	+0.3	+0.7	-0.5	[illegible]
Probability and statistics	14	57.2	56.9	57.3	57.4	57.8	59.2	58.8	58.6	-0.3	+0.4	+0.1	+0.4	+1.4	-0.4	-0.2
Computation	6	57.9	57.6	58.3	59.0	59.6	61.3	61.3	60.8	-0.3	+0.7	+0.7	+0.6	+1.7	-0-	-0.5
Application	8	56.6	56.3	56.5	56.2	56.5	57.6	57.0	56.9	-0.3	+0.2	-0.3	+0.3	+1.1	-0.6	-0.1
All application problems	62	61.8	60.7	60.6	60.7	60.9	61.7	61.3	61.2	-1.1	-0.1	+0.1	+0.2	+0.8	-0.4	-0.1
Arithmetic	28	68.5	67.2	67.1	67.2	67.5	68.3	67.9	67.7	-1.3	-0.1	+0.1	+0.3	+0.8	-0.4	-0.2
Graphs	34	56.2	55.4	55.2	55.3	55.4	56.2	55.7	55.7	-0.8	-0.2	+0.1	+0.1	+0.8	-0.5	-0-

- Some computation scores have increased over the eight-year period, with an overall increase of 2.9 percent correct for computation with whole numbers, a 0.8 percent correct increase for computation with fractions, and a 5.9 percent correct increase for computation with decimals.

- Application scores have fluctuated slightly over the eight-year period, with an overall decrease of 1.0 percent correct for applications involving whole numbers, a 1.2 percent correct decrease for applications involving fractions, and a 2.0 percent correct increase for applications involving decimals.

- Number concept scores have remained nearly constant over the eight-year testing period with an overall increase of 0.9 percent correct.

- Algebraic concept scores also remained nearly constant over the eight-year testing period, with an overall increase of 0.4 percent correct.

- Geometry scores decreased over the eight-year period, with a decrease of 0.6 percent correct for the eight-year testing period. A decrease of 0.3 percent correct occurred in the scores from 1981-82 to 1982-83.

- Measurement scores have generally declined over the seven years, with an overall decrease of 1.5 average percent correct.

- Probability and statistics scores increased over the eight-year testing period by 1.4 percent correct. The 1982-83 score decreased by 0.2 percent correct from that of 1981-82.

- Problem solving skills decreased by 0.6 percent correct over the eight-year testing period.

The Committee's Conclusions

The committee members identified areas of strength and areas in need of improvement. The areas of strength included those skills in which the students achieved at or above the committee's level of expectation. The areas in need of improvement included the skills that committee members would like to have particularly emphasized in the classrooms through a variety of instructional methods.

Areas of Strength

- Identification of numerals named in words or in standard form
- Addition of whole numbers
- Subtraction of whole numbers with or without renaming
- Division of whole numbers
- Multiplication of whole numbers
- Applications involving division facts
- Subtraction of fractions with like denominators
- Addition, subtraction, and multiplication of decimals

- Recognition of common geometric figures and knowledge of geometric facts
- Operations with denominate numbers involving units of time
- Visualization of fractional parts of given diagrams

Areas in Need of Improvement

- Scientific notation
- Conversion of fractions to decimals
- Order relation for numbers written in fraction form
- Multiplication of numbers written in mixed numeral form
- Fraction application problems involving ratio and proportion
- Changing of decimals to percents
- Translation of verbal statements into algebraic expressions
- Recognition of perpendicular and parallel relationships
- Similarity relationship and use of the Pythagorean theorem
- Applications involving measurement
- Determination of the median of a given list of numbers
- Adding algebraic fractions

Mathematics Courses Completed by Grade Twelve Students

A part of the grade twelve test asked students to indicate the types of mathematics courses and the number of semesters spent in these courses in grades eight through twelve. The courses were identified as general mathematics, beginning algebra, plane geometry, intermediate algebra, trigonometry, and advanced topics. Table 13 shows the percentage of students who had taken various amounts of mathematics and their scores in total mathematics as well as in mathematics skill areas on the 1982-83 Survey.

Table 14 shows the percentage of students who took general mathematics, beginning and intermediate algebra, and geometry in 1977-78 and 1982-83. It also shows the percentages of students who took trigonometry and advanced topics for 1982-83 only; no data were collected for these courses in 1977-78. Also shown in Table 14 is the difference in the percents of students taking mathematics courses in California and the nation for 1979-80. A positive difference means that more studen.s in California opted to take a particular course. The California-national comparison allows the reader to judge the amount of mathematics coursework taken by California students in comparison to their national counterparts.

The data in Table 13 show that only 2.3 percent of students had had no mathematics courses at all in grades eight through twelve. Table 14 shows that compared to 1977-78 more students were taking courses in 1982-83 except for general math. Comparing the amount of mathematics coursework of California students with that of students nationwide reveals that California students take slightly more coursework up to intermediate algebra but slightly fewer of them take trigonometry.

Table 13

Mathematics Skill Area Scores of Twelfth Grade Students, by Semesters of Mathematics Taken

Mathematics skill areas	Scores, by semesters of mathematics										
	0 (2.3)*	1 (4.4)	2 (11.3)	3 (9.2)	4 (15.5)	5 (8.0)	6 (15.8)	7 (6.6)	8 (14.4)	9 (5.5)	10 (7.3)
TOTAL	51.6	51.8	56.3	61.7	63.9	66.8	69.1	71.6	76.5	80.8	81.7
Arithmetic	59.0	59.4	64.0	69.3	71.1	73.9	75.8	78.3	82.4	86.1	86.5
No. concepts	57.9	57.6	63.8	69.8	71.7	74.8	76.9	79.9	83.9	87.7	88.7
Numeration	57.1	56.9	61.9	67.4	68.8	71.9	73.4	76.5	81.0	85.1	86.8
No. theory	58.3	57.9	65.3	70.5	73.1	75.7	79.0	82.1	85.9	89.6	89.6
No. properties	58.9	58.9	66.4	74.2	76.5	80.1	82.2	85.0	87.9	91.1	91.7
Whole numbers	67.8	69.5	73.4	77.9	79.4	81.4	82.9	84.7	87.8	90.0	90.5
Computation	72.5	73.9	76.4	80.2	81.6	83.4	84.5	86.5	89.7	92.0	92.5
Application	59.4	61.8	68.0	73.7	75.6	77.9	80.1	81.5	84.4	86.7	86.9
Fractions	48.4	47.9	52.7	59.3	61.3	65.2	67.4	70.3	76.3	80.9	81.1
Computation	53.1	53.2	58.0	64.8	66.9	71.4	72.5	76.4	81.4	85.8	85.9
Application	42.9	41.7	46.5	52.9	54.8	58.0	61.5	63.1	70.4	75.2	75.4
Decimals	64.2	64.9	68.1	72.0	73.6	75.5	77.2	79.4	82.4	86.2	86.2
Computation	70.8	70.2	72.7	76.2	77.5	79.2	80.5	82.3	85.5	88.8	89.0
Application	52.7	55.8	60.1	64.6	66.7	69.1	71.3	74.4	77.1	81.6	81.5
Algebra	44.5	44.4	49.9	56.1	58.8	62.4	65.2	67.7	73.8	79.3	80.2
Computation	47.7	46.2	52.5	60.3	63.0	67.2	70.0	71.9	78.9	84.7	85.5
Application	42.0	42.9	47.8	52.8	55.6	58.6	61.5	64.4	69.8	75.2	76.1
Geometry	46.8	46.6	50.2	56.1	57.7	60.6	62.8	66.0	71.6	76.8	77.7
Computation	61.7	62.5	65.9	71.2	72.6	75.1	77.1	78.9	83.1	85.6	86.2
Application	31.8	30.7	34.5	41.0	42.8	46.1	48.6	53.0	60.2	68.1	69.3
Measurement	43.5	44.0	47.7	52.1	55.2	57.7	60.1	62.4	68.0	72.6	74.3
Computation	51.3	52.9	57.3	62.4	65.8	68.5	70.8	73.2	78.1	82.2	82.6
Application	38.3	38.0	41.3	45.3	48.2	50.5	52.9	55.2	61.3	66.1	68.8
Probability and statistics	41.4	41.1	45.8	51.6	54.6	57.2	60.8	62.6	68.2	72.0	74.1
Computation	42.5	44.3	49.7	54.9	57.9	59.8	63.6	64.4	69.0	72.9	73.8
Application	40.5	38.7	42.8	49.2	52.2	55.2	58.7	61.2	67.6	71.3	74.3

*Numbers in parentheses are the percents of twelfth grade students who had taken the corresponding number of semesters of mathematics courses.

As one would expect, performance improves with training. Table 13 shows that from no mathematics coursework in grades eight through twelve to ten semesters of coursework, the total mathematics score improves by 30 points. Improvements occur for all skill areas; however, the greatest improvements occur for algebra computation (37.8 points) and geometry application (37.5 points). The smallest improvements occur for whole number computation (20.2 points) and decimal computation (18.2 points). By the eighth grade most students have achieved mastery in computational skills; therefore, large growth in percent correct scores cannot be expected.

The Committee's Analysis of Skill Area Results

Some interesting anomalies were observed, however, when results were analyzed at the item level. For example, those who took no mathematics do better on some problems, especially application problems, than do those who have taken one or two semesters of algebra. Here is an example:

It is $\frac{1}{6}$ of a mile from Ben's home to school and $\frac{3}{8}$ of a mile from his home to Lincoln Park. How many miles does Ben walk when he goes home from school and then on to Lincoln Park?

3 ○ $\frac{5}{24}$ 62 ● $\frac{13}{24}$

13 ○ $\frac{4}{14}$ 17 ○ None of these

5 ○ $\frac{5}{12}$

Table 14

Percentage of High School Seniors in California Who Took Mathematics Courses in 1977-78 and 1982-83; and Differences in Mathematics Coursetaking, California and the Nation, 1979-80

Course	In 1977-78	In 1982-83	Difference in percentage California - nation 1979-80**
General math	86.6	71.9	*
Beginning algebra	73.4	77.8	+1.4
Geometry	46.1	50.6	+2.3
Intermediate algebra	30.5	41.5	+1.1
Trigonometry	*	16.6	-0.9
Advanced topics/calculus	*	10.1	0.0

*Data not collected for this course.

**Source: High School and Beyond: A National Longitudinal Study for the 1980's. Washington, D.C.: National Center for Educational Statistics, 1981. A positive number indicates that more students in California took the corresponding course.

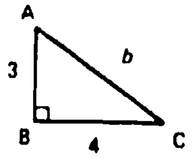
A study was made of the items that showed a great shift in percent correct from 0 years to 5 years (10 semesters) of experience in mathematics classes. Here are four examples from the areas of arithmetic, algebra, geometry, and probability and statistics.

If $S = \frac{15T + 6}{9}$, what is the value of T when $S = 4$?

71 ● 2 18 ○ $\frac{34}{5}$
11 ○ $\frac{14}{5}$ 10 ○ 18

Five people donated money to the Red Cross. The donations were: $52, $76, $18, $94, and $120. What was the average donation?

8 ○ $70 7 ○ $76
69 ● $72 16 ○ $360



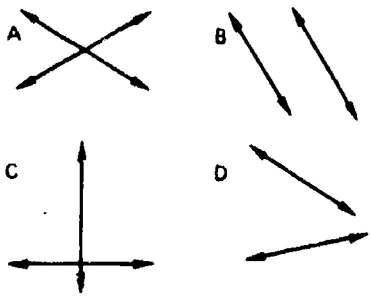
Triangle ABC above has a right angle at B. Two of the other sides have lengths of 3 units and 4 units as shown. How long is the hypotenuse b?

5 ○ 3 units 12 ○ 6 units
8 ○ 4 units 28 ○ 7 units
47 ● 5 units

In scientific notation, 9,870 =

14 ○ 98.70×10^2 6 ○ 9.870×10^2
28 ○ 987.0×10^1 34 ● 9.870×10^3
18 ○ 9.870×10^1

Below are four other examples that showed a small shift in the percent correct when comparing students with 0 years of experience in mathematics classes with those having 5 years of experience.



Which is a pair of parallel lines?

2 ○ A 95 ● B 3 ○ C 0 ○ D

If you toss a coin 1,000 times, which of these outcomes is most likely?

5 ○ 100 heads, 900 tails
4 ○ 250 heads, 750 tails
69 ● 450 heads, 550 tails
16 ○ 599 heads, 401 tails
6 ○ 700 heads, 300 tails

$$\begin{array}{r} .44 \\ \underline{\times\ 2} \end{array}$$

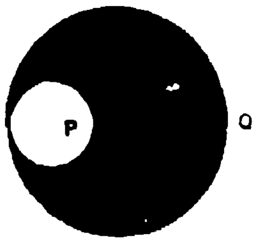
2 ○ .088 0 ○ 8.8
97 ● .88 1 ○ 88

There is a total of 85 students in 5 classes. What is the average number of students per class?

1 ○ 20 93 ● 17
1 ○ 18 5 ○ 16

7—77767

As we see, all students performed well on these items. On the other hand, the next item shows that some items are simply not being learned by California students:



If the radius of circle Q in the figure above is 3 times the radius of circle P, the area of the shaded region is what fractional part of the area of circle Q?

25 ● $\frac{8}{9}$	7 ○ $\frac{512}{729}$
24 ○ $\frac{19}{27}$	44 ○ $\frac{8}{27}$

On this item the best percent correct was a low 37.8. This was earned by those who had taken 10 semesters of mathematics.

Committee's Recommendations

The members of the Mathematics Assessment Advisory Committee made the following recommendations for further improvement of the mathematics results for twelfth grade students:

- Increased instructional emphasis should be given to solving application problems involving fractions, mixed numbers, and ratios.
- Increased instructional emphasis should be placed on using measurement instruments to understand measurement concepts and applications, since these skills are such vital parts of the basic skills needed in everyday life.
- The development of problem analysis and problem-solving skills should be continued.
- Some elementary algebraic skills are useful in formulating and solving problems. All students should be given the opportunity to acquire these skills before they graduate from high school. Such skills include solving simple algebraic equations, evaluating simple expressions and formulas, and reading and interpreting information from coordinate graphs.

- Students should take at least one year of mathematics in the eleventh or twelfth grade so that instruction in mathematical skills and concepts is provided closer to the time when many students graduate and become working citizens in their communities.

- Instructional materials should be selected that require students to read for comprehension and that develop critical reading skills.

- Classroom organization should encourage verbal interaction between students in problem-solving activities.

Sex Differences in Mathematics Performance

Boys and girls in the third and sixth grades answer approximately the same number of mathematics problems correctly, but they differ on the kinds of items they are able to solve. Table 15 illustrates the differences in the performance of girls and boys in various skills in the third and sixth grades. The values in Table 15 were obtained by subtracting the boys' average score from the girls' average score. A negative value means that boys performed better than girls did. A positive value means that girls performed better than boys did.

In terms of the numbers of areas in which one sex or the other excels, girls are outperforming boys at the third grade level. Of the 13 types of problems given in Table 15, third grade girls surpass third grade boys on seven. The situation changes in the sixth grade. Of the 17 types of problems listed, girls surpass boys on only five. Moreover, the differences between boys' and girls' scores are greater at the sixth grade than at the third grade (for example, counting and place value applications). In one area (measurements) the difference between boys' and girls' scores increased in both computation and applications for both the third and sixth grades.

Another way of evaluating the performances of boys and girls is to chart the magnitude of the difference between their scores on each test item. Even though any difference is statistically significant because of the large number tested, the committee felt that a difference of 3 percent correct represents a meaningful as well as statistically significant difference. For the bar graphs in figures 12 and 13, then, a 3 percent correct difference was used as the cutoff point.

In figures 12 and 13, the test item results are grouped into categories. Within each category the items are broken down into three classes: (1) those for which girls scored at least 3 percent correct higher than boys did; (2) those for which boys scored at least 3 percent correct higher than girls did; and (3) those for which boys and girls scored within 3 percent correct of each other. For each category the distribution of the differences in percent correct scores is represented. For example, in the third grade category of problem analysis, girls scored at least 3 percent correct better than boys did on 33 percent of the items in that category. Boys outscored girls by 3 percent correct on 7 percent of the items. Girls and boys scored within 3 percent correct of each other on 60 percent of the items.

Table 15

Differences in Achievement of Girls and Boys for All Mathematics Areas of the Third and Sixth Grade CAP Tests, 1981-82 and 1982-83

	Girls' average score minus boys' average score			
	Third grade		Sixth grade	
Ca. ory	1981-82	1982-83	1981-82	1982-83
Counting and place value				
Computat'..	-0.10	-0.31	-0.74	-0.60*
Applicat'ons	+0.54	-0.01*	-3.41	-3.22*
Nature of numbers and properties				
Computation	+1.32	+0.87*	+0.40	+0.61
Applications	+0.75	+0.36*	-0.58	-0.33*
Arithmetic operations				
Computation	+1.89	+1.60*	+2.30	+2.25*
Applications	-0.62	-1.21	-1.48	-1.41*
Geometry				
Computation	+1.34	+0.89*	-1.57	-0.63*
Applications	+1.31	+0.30*	-0.83	-0.99
Measurement				
Computation	-1.64	-2.45	-2.56	-2.80
Applications	-0.68	-0.87	-2.56	-2.93
Patterns/graphs				
Computation	-0.19	-0.78	+0.84	+1.83
Applications	+1.88	+1.54*	-0.24	+0.42
Probability	--	--	-3.87	-3.13*
Statistics	--	--	-0.43	-0.32*
Problem analysis	+2.88	+2.29*	+1.37	+1.18*

*Categories in which the difference between boys and girls diminished between 1981-82 and 1982-83.

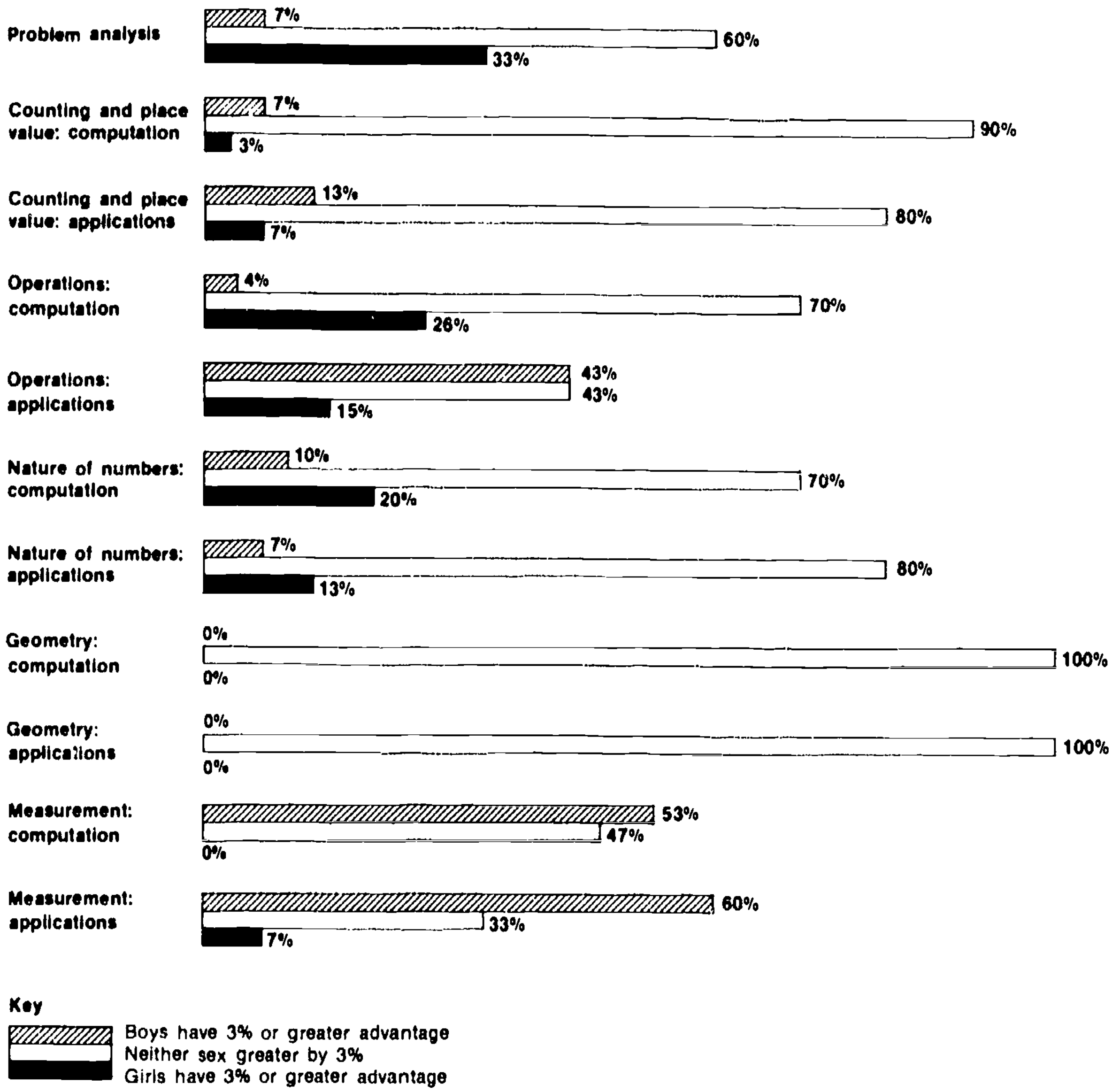


Fig. 12. Percents of grade three mathematics items, by item category, on which boys outscored girls, boys and girls scored about the same, and girls outscored boys

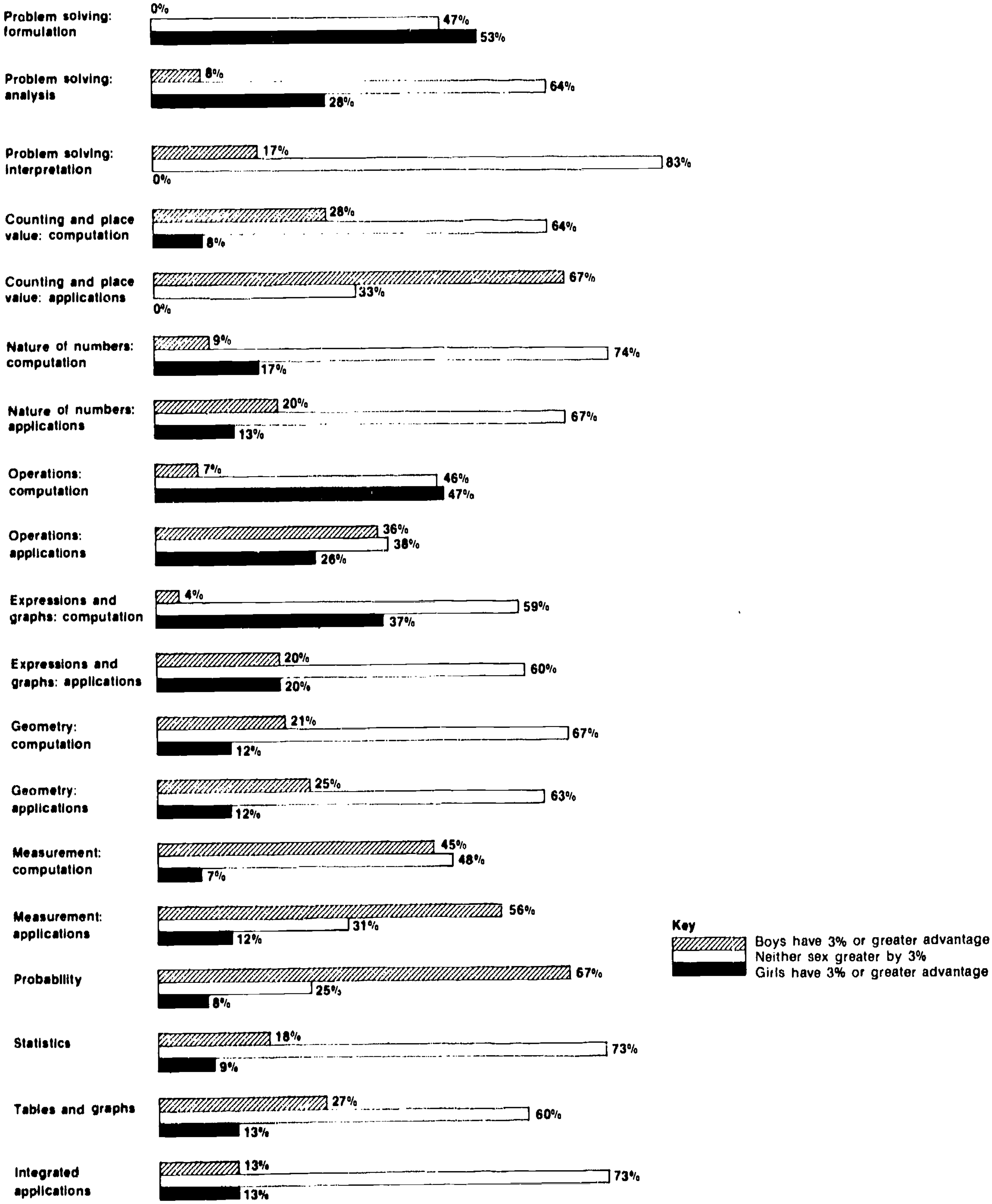


Fig. 13. Percents of grade six mathematics items, by item category, on which boys outscored girls, boys and girls scored about the same, and girls outscored boys

It is clear from figures 12 and 13 that there are definite areas of relative strength for boys and girls at both third and sixth grade levels. Of course, a noted area of relative strength for one sex implies a corresponding weakness for the other sex. Table 16 contains a summary of the relative strengths of boys and girls.

Table 16

Areas of Relative Strength in Mathematics
for Grade Three and Grade Six, by Sex

Grade level	Areas of relative strength	
	Girls	Boys
3	Arithmetic operations--skills Problem analysis and models	Arithmetic operations--applications Measurement
6	Arithmetic operations--skills Expressions and equations Problem formulation and analysis	Arithmetic operations--applications Counting and place value--skills and applications Measurement skills and applications Probability

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VI. Comparisons with National Norms

There are difficulties in using publishers' national norms to judge the adequacy of the performance of California students. Briefly, the two main problems are (1) lack of agreement among publishers' samples; and (2) lack of timeliness. Any comparison based on a single publisher's norm group (a national sample of students tested at a given time) can be quite misleading and is a tenuous undertaking at best. Since no test is given nationwide, one must rely on various publishers' estimates of the nationwide distribution of test scores. These estimates vary from publisher to publisher and are clearly "guesstimates." Part of the problem in establishing norms is that publishers are dependent on the good will and cooperation of the districts they select to administer their tests. When the districts that have been carefully selected as part of a national sample decline to participate in the norming study, the results become that much more uncertain. In addition, because of the expense involved, publishers are able to update their norms only every five to eight years.

To cope with this situation, the State Department of Education provides for the comparison of the performance of California students with the norms of a variety of tests and for updating the comparisons whenever the tests are renormed or when new tests become available. This is done by giving a sample of California students both the publisher's standardized test and the California test. In some cases no extra testing is required. Scores for a publisher's standardized test are simply collected from the school districts that administered the test to all of their students in certain schools for other purposes. The statistical techniques used to equate the two tests are briefly described in Appendix H of the 1978-79 report. The result of this type of "equating study" is to show how California students would have compared to a national norm group if, in fact, all California students had taken the published test.

This approach has several advantages: (1) the national comparisons are more timely because they can be updated as new norms become available; (2) the estimates are more stable because they do not depend on the representativeness of a single publisher's sample; and (3) the progress of California students can be assessed with a test that fits the objectives of the instructional program and simultaneously, with no additional testing, the results can be compared to national norms.

The comparisons presented in this report are based on the tests with the most recent national norms. This report also contains the results of earlier equating studies so that the reader can inspect the long-term (from 13 to 17 years) achievement test trends in California against the backdrop of national norms.

Grade Three

Table 17 contains the estimated national percentile ranks of the median score of California third grade students' performance on the reading tests since 1966-67.

Table 17

Estimated National Percentile Ranks of Median California Pupil Performance
1966-67 Through 1982-83

Grade Three

Content area	Test administered: Stanford Achievement Test					Cooperative Primary Reading Test (CPRT) (1966 Norms)		CAP Reading Test*	CAP Reading Test** (Revised)					CAP Survey of Basic Skills***			
	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Reading																	
Stanford, 1963 norms	34	34	36	36	38												
CPRT, 1966 norms						52	52	52									
CTBS, 1973 norms									55	55	56	57	58	58	59	60	62
1981 norms																41	45
Stanford, 1982 norms																45	47
Language																	
CTBS, 1973 norms														53	54	56	57
1981 norms																40	42
Stanford, 1982 norms																44	47
Mathematics																	
CTBS, 1973 norms														51	52	55	59
1981 norms																44	50
Stanford, 1982 norms																52	53

*The Reading Test was first administered in 1973-74. The percentile ranks are based on an equating study of the Reading Test and the Cooperative Primary Reading Test, Forms 23A and 23B, normed in 1966.

**The revised Reading Test was administered to all California students in 1974-75, 1975-76, 1976-77, 1977-78, and 1978-79. The percentile ranks are based on equating studies of the revised Reading Test and the Comprehensive Tests of Basic Skills, Form S, normed in 1973.

***The new Survey of Basic Skills: Grade 3 was administered to all California students in 1979-80, 1980-81, 1981-82, and 1982-83. The estimated national percentile ranks are based on an equating study of the new test and the Comprehensive Tests of Basic Skills (CTBS), Form S, normed in 1973. For 1981-82 and 1982-83, the percentile ranks are also given for the 1981 edition of the CTBS and the 1982 edition of the Stanford Achievement Test.

The following outline should help the reader understand more fully the national comparisons:

1. The third grade results for 1966-67 through 1970-71 were based on the Stanford Reading Test, which was administered to all third grade students in California. The norms for the Stanford Reading Test were established in 1963. Thus, the gains that occurred each year are relative to those norms.

2. The third grade results for 1971-72 through 1972-73 were based on the Cooperative Primary Reading Test (CPRT), which was administered to all third grade pupils in California. The norms for the CPRT were established in 1966. The dramatic increase in scores in the changeover years was due largely to the great differences between the norms of the Stanford Reading Test and those of the CPRT.

3. In 1973-74 the California Assessment Program (CAP) developed the Reading Test. A systematic sample of one-ninth of all students tested in grade three was used in an equating study to estimate the performance of the median pupil in California relative to 1966 Cooperative Primary Reading Test norms. The results indicated little change from those of the previous years.

4. In 1974-75 the CAP Reading Test was revised and administered to all third grade students in California. The same test was used in 1975-76, 1976-77, 1977-78, and 1978-79. The results of an equating study were used to estimate the performance of California students in comparison to the norms established in 1973 for the Comprehensive Tests of Basic Skills (CTBS), Form S. As a result of the modest increases in the third grade scores, the median score of California pupil performance in grade three in 1978-79 was at the 58th percentile of CTBS 1973 norms.

5. In 1979-80 the new Survey of Basic Skills: Grade 3 was administered to all third grade students in California public schools and equated to the Comprehensive Tests of Basic Skills (CTBS). The same test was administered in 1980-81, 1981-82, and 1982-83. The median California student is estimated to be at the 62nd percentile in reading, the 57th percentile in written language, and the 59th percentile in mathematics on those 1973 norms. On more recent (1981) estimates of national averages for the same test, CTBS, the comparisons show California to be considerably lower: the 45th percentile in reading, the 42nd percentile in written language, and the 50th percentile in mathematics.

   The CAP test has also now been equated to another test with its estimates of national averages. This test is the new Stanford Achievement Test. When California third graders are compared with the 1982 norms for this test, they scored near the national average: the 47th percentile in reading and written language and the 53rd percentile in mathematics.

Grade Six

The performance of sixt raders in California declined in the early 1970s and leveled off by 1974. It has climbed steadily since then. Table 18 shows this trend in terms of national percentile ranks. A more complete description of these trends can be broken down into three parts:

1. From 1969-70 to 1973-74 the Comprehensive Tests of Basic Skills (Form Q, 1968 norms) was administered to all California sixth grade students. During this period the performance of California students declined from four to nine percentile ranks on the basis of the 1968 norms.

2. In 1974-75 the first version of the California Assessment Program test, the Survey of Basic Skills, was administered statewide. An equating study conducted that year showed that scores had improved and that if the Comprehensive Tests of Basic Skills had been administered statewide, the percentile ranks would have gone up 48, 43, and 44 for reading, language, and mathematics, respectively.

3. A revision of the survey was administered from 1975-76 through 1982-83. An equating study showed that on the basis of the 1973 version of the CTBS, California students improved enough by 1975-76 to equal or exceed the national averages. Following the upward trend of earlier years, the 1982-83 improvement in language and mathematics achievement boosted the percentile ranks to 58 and 60, respectively. The slight decline in reading moved the percentile rank back to 57. On more recent (1981) estimates of national averages for the same test, CTBS, the comparisons show California to be somewhat lower in reading and language--at the 52nd percentile and 49th percentile, respectively--and still well above average (60th percentile) in mathematics.

   As with grade three, the CAP Survey was equated to the new Stanford Achievement Test this year. California students are at or are very slightly above these new (1982) estimates of the nation's performance.

Grade Twelve

The performance of twelfth grade students in California declined consistently during the seventies, since testing began in 1969-70. By 1976-77 the median high school senior was at the 42nd, 33rd, and 43rd percentile ranks in reading, written expression, and mathematics, respectively, on the basis of the Iowa Tests of Educational Development (ITED) with its 1962 norms. On the basis of tests with more recent norms (1970), the ranks were even lower (see Table 19). Although not consistent, the last few years have seen some progress, especially in language, which has always been the lowest, and mathematics.

The three CAP tests were renormed on new national samples in 1978. National performance declined during the 1970s. Therefore, when California students are compared to this new norm, their standing is higher than when compared to the 1962 and 1970 national norm samples.

Table 18

Estimated National Percentile Ranks of Median California Student Performance
1969-70 Through 1982-83

Grade Six

Content area	Test administered													
	Comprehensive Tests of Basic Skills (CTBS) (1968 Norms)					Survey of Basic Skills*	Survey of Basic Skills**							
	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Reading														
CTBS, 1968 norms	48	46	44	44	44	48								
1973 norms							53	53	55	55	56	57	58	57
1981 norms													53	52
Stanford, 1982 norms													52	52
Language														
CTBS, 1968 norms	43	43	39	39	37	43								
1973 norms							49	51	51	52	53	55	57	58
1981 norms													48	49
Stanford, 1982 norms													49	50
Mathematics														
CTBS, 1968 norms	47	43	38	38	38	44								
1973 norms							50	51	53	54	55	56	58	60
1981 norms													59	60
Stanford, 1982 norms													52	52

*The new California test, the Survey of Basic Skills: Grade 6, was first administered to all California pupils in 1974-75. The percentile ranks are based on an equating of the Survey of Basic Skills and the Comprehensive Tests of Basic Skills (CTBS), Form Q, which was normed in 1968.

**The revised version of the Survey of Basic Skills: Grade 6 was administered from 1975-76 through 1980-81. A second revision of the test was administered in 1981-82. The percentile ranks, since 1974, are based on equating of the Survey of Basic Skills to three editions (1968, 1973, 1981) of the Comprehensive Tests of Basic Skills (CTBS) and the latest edition (1982) of the Stanford Achievement Test.

Table 19

Estimated National Percentile Ranks of Median California Student Performance
1969-70 Through 1982-83

Grade Twelve

Content area	Test administered: Iowa Tests of Educational Development Form X, normed in 1962					Survey of Basic Skills*	Survey of Basic Skills* (Revised)							
	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Reading														
ITED, 1962 norms	52	49	49	47	47	41	43	42	42	41	41	42	42	41
1978 norms												44	44	44
TAP, 1970 norms						33	35	33	32	32	32	33	32	32
1978 norms												42	42	41
STEP, 1970 norms						34	38	36	35	34	34	35	35	34
1978 norms												47	47	47
Language														
ITED, 1962 norms	42	40	38	36	34	32	34	33	34	34	34	35	35	34
1978 norms												43	43	43
TAP, 1970 norms						25	27	26	26	27	27	29	29	28
1978 norms												40	41	40
STEP, 1970 norms						27	29	28	28	28	28	30	30	30
1978 norms												57	57	57
Mathematics														
ITED, 1962 norms	48	48	48	48	48	41	44	43	43	43	44	46	46	46
1978 norms												46	45	45
TAP, 1970 norms						38	43	41	41	41	42	44	44	44
1978 norms												41	41	41
STEP, 1970 norms						41	44	43	43	43	43	47	47	47
1978 norms												55	55	55

*The California test, the Survey of Basic Skills: Grade 12, was administered to all California students from 1974-75 through 1982-83. The percentile ranks are based on equating studies of the Survey of Basic Skills and three other tests with national norms: (1) Iowa Tests of Educational Development, normed in 1962 and 1978; (2) Tests of Academic Progress, normed in 1970 and 1978; and (3) the Sequential Tests of Educational Progress, normed in 1970 and 1978.

Table 19 includes the specific comparisons with these more recent norms. It can be seen that this decline in national performance gives California a higher standing in all comparisons but one. The latest ranks place California students near but still slightly below the norms on the ITED and the Tests of Academic Progress (TAP). On the Sequential Tests of Educational Progress (STEP), California is above the newer national averages in both language and mathematics.

Scholastic Aptitude Test Results

The results of the California Assessment Program are the only indicators of the level of learning of all California public high school students. The results of the Scholastic Aptitude Test, a nationally administered college admissions test, however, have received considerable attention over the last decade or so. Although the SAT results represent only a select sample of California students, they have followed a pattern similar to that of the CAP scores. They are presented here for the reader's convenience in using both sets of results to judge the educational progress of high school students.

There are advantages and disadvantages to employing the SAT results as a basis for making inferences about the effectiveness of the educational system. The key point on the positive side is that the test results can be traced over a long period of time; although the test items are changed and updated, the common 200-800 score scale allows for valuable longitudinal comparisons.

The chief disadvantage is that only a sample of all students take the SAT. The real problem in interpreting the scores is that one never knows how representative the California and national samples are. They obviously are not representative of all students, and they may or may not be representative of the college-bound population. In California about 37 percent of the seniors take the SAT, whereas nationally about 33 percent are tested. Equally important is the fact that the test reflects almost exclusively the more advanced, higher-level thinking skills in the areas of language and mathematics. This fact is, of course, very logical given the purpose of the test--to predict how well students will succeed in college. It just means that one cannot judge, from this information, the total effectiveness of schools in reaching their various aims, especially as those aims pertain to the other two-thirds of the high school population.

Table 20 presents the scores for the verbal and mathematics parts of the SAT beginning in 1972 when test results for individual states became available from the College Entrance Examination Board. Figure 14 also shows the trends for California seniors since that time and for the nation since 1960. It can be seen that California seniors were above the national average (but not necessarily above the averages of all other states) in the early seventies but declined more rapidly than the rest of the United States.

During the mid-seventies both the California average and the national average began to level off. In 1978 the trend lines began to diverge again: the national average was still slowly declining, whereas the California trend line moved clearly above the national average in mathematics (to a nine-point lead in 1981) and slightly above on the verbal part (a two-point lead).

Table 20

Scholastic Aptitude Test Scores
1971-72 Through 1982-83

Year	Verbal				Mathematics			
	Male	Female	Total	Year-to-year difference	Male	Female	Total	Year-to-year difference
California:								
1971-72	466	462	464		518	467	493	
1972-73	456	448	452	-12	511	460	485	- 8
1973-74	454	446	450	- 2	509	460	484	- 1
1974-75	440	431	435	-15	501	446	473	-11
1975-76	434	426	430	- 5	500	443	470	- 3
1976-77	431	424	427	- 3	500	443	470	0
1977-78	432	423	427	0	496	440	466	- 4
1978-79	432	424	428	+ 1	502	447	473	+ 7
1979-80	429	420	424	- 4	500	446	472	- 1
1980-81	434	419	426	+ 2	503	449	475	+ 3
1981-82	431	420	425	- 1	503	448	474	- 1
1982-83	426	416	421	- 4	503	448	474	0
National:								
1971-72	454	452	452		505	461	484	
1972-73	446	443	445	- 8	502	460	481	- 3
1973-74	447	442	444	- 1	501	459	480	- 1
1974-75	437	431	434	-10	495	449	472	- 8
1975-76	433	430	431	- 3	497	446	472	0
1976-77	431	426	429	- 2	497	445	470	- 2
1977-78	433	425	429	0	494	444	468	- 2
1978-79	431	423	427	- 2	493	443	467	- 1
1979-80	428	420	424	- 3	491	443	466	- 1
1980-81	430	418	424	0	492	443	466	0
1981-82	431	421	426	+ 2	493	443	467	+ 1
1982-83	430	420	425	- 1	493	445	468	+ 1

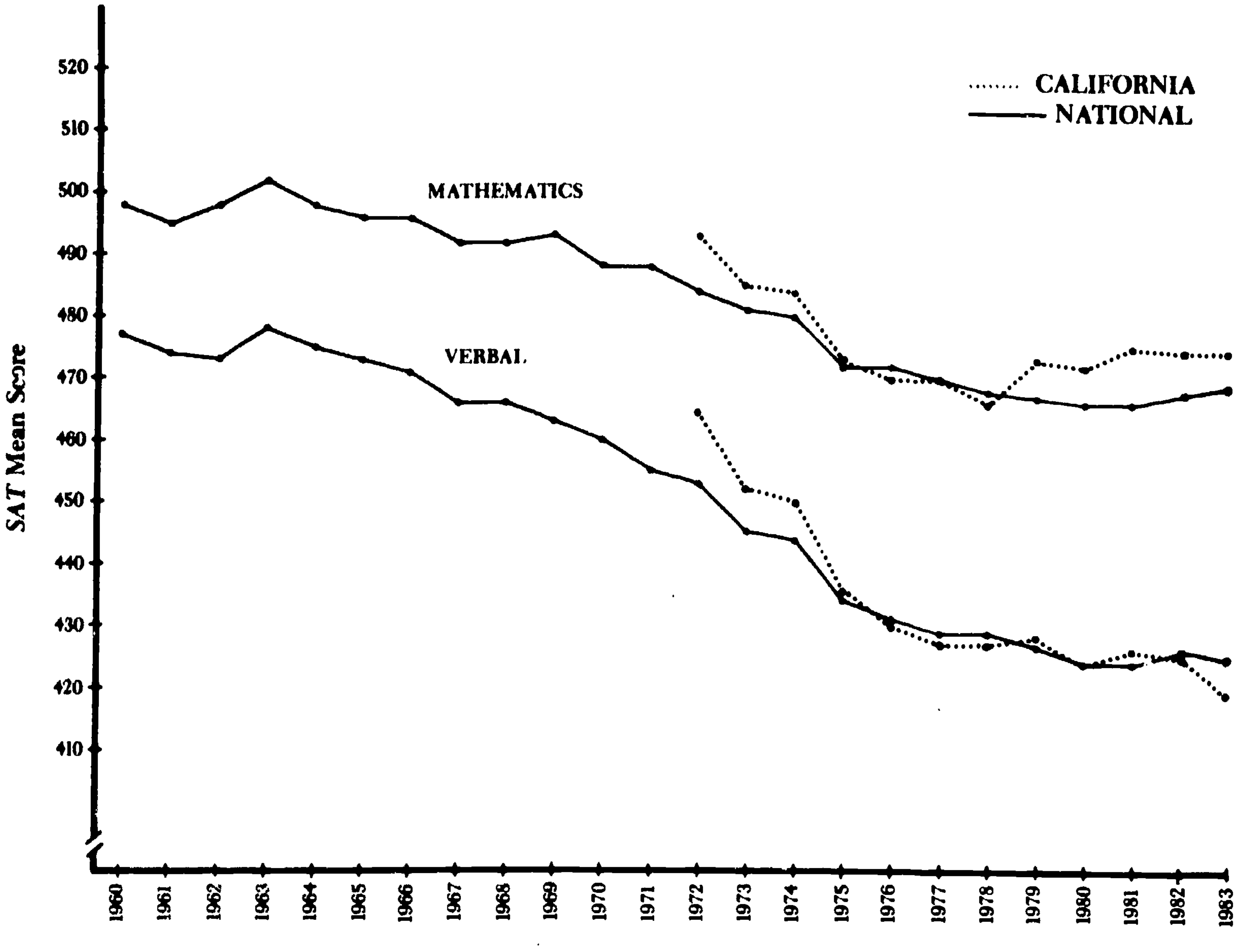

Fig. 14. *Scholastic Aptitude Test* scores for high school seniors in California, 1972 (first year available) through 1983, and in the United States, 1960 through 1983

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Comparisons with National Norms

In 1982 the national averages improved for the first time in 19 years: one point in mathematics and two points on the verbal part of the test. In 1983 this gain was partially lost in the verbal part of the test, although it was maintained in mathematics--thanks to the progress of the girls. California students held steady and still have a five-point lead in mathematics, but dropped four points on the verbal part of the test, putting them behind their national counterparts by that amount.

VII. Computer Literacy of California's Sixth and Twelfth Grade Students

The study described and reported in this chapter was sponsored by the California Assessment Program (CAP) of the State Department of Education, and it was conducted during the 1982-83 school year. A sample group of sixth and twelfth grade students from throughout the state was tested during the study.

Synopsis of Findings

This is a report of a study on the knowledge, attitudes, and experiences of California's sixth and twelfth graders in the area of computer technology. It is intended as a baseline measurement of what is being learned about computer technology in California, not as a measure of success.

A committee of experts on computer technology was drawn from the public school system, universities, and industry. The committee designed a survey that assessed a wide variety of instructional objectives in the area of computer studies as well as attitudes towards computer technology and relevant experiences with computers.

A representative sample of twelfth graders was tested in December of 1982. Sixth grade students were tested in April of 1983.

Twelfth Grade Results

- More than half the students in the twelfth grade sample reported actually having used a programming language of some kind. Thirty-seven percent reported having used BASIC.
- Playing games--instructional games or video games--was not associated with higher test scores in computer literacy or computer science.
- A substantial majority could correctly identify simple truths and misconceptions about computers.
- More detailed knowledge of computers, as measured by test scores, was low. Knowledge of programming was very low. Sixteen percent reported having learned programming in school.
- Twelfth grade boys scored consistently higher than the girls did. The better performance of boys was associated with greater exposure to computer technology.
- There was a clear relationship between test scores and the parents' educational levels. Children of more highly educated parents consistently scored higher than children of less well-educated parents.

Sixth Grade Results

- About 68 percent of sixth graders indicated having some type of in-school computer learning experience, and 56 percent said they had used some type of computer in school.
- About 15 percent of the sixth graders reported having learned to write computer programs at school.
- A substantial majority could identify simple truths and misconceptions about computers and saw a much larger role for computers in the work place.
- Test scores summarizing detailed knowledge of computers were low, and scores representing knowledge of simple programming techniques were quite low.
- Boys scored higher than the girls did, and students with professionally employed parents scored higher than students with parents in semiskilled or unskilled occupations.

Background

The computer can be a means of educating students and an object of study in itself. Historically, in the public schools, there has been more interest in the former application than in the latter. These two applications are not mutually exclusive. Using the computer as an instructional tool invariably requires learning something about the machine and how to operate it. It is also true that the study of computers and programming can be a natural and stimulating way to learn problem-solving skills and various mathematical and scientific concepts.

There is strong evidence for the growth of a serious interest in computer studies. The California State Board of Education in 1983 made computer studies a part of its model graduation requirements, a measure which is being considered and duplicated in other states. The College Entrance Examination Board in 1982 inaugurated an advanced placement test for high school students in the area of computer science. The National Center for Educational Statistics in 1983 initiated a nationwide study of computer literacy.

The primary goal of this study was to examine the knowledge, attitudes, and experiences of California's sixth and twelfth graders in the area of computer technology. The study was designed to encompass the diverse educational objectives of many different district and school programs. The result was a baseline measurement of what California's students know about computer technology. It should not be interpreted as an evaluation of a particular course of instruction.

Educators have witnessed in recent years a lively debate about what students should learn about computers. Statements of educational objectives have been published by the Committee on Computer Education (1972); the National Council of Supervisors of Mathematics (1978); Johnson, Anderson, Hanson, and Klassen (1980); Anderson and Klassen (1980); Rogers (1982); and the Department of Defense Dependents Schools (1982). Interest has risen to the point that textbooks have begun to appear (e.g., Horn and Poirot, 1981; Miller, Chaya, and Santora, 1982; and Luerman and Peckham, 1983). Discussion of various key issues can be found in Papert (1980); Melmed (1982); and Shane (1982).

The National Assessment of Educational Progress (NAEP) included several questions on computers in its 1977-78 mathematics assessment, which have been reported by Carpenter, Corbitt, Kepner, Lindquist, and Reys (1980). They concluded that a large majority of the thirteen and seventeen year old students tested had little or no experience in actual applications of computers. For example, only 8 percent of thirteen year olds and 13 percent of seventeen year olds said they knew how to program a computer. By contrast, there was a somewhat higher level of awareness of the routine uses of computers. Understanding of more sophisticated uses of computers in complex decision making and mathematical modeling of problems was more limited.

Method

Twelfth Grade Survey

A committee of specialists in computer technology was assembled from the public school system, universities, and industry, and they designed a survey to assess a wide variety of instructional objectives in the area of computer studies, attitudes towards computer technology, and relevant experiences with computers. Cognitive test questions were written to conform to a set of objectives that was developed and used with the Department of Defense Dependents Schools (DoDDS) curriculum shown in the chart entitled "DoDDS Student Objectives."[1] Test questions were reviewed for relevance and accuracy of content, sex or ethnic bias, and typographical correctness. All cognitive test questions were multiple choice with four options.

Attitude questions were obtained from a set that had been administered by the National Assessment of Educational Progress in a 1977-78 mathematics assessment. Each of the 13 attitude questions requested the student to indicate agreement (strongly disagree, disagree, undecided, agree, strongly agree) with a particular statement. The statements were:

- Computers dehumanize society by treating everyone as a number.
- The more computers are used, the less privacy a person will have.
- Computers will probably create as many jobs as they eliminate.
- Computers slow down and complicate simple business operations.

[1] The terms "computer literacy" and "computer science," as used in this chapter, should be understood in light of the described objectives. The number of questions relevant to each objective is written in parentheses after each statement. There were, in all, 430 questions, including 239 for the area of computer literacy and 191 for computer science. The Northwest Regional Educational Laboratory in Portland, Oregon, shared questions that had been written for a DoDDS evaluation and assisted in the question-writing process.

DoDDS Student Objectives

Following are the objectives used as the basis for the curriculum of the Department of Defense Dependents Schools (DoDDS). They are arranged by DoDDS objective category and subcategory numbers. The number after each item is the number of survey items devoted to that objective on the twelfth grade test.

1. Demonstrate understanding of the capabilities, applications, and implications of computer technology. (239)

    1. Interact with a computer and/or other electronic devices. (42)

        1. Demonstrate ability to operate a variety of devices which are based on electronic logic. (8)
        2. Demonstrate ability to use a computer in the interactive mode. (13)
        3. Independently select a program from the computer resource library. (9)
        4. Recognize user errors associated with computer utilization. (12)

    2. Explain the functions and uses of a computer system. (91)

        1. Use an appropriate vocabulary for communicating about computers. (25)
        2. Distinguish between interactive mode and batch mode computer processing. (9)
        3. Identify a computer system's major components, such as input, memory, processing, and output. (20)
        4. Recognize tasks for which computer utilization is appropriate. (14)
        5. Describe the major historical developments in computing. (23)

    3. Utilize systematic processes in problem solving. (58)

        1. Choose a logical sequence of steps needed to perform a task. (10)
        2. Diagram the steps in solving a problem. (7)
        3. Select the appropriate tool and procedure to solve a problem. (11)
        4. Develop systematic procedures to perform useful tasks in areas such as social studies, business, science, and mathematics. (12)
        5. Write simple programs to solve problems using a high-level language, such as PILOT, LOGO, or BASIC. (18)

    4. Appraise the impact of computer technology on human life. (48)

        1. Identify specific uses of computers in fields, such as medicine, law enforcement, industry, business, transportation, government, banking, and space exploration. (12)
        2. Compare computer-related occupations and careers. (13)
        3. Identify social and other nontechnical factors which might restrict computer utilization. (10)
        4. Recognize the consequences of computer utilization. (11)
        5. Differentiate between responsible and irresponsible uses of computer technology. (2)

2. Demonstrate understandings of computer systems including software development, the design and operation of hardware, and the use of computer systems in solving problems. (191)

    1. Write structured and documented computer software. (95)

        1. Write well-organized BASIC programs which include the use of color, sound, and graphics statements. (41)
        2. Write programs which demonstrate advanced programming techniques used to solve problems in business, scientific, or entertainment applications. (19)
        3. Write programs in an additional high-level language such as PASCAL, COBOL, or FORTRAN. (25)
        4. Write programs in a low-level language, such as machine language or assembler. (10)

    2. Demonstrate knowledge of the design and operation of computer hardware. (57)

        1. Demonstrate unassisted operation of at least two different configurations of computers and their peripherals. (16)
        2. Use a special-purpose computer or computer-interfaced devices to monitor or control events by sensing temperature, light, sound, or other physical phenomena. (10)
        3. Describe the computer's digital electronic circuitry in terms of binary arithmetic and logical operators. (19)
        4. Perform vendor-authorized minor maintenance on the computer system. (12)

    3. Use computer systems in problem solving. (39)

        1. Use data processing utilities, including word processing and data base management, in problem solving. (12)
        2. Translate software from one language to another or to another version of the same language. (11)
        3. Analyze different solutions to the same problem. (16)

- o Someday most things will be run by computers.
- o A knowledge of computers will help a person get a better job.
- o Computers can help make mathematics more interesting.
- o Computers are suited for repetitive, monotonous tasks.
- o Computers are programmed to follow precise, specific instructions.
- o Computers require special languages for people to communicate with them.
- o Computers have a mind of their own.
- o Computers make mistakes much of the time.
- o To work with a computer, a person must be a mathematician.

The committee designed background statements/questions to assess relevant prior knowledge of computers and experiences with them. The statements/questions were:

- o Indicate which of the following languages you have actually used to write and run computer programs. (BASIC, PASCAL, LOGO, PILOT, FORTRAN, COBOL, FORTH, ASSEMBLY LANGUAGE, Other, None)
- o Indicate which of the following video games you have at home. (Atari, Odyssey, Intellivision, Colecovision, Other, None)
- o Indicate which of the following types of microcomputers you have at home. (Atari 400 or 800, TRS-80, Apple, PET-Commodore, IBM, Texas Instruments, Osborne, Other, None)
- o Indicate which of the following types of microcomputers you have used at school. (Atari 400 or 800, TRS-80, Apple, PET-Commodore, IBM, Texas Instruments, Osborne, Other, None)
- o Approximately how many hours per week outside school do you spend in each of the following activities? (Reading for pleasure, Doing homework, Playing video games at home, Playing video games away from home, Working with a computer, Athletics, Watching television, Other hobbies or recreation--None, Less than 1 hour, From 1 to 2 hours, From 2 to 3 hours, From 3 to 4 hours, From 4 to 5 hours, Between 5 and 10 hours, More than 10 hours)
- o Indicate the types of in-school microcomputer learning experiences you have had. (Write programs, Generally learn about computers, Drill and practice, Simulations (math or science demonstrations), Tutorial, Instructional games, I have had little experience with computer.)
- o Indicate where you learned about computers. (At home, At friends' homes, Special summer programs, Museum or science hall, At school during the day, At school during the evening, Computer stores or salesmen, Playing with video games, I know little about computers.)

Students were asked to report demographic information, including sex and level of parent education. The five possible categories of parent education were:

- Not a high school graduate
- High school graduate
- Some college
- Four-year college graduate
- Advanced degree

That category corresponding to the highest educational level reached by a parent was to be selected.

The test was designed in a matrix format so that each student saw only a small part of the entire pool of questions. Eighty-six unique forms of the test were created, each containing five cognitive test questions, one attitude question, and two background questions. The attitude and background questions were assigned to the 86 test forms so that each would appear approximately an equal number of times. A different set of cognitive test questions, selected to cover both computer literacy and computer science objectives, appeared on each form. These were arranged so that easier questions appeared first on the test. The test forms were spiraled for distribution so that each one would be given about the same number of times within each school.

Sixth Grade Survey

The questions selected for use with sixth grade students were a subset of those developed for twelfth graders. The selected questions were included on the CAP Survey of Basic Skills: Grade Six, which is administered annually to all public school sixth grade students in California. There are 40 different forms of this test, and each student takes just one form. In addition to the reading, written expression, and mathematics questions included on each form, there was space for one additional computer test question. This meant that 40 different computer test questions could be given to sixth grade students.

Twenty-four cognitive test questions were selected. These questions all corresponded to DoDDS objectives appropriate for elementary grades, and all related to computer literacy. The question categories are identified by a DoDDS number. (See "DoDDS Student Objectives.") The categories and number of questions were:

- Objective 1.2.1, Use an appropriate vocabulary. (3 questions)
- Objective 1.2.2, Distinguish interactive and batch processing. (3)
- Objective 1.2.3, Identify major computer system components. (4)
- Objective 1.2.4, Recognize appropriate tasks for a computer. (1)

- Objective 1.2.5, Describe major historical developments. (2)
- Objective 1.3.4, Develop procedures to perform useful tasks. (2)
- Objective 1.3.5, Write simple programs. (4)
- Objective 1.4.1, Know specific uses of computers. (2)
- Objective 1.4.2, Know computer occupations and careers. (3)

In addition to the four regular response options originally included in the questions, sixth graders were permitted an "I don't know the answer" response to each of these questions. The cognitive test questions given to sixth graders were:

- 1.2.1 What is a computer program?
- 1.2.1 What is a computer printout?
- 1.2.1 To say that a computer has 16K memory means that:
- 1.2.2 You can interrupt data processing when you use which mode?
- 1.2.2 Batch mode is often preferred over interactive because it is:
- 1.2.2 What is the main advantage of the interactive mode?
- 1.2.3 Besides input and output equipment, what must a computer have?
- 1.2.3 Which part of a computer is used to prepare permanent written reports?
- 1.2.3 Which part of a computer is used for mass storage of information?
- 1.2.3 Computers are least useful for which of the following tasks?
- 1.2.4 Computers can do which of the following tasks?
- 1.2.5 Who was the inventor of the 80-column IBM punch card?
- 1.2.5 The scientific discovery which made microcomputers possible was:
- 1.3.4 A computer would be most useful for which part of an experiment on farming?
- 1.3.4 Word processing on a computer is useful in business because it:
- 1.3.5 In the BASIC computer language, a string contained within PRINT statement is:
- 1.3.5 In what computer language is the following program written?
- 1.3.5 In what computer language is the following program written?

- 1.3.5 In BASIC programming, you type in the line you want and then ...
- 1.4.1 Which of the following fields uses computers to store large quantities of information?
- 1.4.1 A basic use of computers in libraries involves:
- 1.4.1 Computers are useful in medicine because they can:
- 1.4.2 Which of the following persons is most likely to be skilled in writing computer programs?
- 1.4.2 Translating a flow chart into a computer language is the job of a:
- 1.4.2 What is the main duty of a computer programmer?

The four background questions asked of sixth graders included: types of in-school learning experiences; presence of video games at home; types of computers used at school; and where students learned about computers. All except two of the rating scale, or attitude, questions were included in the sixth grade survey. The two excluded questions were those that assessed factual knowledge of computers: computers are programmed to follow precise instructions; and computers require special languages. This was done to maximize the number of regular cognitive test questions that could be asked.

Teachers supplied information on the sex of the student and parents' occupations. The categories of parents' occupations were:

- Professional
- Semiprofessional
- Skilled
- Unskilled

Teachers were instructed to select the category corresponding to the occupation of the principal wage earner.

Twelfth Grade Sample

Schools included in this study were sampled randomly. On the basis of California Assessment Program data collected the previous year, high schools were ranked and classified into five equal categories on the basis of number tested (a proxy for school size). Within each size category, schools were ranked and classified into five equal groups on the basis of an average index of parent education (a proxy for social class). This resulted in a five-by-five cross-classification of schools with equal numbers in each of the 25 cells. Schools were selected randomly with a probability of $p = .125$ from each cell.

From the original population of 784 schools, 98 were selected, which had an estimated 23,395 students. The sample did not differ significantly from the population in terms of achievement or parent education. The sample average number tested per school, N = 239, was smaller than the population average of N = 281, indicating a slight oversampling of small schools. Eighty-seven schools participated in the study, yielding a school response rate of 89 percent. Several schools declined to participate on the basis that their students were not prepared for such an assessment. Survey questionnaires were received from 17,861 students, yielding an estimated student response rate of 88 percent from participating schools.

Sixth Grade Sample

The Survey of Basic Skills: Grade Six was administered to 293,717 students between April 25 and May 13 of 1983 under standardized conditions. Test forms were assigned to students by an effectively random procedure, with approximately equal numbers of each test form given in each school. As a result, each computer test question was given to an average of 7,343 students. Rates of nonresponse ranged from 4 to 6 percent.

Analyses

Twelfth Grade Analyses

Responses to individual cognitive test questions were classified according to student objectives and aggregated on the basis of sex and parents' education. Students who did not attempt to answer any of the five cognitive questions on a given test form were excluded from the analysis. Given the matrix format of the test, each of the 430 cognitive test questions was answered by about 200 students. Percents correct for all objectives are shown in Table 21.

Plots of computer literacy (CL) and computer science (CS) composite scores for different levels of parents' education and sex are shown in figures 15 through 17. Percents of students selecting each option of the attitude questions were calculated, along with their average test scores. These scores are shown in tables 22 through 34. Each of the 13 attitude questions appeared on six different forms of the test and was responded to by approximately 1,200 students. For each option, the percents of boys and girls and percents of students in each parent education category are reported. Analyses of the background questions, shown in tables 35 through 43, were similar. Background questions were placed on each test form in a pair, so that each one appeared on about 24 different test forms and was responded to by approximately 4,800 students.

Sixth Grade Analyses

All questions given to sixth graders were analyzed in a format similar to that already described. Total percents of students selecting each option of the questions were calculated. For each option, the percents of boys and girls and the percents of students in each parent-occupation category were reported. Percents correct for cognitive questions are shown in Table 44. Responses to attitude questions are summarized in tables 45 through 55. Th analyses for the background questions are presented in tables 56 through 59.

Results

Twelfth Grade Results

Average scores for each student objective are shown in Table 21. There were several trends evident here which were confirmed in subsequent analyses. Test scores were not high for any of the objectives tested. This is not surprising given that most schools and districts were just beginning their computer studies programs. Scores were low, near the so-called "chance level" (25 percent correct) of responding, for those objectives calling for knowledge of programming, especially for those students with little actual programming experience. Students demonstrated higher mastery of objectives relevant to: the operation of electronic devices; appropriate tasks for computers; logical analyses of problems; and uses of computers in specific fields. Boys performed consistently better than girls. In one skill only, "choosing a logical sequence of steps needed to perform a task," did girls outperform boys. For most objectives, the difference in mastery was between 1 and 5 percentage points. There was a clear relationship between achievement and parents' educational levels. Children of more highly educated parents consistently scored higher than children of less well-educated parents. Differences in scores between students whose parents had advanced degrees and those whose parents had not completed high school were typically between 5 and 15 percentage points.

The overall results are displayed graphically in figures 15 through 17. Boys scored consistently higher than girls for all levels of parents' education in both computer literacy and computer science, as shown in figures 15 and 16. Higher levels of parents' education were associated with greater differences in test scores. These results may reflect a tendency for boys to take more advantage of opportunities, a tendency for parents or teachers to encourage boys more than girls, or a combination of both. Computer literacy and science test scores, broken down by parents' education, are displayed in Figure 17.

Concerns about privacy and being treated as a number are often associated with the introduction of computer technology. Student responses to questions about these issues are summarized in tables 22 and 23. Twenty-nine percent of the students were undecided with regard to the statement that "computers dehumanize society by treating everyone as a number," as shown in Table 22. There was a tendency for more students to disagree than to agree. The high average score on this item in computer literacy (CL), of 43.5 percent, correct, was obtained by those who disagreed; and the high average score on this item, of 34.0, in computer science (CS), by those who disagreed strongly. Of the 10.1 percent who strongly disagreed, more were male than female (62.3 percent versus 35.6 percent). Parents' education is associated with attitudes here. A larger proportion of students whose parents had not completed high school more strongly agreed than strongly disagreed. Responses to the statement that "the more computers are used, the less privacy a person will have," summarized in Table 23, were similar to those in Table 22. The modal response category, with 29.8 percent, was "undecided." Those who disagreed tended to score higher than those who agreed. A higher percent of boys than girls strongly disagreed (58.9 percent versus 38.4 percent).

Tables 24 through 27 address attitudes towards the effects of computers in the work place. To the statement that "computers will probably create as many jobs as they eliminate," there was a bimodal response pattern, shown in

Table 24, with large percents of students both disagreeing (24.2 percent) and agreeing (34.9 percent). Overall, more students tended to agree than disagree. The highest average scores on this item were attained by the 9.6 percent who strongly agreed (CL = 57.4, CS = 36.8). There were more boys than girls in this group (56.0 percent versus 41.1 percent).

A plurality of 37.8 percent of students strongly disagreed with the statement that "computers slow down and complicate simple business operations," as shown in Table 25. Average scores of these students were higher than those of other groups (CL = 47.9, CS = 33.2). Relatively higher percents of students whose parents did not have a high school education tended to agree with the statement. The reverse was true for students whose parents had advanced degrees.

Seventy-nine percent of the sample either agreed (46.0 percent) or strongly agreed (33.0 percent) that "someday most things will be run by computers," as shown in Table 26. It was interesting, however, that the highest computer scores were obtained by the 3.0 percent who disagreed (CL = 57.4, CS = 37.4). A higher relative proportion of students from advanced degree families fell into this group than into any of the other groups. This may reflect sophisticated awareness that while computers may control many processes, people are the ultimate controllers of computers.

A similar overall pattern of response, shown in Table 27, was obtained for the statement "a knowledge of computers will help a person get a better job." Nearly three-fourths of those responding either agreed (46.2 percent) or strongly agreed (28.5 percent) with this statement. The highest average scores on this item went to those who strongly agreed (CL = 44.6, CS = 32.2). There were more boys than girls in this group (52.0 percent versus 47.1 percent).

Computer studies are generally thought to be related to mathematics. Two aspects of this belief are reported on in tables 28 and 29. Some 48.2 percent agreed and 23.9 percent of the sample strongly agreed that "computers can help make mathematics more interesting." Those who strongly agreed had the highest test scores on this item (CL = 51.4, CS = 30.5). Of this group, 60.9 percent were boys, compared to 35.4 percent girls. A somewhat different attitude was expressed by the statement that "to work with a computer, a person must be a mathematician." The pattern of responses here was bimodal, with 39.0 percent disagreeing and 21.9 percent agreeing. The highest average scores on this item were exhibited by the 14.3 percent who disagreed strongly (CL = 46.8, CS = 31.4). Relatively larger percents of students from lower educational backgrounds either agreed or strongly agreed. Those whose parents had advanced degrees were more likely to disagree or strongly disagree.

Tables 30, 31, and 32 summarize responses to simple statements of fact about computers. Responses here were less reflections of value judgments than assessments of knowledge of very basic facts about computers. The general pattern of response was the same for all three statements. More students tended to agree than disagree with them. The modal response category was "agree" in each case. Although smaller percentages of students agreed strongly, their scores were consistently higher than those of the other groups. The group that agreed strongly tended to include about 15 percent more boys than girls.

Responses to two possible misconceptions are summarized in tables 33 and 34: "Computers have a mind of their own" and "Computers make mistakes much of the time." Again, the task of the student was not so much to render a value judgment as to pass on the correctness of the statement. There were similar patterns of response to both statements. Larger percentages disagreed than agreed, and average test scores tended to be higher for those who disagreed. An exception to this were the high scores of the 1.8 percent of students who strongly agreed that computers make mistakes much of the time. This may be a sophisticated minority who were responding on the basis that the quality of computer output is no better than what is input. Roughly 15 percent more boys than girls strongly disagreed with these statements. Parents' education was related to the response: Relatively larger percentages of students whose parents have advanced degrees either disagreed or disagreed strongly.

The ability to write and use computer programs is an important outcome of a course on programming. Students were asked to indicate the computer languages they had used to perform these tasks. Results are summarized in Table 35. Percents in this and the following tables may not add to 100, because students could select more than one option. BASIC, used by 37.0 percent of students (54.4 percent versus 44.2 percent), was the most frequently selected language. However, the highest average scores on this item were attained by the 3.3 percent minority who had used PASCAL (CL = 56.0, CS =40.1). Of the PASCAL users, 70.7 percent were boys, and 28.1 percent were girls. A plurality of 43.4 percent indicated that they had not used any languages, and their average scores were the lowest in this table (CL = 45.0, CS = 25.1). This group of nonusers included 53.0 percent girls and 45.3 percent boys.

Video games are considered by some to be a first introduction to computer technology. Responses are summarized in Table 36 to the question "Which of the following video games do you have at home?" The most frequently chosen video game was Atari, 27.9 percent, followed by: Intellivision, 8.4 percent; Odyssey, 3.0 percent; and Colecovision, 2.3 percent. The scores of the Atari group (CL = 48.6, CS = 32.0) were only marginally better than those of the 53.0 percent of students who reported having no video game at home (CL = 47.5, CS = 31.5). Access to the other video games listed was associated with scores in the same range. Very few students whose parents had advanced degrees indicated having no video game at home. This was not true for students in the other parent-education groups.

Access to a microcomputer, at home or at school, ought to be positively associated with student mastery of computer technology. Schools provide a structured climate for learning, leading one to expect higher scores for students with access to a microcomputer at school. This was not necessarily the case, as shown in tables 37 and 38. The microcomputers and percents reporting access were: Texas Instruments, 14 percent; Atari, 9.9 percent; Apple, 5.2 percent; IBM, 4.0 percent; TRS-80, 3.1 percent; Commodore, 2.1 percent; and Osborne, 0.8 percent. The highest average scores on this item were associated with IBM (CL = 53.8, CS = 27.8) and Apple (CL = 53.8, CS = 31.7). This apparent advantage of IBM and Apple may be related to parents' education. Relatively high percentages of students whose parents had advanced degrees reported having access to these machines. Among the more frequently selected machines, Atari and Texas Instruments, and for the group reporting no home access, the scores for boys and girls were approximately equivalent.

Microcomputers found in the schools were: Apple, 20.0 percent; IBM, 12.6 percent; TRS-80, 10.2 percent; Texas Instruments, 7.8 percent; Atari, 7.0 percent; Commodore, 7.0 percent; and Osborne, 1.1 percent. Machines that were frequently selected in the home were not the most popular at school. One possible explanation is that schools may base their purchasing decisions on the availability of educational software and in-service training. Price may be a more important criterion for home purchases. The highest average scores on this item were associated with the TRS-80 (CL = 51.6, CS = 34.1) and the Apple (CL = 50.5, CS = 31.6). Relatively larger percentages of boys than girls enjoyed access to a microcomputer at school. This was noticeable for the Apple and TRS-80 machines at school. Of the 42.6 percent of students who reported having no access to a microcomputer at school, more were girls (45.7 percent versus 52.8 percent).

It was reasonable to expect that the amount of time spent on activities outside school, such as working with a computer or playing with a video game, would be associated with test scores. Ideally, the amount of such activity would be observed directly by people trained for the task. This was not feasible, so students were asked to rate for themselves how many hours per week they typically spent in certain activities. The reliability and validity of such responses were limited by accuracy of memory and social desirability response biases. An indication that similar limitations may apply here was the nonresponse rate of about 15 percent, compared to less than 5 percent for the other questions. Given these points, the results can still be used to indicate general trends. Percents of students in each activity category are shown in Table 39, computer literacy scores in Table 40, and computer science scores in Table 41.

A majority of 59.2 percent of the sample reported doing no computer programming at home. This was identical to the percent reporting no microcomputer at home. Comparable percents of students reported not having a video game at home (57.2 percent). Relatively small percents of students reported programming computers at home more than two hours per week. More popular activities, involving more than ten hours per week, were television (12.3 percent), athletics (11.3 percent), and homework (10.1 percent). Increased involvement in four activities was associated with higher computer literacy scores, as shown in Table 40. These were: computer programming; doing homework; pleasure reading; and watching television. The highest average scores on this item were attained by the small group (1.9 percent) that spent more than ten hours per week programming. All four of these activities, with varying degrees of efficiency, involve the transmission of information and have potential for learning. However, the one activity that involved actually working with computers was associated with the highest test scores. Higher scores in the area of computer science were associated with only three activities. These were: computer programming; reading for pleasure; and homework. Again, the highest average scores on this item were associated with programming activities.

One measure of the effectiveness of school programs is the extent to which they are associated with higher achievement. Data summarizing students' microcomputer learning in school are displayed in Table 42. Fully 53.0 percent reported having little such experience in school, and their average scores were the lowest in the table (CL = 49.4, CS = 33.7). Percents of students indicating each type of experience were: general learning, 16.9 percent; programming, 15.6 percent; games, 12.3 percent; drill, 11.3 percent; simulations, 8.4 percent; and tutorial, 4.8 percent. The highest average scores on this item were associated with programming activities (CL = 56.9, CS = 46.8). Low average scores were associated with computer games (CL = 51.6, CS = 39.1). Boys were more likely to be involved in programming than girls (55.2 percent versus 42.2 percent), and girls were more likely to report having little experience with computers (45.6 percent versus 53.2 percent).

Learning about microcomputers in school appeared to have a powerful effect on test scores. This can be seen by comparing the scores of those who reported having programming experience with the scores of those reporting no experience. In computer literacy, there was a gain from 49.4 to 56.9, or 7 percent. The gain in computer science, from 33.7 to 46.8, or 13 percent, was about two times as large. Given that the test was not designed specifically to assess instructional outcomes in these classes, the estimated gains were conservative.

Microcomputers have so permeated our society that there are many different sources of information about them. Students' responses to where they learned, displayed in Table 43, were: at school during the day, 28.0 percent; video games, 21.2 percent; at home, 14.0 percent; at friends' homes, 9.8 percent; in computer stores, 6.4 percent; summer programs, 3.4 percent; at school in the evening, 2.4 percent; and at museums, 2.0 percent. Relatively higher scores were attained by those who reported learning in school, during the day (CL = 47.2, CS = 35.1) or during the evening (CL = 47.0, CS = 38.8). This fact reinforces the earlier findings regarding the effects of instruction. The lowest average scores were exhibited by the 44.9 percent of the sample who reported knowing little about microcomputers (CL = 38.6, CS = 27.3). This group contained more girls than boys (40.7 percent versus 57.7 percent). Although many students reported learning from video games, their scores were, in fact, low (CL = 40.8, CS = 30.1).

Sixth Grade Results

Average scores for sixth grade students are shown in Table 44. Test scores ranged from a high of 38.6 percent correct for the vocabulary questions to lows of 19.2 percent correct for history and 22.4 percent correct for simple programming. These scores are not directly comparable to those of twelfth grade students for two reasons: the sixth graders were permitted an "I don't know the answer" option which was not available to twelfth graders; and the twelfth grade average scores represent more questions than were answered by sixth graders. With these qualifications in mind, overall twelfth grade scores were about 15 percentage points higher than were sixth grade scores.

Overall, sixth grade boys scored about 5 percent correct points higher than did the girls. Students whose parents were classified as professionals scored about 17 points higher than those whose parents were unskilled. Similar trends were obtained for the twelfth grade boys and girls and for students from different parent-educational backgrounds. It appeared, though, that the group differences in average test scores were smaller for the twelfth graders than for sixth graders.

Sixth graders' attitudes towards privacy and being treated as a number are shown in tables 45 and 46. A majority of students, 56.3 percent, either strongly disagreed or disagreed with the statement that computers treat everyone as a number. This compared to 35.9 percent of twelfth graders who gave similar ratings. Among sixth graders who strongly agreed, there was a relatively higher proportion with parents from unskilled backgrounds, indicating a possible relationship with the parents' occupations. There was a similar pattern of response for twelfth grade students in the lowest parent-educational category.

Sixth graders' concerns about privacy are reflected in Table 46. More sixth graders either disagreed or strongly disagreed, 34.6 percent, that computers lessen privacy than either agreed or strongly agreed. This compared to a figure of 30.8 percent for twelfth graders. Relatively larger percentages of students from unskilled backgrounds strongly agreed, and larger percentages from professional backgrounds strongly disagreed with the statement.

Tables 47 through 50 address sixth graders' feelings about computers in the work place. Twenty-two percent either disagreed or strongly disagreed that computers would create as many jobs as they eliminate, compared to 35.5 percent who agreed or strongly agreed. Some 46.7 percent either disagreed or strongly disagreed that computers slow down and complicate things. A majority of students saw a larger role for computers in the future. Sixty-six percent either agreed or strongly agreed that someday most things would be run by computer, compared to 11.0 percent who either disagreed or strongly disagreed. Students from professional backgrounds were more likely to indicate agreement, and those from unskilled backgrounds were more likely to indicate disagreement. Some 66.4 percent either agreed or strongly agreed that knowledge of computers will help people to get better jobs, compared to 11.4 percent who disagreed or strongly disagreed. Students from professional backgrounds were relatively more likely to agree strongly. Response patterns of sixth graders on these questions were generally the same as those of twelfth graders. Higher proportions of twelfth graders saw a larger role for computers in the future and believed that knowledge of computers will help them get a better job.

Sixth graders tended to believe that computers can help make mathematics more interesting (Table 51). Some 71.3 percent of sixth graders either strongly agreed or agreed with the statement, compared to 72.1 percent of twelfth graders. Of the 24.5 percent of sixth graders who strongly agreed, 60.3 percent were boys, compared to 38.7 percent girls. Although a majority of sixth graders felt that computers help to make mathematics more interesting, they did not overwhelmingly believe one had to be a mathematician to work with a computer (Table 52). The response pattern to this question was bimodal, with 22.3 percent agreeing and 35.0 percent disagreeing. Relatively larger percentages of sixth graders from professional backgrounds and relatively smaller percentages from unskilled backgrounds tended to disagree with the statement. Twelfth grade students exhibited a similar bimodal response pattern, which was similarly related to parents' education.

Sixth grade students were generally able to recognize simple truths and misconceptions about computers, as shown in tables 53 through 55. A majority (53.9 percent) either agreed or strongly agreed that computers are suited for doing repetitive tasks. By contrast, 38.7 percent either disagreed or strongly disagreed that computers have a mind of their own. A possibly complicating factor is the recent publicity of artificial intelligence research. Artificial intelligence is the field of computer science that endeavors to create computers that can simulate human intelligence. A sophisticated student might infer that in some sense, computers can have minds of their own. Finally, 46.3 percent either disagreed or strongly disagreed that computers make mistakes much of the time. The response pattern of twelfth graders was the same but indicated a more informed awareness of these truths and misconceptions.

Video games were more popular among sixth graders (Table 56) than among twelfth graders. Only 34.7 percent of sixth graders reported not having a video game at home, compared to 53.0 percent of twelfth graders. This may reflect a tendency of older students to spend more time away from home. Of the sixth graders without home video games, 37.7 percent were boys, compared to 61.5 percent girls. Atari, with a 44.3 percent share of the sample, was the most popular video game among sixth graders. Twelfth grade results showed almost equal proportions of boys and girls without the devices but did show Atari as the most frequently selected one.

A substantial fraction of sixth graders, 31.9 percent, indicated that they had no in-school computer learning experience (Table 57). Of these students, a majority were girls, 54.5 percent, compared to 44.9 percent boys. Relatively higher percentages of students from unskilled backgrounds reported having no computer learning experiences in school. Types of in-school learning and the percents of students for each were: computer games, 33.1 percent; drill and practice, 21.8 percent; mathematics or science demonstrations, 17.9 percent; programming, 14.7 percent; and general information, 14.7 percent. Percentages may not sum to 100, because multiple responses were possible. Of the students who wrote programs, a majority were boys, 54.9 percent, compared to 44.3 percent girls. A larger proportion of twelfth graders, 53.0 percent, indicated having no computer learning experience in school. By contrast, a smaller proportion of twelfth graders reported using computer games in school.

Less than half of the sixth grade sample, 43.7 percent, reported not having a microcomputer at school (Table 58). Of this group, a majority, 52.0 percent, were girls, compared to 47.4 percent boys. Similar estimates were obtained for twelfth grade students. The most frequently indicated school microcomputer was the Apple, with 20.5 percent, followed by Atari, with 9.4 percent, and Commodore, with 8.9 percent.

Sixth graders reported learning about computers most frequently by playing video games, 42.5 percent, as shown in Table 59. Other frequently selected learning situations were: at school during the day, 27.3 percent; and at home, 22.6 percent. By comparison, fewer twelfth graders reported learning at home, 14.0 percent, or by playing video games, 21.2 percent. The large proportion of sixth graders who selected video games as a response may reflect a lack of clear understanding of the differences between video games and computers. This fuzziness of definition is increased, no doubt, by the use of many computers to play games and by simple computing capabilities of some devices marketed as video games.

Discussion

Affective goals are as much a part of the educational process as are cognitive goals. In addition to technical knowledge and skills, students should develop a positive regard for the beneficial capabilities of computers. Ideally, the more one knows about computer technology, the more evident these attitudes should be. Related to this is the ability to recognize popular myths about computers and their implied value judgments. Concerns about privacy and being treated as a number, although valid when understood in the context of the actual capabilities and limits of technology, can be exaggerated in isolation from such knowledge. Twelfth grade students who exhibited higher test scores tended to reject these concerns. There was a similar tendency to reject other, more naive, myths about computers; e.g., that they have minds of their own or make mistakes much of the time.

At the same time, there was an awareness of basic facts about computers by a substantial majority of twelfth graders. This general pattern of response supports the conjecture that a majority of twelfth graders have, at least, an accurate awareness of the general characteristics of computers. Responses to the background questions suggest that this awareness does not extend to widespread familiarity with machines or working knowledge of them for at least half the sample.

Sixth graders were less likely to believe that computers threaten privacy or treat people like numbers than twelfth graders. This is evidence that sixth graders are less likely to believe naive myths about computers. Other evidence that sixth graders tend to have a realistic awareness of the capabilities and limits of computers was the relatively large percentages who were able to recognize simple truths and misconceptions. Even with this relatively high level of awareness, it still was true that almost a third of the sixth graders either agreed or strongly agreed that a person must be a mathematician to work with a computer. This mistaken belief, which is also held by many adults, is evidence that students need more educating about the basic concepts and uses of computer technology.

Perhaps the primary finding of the analysis of twelfth grade test scores was the generally low overall level of mastery, especially in the area of computer science. Results for the background questions provide some explanation. Roughly half the sample had never used a programming language or had access to a microcomputer at home or at school. Access to a video game was not associated with higher test scores. To learn computer programming, one must actually write programs and run them. School is a good place to learn programming. The BASIC programming language is more widely disseminated with microcomputers than any other; over one-third of the sample reported having used BASIC. However, FORTRAN, COBOL, and PASCAL were each used by 3 to 4 percent of the sample, and they were associated with higher test scores than BASIC. This may be a reflection of the sophistication of the languages. It is thought to be more difficult to learn FORTRAN or COBOL, and having learned these languages, one may know more about computer technology. Availability of software is one reason for the popularity of BASIC in the schools. The choice of programming language in schools needs further debate.

Overall, sixth grade scores were about 15 percent correct points lower than twelfth grade scores. This difference should be interpreted cautiously, since the twelfth grade scores are based on more test questions. Furthermore, the sixth grade students had the "I do not know the answer" option available, and the twelfth graders did not. The presence of this option may have decreased the likelihood of guessing by sixth graders, compared to what it would have been otherwise.

Both sixth grade and twelfth grade boys had generally higher scores than girls did. The reason for this difference appeared to be that boys had more experience with computers and programming than girls did. This was true at school and, to a lesser extent, at home. Sex equity has been an issue in public education, and it is likely that related concerns will carry over into the area of computer studies. If students with a background in computer technology benefit professionally from their experience, there needs to be an assurance that specific subgroups of the population are not being discouraged from acquiring that experience. This study does not explain why girls appear to have less experience in computer studies than boys, but it indicates that there is a difference.

It is unfortunate that social class historically has been correlated with achievement of all kinds. This relationship is clearly demonstrated in the area of computer studies, although the reasons for the relationship are not so clear. The difference in computer literacy scores between the highest and lowest parent education groups was about three times as large as the difference between boys and girls. It was about one and a half times as large for computer science scores. There was no trend for students from lower educational backgrounds to be less involved in learning about computers in school. They were less likely to learn about them at home or from friends. No students from the lowest parent-education category reported learning about computers in museums. Opportunities for learning extend beyond the school into the community and the family. It would be desirable to assure equity of learning opportunities for students from all social classes, although this is no less difficult than important.

Conclusions

The NAEP 1977-78 mathematics assessment concluded that a large majority of students had no experience programming a computer. The more optimistic conclusion of the current study is that a majority of students have had programming experience by the twelfth grade. Programming experience--particularly in school, but at home as well--was associated with markedly higher test scores. This reflects substantial progress in implementing computer studies programs. A large majority of students exhibit awareness of routine characteristics and uses of computers. Performance on programming objectives is low, however, and mastery of general knowledge is not much higher. Boys appear to have an advantage over girls, which is probably the result of greater access to computers and experience with them, both at home and in school.

Students were aware that computer skills could lead to better jobs. Even students who had programming experience or who reported participation in a computer class at school did not display a level of knowledge that would be adequate for the practical needs of business. The issue--whether public schools should provide training sufficient for entry level jobs--is one that needs to be faced squarely. A positive answer would require the spending of large amounts of money on equipment, software, and teacher training. If the commitment is made to computer studies, the problem of equity of access, especially for girls, should be addressed. Efforts should be made to see that students from lower social classes benefit from such access as much as students from higher social classes.

Table 21

Percent Correct Scores for Twelfth Grade Students,
by Objective and Subgroup, April 1983

Objectives	Percent correct scores							
				By parents' educational level				
	Total	Boys	Girls	Not high school	High school	Some college	Four years college	Advanced degree
1. Computer literacy	46.0	47.7	44.3	41.3	43.6	45.5	49.3	49.5
1. Computer Interactions	50.3	51.3	49.3	47.3	48.3	50.0	53.0	52.5
1. Operations	67.9	69.7	66.0	63.7	68.9	67.1	72.4	67.9
2. Interactive mode	49.0	48.8	48.8	41.9	44.8	50.8	50.5	53.7
3. Program selection	48.9	49.4	48.5	50.7	43.7	49.1	50.9	51.4
4. User errors	40.7	43.4	38.5	37.5	40.7	39.6	44.6	41.3
2. Functions and uses	41.5	44.2	38.9	35.7	38.5	40.5	45.4	46.8
1. Vocabulary	38.5	40.6	36.6	32.2	35.5	37.0	42.6	44.0
2. Interactive vs batch	25.9	27.1	24.8	24.1	25.9	23.0	31.1	27.2
3. System components	44.2	47.4	40.9	36.4	40.6	44.3	47.9	49.6
4. Appropriate tasks	69.8	71.7	67.8	62.7	63.6	71.0	73.7	77.4
5. History	30.7	34.0	27.3	25.4	29.4	29.3	33.5	35.8
3. Problem solving	44.2	45.3	43.2	40.0	43.2	43.6	46.8	46.3
1. Logical steps	63.1	63.1	63.2	60.7	60.4	65.1	62.9	64.2
2. Diagrams	49.5	49.7	49.1	41.7	50.3	46.6	55.4	50.6
3. Tools and procedures	43.3	44.3	42.1	36.1	42.4	40.7	45.9	49.3
4. Useful tasks	50.4	51.7	49.3	48.1	49.4	49.9	54.0	51.1
5. Simple programs	28.3	30.0	26.6	26.5	27.4	27.7	30.6	28.6
4. Impact on life	52.9	54.8	51.2	48.6	49.4	53.5	56.0	56.1
1. Specific uses	58.3	62.6	54.2	56.3	53.6	58.1	62.9	61.3
2. Occupations	49.3	49.7	48.9	44.3	46.3	50.3	51.1	54.2
3. Restrictions	52.4	53.8	51.6	47.9	50.8	51.7	55.4	55.3
4. Consequences	53.2	54.2	52.1	48.2	48.6	55.1	57.5	55.5
5. Responsible use	43.8	44.8	42.8	35.0	44.1	46.1	40.6	45.0
2. Computer science	29.2	30.7	27.8	27.1	27.4	29.2	30.1	31.9
1. Software	26.1	27.1	25.2	24.7	24.9	25.8	26.3	29.1
1. BASIC programming	28.7	30.1	27.7	25.0	26.0	29.1	29.4	33.5
2. Advanced techniques	30.7	31.2	30.2	28.2	29.9	30.6	31.[illegible]	32.7
3. PASCAL, COBOL and FORTRAN	20.0	20.8	19.4	20.8	19.5	20.5	19.5	20.5
4. Machine language	21.7	23.1	19.9	26.7	24.0	17.0	20.1	25.1
2. Hardware	34.8	36.7	32.9	31.6	32.5	35.5	35.6	37.1
1. Configurations	37.4	39.7	35.3	33.9	33.4	38.5	35.8	43.6
2. Interface devices	50.2	51.0	49.5	45.1	46.8	49.3	56.4	53.7
3. Circuitry	21.7	23.8	19.5	19.8	21.9	22.2	21.1	22.2
4. Maintenance	39.0	40.8	37.3	35.2	38.1	40.4	39.9	38.7
3. Problem solving	28.6	30.3	26.9	26.5	25.9	28.0	31.4	31.2
1. System utilities	33.7	36.1	31.5	32.0	30.5	33.7	38.0	34.6
2. Software translation	18.3	20.4	16.5	15.3	16.4	17.7	20.2	21.5
3. Analysis	31.6	33.1	30.4	29.8	29.0	31.1	33.3	35.0

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Table 22

Computers Treat Everyone as a Number

Response	Total per-cent	Test scores: Lit-eracy	Test scores: Sci-ence	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some col-lege	Four years col-lege	Ad-vanced degree
Strongly disagree	10.1	42.4	34.0	62.3	35.6	8.2	12.3	30.8	22.6	23.3
Disagree	25.8	43.5	32.5	51.5	47.7	8.9	17.0	29.7	20.2	22.6
Unde-cided	29.0	38.5	28.3	44.4	54.0	10.1	24.2	27.6	22.3	13.7
Agree	22.4	41.6	28.1	49.2	49.5	12.4	24.5	26.3	19.2	16.1
Strongly agree	7.3	38.3	27.9	60.0	39.1	15.2	16.2	24.8	14.3	24.8

Table 23

The More Computers Are Used, the Less Privacy There Is

Response	Total per-cent	Test scores: Lit-eracy	Test scores: Sci-ence	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some col-lege	Four years col-lege	Ad-vanced degree
Strongly disagree	8.4	42.1	35.8	61.5	3[illegible].8	8.2	16.4	25.4	24.6	18.9
Disagree	27.1	43.2	30.6	42.4	56.1	14.5	16.3	25.5	21.7	20.4
Unde-cided	29.8	38.3	26.8	44.2	52.8	11.1	24.1	27.6	20.4	14.8
Agree	23.1	40.0	30.3	46.1	51.5	12.3	23.4	25.5	21.6	16.5
Strongly agree	7.7	43.0	29.7	58.9	38.4	11.6	18.8	25.0	17.9	20.5

Table 24

Computers Create as Many Jobs as They Eliminate

Response	Total per-cent	Test scores: Lit-eracy	Test scores: Sci-ence	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some col-lege	Four years col-lege	Ad-vanced degree
Strongly disagree	8.8	54.7	35.6	69.0	28.7	17.1	20.9	31.8	16.3	12.4
Disagree	24.2	53.8	33.7	51.1	47.5	8.5	20.1	29.1	20.3	20.6
Unde-cided	18.9	52.2	34.3	48.6	49.6	14.1	19.9	26.8	20.7	16.3
Agree	34.9	56.5	33.0	48.0	49.9	9.2	22.9	28.4	20.2	18.4
Strongly agree	9.6	57.4	36.8	56.0	41.1	9.2	26.2	28.4	18.4	16.3

Table 25

Computers Complicate Simple Business Operations

Response	Total per-cent	Test scores: Lit-eracy	Test scores: Sci-ence	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some col-lege	Four years col-lege	Ad-vanced degree
Strongly disagree	37.8	47.9	33.2	58.9	39.6	10.1	15.1	30.1	20.6	21.5
Disagree	34.9	48.1	29.7	43.7	55.1	10.3	20.9	31.2	19.1	16.5
Unde-cided	13.0	44.3	23.1	37.2	61.7	12.2	24.5	35.1	10.6	17.0
Agree	6.4	37.6	29.2	40.2	59.8	13.0	34.7	21.7	17.4	10.9
Strongly agree	2.3	32.6	13.2	54.6	39.4	24.2	15.2	21.2	24.2	12.1

Table 26

Someday Most Things Will Be Run by Computers

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Strongly disagree	4.2	50.0	30.3	59.0	39.3	9.8	23.0	16.4	24.6	23.0
Disagree	3.0	57.4	37.4	51.2	46.5	11.6	16.3	14.0	27.9	30.2
Undecided	10.0	45.6	27.8	50.7	48.6	13.9	25.7	30.6	13.9	15.3
Agree	46.0	52.1	30.7	48.4	49.8	8.9	21.7	28.2	19.5	20.1
Strongly agree	33.0	52.9	33.6	51.5	46.9	8.8	20.6	29.8	20.0	19.5

Table 27

Knowledge of Computers Helps to Get a Better Job

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Strongly disagree	3.4	42.0	29.9	59.2	38.8	16.3	28.6	16.3	16.3	18.4
Disagree	5.4	34.8	29.2	41.6	57.1	6.5	20.8	26.2	18.2	28.6
Undecided	13.1	41.4	26.7	40.4	58.0	11.2	25.5	30.3	17.6	13.8
Agree	46.2	43.2	28.8	50.9	48.5	10.4	23.0	28.0	20.0	17.5
Strongly agree	28.5	44.6	32.2	52.0	47.1	11.7	22.2	26.8	19.5	17.3

Table 28

Computers Make Mathematics More Interesting

				Twelfth graders' subgroup percents						
						By parents' educational level				
	Total	Test scores							Four	
						Not		Some	years	Ad-
	per-	Lit-	Sci-			high	High	col-	col-	vanced
Response	cent	eracy	ence	Boys	Girls	school	school	lege	lege	degree
Strongly disagree	4.3	40.0	26.8	51.6	46.9	10.9	9.4	32.8	21.9	21.9
Disagree	4.4	40.7	29.1	43.1	53.9	18.5	24.6	15.4	16.9	23.1
Undecided	15.9	41.5	25.9	45.5	52.8	12.3	26.0	23.8	16.6	20.9
Agree	48.2	44.9	27.0	43.6	54.3	12.8	21.1	25.9	21.4	17.4
Strongly agree	23.9	51.4	30.5	60.9	35.4	13.0	19.8	28.1	19.8	18.7

Table 29

To Work with a Computer, a Person Must Be a Mathematician

				Twelfth graders' subgroup percents						
						By parents' educational level				
	Total	Test scores							Four	
						Not		Some	years	Ad-
	per-	Lit-	Sci-			high	High	col-	col-	vanced
Response	cent	eracy	ence	Boys	Girls	school	school	lege	lege	degree
Strongly disagree	14.3	46.8	31.4	53.2	45.1	6.4	19.1	27.8	26.0	20.8
Disagree	39.0	44.1	29.6	51.3	47.3	9.9	21.1	25.7	20.0	21.9
Undecided	11.6	38.3	22.8	44.7	51.8	12.8	31.2	27.0	13.5	14.2
Agree	21.9	42.1	25.8	48.1	49.3	14.7	22.6	30.5	16.2	15.4
Strongly agree	9.1	37.8	30.4	48.7	48.7	21.6	25.2	28.8	9.9	11.7

Table 30

Computers Are Suited for Repetitive, Monotonous Tasks

				Twelfth graders' subgroup percents						
						By parents' educational level				
	Total	Test scores								
Response	per- cent	Lit- eracy	Sci- ence	Boys	Girls	Not high school	High school	Some col- lege	Four years col- lege	Ad- vanced degree
Strongly disagree	6.8	53.8	29.1	49.0	45.5	12.2	14.3	20.4	23.5	25.5
Disagree	10.1	49.3	31.0	41.5	55.8	12.2	15.7	28.6	21.8	18.4
Unde- cided	21.3	48.7	29.8	44.2	53.9	12.0	26.6	27.9	17.2	13.3
Agree	37.3	53.0	34.6	45.6	52.4	9.8	21.1	25.9	22.4	18.5
Strongly agree	17.5	55.8	41.4	62.5	36.4	10.3	16.2	29.6	18.6	23.3

Table 31

Computers Are Programmed to Follow Instructions

				Twelfth graders' subgroup percents						
						By parents' educational level				
	Total	Test scores								
Response	per- cent	Lit- eracy	Sci- ence	Boys	Girls	Not high school	High school	Some col- lege	Four years col- lege	Ad- vanced degree
Strongly disagree	4.0	38.7	38.0	36.0	62.0	14.0	26.0	28.0	22.0	8.0
Disagree	2.6	30.2	23.4	53.1	43.8	15.6	31.3	12.5	15.6	18.8
Unde- cided	9.7	40.7	24.6	44.3	53.3	10.7	28.7	26.3	13.9	19.7
Agree	40.7	40.1	30.0	40.9	57.0	11.4	19.7	28.3	23.0	16.1
Strongly agree	37.2	45.4	35.4	56.0	42.5	9.0	16.3	26.0	25.5	22.5

Table 32

Computers Require Special Languages

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Strongly disagree	7.2	39.2	24.2	59.3	40.7	15.4	22.0	19.8	21.9	18.7
Disagree	13.8	40.4	25.4	53.1	45.7	10.9	26.9	35.4	15.4	11.4
Undecided	18.1	39.9	24.0	43.2	53.7	10.9	22.3	27.1	19.7	19.2
Agree	37.5	41.9	28.4	46.9	52.3	11.3	21.9	24.4	19.3	20.4
Strongly agree	19.0	43.3	33.4	56.4	41.9	12.0	17.8	23.2	23.7	21.2

Table 33

Computers Have a Mind of Their Own

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Strongly disagree	31.5	60.7	31.5	62.3	35.7	9.7	17.9	23.4	23.4	22.9
Disagree	31.4	53.1	28.3	47.5	50.3	8.7	21.0	28.8	19.5	19.8
Undecided	14.3	46.8	22.8	32.4	64.8	12.6	23.6	28.6	14.3	17.6
Agree	14.0	47.6	24.1	45.5	50.6	15.2	30.9	24.1	16.9	11.2
Strongly agree	5.3	41.5	27.2	52.9	45.6	23.5	22.1	25.0	8.8	16.2

Table 34

Computers Make Mistakes Much of the Time

Response	Total percent	Test scores: Literacy	Test scores: Science	Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
				Twelfth graders' subgroup percents						
Strongly disagree	22.2	56.8	34.4	61.9	35.6	9.4	22.3	21.2	16.9	28.4
Disagree	40.3	48.4	28.6	50.5	48.3	9.9	19.4	27.9	19.2	22.0
Undecided	20.5	43.4	24.2	43.2	54.9	12.5	24.9	30.0	14.8	16.0
Agree	11.4	43.2	25.2	44.4	53.5	12.5	22.9	29.2	13.9	16.7
Strongly agree	1.8	50.0	39.6	54.6	40.9	4.6	40.9	31.8	9.1	9.1

Table 35

Programming Languages Used

Response	Total percent	Test scores: Literacy	Test scores: Science	Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
				Twelfth graders' subgroup percents						
BASIC	37.0	49.7	30.9	54.4	44.2	11.3	19.6	27.0	20.5	20.8
PASCAL	3.3	56.0	40.1	70.7	28.1	7.9	15.9	30.5	17.7	26.2
LOGO	3.4	47.1	27.1	55.8	40.7	9.3	16.3	31.4	18.6	20.4
PILOT	2.2	42.4	32.0	75.2	22.0	13.8	18.4	33.0	11.9	20.2
FORTRAN	4.2	52.6	34.5	59.1	36.1	6.3	18.8	25.0	24.5	24.0
COBOL	4.4	51.1	35.1	58.3	38.5	6.9	21.6	28.4	19.3	21.6
FORTH	1.0	45.2	38.1	79.2	16.7	8.3	12.5	39.6	20.8	16.7
ASSEMBLY	4.7	48.9	32.3	62.9	34.6	15.6	19.4	25.7	19.0	16.9
Other	4.5	49.7	36.8	59.5	39.2	11.9	16.3	30.0	17.2	23.4
None	43.4	45.0	25.1	45.3	53.0	10.3	21.5	27.3	21.0	18.3

Table 36

Types of Video Games Used at Home

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Atari	27.9	48.6	32.0	52.3	45.8	9.7	21.1	30.4	18.9	18.2
Odyssey	3.0	50.0	32.5	59.0	38.2	6.9	17.4	33.3	18.8	20.4
Intellivision	8.4	47.9	28.4	58.7	40.3	7.1	19.1	30.7	20.9	19.1
Colecovision	2.3	44.6	29.4	67.6	28.7	12.0	19.4	31.5	15.7	17.6
Other	8.2	50.8	34.5	58.3	40.2	8.2	20.5	27.1	16.1	25.8
None	53.0	47.5	31.5	49.9	51.8	13.0	20.2	26.9	19.1	1.6

Table 37

Types of Microcomputers Used at Home

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Atari	9.9	49.9	29.9	48.9	48.3	8.6	21.9	30.2	19.7	17.8
TRS-80	3.1	51.9	29.9	65.0	30.9	11.3	12.4	33.0	18.6	23.7
Apple	5.2	53.8	31.7	61.4	34.4	6.8	11.7	30.1	19.6	27.6
PET-Commodore	2.1	47.7	31.0	71.2	25.8	9.1	10.6	25.8	22.7	28.8
IBM	4.0	54.5	27.8	56.8	40.0	8.8	16.0	23.2	17.6	28.8
Texas Instruments	14.0	48.4	31.7	48.1	49.7	10.8	19.2	27.5	18.7	21.7
Osborne	0.8	48.4	23.8	72.0	20.0	16.0	12.0	20.0	20.0	12.0
Other	6.0	51.8	31.5	52.4	43.9	9.5	13.2	27.5	20.1	25.9
None	59.2	50.3	29.8	49.2	49.7	12.0	21.8	28.6	18.6	17.8

Table 38

Types of Microcomputers Used at School

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Atari	7.0	42.0	24.7	59.5	37.0	12.7	23.1	27.5	19.2	15.4
TRS-80	10.2	51.6	34.1	64.9	33.1	7.1	22.8	27.7	21.3	19.8
Apple	20.2	50.5	31.6	56.3	41.7	10.1	19.7	26.5	21.0	21.2
PET-Commodore	7.0	49.6	32.9	63.5	33.3	10.5	21.9	28.6	17.4	19.1
IBM	12.6	42.9	26.2	20.8	57.1	15.1	24.5	25.9	19.7	12.4
Texas Instruments	7.8	47.1	26.2	53.4	43.6	10.0	20.5	27.1	20.5	18.8
Osborne	1.1	45.5	31.8	70.0	23.8	10.0	20.0	27.5	17.5	22.5
Other	11.0	49.8	32.1	55.2	42.8	10.3	18.4	29.0	19.6	21.1
None	42.6	43.9	26.2	45.7	52.8	10.8	21.3	25.8	21.4	18.9

Table 39

Percents of Students Engaging in Selected Activities, by Hours per Week

Activity	Twelfth graders' hours per week outside of school: None	Less than 1	1-2	2-3	3-4	4-5	5-10	More than 10
Reading	15.4	20.4	19.7	8.9	6.3	5.4	4.8	3.6
Homework	6.9	12.0	18.1	10.6	8.0	8.8	12.9	10.1
Video games at home	57.2	12.7	5.4	2.5	1.6	0.8	0.9	0.7
Video games away	45.5	22.2	7.4	3.1	2.0	0.9	0.8	0.7
Computer	59.2	9.2	4.0	2.1	1.6	1.6	1.6	1.9
Athletics	15.9	11.0	13.3	10.7	7.4	6.6	8.4	11.8
Television	6.7	9.5	12.5	11.9	9.6	10.7	13.0	12.3
Other	6.7	5.4	10.0	10.8	9.6	9.9	12.4	21.0

Table 40

Computer Literacy Achievement Scores, by Hours Spent in Selected Activities

Activity	Twelfth graders' hours per week outside of school: None	Less than 1	1-2	2-3	3-4	4-5	5-10	More than 10
Reading	41.7	46.8	48.7	49.1	49.1	49.0	51.0	47.7
Homework	38.6	45.0	45.3	44.6	47.6	47.0	52.1	51.9
Video games at home	47.2	46.4	47.8	43.3	49.0	59.2	49.1	45.4
Video games away	46.6	48.2	46.0	47.4	44.1	48.8	37.4	47.2
Computer	45.4	49.6	55.7	54.8	55.4	49.5	51.8	55.4
Athletics	44.1	47.8	46.7	46.8	43.8	49.1	48.3	48.9
Television	42.2	46.5	46.5	44.2	47.5	47.3	49.5	47.7
Other	40.1	49.2	44.4	48.2	47.3	47.7	48.3	47.7

Table 41

Computer Science Achievement Scores, by Hours Spent in Selected Activities

Activity	Twelfth graders' hours per week outside of school: None	Less than 1	1-2	2-3	3-4	4-5	5-10	More than 10
Reading	29.9	28.9	31.2	32.2	33.8	35.3	35.7	34.6
Homework	28.3	30.3	28.8	30.7	31.0	32.6	34.8	32.8
Video games at home	31.1	32.0	34.2	31.2	34.3	29.9	27.6	21.7
Video games away	31.1	31.4	33.9	33.2	33.2	27.1	26.4	30.4
Computer	29.3	33.0	39.5	39.3	34.1	40.3	41.9	46.2
Athletics	31.2	32.4	29.6	32.0	28.5	33.3	31.8	30.4
Television	32.2	33.9	28.9	29.5	30.1	31.4	31.6	32.4
Other	28.2	33.2	30.7	30.1	31.1	28.8	34.5	31.6

Table 42

Microcomputer Learning Experiences in School

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Program	15.6	56.9	46.8	55.2	42.2	9.3	19.8	24.0	21.7	19.8
General	16.9	56.8	44.7	48.5	48.9	10.1	20.6	27.0	18.7	21.2
Drill	11.3	53.5	42.5	49.8	48.9	10.9	18.3	24.4	21.9	21.5
Simulations	8.4	56.2	42.8	51.5	45.9	12.6	18.6	29.0	18.2	19.9
Tutorial	4.8	55.0	47.1	52.6	45.9	9.8	21.1	25.6	20.3	21.1
Games	12.3	51.6	39.1	54.1	44.1	10.4	19.8	31.7	19.2	17.5
Little experience	53.0	49.4	33.7	45.6	53.2	9.5	21.2	28.1	21.4	18.6

Table 43

Where Student Learned About Computers

Response	Total percent	Test scores: Literacy	Test scores: Science	Twelfth graders' subgroup percents: Boys	Girls	By parents' educational level: Not high school	High school	Some college	Four years college	Advanced degree
Home	14.0	46.1	33.6	57.4	40.4	4.0	14.2	24.7	26.4	28.7
Friends	9.8	45.0	33.0	64.4	33.8	5.7	18.9	23.8	23.1	27.1
Summer programs	3.4	45.6	36.4	49.0	51.0	9.2	25.5	23.5	13.3	24.5
Museums	2.0	44.9	35.8	56.9	37.9	0.0	13.8	32.8	22.4	27.6
School (day)	28.0	47.2	35.1	48.1	50.0	12.0	23.2	27.2	16.7	19.0
School (evening)	2.4	47.0	38.8	62.3	36.2	8.7	24.6	23.2	20.3	18.8
Stores	6.4	47.5	31.3	67.2	32.8	8.7	15.9	27.9	21.3	23.5
Video games	21.2	40.8	30.1	56.9	40.8	11.7	23.8	27.7	16.0	19.0
Know little	44.9	38.6	27.3	40.7	57.7	10.4	22.5	27.2	19.0	19.3

Table 44

Percent Correct Scores on Cognitive Questions for Sixth Grade Students, by Objective and Subgroup, April 1983

Objective	Percent correct scores						
				By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Overall	28.0	30.1	27.6	38.0	32.3	25.5	20.9
1.2.1 Vocabulary	38.6	42.6	34.4	54.7	46.1	36.4	26.1
1.2.2 Interactive and batch	9.2	10.3	8.0	9.8	9.5	9.2	8.8
1.2.3 Components	31.6	35.3	29.2	39.9	35.5	31.1	24.9
1.2.4 Tasks	42.6	43.9	41.3	60.9	51.5	24.8	27.4
1.2.5 History	18.6	22.1	14.9	25.7	20.5	17.8	14.2
1.3.4 Systematic procedures	35.1	35.22	34.9	45.8	38.6	34.5	27.8
1.3.5 Programs	21.9	24.0	19.9	31.8	25.3	20.0	16.9
1.4.1 Specific uses	36.9	38.1	45.8	49.8	43.3	35.4	27.1
1.4.2 Careers	23.7	25.2	25.6	31.5	27.6	22.4	18.2

Table 45

Computers Treat Everyone as a Number

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Strongly disagree	7.0	62.8	35.8	18.9	17.1	33.9	22.1
Disagree	49.3	49.9	48.9	15.9	18.7	38.0	20.1
Undecided	19.3	49.9	48.9	15.9	18.7	38.0	20.1
Agree	28.0	52.2	47.4	14.7	18.2	38.7	21.1
Strongly agree	7.8	64.1	35.1	15.7	12.7	35.3	26.9

Table 46

The More Computers Are Used, the Less Privacy There Is

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes- sional	Semi- profes- sional	Skilled	Un- skilled
Strongly disagree	10.2	64.1	35.4	18.4	18.1	36.8	20.1
Disagree	24.4	53.6	56.7	17.4	23.5	34.5	17.5
Undecided	27.6	42.8	56.7	17.1	17.5	37.0	20.4
Agree	23.8	52.2	47.1	13.5	17.6	38.5	23.3
Strongly agree	8.5	59.7	39.7	9.0	13.8	39.2	28.6

Table 47

Computers Create as Many Jobs as They Eliminate

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes- sional	Semi- profes- sional	Skilled	Un- skilled
Strongly disagree	6.3	30.2	39.4	16.8	14.6	41.3	19.4
Disagree	15.7	55.6	44.0	18.5	17.9	36.9	19.9
Undecided	27.1	43.0	56.2	15.5	18.9	37.6	19.5
Agree	35.8	49.3	49.9	17.1	18.2	38.9	19.1
Strongly agree	9.7	65.1	34.4	12.9	18.1	38.9	21.6

Table 48

Computers Slow Down and Complicate Things

	Sixth graders' subgroup percents						
				By parents' occupational level			
Response	Total	Boys	Girls	Professional	Semi-professional	Skilled	Unskilled
Strongly disagree	17.5	61.8	37.1	22.8	22.0	33.3	15.4
Disagree	29.2	47.0	52.4	20.5	20.8	35.2	16.3
Undecided	23.4	39.2	60.1	13.4	17.3	37.2	23.5
Agree	18.2	48.7	50.7	8.0	15.9	39.9	26.2
Strongly agree	6.2	58.4	40.9	9.0	12.3	40.5	29.3

Table 49

Someday Most Things Will Be Run by Computers

	Sixth graders' subgroup percents						
				By parents' occupational level			
Response	Total	Boys	Girls	Professional	Semi-professional	Skilled	Unskilled
Strongly disagree	3.8	57.5	40.4	9.5	13.3	41.1	26.7
Disagree	7.2	50.0	49.4	12.9	17.9	36.9	25.8
Undecided	18.8	60.7	58.3	13.6	18.2	39.3	20.5
Agree	46.2	47.8	51.5	17.3	17.3	37.7	18.7
Strongly agree	19.8	64.6	34.8	17.5	20.2	35.6	19.8

Table 50

A Knowledge of Computers Will Help to Get a Better Job

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Strongly disagree	2.8	58.1	41.4	10.5	11.4	39.5	31.4
Disagree	8.6	42.8	56.1	13.5	18.3	38.7	21.9
Undecided	17.7	41.4	58.1	13.3	18.8	38.3	21.4
Agree	46.4	47.7	51.4	16.1	18.6	38.5	19.2
Strongly agree	20.0	62.6	36.6	46.9	20.0	36.1	18.7

Table 51

Computers Can Help Make Mathematics More Interesting

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Strongly disagree	2.7	62.4	36.1	11.9	15.8	32.7	26.7
Disagree	5.6	50.8	48.4	13.7	17.5	38.9	21.6
Undecided	15.6	41.3	58.1	14.6	18.3	40.1	20.1
Agree	46.8	46.9	52.5	45.6	49.8	37.1	20.3
Strongly agree	24.5	60.3	38.7	18.1	19.8	37.9	17.9

Table 52

To Work with a Computer, a Person Must Be a Mathematician

Response	Sixth graders' subgroup percents			By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Strongly disagree	12.2	53.9	45.3	20.3	21.3	36.6	16.3
Disagree	35.0	48.0	50.7	19.5	19.8	36.7	17.3
Undecided	16.5	45.3	53.9	13.8	16.8	39.1	21.0
Agree	22.3	51.7	47.4	11.3	16.9	38.4	25.2
Strongly agree	9.3	56.5	43.0	9.9	11.8	40.1	29.0

Table 53

Computers Are Suited for Doing Repetitive Tasks

Response	Sixth graders' subgroup percents			By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Strongly disagree	3.8	59.6	39.4	14.6	15.3	38.7	23.3
Disagree	8.7	49.1	50.0	13.3	14.5	39.8	23.3
Undecided	28.1	42.1	57.0	14.8	18.9	38.1	20.1
Agree	41.2	50.7	48.3	16.4	18.1	37.9	20.3
Strongly agree	12.7	59.4	39.6	14.9	18.1	38.3	21.1

Table 54

Computers Have a Mind of Their Own

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Strongly disagree	13.1	60.4	38.8	22.7	21.2	36.1	14.3
Disagree	25.6	51.6	47.4	17.9	21.9	36.4	16.9
Undecided	20.1	42.9	56.1	14.0	20.8	36.1	20.8
Agree	28.0	46.2	53.3	12.4	17.0	38.6	24.4
Strongly agree	8.5	59.6	39.9	7.8	15.4	36.7	30.1

Table 55

Computers Make Mistakes Most of the Time

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Strongly disagree	12.2	63.7	35.9	20.9	22.4	34.0	14.6
Disagree	34.1	51.6	47.4	19.0	19.9	36.8	17.1
Undecided	25.3	40.2	59.0	14.4	19.5	36.3	21.8
Agree	19.1	49.2	49.9	9.0	16.4	39.0	26.8
Strongly agree	4.7	64.0	39.0	7.8	12.7	40.2	31.2

Table 56

Types of Video Games at Home

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Professional	Semi-professional	Skilled	Unskilled
Atari	44.3	54.6	44.6	16.7	21.9	38.2	16.2
Odyssey	3.1	61.2	38.3	22.5	18.1	37.4	15.9
Intellivision	7.6	59.1	40.4	19.3	20.4	37.1	17.3
Colecovision	5.8	65.3	34.2	15.7	20.4	31.9	22.0
Other	9.4	59.2	40.1	27.0	19.9	33.3	14.2
None	34.7	37.7	61.5	13.2	14.8	35.5	26.9

Table 57

Types of In-School Computer Learning Experiences

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Professional	Semi-professional	Skilled	Unskilled
Write programs	14.7	54.9	44.3	26.6	22.5	31.3	12.9
General information	14.7	52.0	47.3	25.7	23.5	30.8	14.7
Drill and practice	21.8	49.3	49.6	20.9	18.7	33.5	20.6
Math or science demonstrations	17.9	53.0	46.3	15.8	17.8	34.9	22.5
Computer games	33.1	51.9	47.1	19.6	21.4	35.5	17.2
No experience	31.9	44.9	54.5	28.1	31.8	33.5	32.5

Table 58

Types of Computers Used at School

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
Atari 400 or 800	9.4	57.6	41.8	15.7	18.7	37.1	19.4
TRS-80	6.5	55.8	42.3	21.0	21.0	34.0	19.3
Apple	20.5	55.7	43.9	22.3	19.2	35.1	16.7
PET-Commodore	8.9	53.8	45.4	23.6	21.8	31.7	15.5
IBM	2.6	58.1	40.8	13.1	13.1	40.8	13.0
Texas Instruments	5.7	51.7	47.2	15.1	19.3	38.0	20.8
Osborne	0.4	67.9	28.6	10.7	17.9	28.6	39.3
Other	6.2	55.0	44.2	15.8	20.1	36.8	18.2
None	43.7	47.4	52.0	12.9	46.5	40.0	22.8

Table 59

Indicate Where You Have Learned About Computers

Response	Sixth graders' subgroup percents						
				By parents' occupational level			
	Total	Boys	Girls	Profes-sional	Semi-profes-sional	Skilled	Un-skilled
At home	22.6	56.9	42.4	25.0	22.5	33.8	11.9
Special seminars	3.5	60.2	39.0	34.9	20.1	27.7	12.1
Museum or hall of science	3.7	59.9	40.1	28.3	22.2	30.8	12.2
At school (day)	27.3	48.2	50.9	21.2	20.9	32.7	17.2
At school (evening)	2.7	61.3	37.2	21.1	14.6	32.7	25.1
Computer stores	9.6	51.2	48.0	22.4	22.3	33.7	13.8
Playing with video games	42.4	45.7	39.0	15.1	20.2	37.4	20.1
I know nothing about computers	17.0	38.8	60.6	9.7	14.0	38.7	29.3

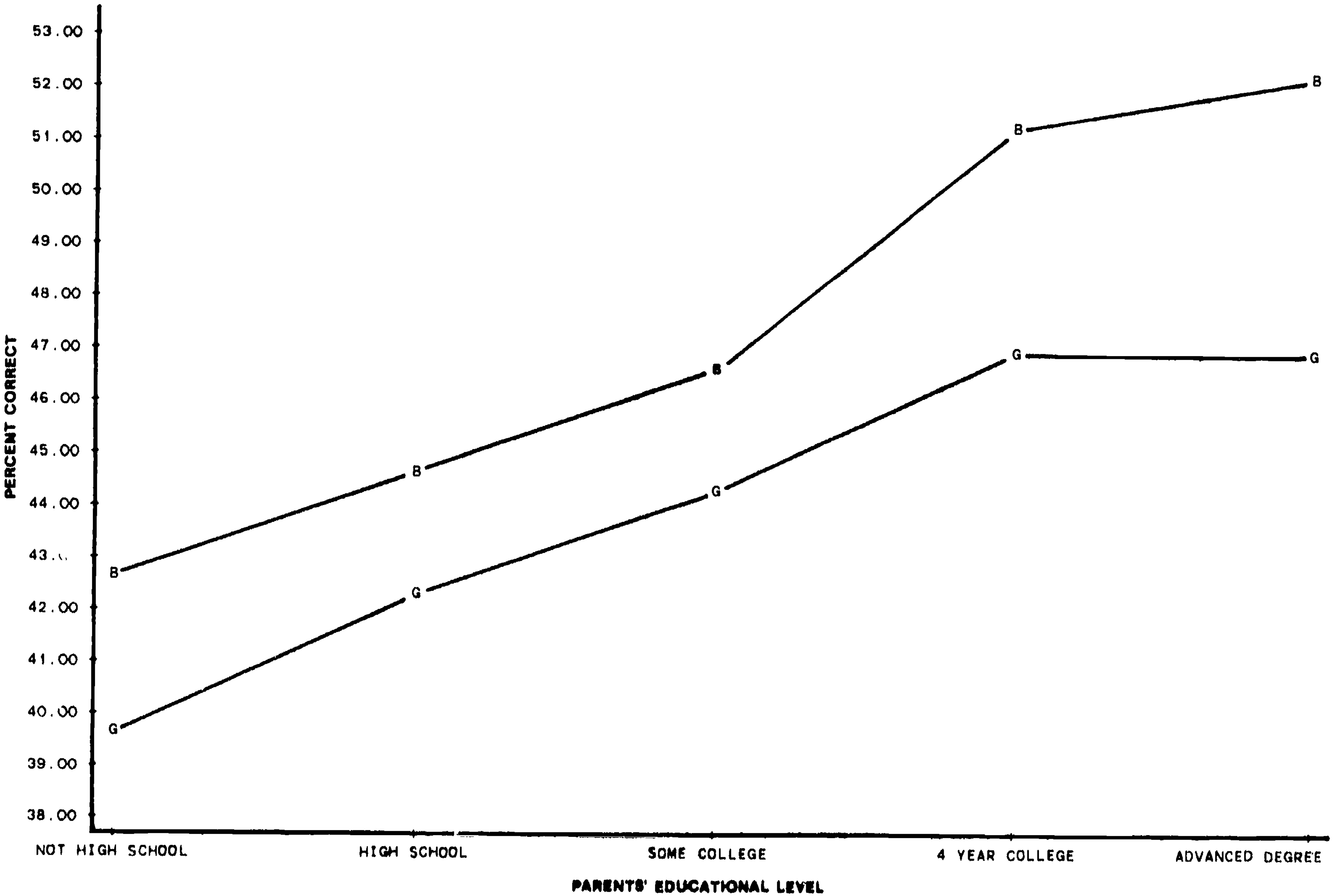

Fig. 15. Percent correct scores in the area of computer literacy for twelfth grade boys and girls, by parents' educational level

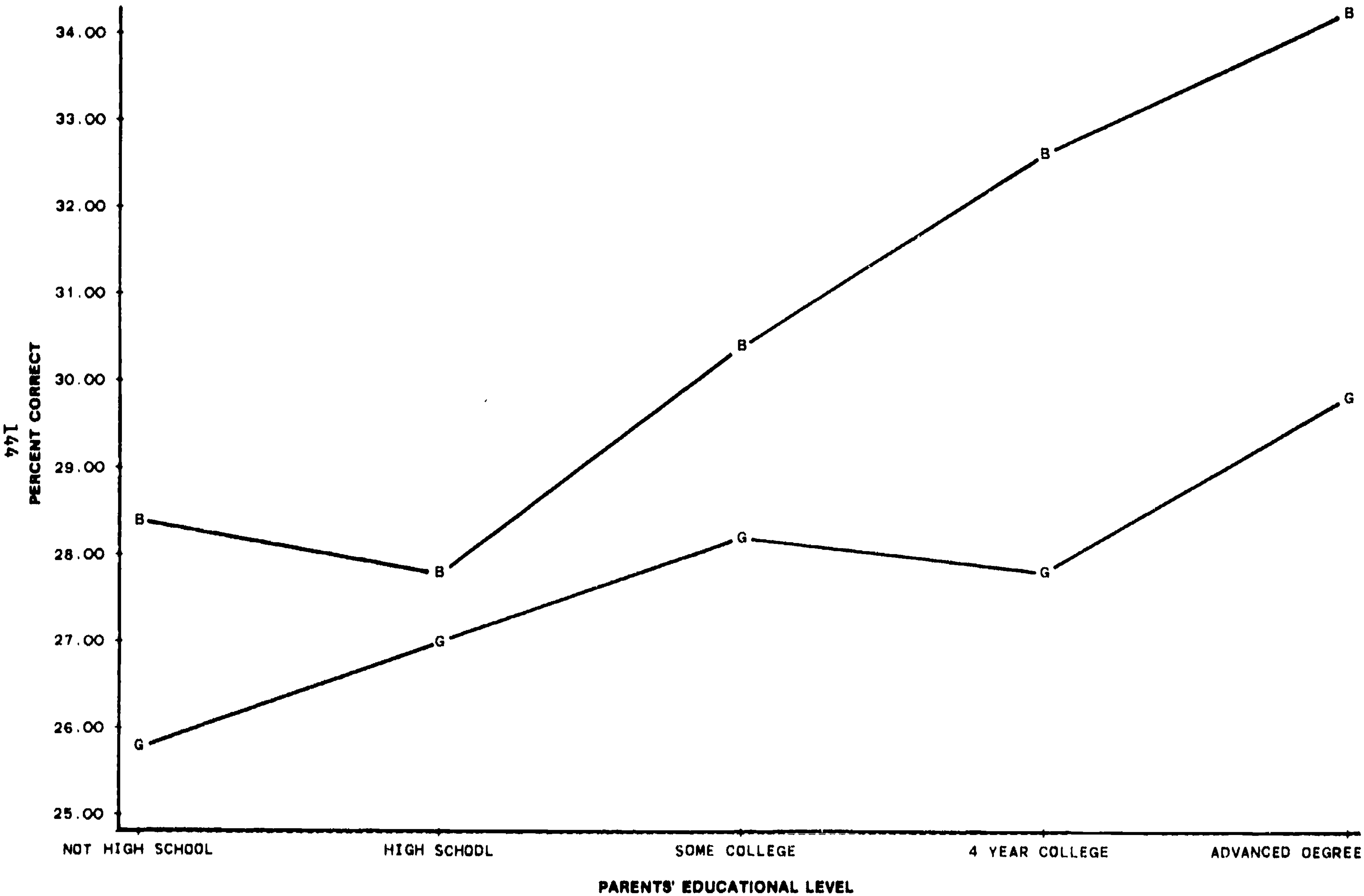

Fig. 16. Percent correct scores in the area of computer science for twelfth grade boys and girls, by parents' educational level

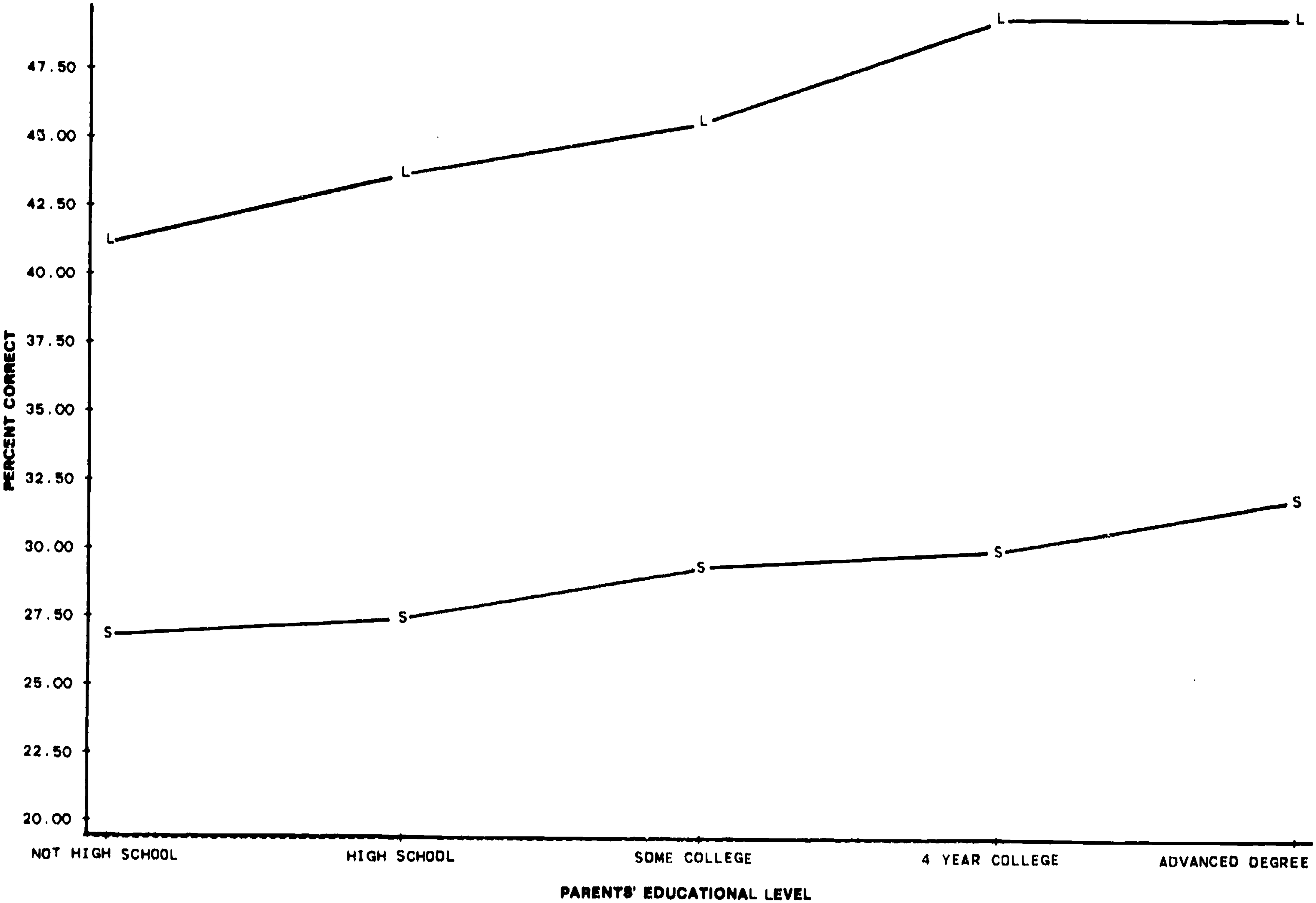

Fig. 17. Twelfth grade percent correct scores for the general areas of computer literacy and computer science, by parents' educational level

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VIII. Time and Learning in California Schools

The study described and reported in this chapter was sponsored by the California Assessment Program (CAP) of the State Department of Education and conducted during the 1982-83 school year. It incorporates data from several national and state sources into a comprehensive look at the relationship between the amount of time that California's students spend in school in comparison with that of students in other states and the implications of the differences for learning and achievement.

Summary

This chapter focuses on the availability and use of one of the most expensive and indispensable resources underlying that learning--instructional time, especially in relation to the new requirements contained in the Hughes-Hart Educational Reform and Finance Act of 1983. Long ignored as a critical factor in the study of educational productivity, time is now receiving statewide and nationwide attention. Insufficient time is viewed as a cause of weakness in the present state of student achievement. Increased time is viewed as a means--along with other resources and higher expectations--for raising student achievement. Time is also viewed as the foundation of all learning and the usefulness of all resources and efforts aimed at improved achievement.

The Educational Reform Act carries far-reaching implications. At the center of its reform package are requirements for increases in the amount of instructional time and the number of courses taken. The reasoning behind the reforms is that taking more courses and spending more time learning will increase a student's level of achievement. The data gathered and the analyses performed during the 1983 CAP investigation (which includes and elaborates on portions of the 1982 time and learning study) into the relationship between amount and use of instructional time and achievement tend to support the Legislature's reasoning. In some regards, however, the results of the CAP study indicate that the Reform Act does not go far enough.

The investigation reported in this chapter includes information on:

1. The amount of time California students spend in school
2. How time is distributed among subject areas in elementary schools
3. How coursetaking patterns and achievement of California high school students compare with those in other states and the nation as a whole
4. The recommendations of national organizations, the State Board, and the Legislature and what must be done to meet them
5. Ways to increase student achievement

In addition, because national attention is now focused on the critical gap between the preparation of American youth in mathematics and science and that of youth in other developed countries, the investigation emphasized the achievement and coursetaking patterns of California's students in these areas.

The study draws on information from a variety of sources. The chief source is the California Assessment Program, which supplies both achievement test scores and time and coursetaking information. Other key sources are:

- The verbal and mathematics aptitude scores of the College Entrance Examination Board's Scholastic Aptitude Test

- The scores of college-bound students who take the College Entrance Examination Board's advanced achievement tests

- The California and national results of the High School and Beyond study of the 1980 and 1982 graduating classes, carried out by the National Center for Education Statistics of the U.S. Department of Education

- The California Basic Educational Data System (CBEDS)

- A 1981 survey of school day and school year length nationwide carried out by Tod Anton, Superintendent, Lincoln Unified School District, Stockton, California

In this chapter major and minor findings are developed, supported, and elaborated, and the supporting data are presented and discussed. It is impossible to separate completely the findings of the study from their supporting data. In the body of the chapter they are, of course, merged for detailed discussion and analysis. For the sake of providing a convenient reference and an overview of the study's contents, five key areas, which correspond to the five major parts of this chapter, are described below, and, where appropriate, a summary of the most important supporting data is included:

1. Amount of time California students spend in school. California students spend considerably less time in school than their counterparts in other states. The differences are present at all grade levels and, viewed cumulatively, are substantial by the time the students graduate from high school. Even if the rest of the nation does not change, when the Reform Act's requirements are fully implemented in 1986-87, the gap between the time spent in school by California's students and students elsewhere will still not be closed.

   - Total instructional time in California is the equivalent of:

     - One-half year less than the national average by the end of grade three

     - One and one-third years less than the national average by the end of high school

   - The 1986-87 standards for yearly minutes of instruction, created by the Reform Act, if fully adopted:

     - Would require an average of 18 minutes more per day in kindergarten, 10-12 minutes more in grades one through three, and an hour more in grades nine through twelve, even with a 180-day year

- Would still fall short of the current national end-of-high-school average by one-fourth of a year

2. Distribution of time to subject areas in elementary school. CAP data on the distribution of instructional time among subject areas in grade six were compiled and compared with similar national data. The data and the comparison reveal that:

   o In grade six, of the five hours of total instructional time per day:

     - Half is spent on the basics: reading (61 minutes), writing/language (47 minutes), and mathematics (53 minutes).

     - One-fifth is spent on science (25 minutes) and social studies (36 minutes).

   o More time is spent on reading in schools serving low socioeconomic populations; this time is taken away from writing/language, science, and social studies, but not from mathematics.

3. High school coursetaking and achievement. About three-fourths of all students are enrolled in a mathematics course in the ninth or tenth grade; about half are enrolled in science in the tenth grade. From these high points, science and mathematics enrollments drop to about 25 percent of twelfth graders in the fall semester and further to only 12 percent by the spring semester. Despite some increases to these enrollments in the last two years, the average California senior still has taken fewer mathematics courses and substantially fewer science courses than the average high school senior nationwide. When California students are compared with students from New York, a state with a strong tradition of high standards for high school graduation and college entrance, the differences are profound. Far fewer California students take college-preparatory science and mathematics courses or the College Entrance Examination Board's achievement tests in those areas. Their achievement is considerably lower on those advanced tests.

   o Nationally comparable data suggest that California high school seniors:

     - Differ little in basic reading and mathematics achievement from the national average

     - In 1982 took College Entrance Examination Board's science achievement tests at half the national rate, but doubled that rate in 1983

   o Comparative data for California versus New York reveal that California high school seniors:

     - Have substantially lower achievement in basic reading and mathematics.

     - Score approximately the same on the verbal section and somewhat lower on the mathematics section of the Scholastic Aptitude Test, even though California's test-taking population is more selective than New York's (approximately half as many California students as New York students take the test).

- Take college-preparatory mathematics and science courses at a lower rate and the more advanced courses (trigonometry, calculus, physics, and chemistry) at one-half the New York rate.

- Take the College Entrance Examination Board's advanced science achievement tests at one-fourth to one-half the New York rate.

- Who take advanced science tests are far more poorly prepared mathematically than New Yorkers on the basis of their average mathematics aptitude scores.

- Perform more poorly on the science tests than New York students with equal aptitude scores.

4. National and state recommendations. Relatively few current graduates--in California or elsewhere--could meet any of the requirements recommended by recent national reports--A Nation at Risk, High School: A Report on Secondary Education in America, and Educating Americans for the 21st Century--especially when the recommendations are considered as a full set. The new course completion standards created by the Educational Reform Act of 1983 are less demanding than those recommended in the national reports. California's new 1986-87 graduation standards created by the Educational Reform Act: (1) are currently not met in mathematics by 39 percent of California seniors and in science by 60 percent of California seniors; and (2) are less stringent than those promulgated by the New York Board of Regents and those advocated in major new national reports.

5. Ways to increase student achievement. This study suggests some ways to improve students' academic achievement. The following methods are discussed:

   o Increasing the amount of time available

   o Increasing the proportion of allocated time devoted to actual instruction

   o Increasing the proportion of actual instructional time devoted to active learning

   o Reducing the time needed to learn

Background

The annual reports of the California Assessment Program have presented information to educators and policymakers on a variety of factors associated with school success. This practice helps fulfill one aspect of the legislative intent of the testing program: "The program of statewide testing shall identify unusual success or failure and the factors which appear to be responsible, so that appropriate action may be taken at the district and state level to obtain the highest quality education for all public school pupils" (Education Code Section 60601). The focus of this year's report is on the coursetaking patterns and the amount and use of instructional time in

California schools in relation to the requirements of the Hughes-Hart Educational Reform Act of 1983. The law contains a set of incentives to increase the amount of instructional time and a set of course requirements for high school graduation:

- o <u>Time</u>: Based on the number of instructional minutes offered in 1982-83, districts will receive a bonus to increase the number of instructional minutes one-third of the distance per year toward the following goals:

  - 36,000 annual minutes in kindergarten
  - 50,000 annual minutes in grades one through three
  - 54,400 annual minutes in grades four through eight
  - 64,800 annual minutes in grades nine through twelve

  Districts must (1) begin increases in 1984-85 to be eligible for bonuses; and (2) maintain instructional minute increases beyond the three-year phase-in period (1984-85 through 1986-87) to retain the bonuses.

- o <u>Course requirements</u>: The law establishes, effective in the 1986-87 school year, new requirements for receipt of a high school diploma, including the following:

  - Three one-year courses in English
  - Two one-year courses in mathematics
  - Two one-year courses in science (including biology and physical sciences)
  - Three one-year courses in social studies (including U.S. history and geography; world history, culture, and geography; and American government, civics, and economics)
  - One one-year course in fine arts or foreign language
  - Two one-year courses in physical education (unless otherwise exempted by law)

The Educational Reform Act carries far-reaching implications. The Reform Act is a result of the deep concern over a decade and one-half of decreasing student achievement. The two key variables in this Reform Act policy are instructional time and course content.

<u>Instructional Time</u>

The incentive to increase instructional time through lengthening the school day and school year is a response to a central concern of schooling. Time is the portal through which all learning must pass, and all resources and efforts aimed at improved learning must directly or indirectly impinge on learning time. But instructional time will result in student learning only if students are actively participating in the teaching-learning process. Recent research has identified important factors that influence students' active learning time. The Reform Act's focus on quality of school personnel, school management, and student discipline accords with the recent research findings. But although instructional time--or more precisely <u>active learning time</u>--is necessary for student achievement, it is not sufficient.

Course Content

Another important factor that affects student achievement is content. Legislators have focused on this aspect by strengthening high school graduation requirements. For central subject matter areas, the Reform Act specifies minimum years of coursework. In doing that, legislators obviously assume that more coursework in such subjects as mathematics and science will mean more content in these subject areas. However, the recent legislation falls short of specifying graduation requirements beyond minimum time per subject area.

It would be unfortunate if the reader got the impression from the singular focus of this chapter that time is the only important aspect of education in California worthy of study and comparison. While time is a crucial issue, it may well be that California students are equally shortchanged in the rigor, breadth, or depth of course content and its presentation. That issue, however, was not addressed by this study.

This chapter addresses content only as a means of categorizing achievement and time use data, not as a factor that affects achievement itself. An extraordinary amount of resources will be needed to mount the additional courses and total schooling that the legislation will stimulate; therefore, it becomes of paramount importance to focus on how that time is used. For example, using two semesters for content that can be covered in a single semester will hardly increase student achievement but only double the resources expended. It should become a high priority to ensure that students are placed in courses that do not repeat previously covered material and that new courses also provide new content. But even that is insufficient. Beyond increasing learning time and subject matter requirements, we will also have to scrutinize present courses. Could pacing be increased, i.e., could the time needed for learning be decreased and consequently more content be covered? Is learning time efficiently allocated and structured so that students have the time they need to master specified skills and that students are not allocated learning time for skills they have already mastered?

At the end of this chapter, we suggest various routes that should be taken to increase student learning and ultimately student achievement. The Hughes-Hart Educational Reform Act of 1983 sets a new time frame for schooling and points to priority learning areas in setting high school graduation standards. This chapter includes statistical support for the important reforms in the act, but it also includes evidence to show that merely allocating more instructional time, i.e., more resources, is insufficient. Beyond quantity of schooling, it is quality of instruction and curricular priorities that educators have to focus on.

Learning Time

The past ten years of research on schooling have strikingly shifted attention toward the uses of resources--especially teaching time--and their consequences for learning (see Wiley and Harnischfeger, 1974). Much of the conceptual underpinnings of this work are due to Carroll (1963) and have been extended by Bloom (1976) and Harnischfeger and Wiley (1976, 1978, 1983). Important empirical results as well as conceptual summaries may be found in Denham and Lieberman (1980) and Fisher and Berliner (1983).

Thus, active learning time is a concept that has redirected much of the earlier research on school and teaching effectiveness to focus on the teaching-learning process and its determinants. This research has led to one simple but profound insight: A student's active learning time is a strong determinant of his or her achievements.

This research implies that there are only four ways to increase achievement (Harnischfeger and Wiley, 1983). One is via a reduction in the time needed to learn. All the others depend on increasing active learning time. These latter three routes consist of:

- Increasing the total amount of time allocated to learning
- Increasing the portion of that allocated time that is actually allowed for learning
- Increasing the amount of this allowed time that students actively devote to learning

The primary focus of studies of total school time--day length and year length--is on the quantity of time available, not its use. The use of that time determines what is learned and how it is learned, thus directly influencing active learning. Total time is allocated to particular subject areas, learning topics, and learning tasks. Only the time made available for these activities can be used for learning; all other time uses can never result in learning.

Time Spent in School

Two years ago, a survey of elementary and secondary schools by a California school superintendent (Anton, 1981) concluded that California pupils are offered less schooling than pupils nationwide. This finding stirred deep concern because of its obvious implication that less schooling results in lower achievement. It became one force in legislative actions that resulted in the Hughes-Hart Educational Reform and Finance Act of 1983.

Anton's estimates of scheduled instructional time were compared to those found in a national study of known high accuracy (Compensatory Education Study, 1978). These 1976 data closely correspond to Anton's national time estimates (Table 60), as does CAP's sixth grade survey, made one year later than Anton's (1981-82 vs. 1980-81). CAP collected from school officials information on subject matter time allocations, as well as on practices and policies concerning time allocations. CAP's data collection resulted in an even slightly lower estimate of instructional time allocation than Anton's. Sixth graders' daily scheduled instruction is estimated as slightly greater than five hours in Anton's 1980-81 survey (308 minutes), while the average is just about five hours (299 minutes) in the 1981-82 CAP survey.

A comparison of CAP's estimate for sixth graders in California to Anton's 1980-81 nationwide estimate, with consideration given to the shorter school year in California, shows that sixth graders in California are offered 93 hours less schooling than sixth graders nationwide.[1] This is equivalent to 19 instructional days, or nearly one month of schooling.[2] This difference is substantial and consistent--the daily scheduled instructional times for all grades in California are systematically shorter than those in the nation as a whole.

Most commonly, high schools in California offer six 50-minute periods of instruction (Table 61), i.e., a 300-minute instructional day (Table 62). Over a third of the high school students (35.7 percent) are in schools that follow this pattern. Generally, California high schools have 50- or 55-minute periods and schedule between five and seven periods per day.

Table 60

Mean Daily Minutes of Instruction and Length of School Year for California and the Nation, by Grade

Grade	Nation		California		
	1975-76	1980-81	1980-81	1981-1982	1982-83
K	203	191	182		
1	304	310	268		
2	308	311	268		
3	311	314	270		266
4	321	322	303		
5	323	323	304		
6	329	326	308	299	
7	349	332	308		
8	350	333	309		310
9		331	302		
10		332	305		308
11		331	305		
12		331	305		
Days per year	177.5	178.5	176.0		

SOURCES: 1975-76 national data are from the tabulations that were done as part of the 1978 Compensatory Education Study by the National Institute for Education; 1980-81 data for the nation and California are from Anton, 1981; the 1981-82 figure is from the CAP grade six survey, 1981-82; the 1982-83 California data are from Study of the Length of the School Day and School Year in California Schools, 1982-83, prepared by the Division of Planning, Evaluation, and Research, California State Department of Education, 1983.

[1] Total hours are calculated by dividing the product of the minutes per day and days per year by 60. This process was carried out for sixth graders in California and the nation, using the figures in Table 60. The resulting discrepancy is 93 hours.

[2] Ninety-three hours divided by five hours per day (299 minutes) equals 19 days.

Table 61

High School Instructional Patterns: Combinations of Length and Number of Periods

Minutes/ period	Percent* of students in high schools with specific patterns				
	Periods per day				
	5	6	7	Other	Total
45	0.3	5.4	2.7	0.2	8.6
50	14.5	35.7	7.0	1.4	58.6
55	3.8	21.7	2.4	0.2	28.1
Other	0.7	1.1	0.9	2.0	4.7
Total	19.3	63.9	13.0	3.8	100.0

SOURCE: CAP data, 1982-83

*The percentage of schools with each pattern is about the same as the percentage of students, except for seven periods of 45 minutes--a small school pattern which represents 7.2 percent of all high schools. The primary patterns (45 to 55 minutes, 5 to 7 periods) represented 96 percent of the schools and 93.5 percent of the students.

Table 62

Total Daily Instructional Minutes, by Pattern of Instruction

Minutes per period	Daily minutes of instruction		
	Periods per day		
	5	6	7
45	225	270	315
50	250	300	350
55	275	330	385

SOURCE: CAP data, 1982-83

Comparing California data for instructional offerings in high school to national data shows that California high school students also have received less schooling because of fewer periods per day and a shorter school year (Table 63). California students have been offered less coursework than students in the nation as a whole. On the average, this shortfall is 73 hours in each year of high school. This is equivalent to 13 school days in California. Thus, over four years of high school, California high school students are offered the equivalent of 52 days, or about two and a half months, less schooling than high school students nationwide.

Table 63

High School Instructional Time, California and the Nation, 1980

Time concepts	California	Nation
1. Minutes per period	54.1	52.1
2. Periods per day	6.1	6.7
3. Minutes per day [(1) x (2)]	330.0	349.1
4. Days per year	177.3	180.1
5. Hours per year* [(3) x (4)÷ 60]	975	1,048

*Total high school instructional time in California is 7.0 percent less than that in the nation according to data from High School and Beyond. According to the Anton survey (Table 60), the corresponding shortfall is 9.2 percent.

Hypothetically, a typical California student's school life, as exhibited in Table 60, from kindergarten through twelfth grade is 72,000 minutes shorter than that of a typical student in the nation; this is the equivalent of one and one-third sixth grade school years. This large discrepancy is the result of shorter instructional days and a shorter school year. California ranks among the ten states with the shortest school year in the nation (Digest of Educational Statistics, 1980).

The extent of the differences in amount of schooling shows that relative to the nation, the instructional days in California are especially short in the primary grades (K-3). By the end of grade three, California students have been offered one-half year less schooling than students nationwide. The yearly discrepancies in later grades are somewhat smaller, but they consistently increase the cumulative shortfall.

The New California Standards for Instructional Time

This summary picture of instructional offerings truly calls for new efforts, as taken in the Hughes-Hart Educational Reform and Finance Act of 1983. This legislation specifies new state standards for instructional offerings in elementary and secondary schools which are to be met by the 1986-87 school year to qualify districts for supplementary funding (Table 64).

In line with these new standards, CAP calculated on the basis of the Anton data (Table 60) by what amount the school day or the school year needs to be extended to qualify for supplementary state funding (Table 65). If districts would maintain a 176-day school year, school days for all grades, except for grades six, seven, and eight, need to be extended and the largest increase--of over one hour--would have to occur in high school. If school districts would move to or maintain a 180-day school year, only grades four to eight would not have to lengthen the instructional day to comply with the new state standards. If school districts would retain daily instructional offerings as assessed by Anton for 1980-81 (Table 60), then school years need to be substantially longer for all grades except grades four through eight. On the average, kindergarten would have to be offered for 198 days, the primary grades (one through three) would have school years of between 187 to 189 days, and high school offerings would have to be increased to between 213 and 215 days to comply with new state standards. Obviously, extensive resources are needed to meet the new legislated standards.

Table 64

Total Yearly Minutes of Instruction Required to Meet 1986-87 State Standards for Supplementary Funding

Grade range	Yearly minutes of instruction
K	36,000
1-3	50,400
4-8	54,000
9-12	64,800

If these new standards were fully implemented, would California students then be offered the same amount of schooling as students nationwide? Basing comparisons on Anton's national estimates (Table 60), the answer is no. A California student is offered 72,000 fewer minutes of schooling from kindergarten through twelfth grade than a typical student in the nation. The new California standards reduce this gap by 80 percent to 13,000 fewer minutes. Thus, instead of having the equivalent of one and one-third school years less schooling, students in California would be offered one-fourth less of a school year. Even with the huge increase in offerings that is supported by the new legislation, California students would still lag behind students nationwide.

Time and Learning in Elementary School

The sixth grade time allocations to subject areas--from the 1981-82 assessment of California sixth graders and a national study carried out in 1976-77 (Hinckley et al., 1978)--are displayed in Tables 66 and 67. Table 66 exhibits national data on minutes per day of instruction offered in reading and mathematics in grades one through six in 1976-77 (Hinckley et al., 1978). The data indicate that nationally the number of minutes per day of reading instruction decreases substantially and continuously from grade one (about one and three-fourth hours) to grade six (about one hour). The California data for grade six match those for the nation. In mathematics the national data are essentially constant (at about an hour per day) across the elementary grades.

Table 65

Increases in School Day and Year Required
to Meet 1986-87 State Standards for Supplementary Funding

Grade	Required minutes per day: 176-day year: Daily required minutes	Required minutes per day: 176-day year: Increase beyond 1980-81 days*	Required minutes per day: 180-day year: Daily required minutes	Required minutes per day: 180-day year: Increase beyond 1980-81 days*	Required days per year if 1980-81 minutes per day* are maintained: Required days	Required days per year if 1980-81 minutes per day* are maintained: Increase beyond 176 days
K	205	23	200	18	198	22
1	287	19	280	12	189	13
2	287	19	280	12	189	13
3	287	17	280	10	187	11
4	309	6	300	0	178	2
5	309	5	300	0	178	2
6	309	1	300	0	176	0
7	309	1	300	0	176	0
8	309	0	300	0	175	0
9	368	66	360	58	215	39
10	368	63	360	55	213	37
11	368	63	360	55	213	37
12	368	63	360	55	213	37

*See Table 60 for 1980-81 minutes per day by grade.

Table 66

Mean Daily Minutes of Instruction in Reading and Mathematics,
Nationally, by Grade, and California, for Grade Six

Grade	Reading: Nation (1976-77)*	Reading: California (1981-82)**	Mathematics: Nation (1976-77)*	Mathematics: California (1981-82)**
1	107	-	58	-
2	100	-	59	-
3	86	-	61	-
4	73	-	61	-
5	68	-	61	-
6	62	61	57	53

*Adapted from Hinckley et al., 1978
**California Assessment Program, Grade Six Survey, 1981-82

Table 67 shows that in grade six in California the basic skills areas--reading (61 minutes), writing/language (47 minutes), and mathematics (53 minutes)--have the largest time allocations, each approaching an hour on the average. These are followed by social studies (36 minutes), physical education (27 minutes), and science (25 minutes). Art, music, and health trail with about a quarter of an hour each. In total, the average instructional time per day is reported as about 5 hours, and noninstructional time (recess, lunch, and so on) is reported at about one hour, yielding a total school day of about 6 hours.

These time allocations are averages in two senses. First, they are the assessment of a school principal or other school official of the typical daily time spent on these subject areas. In a sense, these are "average" values over different school days and over different school classes. Some of this variation is reflected in Table 68. About one-half of the schools report that there is little or no variation in subject area time allocations. This report differs, however, depending on school organization. About three-quarters of schools with completely departmentalized sixth grades report lack of variation.

Data collected from teachers in other studies (DeVault et al., 1977; Denham and Lieberman, 1980) indicate that the principals' estimates might understate the actual variation--especially the figure of 46 percent for schools with self-contained classrooms. These other studies, which include data from California and other states, indicate that basic skills time allocations may differ by three- or four-to-one across self-contained classes in the same school.

Instructional time allocations also vary for students from different socioeconomic backgrounds (Table 69). Using CAP's socioeconomic status (SES) index, we have assessed the sixth grade time allocation data for schools with very low, typical, and very high socioeconomic student backgrounds. We have compared subject area time allocations for reading, writing/language, mathematics, science, and social studies. Although the total amount of time allocated to these subject areas is the same for all schools, there are sizable differences among types of schools, by subject area. These differences are largest for reading.

Schools serving communities of low socioeconomic levels (the lowest 10 percent) allocate the largest amount of time to reading (63 minutes per day). Students in these schools are offered 9 percent more reading instruction than students who are enrolled in schools in communities of high socioeconomic level (the highest 10 percent). Since the total time allocation to the above-named subject areas is the same for all schools, the extra reading time must effect a shorter time allocation in other subject areas. Mathematics time allocation is not cut. But an increase in time allocation to reading tends to decrease the time allocations to writing/language, science, and social studies, but not to mathematics.

It should be noted, however, that these numbers refer to somewhat arbitrary indicators of efforts to structure the teaching day to achieve general curricular ends. As such, they may not be good indicators of the types of learning that take place; subject areas are heavily overlapping and interactive. For example, a reading lesson may very effectively communicate important scientific or historical concepts or principles. Similarly, the act of reading for a history project can improve reading skills. In fact, the case can be made that the increased effectiveness of modern reading programs is largely cancelled by ignoring this basic principle, i.e., by teaching reading as reading, history as history, etc. Research findings support the logic that the current emphasis on content areas--and reading and writing in the content areas--is the best way to improve achievement in all school subjects.

Table 67

Mean Time Allocations, by Subject Area, in California, Grade Six, 1981-82

Subject area	Mean minutes per day
Reading	61
Writing/language	47
Mathematics	53
Science	25
Social studies	36
Art	16
Music	14
Health	16
Physical education	27
Other	7
Total	302*
Total instructional time	299*
Total noninstructional time	67
Total school time (sum)	366
School day length	365

*The "Total" does not equal the "Total instructional time" because of adjustments for outlying (obviously incorrect) values.

Table 68

Organization of Sixth Grade Classes in California and Reported Variation in Time Devoted to Subject Areas, 1981-82

Reported variation in time devoted to subject areas over classes	Percent of schools by organization of sixth grade classes				
	Self-contained classrooms	Modified self-contained classrooms	Partially depart-mentalized	Completely depart-mentalized	All schools
Only one class per grade	9	4	4	6	8
Little or none	46	58	65	76	52
Variation	45	38	31	18	40
Total	100	100	100	100	100
Percent of all schools	59	23	15	3	100

Table 69

Time Allocations Across Subject Areas for California Schools Serving Communities of Different Socioeconomic Levels, Sixth Grade, 1981-82

SES percentile	Instructional time (minutes/day)					
	Reading	Writing/ language	Mathematics	Science	Social studies	Total
10	63.0	44.9	56.0	25.9	35.5	225.3
50	60.1	46.1	55.9	26.6	36.4	225.1
90	57.4	47.8	55.7	27.2	37.3	225.4
Differences (10 - 90) Minutes per day	+5.6	-2.9	+0.3	-1.3	-1.8	---
Percent	+9.3	-6.3	+0.5	-4.9	-5.0	

At the sixth grade level, the assignment of homework varies considerably, by subject area (Table 70). Ninety-five percent of sixth graders report regular homework in mathematics, but only 61 percent do so for writing. And only 66 percent of these students report having had homework in any subject the previous day.

Table 70

Sixth Grade Students' Reports of Amounts of Homework Assigned, by Percents, by Subject Area (CAP 1981-82)

Subject area	Percent reporting
Usually have homework	
Reading	82
Writing	61
Mathematics	95
Science	63
Social studies	80
Yesterday did homework	
Any subject	66

SOURCE: CAP data, 1981-82

Not reported in Table 70 is the relationship between the students' social backgrounds and the assignment of homework. The highest rates of homework assignment for reading, writing, and mathematics are for students whose parents are employed in unskilled occupations. On the other hand, these same students have the lowest rates of homework assignments--in comparison to other occupational groups--for science and social studies. These findings are strongly consistent with the earlier finding of greater emphasis on reading and less emphasis on science and social studies in schools serving low socioeconomic status communities.

Aside from direct policy issues about the amounts of time to be spent on homework and the subject-area priorities for this time, central questions arise about who sets these policies. CAP's sixth grade school questionnaire touched on this issue (Table 71). The most surprising finding is that these policies are either set at the district level or left to the individual teacher. The school principal--who has emerged in recent research on school effectiveness as the key instructional leader--seemingly plays almost no role in homework policy in California.

This brief look at the important topic of homework merely serves to show the complexity of the issue. The appropriate amount of homework must vary according to the students' needs, school priorities, and the subject being studied. Finally, the roles of parents, teachers, principals, district personnel, and school board members in developing and implementing homework policy and priorities need to be clarified.

Table 71

Origin of Homework Policies,
California Elementary Schools, 1981-82

Origin of policy	Percent of schools
Teacher, not school	42.8
School, not district	1.2
District	56.0
Total	100.0

Time and Learning in High School

In this section we explore and compare time and learning in California high schools, our touchstones for comparison being the nation as a whole and the State of New York. The latter was chosen because of similarities in size and because New York's educational system--with its regents' examinations and diploma and its long-standing statewide graduation requirements--served as a major comparison point in the debates which led up to the California reform legislation. The section is divided into four parts:

First, the achievement test scores of California students are compared with those of other students. Separate comparisons are made on the basis of (1) all students; (2) the college bound; and (3) those who took only advanced achievement tests for college entry.

Second, these groups are compared on the basis of the number of high school courses the students in the groups completed in the basic academic subjects.

Third, the results of a special 1982-83 CAP survey of California seniors are reported. This survey focussed on the specific mathematics and science courses the students have taken, the number of semesters of study for each, and the grade the students were in at the time of study.

Fourth, some relationships between CAP grade twelve mathematics test scores and the number of mathematics courses taken are analyzed and discussed.

National Achievement Comparisons and Trends

In this section the aptitude and achievement of California's high school seniors are compared with those of students nationwide. The bases for the comparisons are provided by the High School and Beyond study and scores on the Scholastic Aptitude Test and the College Entrance Examination Board's achievement tests.

High School and Beyond test information. The High School and Beyond study allows for comparison of reading and mathematics achievement of California twelfth graders and that of twelfth graders nationwide (Table 72). California twelfth graders compare favorably to twelfth graders in general. Given the lower amount of schooling that California students are offered, the data in Table 72 might imply higher productivity of California schools. Focusing on the New York contrast, however, we find fairly large differences. In reading and mathematics New York seniors outperform Californians by about 20 percent of the standard deviation.

Scholastic Aptitude Test results. Although California high school seniors in general compare favorably in their reading and mathematics achievement test scores to high school seniors nationwide, concern has been voiced over the recent SAT scores, because the California college-bound seniors did not match the new, slightly upward trend of SAT scores for twelfth graders nationwide (Table 73). Some clarification on this issue is needed. The Scholastic Aptitude Test is taken by about one-third of high school seniors nationwide. Also, about one-third of high school seniors take the SAT in California. The mathematics scores of California college-bound seniors on the 1983 SAT indicated higher mathematics aptitudes than those of college-bound seniors nationwide. However, the verbal aptitudes of California college-bound seniors were lower than the verbal aptitudes of college-bound seniors across the nation.

A comparison of California college-bound seniors' verbal scores to those of college-bound seniors nationwide over the past ten years, however, reveals a much larger test score drop for California test takers. In California, verbal SAT scores dropped by 30 points; nationwide, verbal scores dropped 20 points.

Table 72

Mean Reading and Mathematics Scores of High School Seniors, California and the Nation, 1979-80

Test area	Mean score,* by location			Difference	
	California	New York	Nation	CA vs Nation	CA vs NY
Vocabulary					
Part I	51.4	52.3	50.0	1.4	-0.9
Part II	50.3	51.7	50.0	0.3	-1.4
Reading	50.1	52.1	50.0	0.1	-2.0
Mathematics					
Part I	50.6	52.6	50.0	0.6	-2.0
Part II	50.3	52.1	50.0	0.3	-1.8

SOURCE: Special analysis of the High School and Beyond base year data by CAP and the New York State Education Department

*These are standardized scores. The values have been transformed so that the weighted national mean is 50 and the standard deviation is 10. The vocabulary tests are five-option, multiple-choice questions requiring selection of a synonym. The reading test consists of five passages, each followed by four multiple-choice questions. The mathematics tests cover basic mathematics (Part I) and more advanced high school content (Part II), primarily algebra.

Table 73

Average SAT Scores of College-Bound Seniors, California and the Nation, 1973-1983

Category	SAT scores										
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Verbal											
California	452	450	435	430	427	427	428	424	426	425	421
Nation	445	444	434	431	429	429	427	424	424	426	425
Difference	7	6	1	-1	-2	2	1	0	2	-1	-4
Mathematics											
California	485	484	473	470	470	466	473	472	475	474	474
Nation	481	480	472	472	470	468	467	466	466	467	468
Difference	4	4	1	-2	0	-2	6	6	9	7	6

SOURCE: College Entrance Examination Board's reports on college-bound seniors

Ten years ago, California SAT test takers had much higher verbal SAT scores than SAT takers nationally.[3] Mathematics SAT scores have dropped less dramatically over the past decade than those of college-bound seniors nationwide.

Despite decreases in aptitude scores, the California verbal score (425) in 1982 was nearly the same as that of New York (429). There was a greater difference in the mathematics scores for California and New York--474 and 492, respectively. The difference is magnified by the fact that a considerably smaller proportion of California students take the SAT (see Table 74). In California, 25.4 percent of high school age students took the test; in New York, 44.3 percent did. In other words, the California students form a statistically more select group and should, therefore, be expected to be approximately the top 25 percent among California's high school students. They were outscored by approximately the top 45 percent of New York students.

College Entrance Examination Board's achievement test results. Beyond the verbal and mathematics aptitude tests, many college-bound high school seniors also take achievement tests in various subject matter areas. The achievement test scores show a more revealing picture of school learning, because they are linked more directly to specific course content. A comparison of achievement test scores of California college-bound high school seniors to college-bound high school seniors elsewhere cannot merely focus on their achievement test scores, because relatively more students in California take one or more of these achievement tests than do similar groups of students nationwide. One reason for this is that one entrance requirement of the University of California is that students take three achievement tests: English composition, mathematics, and a foreign language or social sciences area test. Thus, in contrast to the verbal and mathematics aptitude tests for which the California and national proportions are quite similar, the subject-matter-specific achievement tests are taken by larger proportions of California students than by students nationwide.

Achievement tests are given in English composition and literature, mathematics (I and II), biology, chemistry, physics, American history, foreign languages, and several other areas. Most California students take the tests in English composition, mathematics, and American history; the history test fulfills the social science requirement in California. In this section, however, we will restrict our focus to test scores in mathematics and science. We will also contrast the performance of California seniors with those in New York State as well as those in the nation as a whole.

As we noted above, students in different parts of the country take the College Entrance Examination Board's tests with different frequencies. Although about a quarter of all students aged fourteen to seventeen take the basic SAT tests in California and in the nation as a whole, almost 45 percent take them in New York (Table 74). When we examine the implications of this for the proportion taking the College Entrance Examination Board's achievement tests, we see further differentials. For example, in 1982, about 2 percent of California SAT takers took the biology achievement test, and about 9 percent of New York SAT takers did so. As a percent of an age group, however, the rates were 0.5 percent and 4 percent, respectively, an eight-fold difference.

[3] If the comparison is extended to 1972, the first year that state-level information became available, the decreases for California and the nation were 42 and 27 points, respectively.

Table 74

Percent of Students Taking the College Entrance Examination Board's Aptitude and Selected Achievement Tests, California, New York, and the Nation, 1982 and 1983

Category	California 1982	California 1983	New York 1982	Nation 1982	Nation 1983
Percent of students taking SAT*	25.4	26.3	44.3	24.3	24.7
Percent of SAT takers taking achievement test					
Mathematics I	26.0	26.1	15.7	14.7	14.8
Mathematics II	6.3	7.1	2.4	3.8	4.1
Biology	2.0	4.6	8.8	4.1	4.4
Chemistry	1.4	2.9	5.7	3.5	3.7
Physics	0.7	1.4	1.9	1.6	1.7
Percent of students taking achievement test					
Mathematics I	6.6	6.9	7.0	3.6	3.7
Mathematics II	1.6	1.9	1.1	0.9	1.0
Biology	0.5	1.2	3.9	1.0	1.1
Chemistry	0.4	0.8	2.5	0.9	0.9
Physics	0.2	0.4	0.8	0.4	0.4

*These are the total numbers of SAT takers as a percent of the average single-year age group in the state or nation for individuals fourteen to seventeen years of age in 1980--for 1982 figures--and in 1981--for 1983 figures.

If we examine these rates in Table 74, three striking facts emerge:

- The rates of mathematics achievement test taking (in terms of age groups) are similar for both states and the nation as a whole.

- Science achievement test taking in New York is much more common than in either California or the nation as a whole. This is undoubtedly due to much larger proportions of an age group reaching advanced courses. We will discuss this issue further below.

- There was a doubling of science achievement test taking in California between 1982 and 1983. This brought test taking levels in California to the national level, but they still remain at about one-third of New York's 1982 levels.

To evaluate these data, we must also consider Table 75. In general, within a single educational system, if a larger proportion of an age group were to take an achievement test, we would expect that the larger group would have lower average aptitude than the smaller, i.e., be less highly selected. This is because we generally expect the most able students to take advanced tests. An example of this phenomenon occurred between 1982 and 1983 for California physics test takers. The percentage of the age group taking the test doubled from 0.2 to 0.4, and the average mathematics aptitude score of the test takers fell from 663 to 651. A similar result occurred for New York in 1982 versus California: With 0.8 percent of the age group taking the test, the mean mathematics score in New York was only 636, lower than either year for the California test takers.

This pattern, however, is not repeated for the other tests. In chemistry, biology, and mathematics I, the mathematics aptitude levels of New York seniors taking these achievement tests are either about equal or absolutely greater than those with substantially lower rates of test taking. Clearly, New York is doing a better job of mathematical preparation for those in the top 1 to 7 percent of an age group than either California or the rest of the nation.

Table 75

Mean Achievement and Aptitude Test Scores of College-Bound Students in California, New York, and the Nation Who Took Selected College Entrance Examination Board Achievement Tests, 1982 and 1983

	Achievement test scores			Aptitude test scores					
				Mathematics			Verbal		
Achievement test	CA	NY	Nation	CA	NY	Nation	CA	NY	Nation
1982									
Mathematics I	522	575	545	532	580	552	479	525	501
Mathematics II	655	670	661	638	658	646	533	569	553
Biology	541	587	548	565	576	564	524	540	527
Chemistry	590	604	575	649	617	619	550	545	539
Physics	614	612	592	663	636	642	537	544	537
1983									
Mathematics I	521	Not available	543	535	Not available	556	475	Not available	500
Mathematics II	646		655	637		649	520		550
Biology	518		544	561		570	495		523
Chemistry	562		569	633		624	510		536
Physics	590		595	651		647	505		536

SOURCE: The College Entrance Examination Board's reports on college-bound seniors

If we now turn to the science achievement test performances themselves, we must be careful to state what we are evaluating. Differential performance can come about because of differences in preparation--arrived at because of either better earlier training generally or by more stringent selection of those few who have better preparation. Or it may come about by differences in the quality and quantity of the science education itself. Since our evaluation of performance differences and their implications will strongly depend on whether they are a consequence of prerequisite skills at course entry or caused by the quality of the subject-specific course instruction itself, we must relate the achievement levels to the aptitude levels of the test takers.

Because the basic scale of the achievement scores is similar to that of the aptitude scores (ranging from 200 to 800), the rough adjustment of subtracting the aptitude level from the achievement level is employed. This is not a precise adjustment, but it is sufficiently accurate to allow the assessment of gross differences in performance.

Table 76 exhibits these differences and contrasts them. A higher assigned value of the difference indicates that the performance, adjusted for aptitude level, is "better" than the performance corresponding to a lower value. Thus, for California in 1982 the mean biology achievement level was 24 points below the mean mathematical aptitude level of the test takers (565 - 541). For the nation the achievement level was only 16 points below the aptitude level. Thus, the contrast column indicates a superiority of 8 points in adjusted performance for the nation vs. California.

Examining the adjusted contrasts, we find:

- o Small differences in adjusted mathematics performance between California, New York, and the nation
- o Large differences in science performance, favoring New York, especially, and the nation over California

Our main conclusion must be that New York is doing a superior job of science education[4] in three regards:

- o Mathematical preparation
- o High proportions of students taking advanced courses
- o Superior achievement in the courses themselves

High School Coursetaking

The data and discussion of the coursetaking characteristics of high school seniors are presented in two parts: (1) for all high school seniors; and (2) for college-bound seniors.

[4] We note that in areas in which we expect a verbal aptitude component--biology and, perhaps, chemistry--that New York's performance superiority is still large if we adjust for verbal rather than mathematical aptitude.

Table 76

Differences Between the College Entrance Examination Board's Mathematics and Science Mean Achievement Scores and Mathematics and Verbal Aptitude Scores, California, New York, and the Nation, 1982 and 1983

Achievement test	Achievement scores minus aptitude scores							
	1982					1983		
	CA	NY	Nation	CA minus NY	CA minus nation	CA	Nation	CA minus nation
	Achievement minus mathematical aptitude							
Mathematics I	-10	-5	-7	-5	-3	-14	-13	-1
Mathematics II	+17	+12	+15	+5	+2	+9	+6	+3
Biology	-24	+11	-16	-35	-8	-43	-26	-17
Chemistry	-59	-13	-44	-46	-15	-71	-55	-16
Physics	-49	-24	-50	-25	+1	-61	-52	-9
	Achievement minus verbal aptitude							
Mathematics I	+43	+50	+44	-7	-1	+46	+43	+3
Mathematics II	+122	+101	+108	+21	+14	+126	+105	+21
Biology	+17	+47	+21	-30	-4	+23	+21	+2
Chemistry	+40	+59	+36	-19	+4	+52	+33	+19
Physics	+77	+68	+55	+9	+22	+85	+59	+26

All high school seniors. Table 77 exhibits average coursework of California twelfth graders from the ninth through twelfth grade in several subject areas. Students take more English than any other type of coursework. The average number of years of English taken is 3.8. This is followed by social studies (3.1 years), physical education (3.1 years), mathematics (2.8 years), science (2.1 years), and foreign language (1.5 years). Twenty-nine percent of California seniors report no foreign language coursework in high school.[5]

[5]The response format for data reported in this section (1979-80 and 1980-81), both in CAP and High School and Beyond, may result in biases toward overestimation because of the reporting method (students reported the number of years of a subject, rather than which course was taken each semester of high school). This overestimation bias is obvious for the data reported in Table 77. For example, 74 percent of the 1982 seniors in California claimed four years of English courses, whereas an analysis of the transcripts done as a part of the High School and Beyond follow-up study for a sample of those seniors showed that 48 percent completed four years of English (see Table 90). However, because of similarity in reporting format for California and national data prior to 1983--including the College Entrance Examination Board's data on college-bound seniors--CAP places great confidence in the reported comparisons of California with New York and the nation.

Table 77

Percent of California High School Seniors Reporting Various Amounts of Coursework, by Subject Area, 1981-82

Subject area	Mean years	Percent of students, by number of years of coursework					
		0	1	2	3	4+	Total
English	3.8	0	1	3	22	74	100
Mathematics	2.8	0	9	30	32	29	100
Science	2.1	1	33	36	20	10	100
Social studies	3.1	1	6	15	41	37	100
Foreign language	1.5	29	21	31	13	6	100
Physical education	3.1	1	2	24	33	40	100

SOURCE: CAP data, 1981-82

On the other hand, 74 percent report taking four or more years of English. The percent of students reporting similarly high levels of courses taken in other subject areas is substantially lower--physical education (40 percent), social studies (37 percent), mathematics (29 percent), science (10 percent), and foreign language (6 percent).

In additional tabulations, we found that only 1 percent of California seniors take four or more years each of English, mathematics, science, and foreign language. Even when the criterion is dropped to three years of science and foreign language but four years of English and mathematics, only 5.5 percent of California high school seniors report taking that amount of higher level academic coursework.

Comparing the California data on courses taken to national data is difficult for two reasons. Purely statistical national data on courses taken are based on institutional reports that yield enrollment rates for particular courses but do not link aggregate course registrations to the individuals who produce them (Ostendorf, 1975). Also, since these surveys cover single years, it is impossible to estimate cumulative years of courses taken in terms of the percentage of individuals with zero, one, two, and so on, courses or years of coursework. Survey data on high school students, such as those from the National Longitudinal Study of High School Class of 1972 and High School and Beyond, are potentially comparable data, but in both cases, the data were collected for three rather than four years of high school.

One approximate comparison, however, is presented in Table 78. Essentially all California high school students take at least one year of mathematics. By assuming that students take their first (or only) mathematics course in ninth grade,[6] CAP derived twelfth grade data that are in line with those of High

[6] According to the 1982-83 data, only three-quarters of the seniors took mathematics in the ninth grade; thus, if this were true in 1979-80 and 1981-82, these data would indicate closer parity of California and national data.

School and Beyond. It can be seen from Table 78 that California levels of mathematics coursework are similar to, but slightly less than, those across the nation.

Table 78

Percent of Twelfth Graders Reporting Specified years of Mathematics Coursework Taken in the Last Three Years of High School, 1979-80 and 1981-82

	1979-80*		1981-82**
Years of mathematics	Nation	California	California
0	7.8	9.7	8.6
1	27.3	32.1	30.1
2	33.5	32.6	32.1
3 or more	31.4	25.6	29.2
Total	100.0	100.0	100.0
Median years	1.44	1.25	1.35

*These data are derived from the High School and Beyond survey conducted by the National Center for Education Statistics in 1980.

**These figures have been adjusted to reflect the fact that the High School and Beyond survey inquired only about the final three years of high school and that essentially all California students take at least one mathematics course. Thus, the values have been reduced by one year.

One direct comparison of specific coursetaking is available from High School and Beyond. This involves the specific courses in college preparatory mathematics and science, which are precursors of the College Entrance Examination Board's achievement tests. Table 79 exhibits the percentage of seniors who have enrolled in these courses in California, New York, and the nation. The table indicates great similarity between California and the nation for mathematics but a small systematic deficit for California in science. Comparisons with New York, however, confirm the previous conclusion based on achievement test data: New York seniors are substantially better prepared in mathematics; fully twice as many students, proportionately, take trigonometry (53 percent) and calculus (16 percent). Science is similar: Twice as many students enroll in physics, and 40 percent more enroll in chemistry. This is truly a striking confirmation of the achievement differences.

College-bound seniors. Of special interest is the coursework of college-bound students, who compose about one-fourth of the relevant age population in California as well as in the United States as a whole. A comparison of coursework of California college-bound seniors to that of college-bound seniors nationwide is shown in Table 80. California college freshmen of 1983 tended to have less coursework than college freshmen nationwide for all core subject areas. On the whole, the latest year's comparison of coursework in English,

Table 79
Percent of 1980 Seniors Reporting
Enrollment in Advanced Science and Mathematics Courses

Course	California	New York	Nation
Algebra I	81	86	79
Algebra II	50	59	49
Geometry	59	68	56
Trigonometry	25	53	26
Calculus	8	16	8
Physics	17	36	19
Chemistry	33	55	37

SOURCE: These data were prepared by Penny A. Sebring, School of Education, Northwestern University, 1983, from High School and Beyond data.

mathematics, and foreign language looks more favorable in California than it has in previous years. In physical science, however, only 43 percent of California's college-bound seniors report taking two or more years of physical science as compared to 61 percent of college-bound seniors nationwide.

Since coursework in mathematics and science is almost always prerequisite to achievement in these areas, the lighter course loads of students in California are significant. California college-bound seniors take significantly less coursework in mathematics and science (chemistry, physics, biology) than do college-bound seniors in the United States as a whole (Table 81). We note also that New York generally exceeds the national average, but here we must keep in mind that these data for New York represent 45 percent of an age group as compared to only about 25 percent for California and the nation. This means that--relative to the total numbers of students--almost twice as many New York as California seniors complete these levels of coursework.

Coursetaking in Mathematics and Science

Table 82 presents the percent of students in grades nine through twelve enrolled in mathematics courses over the past three school years.[7] The trend is encouraging. Enrollment in general and remedial mathematics courses declined by 8 percent between 1980-81 and 1982-83, and college-preparatory mathematics course enrollments increased during the same period by 11 percent (Table 82). The enrollment increase in college-preparatory courses occurred only last year and mainly in algebra.

[7] Each October for the last three years, each California teacher has completed a Professional Assignment Information Form as part of the statewide information collection system known as the California Basic Educational Data System (CBEDS). On this form the teachers indicated the number of students in each course they teach.

Table 80

Coursework Levels of College-Bound Seniors in California and the Nation, 1973-83

Years of study	Percent of seniors with course level, by year										
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
English 4 or more years											
California	72	69	68	67	69	73	78	81	88	90	91
Nation	90	90	89	88	89	90	91	91	92	93	93
Difference	-18	-21	-21	-21	-21	-17	-13	-10	- 4	- 3	- 2
Mathematics 4 or more years											
California	35	35	34	36	37	38	42	45	47	51	55
Nation	49	48	49	51	50	53	55	57	59	61	64
Difference	-14	-13	-15	-15	-13	-15	-13	-12	-12	-10	- 9
Foreign language 3 or more years											
California	40	37	34	33	32	32	33	34	34	38	38
Nation	44	43	41	39	37	38	37	37	37	39	39
Difference	- 4	- 6	- 7	- 6	- 5	- 6	- 4	- 4	- 4	- 1	- 1
Physical science 2 or more years											
California	31	36	39	40	37	37	39	40	40	41	43
Nation	47	48	49	50	54	57	58	58	58	60	61
Difference	-16	-12	-10	-10	-10	-20	-19	-18	-18	-19	-18

SOURCE: The College Entrance Examination Board's reports on college-bound seniors

Enrollments in science courses also show a significant increase in the 1982-83 school year as compared to the two prior years (Table 82). Especially, general science courses have benefited from the recent focus on science: Course enrollment increased by 11 percent over a two-year period. College-preparatory science courses have experienced enrollment increases of percent during the same period. Note that these increases occurred in chemistry and physics only.

Table 81

Mean Years of Coursework in Academic Subjects for College-Bound Seniors, California, New York, and the Nation, 1982 and 1983

Subject area	California 1982	California 1983	New York 1982	Nation 1982	Nation 1983
English	4.0	4.0	4.0	4.0	4.0
Mathematics	3.4	3.5	3.5	3.6	3.6
Science	2.7	2.7	3.3	3.2	3.3
Social studies	3.2	3.2	3.6	3.2	3.2
Foreign language	2.3	2.3	2.5	2.2	2.2

SOURCE: The College Entrance Examination Board's reports on college-bound seniors

Table 82

Mathematics and Science Enrollment as Percents of Total Enrollment in California Schools, by Type of Course, 1980-81 Through 1982-83

Course topic	1980-81	1981-82	1982-83	1980-81 through 1982-83 Difference	1980-81 through 1982-83 Percent change
Mathematics					
General/remedial	32.0	28.8	29.4	-2.6	- 8
College-preparatory	38.4	28.7	43.1	+4.7	+11
Beginning algebra	18.8	18.8	20.9		
Plane geometry	9.0	9.1	9.8		
Intermediate algebra	4.1	4.2	5.1		
Precalculus advanced topics	5.9	5.8	6.3		
Calculus	0.6	0.8	1.0		
Other courses	8.3	9.9	10.0	+1.3	+20
Total	78.7	77.4	82.5	+3.8	+ 5
Science					
General	17.0	17.2	18.8	+1.8	+11
College-preparatory	22.7	22.4	23.3	+0.6	+ 3
Biology	16.0	15.5	15.9		
Chemistry	4.7	4.8	5.2		
Physics	2.0	2.2	2.3		
Advanced courses	1.4	1.3	1.3		
Other courses	6.6	6.8	7.7	+1.1	+17
Total	46.3	46.4	49.8	+3.5	+ 8

SOURCE: California Basic Educational Data System (CBEDS)

Timing of coursetaking. CAP's 1982-83 survey of mathematics and science coursetaking produced information about the completion of specific courses in each semester from grades eight through twelve.[8] Courses are categorized in both areas into two groups: college-preparatory and any other, or general. At different points in this report, we display summary figures for these subdivisions and for total coursetaking in each area. For science, college-preparatory courses consist of biology, chemistry, and physics. For mathematics, they are algebra (all levels), geometry, trigonometry, and advanced topics.

The timing of coursetaking is exhibited in Tables 83, 84, and 85. First, we see that the majority of 1982-83 seniors took science only in grade ten, and even at this grade only 59 percent were enrolled in science during the second semester. General science is primarily taken in grades eight and nine, and college-preparatory courses are rare in those grades. These science courses are mostly taken in grades ten through twelve, with biology, chemistry, and physics taken primarily in grades ten, eleven, and twelve, respectively (Table 84). As can be seen below, the major falloff over grades is due to smaller proportions

Table 83

Percent of Students Taking Mathematics and Science Courses in Grades 8-12, by Grade and Semester

		No coursework		Some coursework			
				Any coursework		College-preparatory	
Grade	Semester	Mathematics	Science	Mathematics	Science	Mathematics	Science
8	First	46	51	54	49	13	4
	Second	36	46	64	54	17	3
9	First	34	56	66	44	47	8
	Second	21	55	79	45	55	8
10	First	36	44	64	56	52	36
	Second	30	41	70	59	57	40
11	First	50	57	50	43	43	30
	Second	47	53	53	47	46	33
12	First	73	75	27	25	23	16
	Second	87	88	13	12	12	8
Total							
Grades 8-12		2	3	98	97	82	70
Grades 9-12		3	4	97	96	81	69

SOURCE: CAP data, 1982-83

[8] These data were collected by asking each twelfth grader to respond about taking specific courses in each semester of grades eight through twelve. We believe that this results in more accurate data than merely recording summary years and coursework.

Table 84

Percent of Students Taking Science Courses, by
Grade and Semester and Total Years of Science, Grades 8-12

		General/other					College-preparatory				
Grade	Semester	Life	Physical	Earth	Other	Total	Biology	Chemistry	Physics	Total	Total
8	First	30	9	4	2	45	2	1	1	4	49
	Second	30	13	5	2	50	2	1	1	4	54
9	First	16	12	5	3	36	6	1	1	8	44
	Second	14	14	5	3	37	6	1	1	8	45
10	First	9	5	3	3	20	32	3	1	36	56
	Second	8	5	3	3	19	36	3	1	40	59
11	First	4	3	2	4	13	14	14	2	30	43
	Second	4	3	2	5	14	15	15	3	33	47
12	First	2	2	1	4	9	4	6	6	16	25
	Second	1	1	-	2	4	2	3	3	8	12

SOURCE: CAP data, 1982-83

Table 85

Percent of Students Taking Mathematics Courses, by
Grade and Semester and Total Years of Mathematics, Grades 8-12

			College-preparatory						
Grade	Semester	General	Beginning algebra	Plane geometry	Inter. algebra	Trigonometry	Advanced topics	Total	Total
8	First	41	12	-	1	-	-	13	54
	Second	47	15	1	1	-	-	17	64
9	First	21	37	6	4	-	-	47	68
	Second	24	43	7	5	-	-	55	79
10	First	12	18	22	10	1	1	52	64
	Second	13	18	25	11	2	1	57	70
11	First	7	6	12	16	6	3	43	50
	Second	7	6	13	16	7	4	46	53
12	First	4	2	4	5	6	6	23	27
	Second	1	1	2	3	2	4	12	13

SOURCE: CAP data, 1982-83

of students enrolling in the more mathematically stringent courses. However, the extremely small enrollment rates for grade twelve, especially in the second semester, indicate major reduction in academic coursetaking for these seniors in grade twelve. Because this reduction is paralleled for mathematics (Tables 83 and 85), it reveals a serious point of concern. Finally, for science, we note that only 4 percent of these seniors did not take any science in grades nine through twelve and that almost 70 percent took at least one semester of college-preparatory science.

The picture for mathematics is more diverse. Algebra is started by some students before ninth grade and is still taken by significant numbers of students in eleventh grade (Table 85). Plane geometry is taken mostly in grades ten and eleven. Intermediate algebra has its highest enrollment rates in grades ten and eleven, and trigonometry and advanced topics are primarily taken in grades eleven and twelve. General mathematics courses are common for students in each of grades eight, nine, ten, and eleven. Again, there is a severe dropoff in mathematics coursetaking in the senior year and especially in the final semester. During the last four years of high school, only 3 percent of students did not take any mathematics, and over 80 percent took at least one semester of college-preparatory work.

College-preparatory versus general. In Tables 86 and 87, we display the pattern of coursetaking--college-preparatory vs. general mathematics and science

Table 86

Percent of Seniors Taking Varying Numbers of Semesters of College-Preparatory Versus Other Science, Grades 9-12

Semesters of college-preparatory coursework		Semesters of other science coursework: 0	1	2	3	4+		Total percent college-preparatory
0	Less than 2 semesters---->	4	6	14	3	4		31
1	(15%)	5	5	3	1	1	4 or more	15
2		14	4	9	1	2	<---semesters (40%)	30
3		2	1	2	0	1		6
4+		8	1	6	1	2		18
Total percent other		33	17	34	6	10		100

2-3 semesters (45%)

Table 87

Percent of Seniors Taking Varying Numbers of Semesters of College-Preparatory Versus General Mathematics, Grades 9-12

2-3 semesters (49%)

Semesters of college-preparatory coursework		Semesters of general mathematics coursework: 0	1	2	3	4		Total percent college-preparatory	
0	Less than 2 semesters----->	3	4	5	2	5	4 to 5 <---semesters	19	
1	(10%)	3	3	2	1	1	(31%)	10	
2		8	3	4	1	1		17	
3		6	1	1	-	-		8	
4		12	1	3	-	-	6 or more <---semesters	16	
5		4	-	1	-	-	(30%)	5	
6		13	-	1	-	-		14	--46
7		5	-	-	-	-		5	
8*		6	-	-	-	-		6	
Total percent general		60	12	17	4	7		100	

for 1982-83 seniors. In science only 4 percent take no courses at all. Twenty-seven percent--the total for row 1 (31 percent) minus the percentage of those taking no courses (4 percent)--take only general science; 29 percent--the total for column 1 (33 percent) minus the percentage of those taking no courses (4 percent)--take only college-preparatory courses. Forty percent take both types of courses--all students (100 percent) minus the percentage of those who take only general science (27 percent) minus those who take only college-preparatory courses (29 percent) minus those who take no courses (4 percent). In total, only 18 percent of students accumulate two or more years of college-preparatory science. Only 40 percent meet the new 1986-87 requirement of two full years of any kind of science.

Mathematics presents a more differentiated picture (Table 87). Three percent of all seniors graduate with no mathematics courses in grades nine through twelve. Fifty-seven percent take only college-preparatory courses, and 16 percent take only general mathematics. This leaves only 24 percent with general and college-preparatory coursework, a clearer tracking than for science.

Fully 46 percent of seniors take two or more years of college-preparatory mathematics, and 61 percent meet the new two-year requirements of total mathematics coursetaking, which includes general and college-preparatory coursework (30 percent plus 31 percent).

Achievement and Coursetaking in Mathematics

If we recall that the CAP mathematics test covers content which is taught primarily in pre-high school mathematics courses, then we expect smaller relations between mathematics coursetaking and achievement than would be obtained with a test focused directly on the content of high school-level courses. To alleviate this problem, we have selected three items from the instruments which focus specifically on high school-level college-preparatory content. Item A is an algebra problem requiring the symbolic addition of reciprocal fractions. This content would ordinarily be covered in the second or third semester of algebra, depending on the text used.

A. $\frac{1}{x} + \frac{1}{y} =$

[ ] $\frac{2}{x + y}$ [ ] $\frac{1}{xy}$

[ ] $\frac{2}{xy}$ [X] $\frac{x + y}{xy}$

Item B is an algebra substitution item involving two quantities. This item content should be covered in the first year of algebra.

B. The number of feet that an object will fall in t seconds (neglecting air resistance) is given by the formula $s = 1/2\ gt^2$, where s = the number of feet, and g = 32 (the acceleration due to gravity). Assuming there is no air resistance, how far will a parachutist drop in a free fall of 10 seconds?

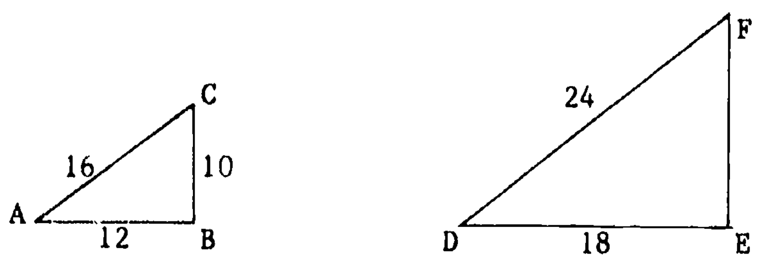
[X] 1,600 feet [ ] 3,400 feet

[ ] 2,440 feet [ ] None of these

[ ] 3,200 feet

Finally, Item C is a geometry item comparing two similar triangles and requiring the calculation of the length of one side.

C.



In Item C, $\triangle$ ABC is similar to $\triangle$ DEF. How many units are there in the length of side EF?

[ ] 12   [X] 15   [ ] 16   [ ] 20   [ ] None of these

This item should be covered in the first semester of a geometry course.

The content of each of these items should be mastered by the third semester (A), first year (B), and second year (C) of college-preparatory mathematics, respectively. As shown on Table 88, of individuals with three full years of college-preparatory work, only 43 percent solved Item A. Of those with one year, only 36 percent solved Item B, and of those with two years, only 31 percent solved Item C. We also see that after four full years of college-preparatory mathematics, only 67 percent of seniors can solve the problem requiring symbolic addition of reciprocals, only 88 percent can solve the simple first-year algebra substitution item, and only 65 percent can solve the geometry problem.

The bottom line of Table 88 exhibits the mean performance on all of the CAP mathematics items for students with various amounts of college-preparatory mathematics. As can be seen, there is a steady increase in performance with increased coursetaking. This is partly due to coverage of more advanced topics which simultaneously reinforces earlier content, but it is also due to the fact that students who advance to the higher levels of mathematics coursetaking have already had greater mastery of the more elementary content.

Graduation Requirements

The new California course requirements for high school graduation, to take effect in the 1986-87 school year, reflect a new consensus on the quality of California education. The data thus far presented in this report surely undergird that consensus. As California has dropped from a position of leadership to below average, the national average has also fallen. Thus, the new educational reform in California immediately preceded a series of reports that recommend important changes in the national educational system:

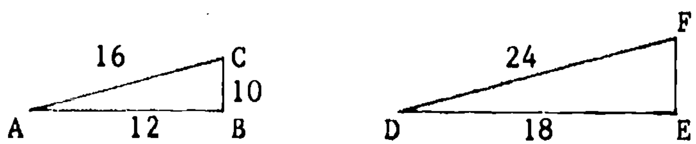
<u>A Nation at Risk</u> (National Commission on Excellence in Education, 1983)
<u>High School: A Report on Secondary Education in America</u> (Boyer, 1983)
<u>Educating Americans for the 21st Century</u> (National Science Board, 1983)

Additionally, the California State Board of Education has recommended that school districts adopt a set of requirements more stringent than the legislated ones. Also, the Board of Regents in New York--which has more direct control over districts than the California board--has proposed revisions to graduation standards, both for the ordinary and the regents' diploma.

Although other states and other reports (e.g., Adler, 1982) have addressed these issues, in this section we will concentrate on two goals: (1) to compare the California efforts to other efforts; and (2) to assess how current California seniors measure up to the standards in the reform legislation and the State Board of Education's model.

Table 88

Mathematics Achievement of Students with Varying Amounts of Mathematics Coursework

Achievement indicator	Number of semesters of college-preparatory courses 0	1	2	3	4	5	6	7	8	Total	Percent increase/ semester
Item											
A. $\frac{1}{x} + \frac{1}{y} =$ [ ] $\frac{2}{x+y}$ [ ] $\frac{1}{xy}$ [ ] $\frac{2}{xy}$ [X] $\frac{x+y}{xy}$	2.5	2.8	5.6	18.0	18.7	31.1	43.1	64.2	67.1	21.9	8.1
B. The number of feet that an object will fall in t seconds (neglecting air resistance) is given by the formula $s = 1/2\ gt^2$, where s = the number of feet, and g = 32 (the acceleration due to gravity). Assuming there is no air resistance, how far will a parachutist drop in a free fall of 10 seconds? [X] 1,600 feet [ ] 3,400 feet [ ] 2,440 feet [ ] None of these [ ] 3,200 feet	19.0	25.2	35.8	51.2	55.6	66.7	69.2	88.7	88.2	50.2	8.7
C.  In the figure above, △ ABC is similar to △ DEF. How many units are there in the length of side EF? [ ] 12 [X] 15 [ ] 16 [ ] 20 [ ] None of these	11.5	13.4	17.8	27.5	30.8	36.1	51.7	62.5	64.8	30.4	6.7
Total mathematics mean	50.3	57.9	63.3	69.5	71.9	75.2	80.0	84.1	84.7	67.7	4.3

In Table 89 we display some of the new graduation course requirements. All specify the last four years of high school as the time span for meeting the standards. The table first exhibits the new California Reform Act and the model graduation requirements (Raising Expectations, California State Board of Education, 1983). Next are the newly proposed graduation requirements of ordinary and regents' diplomas in New York. Then we record the requirements advanced in the A Nation at Risk report.

In the second half of the table, we contrast the state requirements/recommendations with those in A Nation at Risk. We note that the requirements in the new legislation--while marking a large shift from no requirements at all--are the weakest of all those exhibited. The legislation mandates three years of English instead of four; two years of mathematics instead of three; two years of science instead of three; and no computer studies. Only in the area of social science (three years) does the legislation match the report's recommendations.

The State Board model compares more favorably. The only negative contrast is in science, where--in quantitative terms--the model matches the legislation. In content, however, as we will see below, it is more stringent. Finally, the California State Board's model does address foreign language instruction, with two years recommended. Also, the recommendations in the model match the A Nation at Risk report in specifying a semester of computer studies.

Table 89

Graduation Requirements in California and New York
Compared to Those of A Nation at Risk

						Difference to A Nation at Risk			
	California		New York[c]			California		New York	
Subject area	Legislation	State Bd. model	Non-regents	Regents[b]	Nation at Risk	Legislation	State Bd. model	Nonregents	Regents
English	3	4	4	4	4	-1	0	0	0
Mathematics	2	3	2	3	3	-1	0	-1	0
Science	2	2	2	4	3	-1	-1	-1	+1
Social science	3	3	4	4	3	0	0	+1	+1
Foreign language	0	2	a	3	0[d]	0	+2	a	+3
Computer studies	0	1/2	0	0	1/2	-1/2	0	- 1/2	- 1/2

[a]New York requires foreign language proficiency, confirmed by an examination.

[b]The New York Regents' diploma requires passage of a Regents' examination, in addition to course requirements.

[c]These requirements are due for final approval in the spring of 1984.

[d]The A Nation at Risk report "strongly recommends" two years of foreign language for college-preparatory students.

The New York requirements--for a regular high school diploma--are slightly more stringent than California's: one more year of English and the same amounts of mathematics and science. However, New York requires an additional year of social science and foreign language proficiency--validated by a test. New York's Regents' diploma is--by far--the most stringent. It equals or surpasses the A Nation at Risk report in all areas but computer studies, requiring four full years of science and three of foreign language.

Recently, data have become available--for the nation as a whole and selected states--on the proportion of 1982 high school graduates who have met the various graduation course requirements specified in A Nation at Risk. These data (How Well Do High School Graduates of Today Meet the Curriculum Standards of the National Commission on Excellence? 1983) derive from analyses of the high school transcripts of 1982 seniors who are participating in the High School and Beyond longitudinal study (National Center for Education Statistics, 1981). The data are presented in Table 90. The percents of 1982 high school graduates meeting each requirement are exhibited for California, New York, and the nation as a whole. California is approximately comparable to the nation in most curricular areas except science, where only 17 percent of graduates meet the three-year requirement (compared to 52 percent nationwide). In contrast with New York, however, California falls short in every area, but most greatly in English, social studies, and science.

Table 90

Percent of 1982 High School Graduates Who Met Graduation Requirements Specified in A Nation at Risk

Requirement	Subject area	Coursework required	California	New York	Nation
Separately					
	English	4 years	48	72	59
	Social studies	3 years	67	92	65
	Mathematics	3 years	43	55	46
	Science	3 years	17	52	30
	Computer science	1/2 year	11	20	13
Simultaneously					
	All		1	9	3
	All but computer science		5	29	13

SOURCE: These figures are based on an analysis of transcripts of 1982 high school graduates. These transcripts were obtained as a part of the ongoing High School and Beyond study of 1980 and 1982 graduates conducted by the National Center for Education Statistics, U.S. Department of Education.

If we focus on the percentage of graduates who meet all the A Nation at Risk recommendations simultaneously, the results are even more striking: Only 3 percent of the 1982 graduates in the U.S. met them and only 1 percent of

California graduates do so. New York fares better with 9 percent. If we disregard the computer science requirement, the results may be more meaningful because this part of the curriculum was not as fully developed in the period from 1978 to 1982, when these graduates were studying. With this requirement removed, the figures are:

California	5%
New York	29%
Nation	13%

This is surely unsatisfactory all around, but again New York has the highest level of academic coursetaking.

Because CAP's particular focus in the 1982-83 twelfth grade data collection was mathematics and science, we now turn to a systematic content and quantity comparison of the California requirements with those of all the major reports (Table 91). First we note that the State Board's recommendations specify that students take three full-year courses in mathematics, two of which must be algebra and geometry, thus extending minimal college-preparatory coursework to all students. We also note that the A Nation at Risk report has no course content specifications. The Carnegie Foundation-sponsored High School (Boyer, 1983) report also omits specification of content in the formal requirements. The National Science Board's 21st Century report is most detailed and stringent in this area. It specifies three years of both science and mathematics--including algebra--for all students; for the college-bound it would require both physics and chemistry within four years of science, and two years of algebra within four years of mathematics. It further specifies for all students a semester of computer science to be included in the science coursework. The report is notable for explicitly recommending that plane geometry not consume a full year's work.

How well do current California students satisfy these mathematics and science requirements (Table 91)? Only 40 percent of 1982-83 California seniors satisfy the new requirements of two or more years of science (Table 86); 61 percent satisfy the parallel mathematics requirements (Table 87). If we apply the more stringent recommendations for graduation given by the California State Board, considerably fewer of all 1982-83 California high school seniors would be qualified to graduate.

Placing California students in the context of the three major national reports presents a more varied picture:

- A Nation at Risk. Only 15 percent of 1982-83 California high school seniors meet the science requirement, and 33 percent fulfill the mathematics requirement.

- High School (Carnegie). Forty percent of 1982-83 California high school seniors fulfill the science requirements, and 61 percent satisfy the mathematics requirements. Note that in these areas the report matches the new California legislation.

- Educating Americans for the 21st Century. A CAP comparison of mathematics and science coursetaking in California with the National Science

Board's suggested requirements showed that 21 percent of 1982-83 California high school seniors meet the specified science requirement, and 32 percent fulfill the mathematics requirement.

It is important to observe that the California science requirements are substantially weaker than those recommended in two of the reports. The discrepancies are especially large when we compare science and mathematics coursework of 1982-83 California high school seniors to the requirements that are specified by the National Science Board: Only 5 percent of California seniors presently meet those science requirements and merely 1 percent meet the mathematics requirement. These proportions are far below those of California high school seniors who presently enter college. Although the State of California is mounting a great effort in increasing students' skills and knowledge in mathematics and science, the recent legislation might be only the first overdue step.

Table 91

Percent of 1982-83 California High School Seniors Meeting Various Legislated and Proposed Mathematics and Science Graduation Requirements

Requirements	Science requirements	Mathematics requirements
California, Legislated and Proposed Legislated (1987 and after)	40	61
Proposed		
California State Board Model Requirements	40	30
National, Proposed		
Requirements for all students		
A Nation at Risk	15	33
Carnegie	40	61
National Science Board	21	32
Requirements for college-bound students		
National Science Board	5	1

Ways to Increase Student Achievement

Once it has been decided what students are to learn, there are four ways to increase student achievement, the first three of which depend on increasing active learning time:

1. Increase the time allocated to instruction.

2. Increase the proportion of allocated instructional time actually devoted to instruction.

3. Increase the proportion of time devoted to instruction that students spend actively learning.

4. Reduce the time needed for learning.

Presented below are some suggestions that should be addressed in policy discussions related to improving student achievement.

Increasing the Amount of Time Available

The time allocated to instruction can be increased in three ways:

- Lengthening the school day and/or school year
- Reallocating instructional time
- Increasing homework assignments

Lengthening the school day and/or school year. Since California students are offered considerably less schooling than students nationwide, lengthening the school day and the school year seems an appropriate strategy for increasing student achievement. By passing the new Educational Reform Act, the Legislature has encouraged this strategy. As long as procedures are implemented to ensure that the additional time is used to increase the amounts of time devoted to learning activities, this method may be extremely effective. However, as we noted above, even full implementation of these instructional time targets would result in total instructional time in California still short of the national average. Perhaps additional measures, especially those that reduce the time needed for learning, should be considered.

Reallocating instructional time. Another way to increase allocated learning time is through reallocation. In elementary schools, where individual teachers usually plan their own activities in self-contained classrooms, reallocating instructional time implies either external control or consensus on priority learning areas. All available evidence points to wide variations in teacher priorities, even within a single elementary school. One possibility would be to increase the degree of departmentalization in elementary schools, including lowering the grade levels for which it is the mode of instructional organization. In secondary schools this could occur through elimination of electives or by reinstituting or expanding required courses. These actions result in reallocations from low- to high-priority learning activities and subject areas.

Surely, the newly legislated high school graduation standards will accomplish a much needed reallocation to priority academic subject areas, especially in schools which do not increase total instructional time. Again, however, the question must be raised about whether this is sufficient. Even the new California requirements will not match New York's new standards in English and social science. And merely meeting the new minimums will leave a considerable gap between the coursetaking of California high school students and those in New York, especially in college-preparatory mathematics and science. Additional action may be called for, particularly for college-bound students.

Increasing homework assignments. Increasing homework assignments can be very effective in improving student achievement. One way to increase achievement for all students would be to extend the school day with a homework period. Another might incorporate pare. . . "sign-off" on homework assignments.

Increasing the Proportion of Time Devoted to Instruction

All the time nominally allocated for instructional activities is not actually used for instruction. Some of this loss of time from subject matter instruction is a result of explicit policy--e.g., fire drills or schoolwide assemblies and transitions between one classroom activity and another. However, much lost time can be avoided.

Time accounting studies of elementary school classrooms have found variations of 50 to 90 percent in the portion of total allocated time actually devoted to instruction. Much of the loss results from poor management of student activities: excessive transition time between activities, poorly handled recesses and breaks, pullout activities that are disruptive or that increase transition time, and subgroup and seatwork activities that take too long to establish. Also, in many classrooms, schedules are not met or activities involving more than one teacher are poorly coordinated. All these problems result in losses of precious instructional time in elementary schools.

Secondary schools, because of the period structure and departmentalized organization, are less prone to losses of this type, but issues do arise about the length of period transitions and how related rules are enforced. More effort devoted to identification of such problems and formulation of appropriate school policies or in-service training efforts would be worthwhile. The following steps should be considered:

- o Review pullout programs to determine the difference between allocated instructional time and time actually devoted to instruction.

- o Increase teachers' classroom management skills. Teacher training institutions need to put more emphasis on developing such skills.

- o Evaluate school schedules (e.g., length of period, recess, lunch) to determine how much time scheduled for instruction is lost.

- o Other steps might focus on:
  - -- Increasing attendance and reducing tardiness through clear and consistent school policies
  - -- Reducing discipline problems by the use of firm codes and alternative programs for the chronically disruptive
  - -- Lightening teachers' administrative burdens

Increasing the Proportion of Time Spent Actively Learning

The clearest message from the research on active learning time is that active learning is fostered by teacher-student contact and interchange. Unsupervised learning activities have uniformly lower levels of active learning time. Small-group instruction and, to an even greater extent, tutorial instruction increase students' active learning time. This increase is most pronounced among students who have low achievement or motivation levels, such as educationally disadvantaged students.

The problem with routinely implementing changes based on this finding is one of resources. In many classrooms, lower student-teacher ratios could be achieved by reducing the size of supervised instructional groups, thereby increasing student-teacher contact time. In self-contained classrooms, without additional resources, there is a trade-off: When some students are tutored or taught in small groups, others are necessarily unsupervised. Thus, the critical issue--with resources being constant--is the trade-off between (a) large-group instruction accompanied by little unsupervised work; and (b) small-group/tutored instruction accompanied by considerable amounts of unsupervised, student-managed activity. The best evidence available is that reducing unsupervised time, even at the cost of increasing the total amount of large-group instruction, is appropriate, especially with students who have low levels of learning motivation and self-discipline and who are poorly prepared for academic work. It is recommended that school personnel:

- o Review the grouping strategies that are routinely used in elementary schools and that are encouraged by textbooks and workbooks. Minimizing subgrouping, and thereby unsupervised seatwork, should be primary goals.
- o Evaluate the use of aides in classrooms; using qualified aides is an effective way to increase direct instruction for students.

Reducing the Amount of Time Needed to Learn

Instruction can be made more effective in many ways, and effectiv instruction in turn will reduce the time needed for learning. Two ways deserve attention:

- o Increasing the clarity and communicability of task-related instructions provided by the teacher or in text materials

- Increasing the capabilities of teachers to diagnose students' prior learning, to sequence the instructional tasks, and to keep the students working at a satisfying but challenging pace

First, clear explanations and communication are the keys to decreasing the time students need to master or complete a task. This is especially true for students from low socioeconomic backgrounds. These students are especially affected by inappropriate and unclear explanations and verbal communications, whether they emanate from teachers, textbooks, or other instructional materials. The more capable students and those from higher socioeconomic backgrounds are more likely to be able, by themselves, to "fill in" or substitute for incomplete or insufficiently communicated instruction.

Second, teachers need to consider students' abilities and prior learning in arranging learning tasks for them and estimating the time needed for learning. The time needed for learning is unnecessarily increased if teachers incorrectly assume specific prior learning for a task or if they allocate time to tasks that students have already mastered.

Staff development efforts should address these issues. Also, textbooks and workbooks should be more carefully screened and pretested with particular types of students. Teachers should be taught to use diagnostic instruments more extensively for assessing students' prior learning. At best, improving teachers' abilities to communicate is difficult, because communication skills are learned over long periods early in one's life. Improved teacher recruitment and selection may be the only long-term solutions certain to bring about significant improvement in communication skills.

In addition to modifying instructional materials and strategies, time needed for learning can be reduced by enhancing student study skills. If students can learn effective ways to organize their study time, to draw upon library and reference resources, and to request help when it is actually needed, the total time needed to master school learning tasks is lessened. It is recommended that school personnel:

- Evaluate textbooks and workbooks for clarity of instruction.

- Make greater use of diagnosis to ensure improved pacing and increased challenge of students.

- Focus instruction on building effective study skills and efficient and appropriate use of learning resources.

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Appendix
Assessment Advisory Committees

Listed below are the members of the Reading Assessment Advisory Committee, English Language Assessment Advisory Committee, and the Mathematics Assessment Advisory Committee, who were instrumental in the review and analysis of the 1982-83 findings.

Reading Assessment Advisory Committee

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