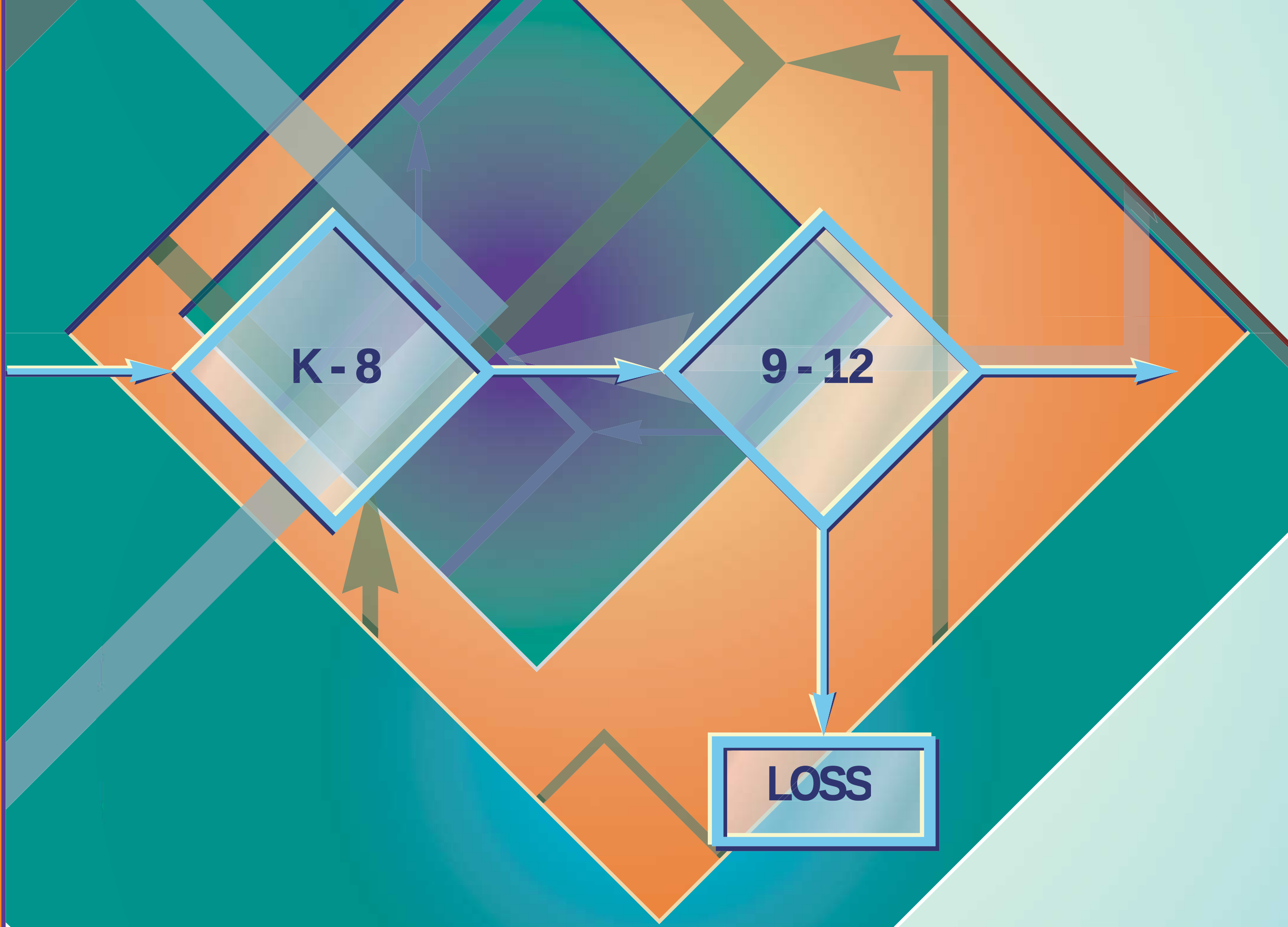
Critical Path Analysis of California's S&T Education System:

California's K-12 Sector

Julian R. Betts

February 2002



CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY

California's K-12 Sector

A Report Prepared for

The California Council on Science and Technology

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February 2002

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The California Council on Science and Technology is a nonprofit organization established in 1988 at the request of the California State Government and sponsored by the major post secondary institutions of California, in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and recommending policies and initiatives that will maintain California's technological leadership and a vigorous economy.

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1. INTRODUCTION

In 2000, the California Council on Science and Technology (CCST) initiated the project "Critical Path Analysis of California's S&T Education System" in the belief that California may not be doing enough to supply an adequate number of highly trained workers to the state's economy.

Evidence from a number of sources suggests that California may indeed be falling short in educating its youth. For example, Betts (2000) estimates that between 1970 and 1990, California's universities produced roughly 53% of the net growth in college-educated adults during this period. This number is surprisingly small. To see why, suppose (incorrectly) that in the nation as a whole, colleges had produced only 53% of the net growth in the number of college educated adults over the same period. The only way that the country as a whole could have bridged this gap is if, in the long run, one out of every two college graduates in the United States was an immigrant. This does not come even close to the truth. For instance, even in immigrant-rich California, in 1990 only about one in five adults with a bachelor's degree or higher was an immigrant (Betts, 2000). Clearly, California is unlike other states in the sense that it imports unusually large numbers of college graduates from elsewhere. In particular, California "imports" large numbers of college-educated workers from other states.

This finding raises serious questions about the education provided to natives born in California, from the earliest stages of public school through university. To illustrate the problem more clearly, Figure 1.1 shows the breakdown of California's adult population between immigrants, natives born in California and natives born in other states, for various education levels. The figure makes clear that natives born elsewhere are unusually well represented in the college-educated levels, while natives born in California are most strongly represented at the "some college" level. (Immigrants are most strongly represented among high school dropouts.) To be sure, some of the natives born in other states who hold college degrees probably obtained their degrees after moving to California. The same holds for immigrants. But the figure drives home the idea that adults born in California are not as highly educated as California residents born in other states. This provides direct evidence that California needs to consider very carefully why more California-born adults do not hold college degrees.

Reasonable people can certainly disagree about whether California's reliance on other states and countries for college-educated workers is a good or bad thing. On the one hand, California in a sense gets a "free ride" on the governments of other states and counties, which heavily subsidize education of students, some of whom later come to California. But on the other hand, California places itself at some risk by relying so heavily on out-of-state college graduates. Should California become a less attractive place to live and work relative to other states and countries, California could suddenly face a significant shortage of skilled workers. Such a situation would place California's high-tech businesses at some jeopardy. Given the housing, energy and transportation problems that have afflicted California recently, it would be a serious mistake to take for granted California's continued ability to recruit highly educated adults from elsewhere.

This goal of this CCST project is to study the "critical pathways" through which young Californians obtain college degrees, and subsequently obtain jobs in highly skilled occupations. In light of the above evidence, one important goal of this project must be to find the bottlenecks in the educational pipeline that are preventing more young Californians from obtaining college degrees.

This paper examines the early stages of this pathway: elementary and secondary education. The paper begins with a comparison of California's schools with those in the rest of the nation. Because California lags behind other states in the level of resources that it puts into its public schools, the paper examines evidence on the extent to which California could improve student achievement by spending more on its schools. The paper also documents large resource inequalities across schools. This resource inequality is relevant to the Critical Pathways project because many school students in California may not have an opportunity to attend college due to the lack of resources in the schools that they attend. Another section of the paper documents the alarmingly small percentage of high school students who graduate from high school after completing the set of courses needed to attend either of the state's public university systems. In sum, problems in California's public schools appear to represent an important bottleneck in the state's efforts to increase the number of young people who go on to graduate from college. The paper concludes with a discussion of policies that might be adopted to alleviate this bottleneck.

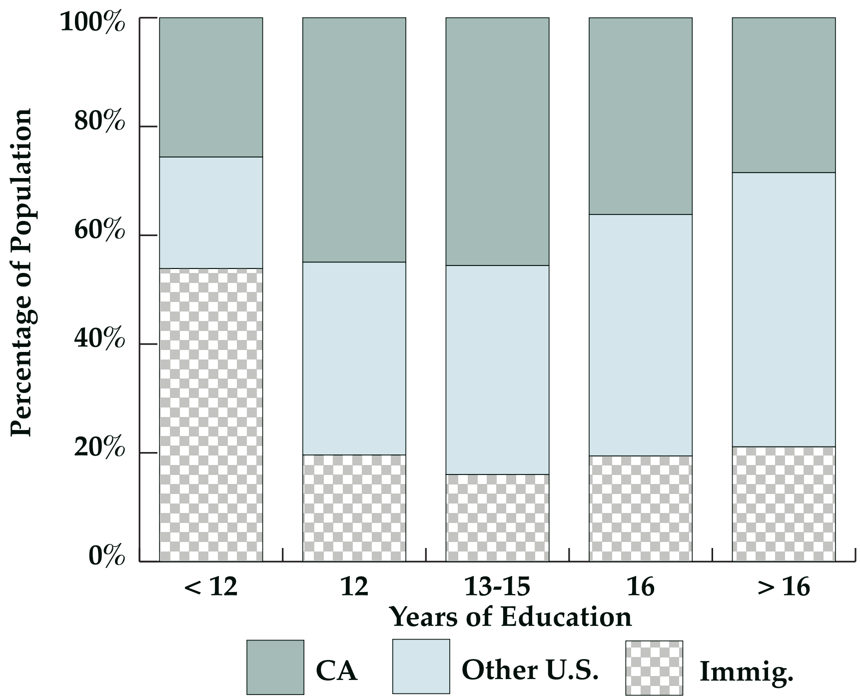


Figure 1.1 -- Sources of California's Adult Population in 1990, Educational, Category and Birthplace

2. A COMPARISON OF TRENDS IN SCHOOL RESOURCES IN CALIFORNIA AND THE UNITED STATES

This section begins the analysis by showing trends over time in the level of school resources in public schools both in California and the United States as a whole. This allows us to examine whether California has improved the quality of school resources over time, and to ask whether California is keeping pace with other states' school systems. Figure 2.1 shows trends in spending per pupil in California and the United States as a whole, adjusted to 1997 prices. Throughout the 1970s California's expenditures per student almost exactly matched the national average. However, beginning in the 1980s the growth rate of spending slowed considerably in California, so that by the mid 1990s the average American school spent about 20% more per pupil than the average school in California. (The appendix includes tables listing the data underlying all of the figures in this section. In addition, the appendix tables compare school resources in California and a selection of eleven other major states that at least in some industries compete with California as centers of "high-tech" employment. Tables beginning with "A" show the relevant numbers, while tables beginning with "B" re-state these numbers as a percentage of the values in California for the given year.)

The low ranking of California spending per pupil compared to that in other states has garnered considerable public attention in California. But at the same time it is crucial to keep in mind that California spends significantly more per pupil now than it did in the 1970s. The increased spending might startle some readers: between 1970 and 1996 real spending per pupil in California increased by just over 50%.

The institutional reasons for the divergence in spending between California and the United States are complex. The Serrano v. Priest court case (1971) placed California at the forefront of the battle to equalize spending per pupil across districts. This California Supreme Court case sparked a series of California state legislation that weakened the link between the property tax rate that local authorities set and the actual revenues received by local government agencies, including school districts. Then, in 1979 Proposition 13 set a strict limit on property taxes, and more importantly, on the rate at which they were allowed to rise. The Proposition effectively removed the ability of local agencies to increase revenues by increasing property taxes. Sonstelie, Brunner and Ardon (2000) argue that the combined effect of these events was to put a severe damper on California's school spending growth throughout the 1980s and 1990s, leading to the gap of roughly 20% in spending per pupil between California and the nation as a whole that emerged by the mid-1990s.

How did this widening gap in expenditures per pupil translate into variations in the school resources that students received between California and the nation? Because teachers' salaries generally account for over half of school expenditures, a logical place to begin our search is teachers. Figure 2.2 shows the average salaries of teachers in California and the United States as a whole. Throughout the 1970s, 1980s and 1990s California's teachers earned considerably more than teachers in the United States as a whole. Of course, this does not necessarily mean that California's teachers are overpaid relative to teachers elsewhere. California has a higher cost of living than most other states, and in general employers in the state pay higher wages than similar employers in other states, in order to attract and retain qualified workers.

To explore this question of interstate variations in the cost of living in more detail, we calculated average annual earnings of all full-time workers holding a bachelor's degree or higher in the United States and California. Are California's teachers better or worse paid relative to this comparison group than teachers in the country as a whole? Table A.2 suggests that the ratio of teachers' salaries in California and the nation as a whole in 1997 was 1.11. For workers strongly attached to the labor market in this period, who held a bachelor's degree or more, the ratio was 1.07. Thus, over half of the wage advantage received by California teachers relative to teachers in the United States as a whole simply reflects variations in earnings of college graduates in these two regions.[1]

Of course, the quality of teaching may depend on the level of education and experience of teachers. Figures 2.3 and 2.4 show that California's teachers have considerably lower levels of education than do teachers in the country as a whole. For instance, Figure 2.3 shows that in 1993 the percentage of teachers holding a bachelor's degree or less was 58.6% compared to just 52.0% in the United States as a whole. In contrast, Figures 2.5 and 2.6 indicate that the percentages of teachers with low and high experience are roughly equivalent between California and the country as a whole.

The message to this point is that California, while spending roughly 50% more than it did per pupil in the 1990s than it did in 1970, has nonetheless slipped behind in spending per pupil relative to the rest of the country. At the same time, teachers earn more in California than elsewhere, in spite of having slightly lower education levels and comparable levels of experience. If California is spending less overall, but pays teachers more, it suggests that California must spend considerably less than other states on items apart from teacher salaries.

An obvious next place to look for spending discrepancies is the pupil-teacher ratio. After all, the total teacher salary bill is the product of average teacher salary and the number of teachers in the state. Figure 2.7 shows that California's pupil-teacher ratio declined only slightly between 1970 and 1997, while in the rest of the country the pupil-teacher ratio dropped considerably, from 22.3 in 1970 to only 16.8 in 1997.[2] Thus, California hires fewer teachers for a given size school, but pays them more than they would earn elsewhere.

In the last four years, California has spent approximately a billion dollars a year to reduce class size in K-3 classrooms to no more than 20 students. Thus, when comparable data for the United States and California become available for 1999 or 2000, a portion of the pupil-teacher gap should have diminished.

There are other categories of resources where a considerable California-United States gap has emerged. Measures of various ancillary academic services suggest that California is falling behind. Figure 2.8 shows that the ratio of pupils to counselors in California by the late 1990s was just over twice as high as in the nation as a whole. This raises serious questions about whether California's students are receiving as good advice on course selection and career preparation as students elsewhere. Figure 2.9 shows the ratio of pupils per instructional aide between 1985 and 1997. At the start of this period California had considerably fewer students per aide than the country as a whole, but by 1997 this advantage had been reversed. Comparisons of physical resources across states are hard to come by. However, Figure 2.10 shows that California has had four to six times as many students per librarian as the country as a whole in the 1990s, which raises questions about whether a similar inequality in books per student exists.

1 Average salaries of those holding a bachelor's or more are calculated from the March 1997 Current Population Survey using the subsample of workers aged 25-60 in 1997 who worked 26 weeks, an average of 20 hours per week and reported positive earnings.

2 The latter pupil-teacher ratio may sound surprisingly low to some readers. However, because teachers typically do not teach all periods in the day in middle and high schools, actual class sizes tend to be higher than the pupil-teacher ratio itself.

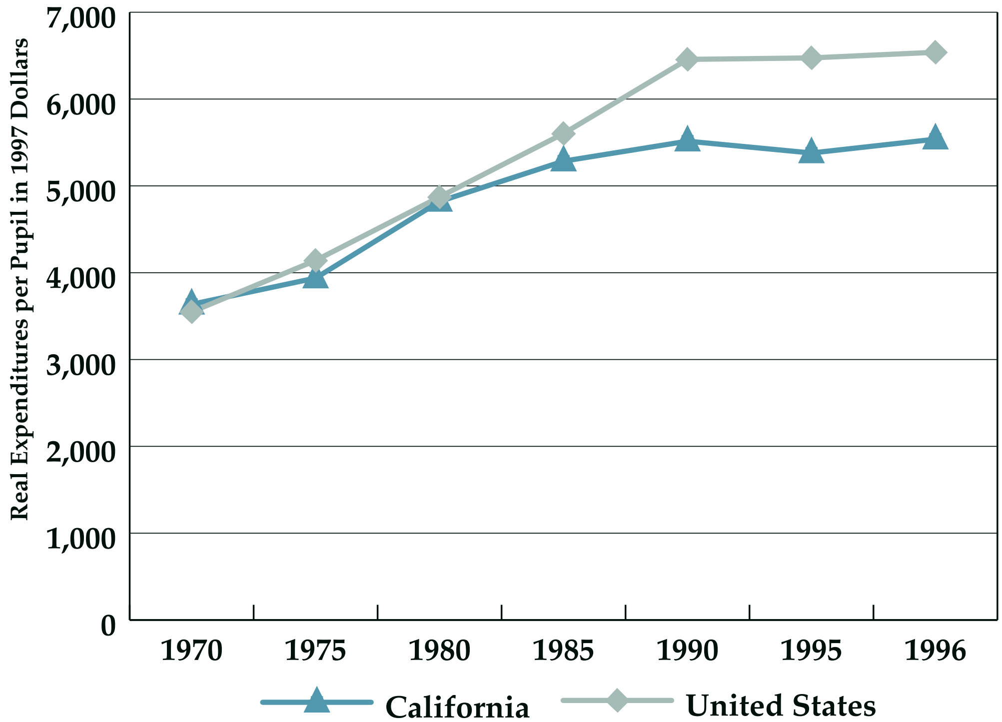
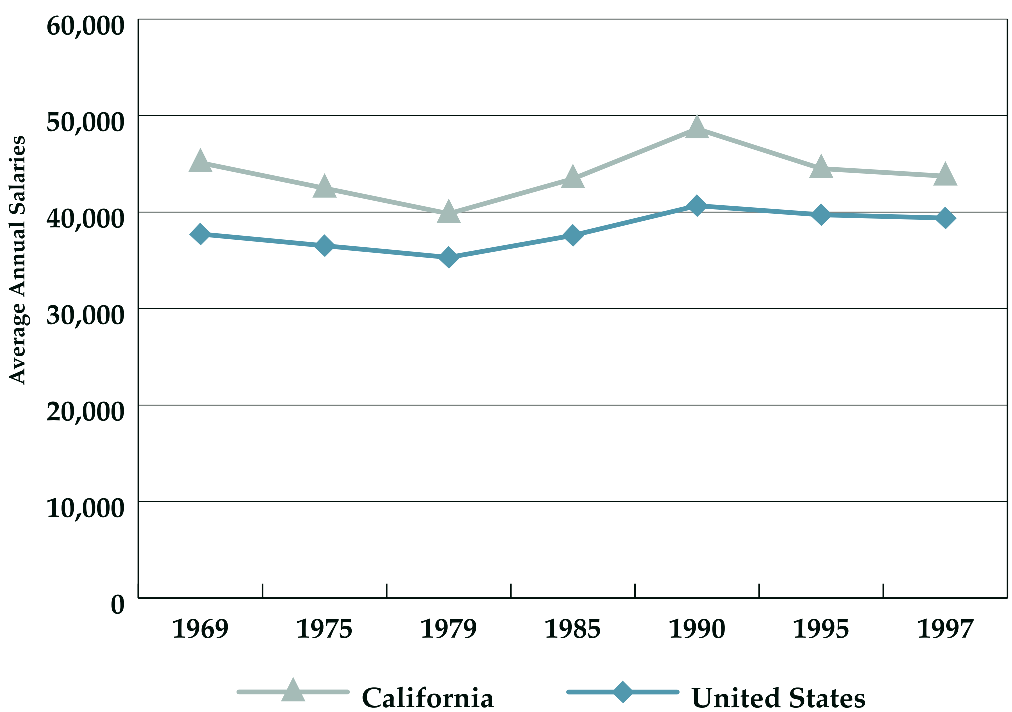


Figure 2.1 -- Real Expenditures Per Pupil, U.S. and California



Note: Real Expenditures are in constant 1997 dollars based on the CPI.
Figure 2.2 -- Average Annual Salaries of Teachers, U.S. and California

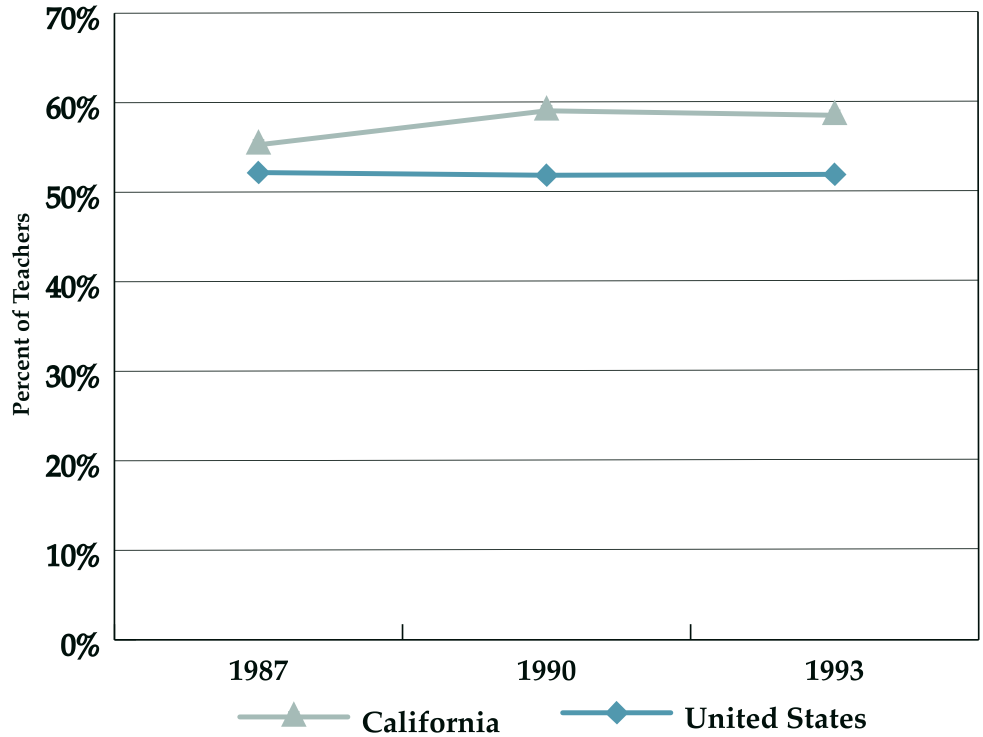


Figure 2.3 -- Percent of Teachers with Bachelor's as Highest Degree, U.S. and California

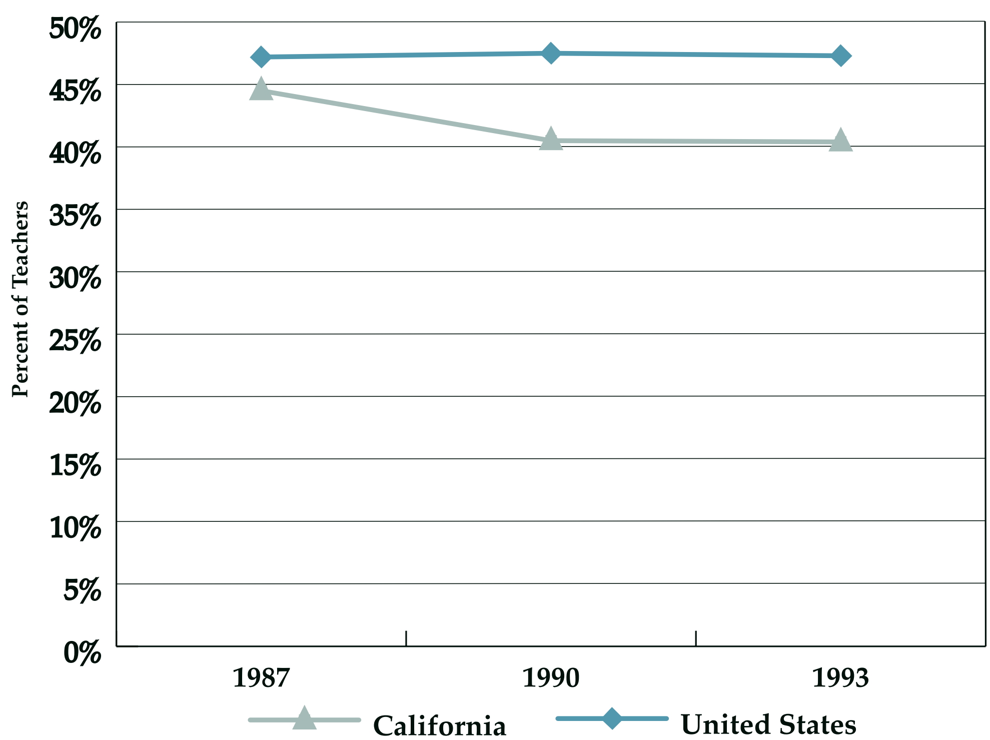


Figure 2.4 -- Percent of Teachers with Master's Degree or Higher, U.S. and California

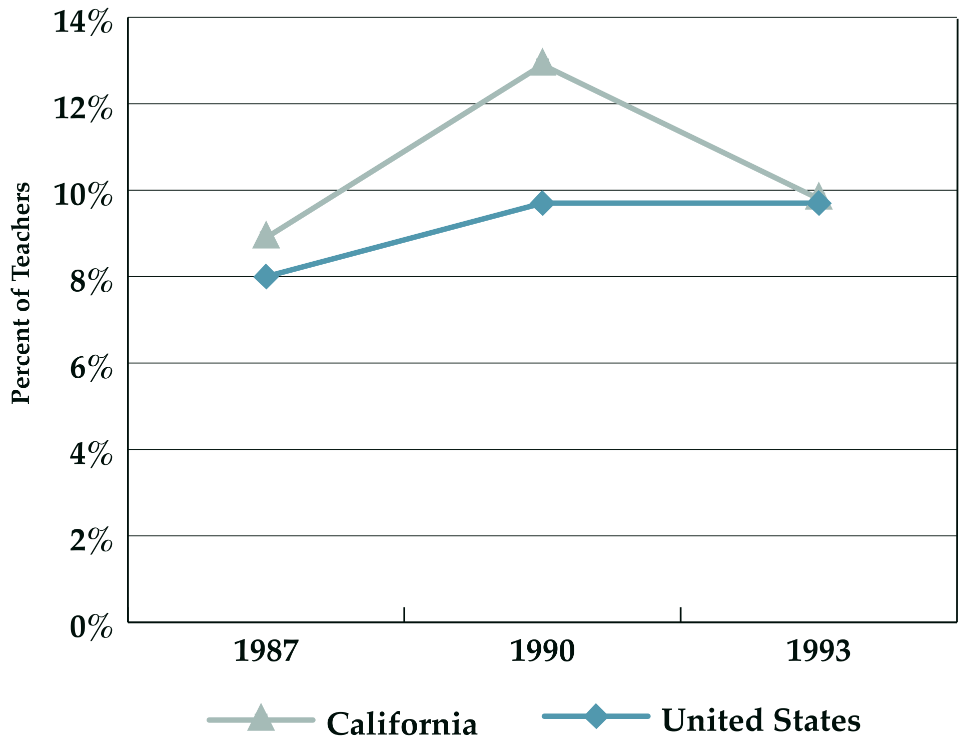


Figure 2.5 -- Percent of Teachers with less than Three Years of Experience, U.S. and California

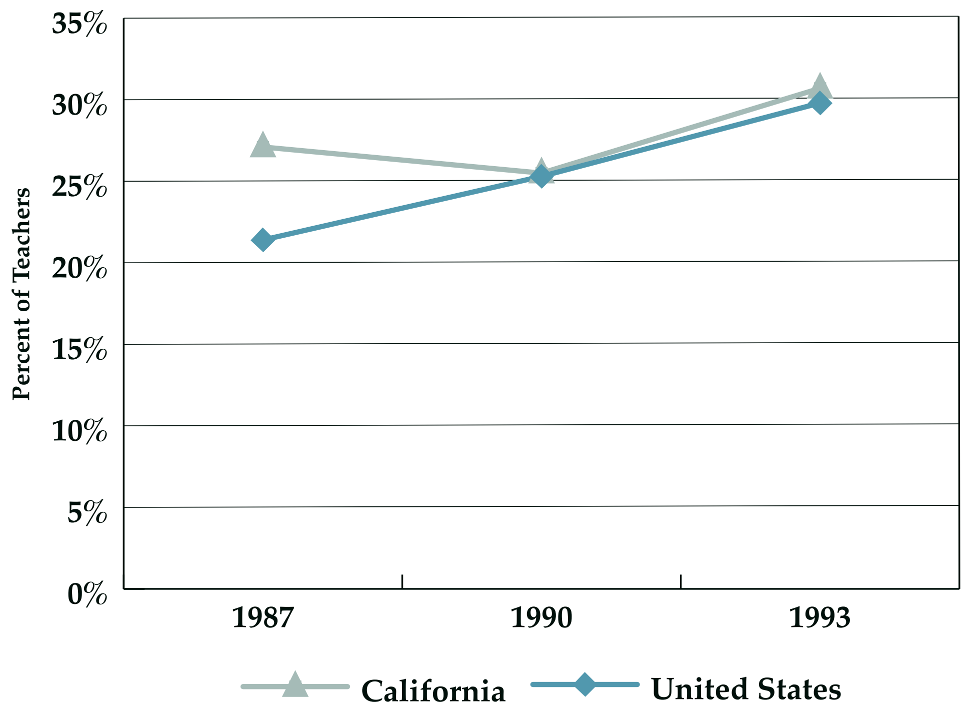


Figure 2.6 -- Percent of Teachers with more than Twenty Years of Experience, U.S. and California

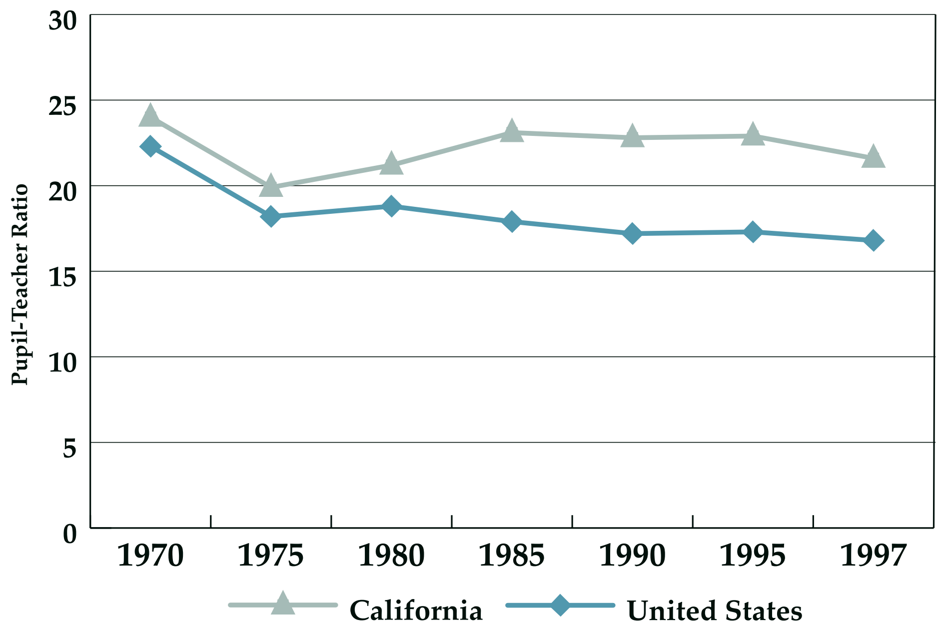


Figure 2.7 -- Pupil-Teacher Ratio, U.S. and California

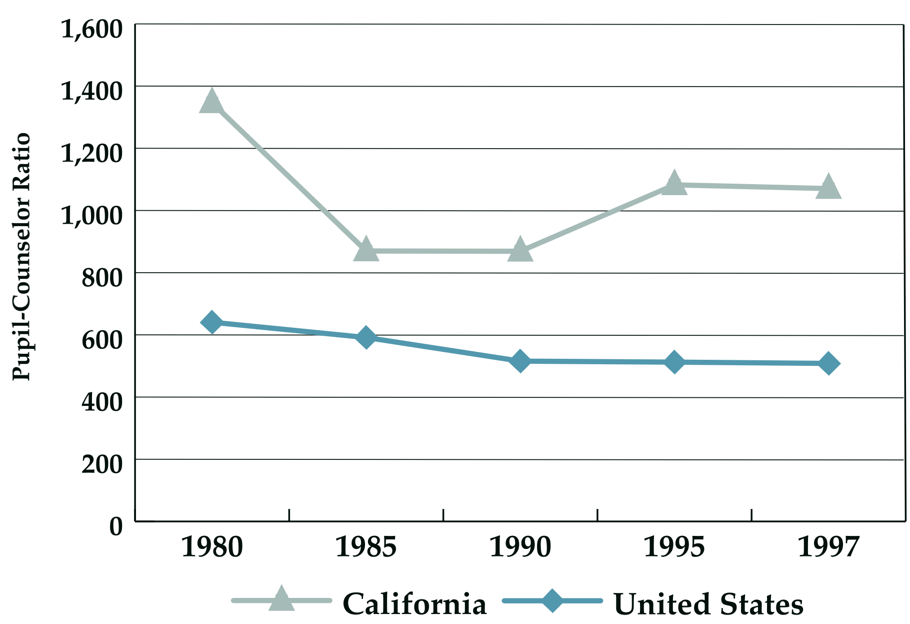


Figure 2.8 -- Pupil-Counselor Ratio, U.S. and California

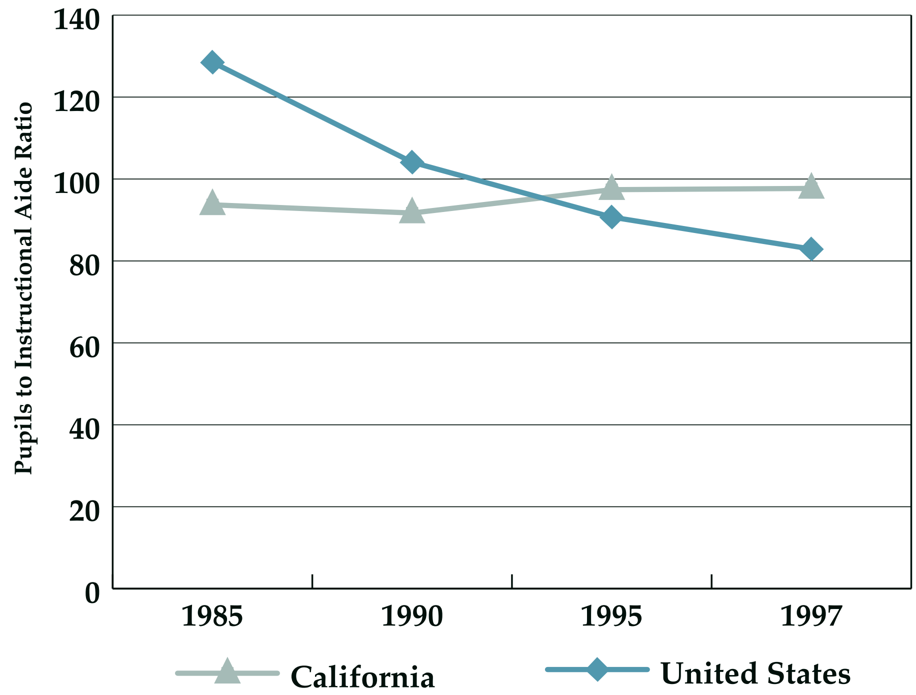


Figure 2.9 -- Pupil-Instructional Aide Ratio, U.S. and California

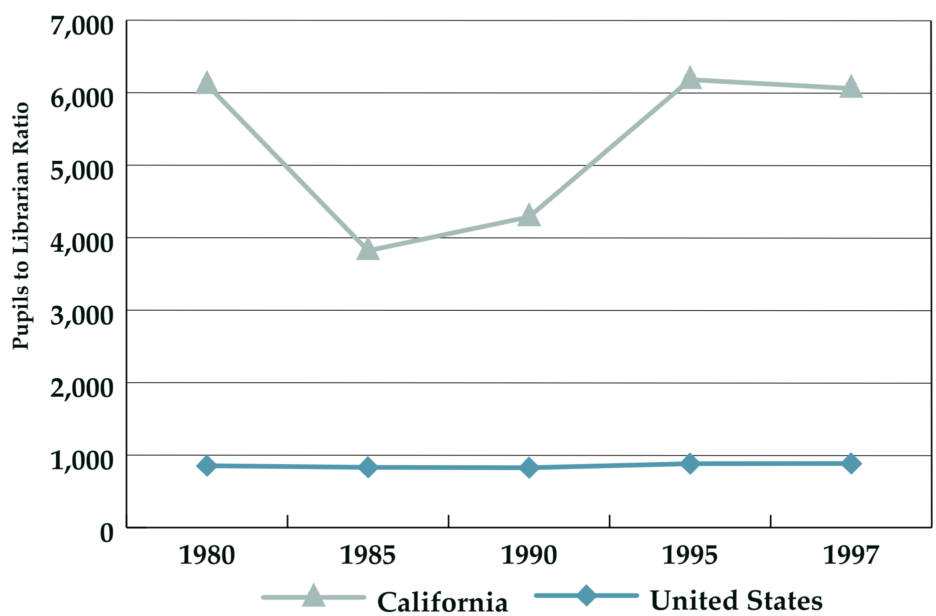


Figure 2.10 -- Pupil-Librarian Ratio, U.S. and California

3. A CLOSER LOOK AT VARIOUS SCHOOL RESOURCES WITHIN CALIFORNIA

3.1 Computers

One potentially important school resource that we have not discussed is computers. What amount of resources do the state's schools have? On average does each school have only a handful of computers, or are computer by now so abundant that each classroom of 20 or 30 students could contain one or perhaps several computers? The California Department of Education conducted surveys of a subsample of schools in 1996 and 1997 to examine such questions. Table 3.1 shows the ratio of students per computer in 1996 to 1997. Even by the mid 1990s the average California school had the capacity to place multiple computers within each classroom. Furthermore, the number of computers per classroom of given size appears to have grown by about 10% between 1996 and 1997. To be sure, these are rough proxies to the actual quality of computer-based instruction in the typical California school. We do not know the vintage of computers installed, the software installed, or perhaps most important of all, the computer support and training given to teachers to help them integrate computers into the daily life of their classrooms.

3.2 Inequality in Class Size, Teacher Preparation, and Access to Advanced Courses in High School in California

To this point we have examined only the average level of school resources in California. But inequality in the distribution of resources could also influence the total number of students graduating from the state's schools with adequate preparation for college. To take a simple but unrealistic illustrative case, suppose that the chances that a student could complete the high school courses needed to gain admission to either of the state's public university systems were 100% if half or more of his or her high school teachers held master's degrees. But if fewer held master's degrees, the student's chances of college admission plummeted to 0%. Then it matters tremendously how teachers with master's degrees were distributed across schools. If exactly half of teachers held a master's degree at all of the states' high schools, then all students would have a 100% chance of making it to college. But what if half of schools had no teachers with master's degrees while at the other half all teachers held master's degrees? As before, statewide, 50% of teachers would hold master's degrees, but only half of students would be able to gain college admission, compared to 100% in the scenario where teachers with master's degrees were distributed uniformly across all high schools.

Obviously, this example is not realistic, but it does demonstrate that inequality in school resources could virtually eliminate the possibility of college completion for students who attend the "have-not" schools. So, our critical pathways analysis must explore how unequally school resources are distributed, and beyond that, identify the types of students who are receiving fewer resources in California's schools.

Betts, Rueben and Danenberg (2000) examine the distribution of class size, teacher education, credentials, and experience, as well as the distribution of course-taking in advanced high school courses, based on classroom- and school-level surveys conducted in the 1997-98 school year by the state Department of Education. The analysis is extremely detailed, but several consistent patterns emerge:

1) Considerable inequality exists across a wide range of school inputs in California, including teacher education, experience, credentials, class size, course completion in the "a-f" courses required for admission to the University of California and the closely related courses required for admission to the California State University system, and course offerings in Advanced Placement courses that qualify students for college credit.

The closest thing to an exception to this rule is class size. Because the Class Size Reduction (CSR) initiative has provided strong financial incentives to schools to reduce class size in kindergarten through grade 3 to no more than 20 students, very little inequality in class size exists in these grades. Slightly higher inequality exists in class size at higher grade levels.

Table 3.2 shows the distribution of class size, teacher characteristics and curriculum in California high schools. These numbers were calculated by sorting all high schools in the state by the given characteristic. The table shows the characteristic at the tenth through 90th percentiles. (A school at the 60th percentile of a given characteristic, such as class size, has larger class size than 60% of all high schools in the state.) For instance, the second row of the table shows that the tenth and 90th percentiles schools, when ranked by college prep curriculum, offer a-f courses as 40.8% and 67.0% of their entire course offerings. This indicates quite radical disparities in the "richness" of the high school curriculum.

2) The level of school resources, by all of the above measures, is systematically related to the socioeconomic status of students at the school, where we measure SES by the percentage of students receiving full or partial lunch assistance. Specifically, students with higher SES receive more resources.

Table 3.3 divides high schools into five equal groups, based on the socioeconomic status of the students. Within each of these groups, the distribution of school characteristics is shown. The table offers a wealth of information, but the main message emerges by examining the column showing the 50th percentile, or median, of each school characteristic. For instance, among the schools in SES quintile 1, serving the most disadvantaged students, the median percentage of teachers without a full teaching credential is 11.7%. This contrasts sharply with the least disadvantaged schools, where the median percentage is only 3.6%. (In elementary schools, the variation in these two numbers is even larger, with 21.7% and 2.0% of teachers lacking full credentials in the most and least disadvantaged schools.)[3] Similar disparities across SES groups emerge for most other high school characteristics, as the table shows.

3) Students from ethnicities that are traditionally underrepresented at the state's public universities, Hispanics, African-Americans, and Native Americans, also tend to receive fewer resources than do students who are white or Asian. However, inequality in resources appears to be somewhat more strongly related to student poverty than to student race.

Table 3.4 shows the median of various high school characteristics when the data across schools are weighted first by enrollment of all students, and then by various categories of students. It illustrates that Hispanics and African-Americans tend to receive fewer resources and a less rich high-school curriculum than do white and Asian students.

4) Disparities in resources and curriculum also arise among urban, suburban and rural schools, with suburban schools generally having the most resources and richest curriculum.

Betts, Rueben and Danenberg (2000) report large variations in school resources among urban, suburban and rural schools. Table 3.5 illustrates this for high schools. Typically, suburban schools have more resources than urban and rural schools. The table shows the same variables as Tables 3.2 to 3.4, but in addition shows the median percentage of teachers with a master's or higher. An interesting fact emerges. Urban schools lag far behind suburban and rural schools according to one measure of teacher preparation: the percentage of teachers with a bachelor's degree or less. But when we instead examine the percentage of teachers with a master's degree or higher, it is instead rural schools that lag behind.

We now turn to student outcomes in California, as measured by graduation rates, and perhaps more pertinent to the CCST Critical Pathways project, the rate at which students graduate from school with the courses needed to attend either of the state's public university systems.

3 Elementary and middle school results similar to the high-school analyses in Tables 3.2 to 3.4 are not shown, in order to conserve space, but can be found in Betts, Rueben and Danenberg (2000).

Table 3.1
Computer Resources in California Schools, 1996 and 1997

Year	Type	Number of Schools	Ratio of Students/Computer	% Change 1996-97
1996	Elementary	4,498	12.41	
1996	Middle	1,052	10.19	
1996	High	1,362	10.38	
1996	Other	1,067	10.61	
1997	Elementary	4,579	10.93	-11.90%
1997	Middle	1,073	9.18	-9.90%
1997	High	1,390	9.25	-10.80%
1997	Other	1,137	9.30	-12.30%

Source: Downloaded from http://www.cde.ca.gov/demographics/files/comput.htm in 11/2000.

Table 3.2
Percentile of California High School Characteristics, 1997-1998, Weighted by Student Enrollment

Variable	Distribution Percentile				
	10th	25th	50th	75th	90th
Class size	20.0	21.6	23.3	26.1	31.6
% a-f classes	40.8	47.2	54.9	61.1	67.0
% AP classes	0.6	1.4	2.2	3.4	4.8
% Teachers with 0-2 years of experience	5.2	8.4	12.2	16.8	21.7
% Teachers with at most bachelor's	2.4	5.4	10.4	20.6	37.5
% Teachers not fully certified	0.0	2.3	6.3	12.2	17.6

Source: Betts, Rueben and Danenberg (2000), Table A.2.

Table 3.3
Percentiles of California High School Characteristics, 1997-98, by Student Socioeconomic Status (SES) Quintile (1=Lowest SES)

Variable	SES Quintile	Percentile 10th	25th	50th	75th	90th
Class size	1	25.2	27.2	28.6	29.9	31.3
	2	24.8	27.1	28.8	31.2	34.0
	3	24.7	26.9	28.9	30.6	32.4
	4	25.3	26.8	28.8	30.5	32.5
	5	26.2	27.6	29.4	31.2	32.9
% a-f classes	1	29.4	44.9	51.8	57.2	60.8
	2	37.3	44.5	50.1	56.3	60.8
	3	43.1	47.1	53.7	59.0	64.4
	4	44.5	52.3	57.7	62.9	69.2
	5	50.0	58.1	63.2	70.2	74.6
% AP classes	1	0.6	1.2	2.0	2.8	3.6
	2	0.4	1.1	2.1	3.0	4.1
	3	0.8	1.4	2.1	3.2	4.3
	4	0.7	1.2	2.7	4.1	5.6
	5	0.8	2.1	3.2	4.9	7.1
% Teachers with 0-2 years of experience	1	6.3	8.8	11.8	16.7	22.3
	2	5.2	10.3	12.9	17.9	22.3
	3	5.6	9.1	12.5	16.7	20.3
	4	4.8	8.2	11.8	17.2	22.5
	5	5.3	7.1	10.2	16.4	21.2
% Teachers with at most bachelor's	1	5.1	8.9	20.1	37.2	42.5
	2	4.7	8.3	12.8	19.9	37.0
	3	2.9	6.0	10.0	18.0	31.2
	4	2.1	4.4	8.5	15.7	29.1
	5	1.9	3.5	6.6	14.6	24.1
% Teachers not fully certified	1	1.7	5.5	11.7	17.4	21.9
	2	0.0	3.2	7.8	13.1	16.9
	3	0.0	2.1	5.9	11.1	15.9
	4	0.0	1.6	4.8	8.4	12.8
	5	0.0	0.7	3.6	7.1	11.5

Source: Betts, Rueben and Danenberg (2000) Table B.1.

Table 3.4
Median of Selected High School Characteristics Weighted by Enrollment of Various Types of Students, 1997

	Student Enrollment Weight						
	All	**Low Income**	**Non-White**	**Asian**	**Black**	**Latino**	**White**
Average Class Size	**28.9**	**28.7**	**28.8**	**28.9**	**28.5**	**28.9**	**28.9**
% "a-f" Classes	**54.9**	**52.2**	**54.0**	**55.4**	**54.3**	**53.1**	**56.1**
% AP Classes	**2.2**	**2.1**	**2.1**	**2.8**	**2.0**	**2.1**	**2.5**
Teachers							
% 0-2 Yrs. Experience	**12.2**	**12.3**	**12.4**	**11.9**	**12.6**	**12.4**	**11.8**
% At Most BA Education	**10.9**	**13.6**	**12.7**	**9.5**	**15.4**	**13.7**	**9.0**
% Not Fully Certified	**6.3**	**8.7**	**8.4**	**5.7**	**10.1**	**9.8**	**4.3**

Source: Betts, Rueben and Danenberg (2000) Table 4.4.

Table 3.5
Median High School Characteristics, 1997-1998, by Urbanicity

School Urbanicity:	**Urban**	**Suburban**	**Rural**
Mean Class Size	**28.8**	**29.4**	**27.3**
% a-f of all Classes	**54.5**	**56.7**	**49.8**
% AP of all Classes	**2.1**	**2.6**	**1.8**
% Teachers with at least Master's	**37.0**	**43.9**	**29.7**
% Teachers with Bachelor's or Less	**18.1**	**9.6**	**8.9**
% Teachers with 0-2 Years of Experience	**11.8**	**12.3**	**11.8**
% Not Full Credential	**11.1**	**4.9**	**5.7**

Source: Betts, Rueben and Danenberg (2000) Table 5.2.

4. A CRITICAL POINT IN THE ACADEMIC PIPELINE: TRENDS IN HIGH SCHOOL STUDENTS' COMPLETION OF COLLEGE PREP COURSES, AND HIGH SCHOOL GRADUATION RATES

Given the evidence above about the resources devoted to California schools, one of the key binding constraints on the supply of S&T workers to the California economy might be the number of people graduating from California's high schools with the right set of courses needed to enter Science and Technology fields in college. This section examines recent trends in the supply of well-trained graduates from California's high schools.

Figure 4.1 shows the proportion of all high school students enrolled in algebra, advanced math, chemistry and physics during the 1990s. They are calculated based on actual enrollments in each class across all subjects and all high schools in the state. The level of these variables in an absolute sense is not particularly meaningful, but the trends over time can provide important clues as to whether California's schools have increased the rate at which they produce well-trained graduates ready to take on the challenges of S&T careers. The most dramatic pattern is that the proportion of class enrollment deemed "advanced math" increased from just over 0.07 in 1987-88 to 0.10 in 1998-99. Algebra and chemistry classes have also grown in their share of total student enrollment over time, but slightly less dramatically. Finally, physics enrollment as a proportion of all classes taken has stagnated between the mid 1980s and the late 1990s.

Of course, this figure tells us nothing about who is taking the courses. For one thing, we could have more people taking advanced math, but fewer taking all of the prerequisites for admission to the public universities. As a result, the proportion of high school graduates eligible for college admission could have, in the extreme, fallen slightly over time. Further, we cannot tell from this figure why the percentage of courses designated as advanced math rose. It could be that a greater proportion of students are taking these courses, which is all to the good. Alternatively, it could be that students who are marginal academically were over time becoming more likely to drop out of school, rather than remaining in high school but taking courses that did not qualify as college preparatory. It would be misleading to claim in such a scenario that high schools have managed over time to increase the proportion of students who complete a-f requirements.

For these reasons, we need to look at dropout rates in California schools, as well as the percentage of students who successfully complete all of the courses that serve as prerequisites for public universities. We begin by examining dropout rates.

California's data on high school completion and dropout rates have generated intense controversy for quite a few years. One of the biggest problems is that the state lacks a comprehensive student data system that follows students over time. In some cases, when a student leaves a high school, it becomes very difficult for the school district to know with certainty whether the student has dropped out or transferred to another district. A second problem arises from the dynamic flows of people into and out of California, especially immigrants. Census data make clear that many immigrants living in California today either graduated from the equivalent of high school before coming to the United States, while others dropped out of school altogether before entering the United States. Betts (2000) estimates that about three-quarters of all adult immigrants living in California in 1990 fit into one of these two categories. For this reason, it is better to evaluate the "success rate" of California's schools in producing graduates using the schools' own data, rather than using Census data on the entire state population. But at the same time, the lack of a statewide student-level data system makes the school systems' own data less than completely reliable.

Based on its statewide survey each fall, the state Department of Education calculates and releases one-year dropout rates from California high schools. These rates are depicted in Figure 4.2. They show that the proportion of students enrolled in grades 9-12 who drop out during any given year is fairly small, and has declined over time.

It is highly uncertain whether this picture is accurate, overly optimistic, or overly pessimistic. If we instead compare high school graduations with enrollment in grade 9 three years earlier, we find hints that large numbers of students initially in grade 9 may not graduate from California high schools. Table 4.1 presents aggregate data from the California Department of Education on grade 9 enrollment, grade 12 enrollment, the number of high school graduates, and the number of graduates who completed the a-f course requirements with grades of C or better, for various school years between 1988-89 through 1999-2000. The most obvious pattern in the table is that over this period the number of enrollees and graduates grew substantially, mostly due to a surge in the California population of high-school age. The rightmost column demonstrates that the number of high school graduates successfully completing college preparatory coursework with grades of C or better has risen substantially over the period. In an absolute sense, then, California's schools have produced more and more college-ready graduates as time has gone by, at least as measured by these criteria.

But we want to dig deeper, to probe for bottlenecks that might have prevented the number of college-ready graduates from growing more quickly than it has. Accordingly, Table 4.2 presents the same graduation data, but this time as percentages of the number of students enrolled in grade 9 three years earlier. The results are revealing. In no year did the percentage of students enrolled in grade 12 represent more than 88.4% of students enrolled in grade 9 three years earlier. Moreover, this percentage fell during the 1990s. Similarly, high school graduates as a percentage of grade 9 enrollment three years earlier fell from 79.6% in 1991-92 to roughly 69% in the late 1990s. In contrast, the number of high school graduates completing a-f requirements with grades of C or better held fairly steady during the 1990s at roughly 25% of enrollment in grade 9 three years earlier.

All of these statistics present cause for genuine concern. There appears to be a sharp drop-off in high school attendance between grade 9 and grade 12, and an even sharper drop-off between grade 9 attendance and high school graduation three years later. Worse, the attrition appears to have increased in the 1990s, in contradiction to the slight decrease in one-year dropout rates as presented in Figure 4.2. Perhaps of most relevance to the S&T critical pathways analysis, only one quarter of students in grade 9 in a given school year appear to have graduated while completing college prerequisites with grades of C or better three years later. Clearly, substantial bottlenecks severely curtail the number of young Californians who graduate from high school with the courses needed to gain regular admission to either system of public universities in California.

A word of caution is in order here. Because the state lacks a longitudinal student data-set, we cannot know what happens to the hundred thousand or more grade 9 students who do not appear to graduate from high school three years later. Some of these students may have moved with their families to other states between grade 9 and 12. Another possibility is that reverse migration of immigrant families from the United States to the original source countries may have occurred during the late teenage years of the students in these families.

Table 4.3 shows graduates and graduates with adequate grades in a-f courses as a percentage of fall enrollment in grade 12 in the given school year. Even here, we find evidence of significant amounts of student attrition before graduation day, and quite low rates of completion of the a-f course requirements. Finally, Table 4.4 shows trends in the percentage of high school graduates who graduate having completed the a-f requirements with grades of C or better. Throughout the 1990s this percentage hovered around 35%. In sum, no matter how we examine these data, they tell a consistently grim story about the academic achievement of California's high school students.

Even though high school graduation with proper college preparation clearly represents a huge barrier to most California students, we must not forget the role played by California's unusually large community college system. Only a small fraction of community college students transfer to four-year colleges and successfully obtain a bachelor's degree. Still, the community colleges offer a second chance to those who do not graduate from high school with the right courses. Further analysis of this question is beyond the scope of this paper, but the role of community colleges in providing an alternate "pathway" to skilled occupations seems highly relevant to the CCST project.

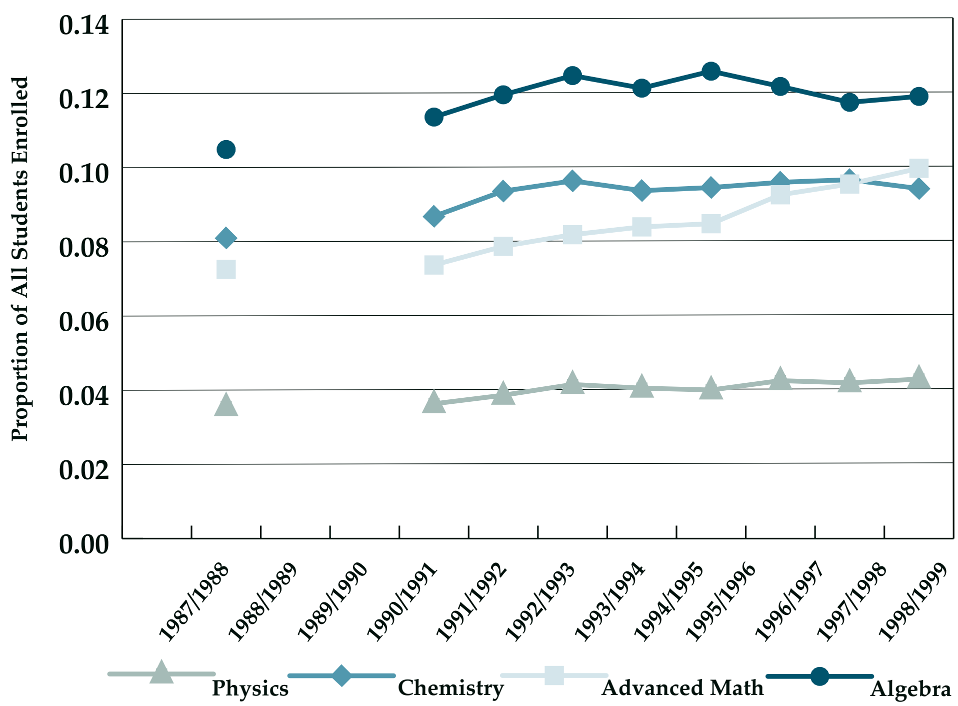


Figure 4.1 -- Courses Taken as a Proportion of Enrollment

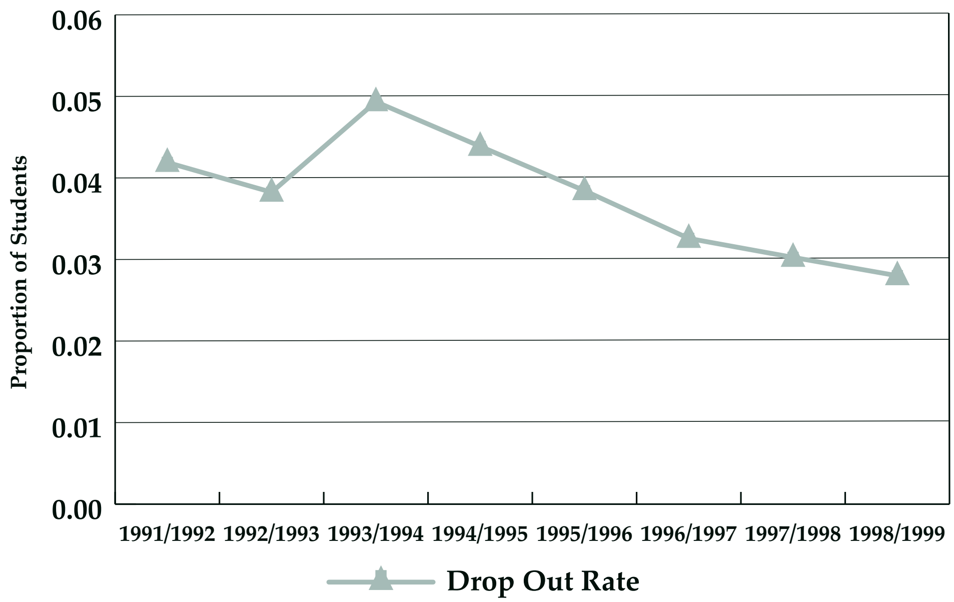


Figure 4.2 -- Drop Out Rate

Table 4.1
High School Enrollment and Graduation Statistics

Year	Grade 9 Enrollment - 3 years Earlier	Grade 12 Enrollment	Graduates	Graduates Fulfilling a-f with Grade of C or Better
1988/1989		254,277	260,053	75,448
1989/1990				
1990/1991				
1991/1992	291,402	257,504	231,949	77,160
1992/1993		267,424	242,628	79,422
1993/1994		273,614	247,693	82,298
1994/1995	340,435	281,035	251,702	81,446
1995/1996	347,178	283,692	253,668	88,771
1996/1997	362,516	293,799	257,536	91,672
1997/1998	388,914	310,454	267,059	96,703
1998/1999	411,840	334,852	282,897	103,421
1999/2000	435,155	347,813	299,221	106,441

Source: Author's calculations based on data downloaded from http://www.cde.ca.gov/demographics/files/cbedshome.htm in 10/2000.

Table 4.2
Enrollment and Graduates as % of Grade 9 Students Three Years Earlier

Year	Grade 12 Enrollment	Graduates	Graduates Fulfilling a-f with Grade of C or Better
1991/1992	88.4%	79.6%	26.5%
1992/1993			
1993/1994			
1994/1995	82.6%	73.9%	23.9%
1995/1996	81.7%	73.1%	25.6%
1996/1997	81.0%	71.0%	25.3%
1997/1998	79.8%	68.7%	24.9%
1998/1999	81.3%	68.7%	25.1%
1999/2000	79.9%	68.8%	24.5%

Source: Author's calculations based on data downloaded from http://www.cde.ca.gov/demographics/files/cbedshome.htm in 10/2000.

Table 4.3
Graduates as % of Grade 12 Enrollment

Year	Graduates	Graduates Fulfilling a-f with Grade of C or Better
1991/1992	90.1%	30.0%
1992/1993		
1993/1994		
1994/1995	89.6%	29.0%
1995/1996	89.4%	31.3%
1996/1997	87.7%	31.2%
1997/1998	86.0%	31.1%
1998/1999	84.5%	30.9%
1999/2000	86.0%	30.6%

Source: Author's calculations based on data downloaded from http://www.cde.ca.gov/demographics/files/cbedshome.htm in 10/2000.

Table 4.4
a-f Graduates with Grades of C or Better as a Percentage of Graduates

Year	Graduates Fulfilling a-f with Grade of C or Better
1991/1992	33.3%
1992/1993	
1993/1994	
1994/1995	32.4%
1995/1996	35.0%
1996/1997	35.6%
1997/1998	36.2%
1998/1999	36.6%
1999/2000	35.6%

Source: Author's calculations based on data downloaded from http://www.cde.ca.gov/demographics/files/cbedshome.htm in 10/2000.

5. MAKING THE GRADE? EVIDENCE ON THE BASIC SKILLS OF CSU AND UC FRESHMEN

As another measure of the skill level among recent California high school graduates, this section examines recent trends in failure rates on the basic skill examinations of freshmen entering the California State University (CSU) and the University of California (UC) systems. Both systems are quite selective, with the two systems accepting roughly the top third and top eighth of high school graduates in California respectively. CSU tests entering students' skills in English and math, while the UC Subject A exam tests writing skills of entering UC freshmen.

Tables 5.1 and 5.2 detail recent trends on the CSU tests. The top panel of Table 5.1 reveals that roughly half of entering CSU freshmen fail the math and the English tests, even though these tests are pitched at the high school level. The bottom panel shows that men and women fail the English test at about the same rate, while women fail the math test at a much higher rate.

Table 5.2 shows the breakdown on failure rates by racial and ethnic groups. The table shows that among California residents, the groups with the lowest failure rates in math are whites and Asians, with whites having the lowest failure rates on the English test.

Figure 5.1 shows the trends in the percentage of students at CSU requiring remediation in the two subject areas. Notably, the failure rate on the CSU math test has diminished markedly over the last two years. This good news, however, should not overshadow the main message of the test results, which is that roughly half of the students entering CSU lack basic skills in math and English. What makes this all the more surprising is that the CSU system is mandated to accept students from the top third of all California high school graduates. Although recent improvements are notable, the large failure rate among this relatively elite group suggests that California high schools are not producing as many highly skilled graduates as policymakers might like.

Summarizing the writing skills of UC freshmen is somewhat less straightforward. UC freshmen can satisfy the "Subject A" writing requirement by passing the writing test given the spring before college entrance. But many students gain exemption from the spring test by a number of means, such as obtaining a sufficiently high score on the relevant SAT II or Advanced Placement tests. Overall, in 1998 7543 or about 28.7% of entering UC freshmen failed to satisfy the Subject A requirement. Of these students failing to meet the requirement, 25.5%, or one quarter, were judged by exam readers to manifest language difficulties typical of non-native speakers or English-as-a-Second-Language students. Thus, a strong majority of students failing the Subject A requirement were native English speakers or Fluent English Proficient. Between 1987 and 1998 the percentage of students failing to meet the Subject A requirement has varied up and down but shows no trend.[4] As for CSU, these numbers for UC suggest that at the least a significant minority of entering freshmen in California's public universities is not adequately prepared in writing.[5]

4 The growing linguistic diversity among UC undergraduates over time suggests that if anything the trend might have been towards a higher failure rate over time.

5 Calculations described in this paragraph were based on data obtained from the Corporate Data System, Office of the President, University of California. I thank Jane Stevens of UCSD for supplying data and both Jane Stevens and Immouna Ephrem from the UC Office of the President for several useful conversations about the Subject A requirement.

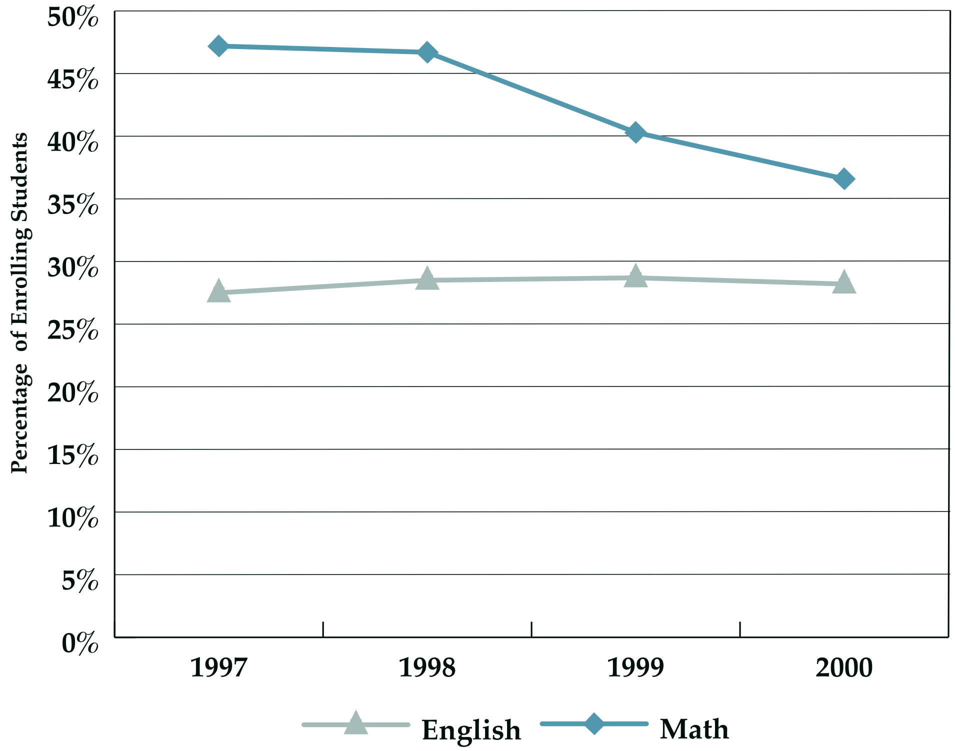


Figure 5.1 -- Remediation Rates of Cal State Freshman

Table 5.1
Percentage of California State University Freshmen Failing Entrance Test in Math and English, 1997-2000

Year	Freshmen Failing Test in: Math	English
Total for Cal State		
1997	54.4%	46.8%
1998	54.3%	47.1%
1999	46.4%	46.5%
2000	45.2%	45.7%
Female		
1997	62.9%	47.1%
1998	62.8%	47.8%
1999	55.4%	46.0%
2000	53.1%	46.1%
Male		
1997	42.9%	46.3%
1998	43.0%	46.3%
1999	37.2%	47.1%
2000	34.6%	45.0%

Source: Downloaded from http://www.calstate.edu/tier2/Facts.shtml in 12/2000 and 2/2001.

Table 5.2
Percentage of California State University Freshmen Failing Entrance Test in Math and English, 1997-2000 by Ethnicity

Freshmen Failing Test in:				**Freshmen Failing Test in:**			
White				**Filipino**			
	Year	**Math**	**English**		**Year**	**Math**	**English**
	1997	**47.2%**	**27.5%**		**1997**	**53.5%**	**55.8%**
	1998	**46.7%**	**28.5%**		**1998**	**55.4%**	**58.7%**
	1999	**40.3%**	**28.7%**		**1999**	**47.9%**	**57.3%**
	2000	**36.6%**	**28.2%**		**2000**	**46.7%**	**54.5%]**
Mexican American				**American Indian**			
	Year	**Math**	**English**		**Year**	**Math**	**English**
	1997	**71.1%**	**64.6%**		**1997**	**54.5%**	**34.2%**
	1998	**72.8%**	**65.1%**		**1998**	**59.7%**	**38.8%**
	1999	**65.7%**	**64.6%**		**1999**	**49.1%**	**35.9%**
	2000	**64.0%**	**62.9%**		**2000**	**48.0%**	**37.1%**
Other Latino				**Pacific Islander**			
	Year	**Math**	**English**		**Year**	**Math**	**English**
	1997	**68.4%**	**57.1%**		**1997**	**51.1%**	**41.0%**
	1998	**70.6%**	**57.6%**		**1998**	**52.9%**	**46.3%**
	1999	**64.4%**	**56.5%**		**1999**	**52.1%**	**47.9%**
	2000	**60.9%**	**54.6%**		**2000**	**41.5%**	**46.5%**
African American				**Unknown**			
	Year	**Math**	**English**		**Year**	**Math**	**English**
	1997	**80.2%**	**64.4%**		**1997**	**51.0%**	**36.6%**
	1998	**80.5%**	**66.4%**		**1998**	**51.3%**	**36.7%**
	1999	**74.2%**	**64.3%**		**1999**	**41.8%**	**34.2%**
	2000	**73.1%**	**65.9%**		**2000**	**42.6%**	**37.4%**
Asian American				**Non-Resident**			
	Year	**Math**	**English**		**Year**	**Math**	**English**
	1997	**43.0%**	**66.1%**		**1997**	**35.1%**	**79.6%**
	1998	**43.1%**	**65.4%**		**1998**	**36.8%**	**83.0%**
	1999	**38.7%**	**66.0%**		**1999**	**35.9%**	**81.3%**
	2000	**36.0%**	**64.1%**		**2000**	**35.9%**	**75.9%**

Source: Downloaded from http://www.calstate.edu/tier2/Facts.shtml in 12/2000 and 2/2001.

6. A REVIEW OF THE LINK BETWEEN SCHOOL RESOURCES AND STUDENT OUTCOMES

6.1 School Resources Affect Student Achievement

Given the inequalities in resources documented above, and the fact that California lags the nation as whole in the resources it provides to schools, this section examines the extent to which school resources affect student achievement. Education policy debates sometimes implicitly assume that boosting school spending can materially improve student outcomes. However, the research literature suggests a different conclusion: the impact of school resources on various student outcomes is weak and uncertain, and in most studies variations in student socioeconomic status appear to explain more of the variations in student outcomes than do variations in school resources.

Given the labor-market focus of the CCST project, this section begins by focusing on the impact of school resources on students' earnings years after they have left school.

6.1.1 The Link between School Resources and Earnings of Students after Graduation

Several studies have found a relation between adult males' earnings and school resources in their state of birth. But the literature is by no means unanimous. Work by Betts (1995) and Grogger (1996), among others, shows that when school resources are measured at the school actually attended, typically the impact of school inputs on earnings is not statistically significant. Similarly, studies that measure spending per pupil at the level of the actual district attended by each student typically find smaller effects of school spending than do studies that measure spending at the state level. (These latter studies make a rough approximation to the school spending a student received based on the student's year and state of birth.)

More to the point, the estimated effect of raising school spending on students' subsequent earnings is extremely small. This is true regardless of whether one measures school resources at the school actually attended, in the district attended, or whether one instead uses the person's state of birth to create a rough proxy for school resources. We can think of increased school spending like an investment project carried out in the private sector. A private business incurs costs today when buying new equipment, in the hopes that in the future the equipment will boost revenues at the firm. But because a dollar today is worth more than a dollar in the future, businesses must take into account the current "discount rate," or interest rate. To just break even, a firm that invested $1 today might need $2 in increased revenues a few years from now in order to pay for the interest cost of borrowing to spend today. The higher the interest rate, the greater "bang for the buck" each dollar invested today must produce in terms of future revenues in order for the investment project to make sense. This example brings us to a useful definition. The internal rate of return to an investment project is simply the interest rate at which the investment costs incurred today are just balanced by the future gain in profits. The better the investment project, the higher the internal rate of return.

Betts (1996) reviews the literature, and then uses his estimates of the average impact of school resources on earnings of students later in life to calculate the internal rate of return to increasing school inputs. Studies that use state-level measures of school resources tend to be the most optimistic, and even they find small internal rates of return, around 2.5%. Estimates of the impact of school resources on students' later earnings that use the actual resources at the school yield even lower results than do the studies that use state-averaged school resources. For example, consider estimates of the impact of reducing the pupil-teacher ratio based on all available studies, regardless of whether the study measured the pupil-teacher ratio at the school, district, or state level. Betts finds that even if we don't discount the predicted gains in students' future wages at all, the cost of reducing the pupil-teacher ratio today would never be repaid by future gains in the students' earnings. Further, even the most optimistic rate of return, roughly 2.5%, is far smaller than the rate of return than a student receives by staying in school one year longer, which Betts estimates to be roughly 11%. In other words, we might do more to improve students' outcomes in the labor market by increasing the school-leaving age rather than spending more in any given grade or year.

6.1.2 Educational Attainment and School Resources

It is also useful to examine whether additional school resources are related to how much schooling students obtain. Betts (1996) reviews the relevant papers and finds only weak evidence that school resources affect educational attainment. Some of the same patterns that emerge in the work on earnings and school resources appear here as well. Specifically, studies that proxy school resources using state-level averages matched to the person's state of birth tend to find stronger effects than do studies that measure resources at the actual school attended by each student.

6.1.3 The Link between Test Scores and School Resources

Far larger than the bodies of school quality research devoted to earnings and educational attainment is the work on the link between test scores and school resources. A report by Coleman et al. (1966) represents a landmark in this work. Using a large national sample of students, the "Coleman Report" came to a remarkable finding: most of the variations in student performance in the United States were related to students' socioeconomic status rather than class size or the qualifications of teachers.

Several hundred papers that statistically model test scores have been written since that time. Some find more positive results than did the Coleman Report, but many others find highly similar results to those of Coleman et al. For example, in surveys of this work Hanushek (1986, 1996) concludes that a surprisingly small proportion of these studies have found that additional school resources lead to significantly higher achievement. For many measures of school resources, such as class size, most studies find no significant link to student achievement, while a distinct minority finds that resources do matter. Other studies even find a link suggesting that more resources are associated with lower achievement. Teacher experience is the measure of school resources that most regularly has been found to be significantly and positively related to student achievement. Overall spending per pupil and teacher salary are the measures of school resources that are found to "matter" the second and third most often. Surprisingly few studies find that teacher education affects student achievement. In published work, a number of authors have disputed Hanushek's claims.[6]

Hanushek's review of the literature does not focus on computers, either in the classroom or in the home. However, there is a small but growing literature on the effectiveness of computers in education. In a CCST report, Noll, Older-Aguilar, Rosston and Ross (2000) review this research and conclude that there is not yet compelling evidence that computers in schools or in the home cause student achievement to improve.

6 See for instance Hedges and Greenwald (1994), and Hanushek (1994) for a rebuttal that points out some inconsistencies in the approach of Hedges and Greenwald.

6.2 An Example from California

Betts, Rueben and Danenberg (2000) statistically analyze the determinants of inter-school variations in performance on California's state test, the Stanford 9. The results are more optimistic than those of the Coleman Report, but the overall tenor is remarkably similar.

Regression analysis suggests that school resources do affect achievement. Figure 6.1 shows the predicted percentage of non Limited English Proficient (non-LEP) students scoring at or above national norms in grade 5 in reading under various scenarios. Each trio of bars compares outcomes when an otherwise typical school moves from the 25th to the 50th and then the 75th percentile in a number of school resources. (Results for reading in other grades and for math are similar.) Consider for example the first trio of bars, showing the predicted percentage of students scoring at or above national norms if the socioeconomic status (SES) of a school's students ranks at the 25th, 50th, or 75th percentile. The predicted effects are large: the school with the 75th percentile SES is predicted to have 57.5% of students above national norms, compared to just 26.8% of students at schools at the 25th percentile of SES. The remaining bars show the predicted effects of changing measures of school resources. All variables in the figure except for class size have a statistically significant impact on student achievement. But the predicted impacts of changing teacher credentials, experience, education, or class size are minor compared to the impact of student disadvantage. The figure demonstrates that variations in poverty can account for a far higher share of variations in student performance than can variations in school resources, in spite of the large variations in teacher resources documented earlier in this paper. One implication of these findings is that equalization of resources among all California schools might reduce inequalities in student outcomes modestly. However, radical reallocations of resources would be needed if policymakers held firm to the goal of all students meeting rigorous standards.

6.3 More on Class Size

In spite of the finding in the literature as a whole that class size is the least likely school resource to influence student achievement, a prominent experiment in Tennessee suggests that class size might indeed matter. A good review of this experiment appears in a special issue of Educational Evaluation and Policy Analysis (Summer, 1999). The Tennessee experiment suggested that students placed in classes of about 15 students learned more quickly than students placed in larger classes of about 23. Disadvantaged students gained somewhat more than other students.

The Tennessee experiment raises as many questions as it answers. Surprisingly, most of the gains accrued to students in the first year that they were placed in smaller classes. Gains over the next three years were relatively small. Krueger and Whitmore (1999) study test scores of students in the smaller classes and those in the larger classes after grade 3, when all students were placed back in regular-sized classes. The gains in performance among those who had received smaller classes appear to have largely disappeared once they were placed back in regular-sized classes. (On average, about three-quarters of the gains disappeared within a year; the deterioration in percentage terms was slightly higher for students receiving free lunch and slightly lower for black students). However, by high school the students who had initially received smaller classes retained a small but statistically significant test-score advantage over students who had been placed in larger classes during kindergarten through grade 3. Students in smaller classes had a 4.5 percentile point advantage over other students at the end of grade 3, but this had diminished to a disappointing 1 percentile point by the end of grade 8. (For an example of what this means, suppose that nationally a student ranked 50th out of 100 in achievement. If he had instead had smaller classes, his achievement ranking would have risen to 49th out of 100 nationally.)

Taken together, the many research studies that have analyzed the Tennessee data suggest that students in smaller classes learned at a slightly higher rate than those in larger classes, that most of the gains accrued during the first year in which a student is placed in a smaller class, and that while a portion of the gains persisted after all students are put back into regular-sized classes, most of the gains disappeared within a year. These results are correctly perceived as the most persuasive evidence to date in favor of reducing class size. But the results are highly nuanced, and suggest that even sizeable reductions in class size, from about 23 students to 15, produce modest gains, especially if students are put into larger classes again in later grades.

In California, the state has mandated a formal evaluation of its class size reduction program in grades K-3. The two initial reports by the CSR Consortium (1999, 2000) suggest that reducing class size in California has modestly increased student achievement. However, the Consortium authors are careful to point out the many limitations of the evaluation. Unlike Tennessee, there was no natural 'control group', that is, a group of otherwise identical students that did not receive smaller classes. This makes the statistical analysis problematic. In spite of these major technical issues, if we were to take the results of the evaluation at face value, they suggest that smaller class sizes in K-3 can contribute to equalizing test scores across groups, but only very partially.

6.4 The National Assessment of Educational Progress

Recently, a number of studies have used test scores from the National Assessment of Educational Progress (NAEP) to examine whether specific types of school spending matter. Some of these studies have received prominent national headlines. While all of these studies are quite useful, they suffer from small sample sizes because they measure school resources at the state level. For instance, if a study uses test scores from a NAEP test in two different years, with 45 states participating each time, there are truly only 90 observations. In studies with such small sample size, it is difficult to know how resilient the estimates are. To give some examples, Grissmer, Flanagan, Kawata, and Williamson (2000) attempt to model the average test scores in each state that participated in NAEP between 1990 and 1996 as a function of class size, teacher education, teacher experience and several other measures of educational resources. The study finds that variations in class size explain more of the variation in test scores among states than do variations in other measures of school resources, including teacher education and experience. But another study based on NAEP data by Darling-Hammond (2000) comes to the opposite conclusion. Her study examines NAEP data from 1990 to 1996, and finds that teachers' credentials and experience are the two most important factors explaining inter-state variations in test scores, with class size being far less important.

As another example of the limits of the state-level studies using NAEP data, Klein, Hamilton, McCaffrey, and Stecher (2000) examine NAEP data from a slightly different set of years (1994 and 1998 instead of 1990 to 1996 as in Grissmer et al.). Klein et al. find that gains in test scores between 1994 and 1998 in Texas outpaced the national average in only one of four tests they examined. This stands in contrast to the results of Grissmer et al., who found that Texas ranked at the top of participating states.[7] Clearly, when using state-level data-sets such as the NAEP, small changes in the years examined or the specifications used can lead to varying results. In addition, caution must be used in interpreting studies such as these, because

7 For a critique of these two studies, see Hanushek (2001a,b).

they do not capture the large variations across schools and districts within states.

Taking all of these strands of research together, evidence exists that school resources might have a positive impact on student test scores, years of schooling and perhaps earnings of students after they graduate. But the effects of school resources on these outcomes is hard to detect, variable, and small.

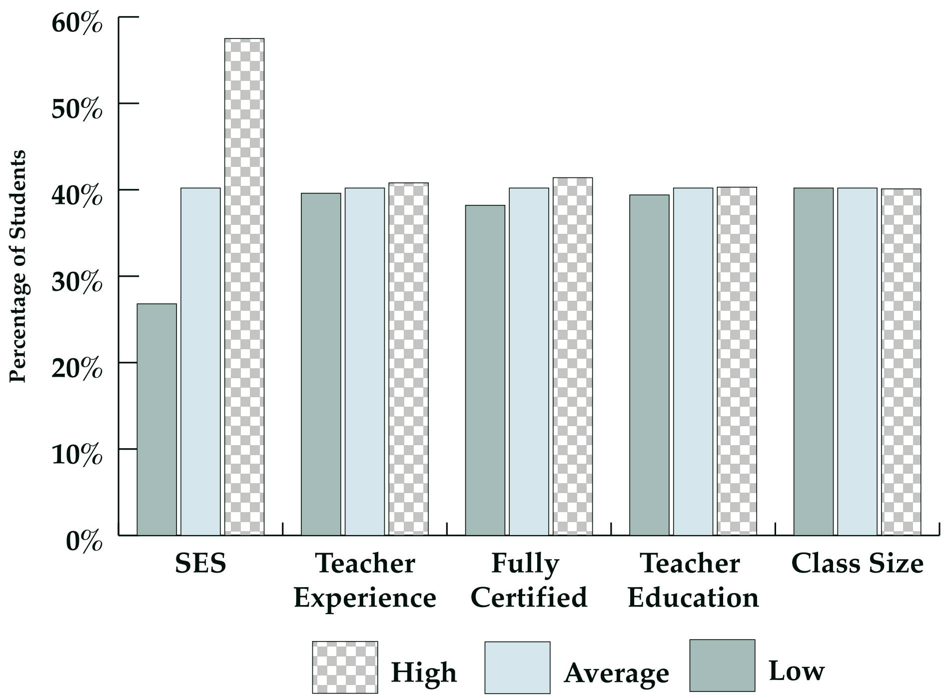


Figure 6.1 -- Predicted Percent of Fifth Grade Non-LEP Students Scoring Above the National Average on Reading Test, Given Different Levels of Student, Teacher and School Characteristics

7. THE ROLE OF CURRICULUM IN DETERMINING COLLEGE COMPLETION AND EARNINGS

Increasing school spending represents one option for improving student outcomes. Quite separately, many policymakers have started to promote the idea that a more rigorous curriculum could do much to prepare secondary students better to compete both for admission to the most demanding colleges and for the most rewarding jobs.

Rose and Betts (2001) review the literature on the link between curriculum and long-term student outcomes, and find mixed evidence on these issues. Then, using national data from High School and Beyond, they extend earlier work by studying the impact of the types of high school courses students take and their later outcomes, including college completion and earnings a decade after graduating from high school.

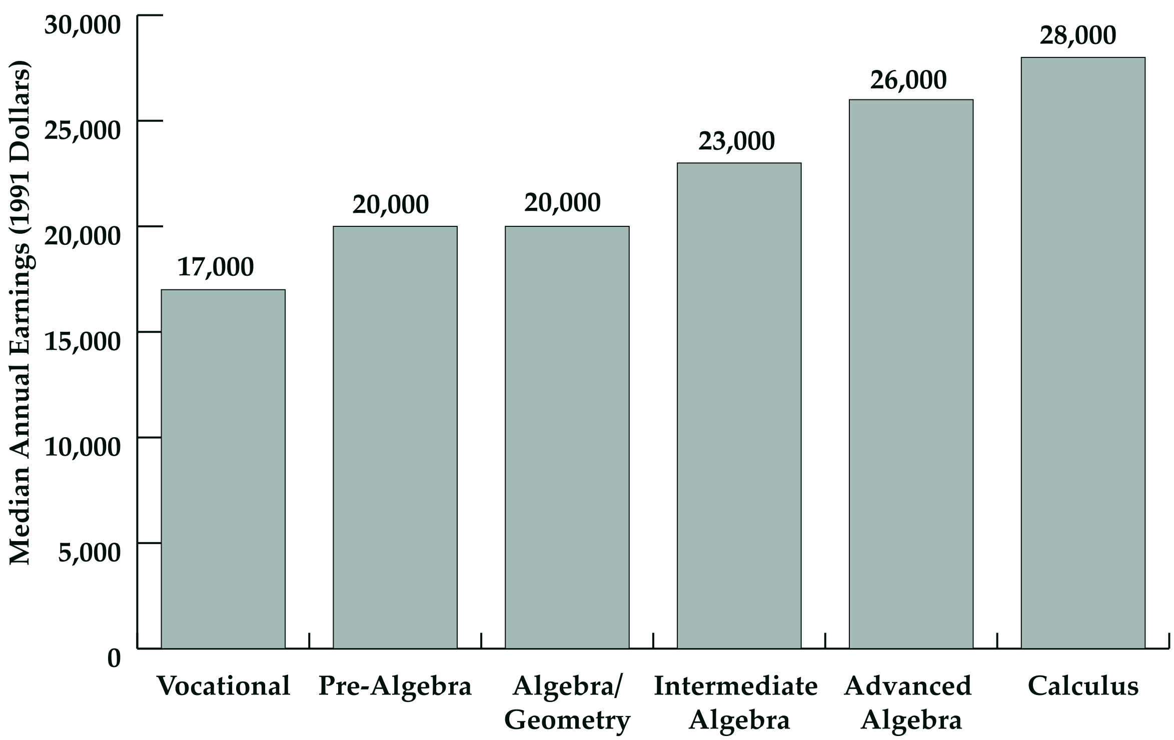
Figure 7.1, taken from Rose and Betts (2001), is based on a representative national sample of high school students from the early 198's, with earnings observed a decade after high school graduation, in the early 1990s. The figure reveals a very strong link between the highest level of math course that students take in high school and students' earnings a decade later. Of course, the strong correlation shown in the figure does not necessarily imply that high schools should require that all students must complete the most advanced math courses before graduation. After all, students vary in both ability and motivation, and it may be that high school students who complete advanced algebra and calculus earn more a decade after high school simply because they have above-average ability and motivation. In other words, the additional math courses may not cause earnings to rise.

Rose and Betts therefore undertake a detailed statistical analysis that tries to control for intervening factors such as ability, motivation, and the student's surroundings, by taking account of variations in students' test scores, high school grade point average, family background, and resources at the local high school. In spite of these and other controls, the correlation between math curriculum and earnings persists. Similarly, the authors find a strong correlation between high school math courses taken and the probability that students later graduate from college.

The authors conclude that "math matters." That is, taking higher level math in high school opens doors to students that can lead to significantly higher chances that the student will later graduate with a bachelor's degree and earn above-average wages a decade after high school. Roughly similar patterns emerge for English courses.

These findings may hold relevance for California policymakers. Historically, California has required an unusually low set of high school course requirements for graduation from high school, in part because local districts have taken the lead in setting graduation standards. But the state legislature has decisively reversed this trend, with passage of a number of pieces of school accountability legislation over the last three years. Most notably, California has put into place a detailed set of content standards stipulating what students should learn in a variety of subjects, on a grade-by-grade basis. In particular, California adopted English/language arts and mathematics standards in late 1997, and science and history/social science content standards in late 1998. The State Board of Education (SBE) typically has published two companion volumes for each subject, a set of content standards that lists skills that should be mastered in each grade, and a much longer "content framework" that provides specific examples of each type of content. In addition, the state legislature passed a law requiring all high school graduates to pass a High School Exit Examination that will test students' knowledge of math and other subjects.

Both the content standards and the exit examination may induce students to take a more rigorous high school curriculum. It will be several years before we know whether high school students have responded by enriching their mix of courses. But if the initiatives induce such shifts in course-taking, they could contribute toward reducing the massive bottlenecks exhibited in section 4, which showed that only a small fraction of high school graduates graduated with the right mix of courses needed to attend public universities.



Source: Rose and Betts (2001)
Figure 7.1 -- Median 1991 Annual Earnings a Decade after High School Graduation by Highest Math Course Taken

8. POLICY OPTIONS FOR EXPANDING THE NUMBER OF HIGHLY SKILLED GRADUATES FROM CALIFORNIA'S PUBLIC SCHOOLS

The problems facing California's public school system are easy to document; it is a far more difficult task to find silver bullets to fix these problems. The crux of the problem is that additional school spending cannot work miracles. California could increase spending per pupil considerably and have little to show for its efforts.

Given this reality, where should California start? A number of studies, including the study of California schools by Betts, Rueben and Danenberg (2000), suggest that a focus on teacher education and training might make sense. After student socioeconomic status of the students themselves, teacher preparation as measured by experience and credentials appear to be the most important determinants of student achievement in California. Spending on smaller class sizes might also improve achievement, although the cross-sectional analysis by the aforementioned authors found that class size "mattered" for student achievement in grade 3 but not in grades 2, 5, 8 or 11. In contrast, teacher experience and credentials and to a lesser extent teacher education were significant determinants of student achievement in most of the grades that these authors studied. Probably the most compelling evidence that smaller classes can boost achievement in California comes from the state-mandated evaluation of the class size reduction program in K-4 in California (CSR Consortium, 1999, 2000). But the effects of smaller class size seem to be rather modest.

The foregoing analysis of resource inequality makes clear that policymakers must do much more than stipulate the average level of resources in California schools. Considerable inequities exist in the resources that California receives. The inequities are particularly large with respect to teacher experience, credentials and education, on the one hand, and the richness of offerings in the state's high schools. It seems quite likely that these two types of inequalities are related – a school that has more highly prepared teachers can offer a larger percentage of college prep and Advanced Placement courses.

But it is also probably true that policymakers should not focus solely on inequalities among high schools; students begin to fall behind far before they reach high school. It would be naïve to think that the solution to the relatively low percentage of courses that are college preparatory in urban and rural high schools, and in disadvantaged high schools more generally, is to mandate that all high schools simply offer more of these courses. If inadequate supply of courses were the problem then we would expect to see overflowing college prep and Advanced Placement classrooms in such schools. But Betts, Rueben and Danenberg (2000) find that schools serving populations with low socioeconomic status offer fewer Advanced Placement courses than elsewhere, and further, that the average enrollment in one of these classes is smaller. In other words, we cannot simply blame high schools for supplying fewer such courses than other schools do. It appears that at least in part students in these schools also demand fewer of these courses. The solution to this divergence in high-school curriculum probably requires intervention in affected districts at the elementary and middle school level, not just at the high school level.

What then is the best policy prescription to alleviate the disparities in student outcomes across schools? It will involve interventions all the way from kindergarten through high school. It will also require considerable increases in the resources received by schools serving disadvantaged students. Equalization of resources will not suffice. Figure 6.1 made clear that equalization of resources would barely put a dent in the large inter-school gap in student achievement related to socioeconomic status. Rather, California would have to increase resources in disadvantaged schools well beyond the levels enjoyed by schools in more prosperous areas.

As if all of this doesn't sound difficult enough, policymakers must also recognize that many of the resource inequalities in California's schools reflect the workings of the labor market for teachers. One cannot simply equalize teacher experience, credentials and education by government edict. Indeed, the most highly experienced teachers in California appear to gravitate towards the suburban schools that already do well in terms of student achievement. This teacher mobility is facilitated by "first-right-of-transfer" clauses that typically appear in teachers' contracts, which guarantee job openings to the most senior teacher among the group of qualified applicants. Such contract stipulations only aggravate the large inequalities in teacher experience and credentials documented above.

What is the solution to this problem? The most difficult approach would be to tackle the problem head on, by encouraging school districts and teachers' unions to remove first-right-of-transfer clauses from collective bargaining agreements. At present this seems like a remote possibility. Furthermore, even without such contract clauses, teachers would probably continue to migrate toward suburban, resource-rich schools as they gained more experience. A second possibility would be to offer financial incentives to experienced teachers who agree to teach in low-performing schools. This could be done through salary bonuses. But such a change would mark a radical departure from existing salary policies that typically fix salary based on teachers' seniority and education level. Another way to create a financial incentive for teachers to teach in the schools most in need is through non-salary bonuses such as tax relief, housing subsidies and so on. A third route to reduce the incidence of inexperienced and uncredentialled teachers in disadvantaged areas is to increase teacher salary across the board. Such a policy would encourage more college students to enter teaching, encourage experienced teachers to stay in the profession, and might also induce former teachers back into the profession. Such a policy would not remove inequalities in teacher preparation across schools, but it would reduce the dependence of schools in disadvantaged areas on inexperienced teachers. Clearly, the last of these options is the most indirect route to reducing inequality in teacher preparation, and also the most expensive, as it raises the salaries of all teachers.

In part, today's shortage of credentialed teachers in California results from past state policy decisions. The CSR Consortium (1999) documents that the percentage of teachers lacking a full teaching credential ballooned shortly after the state implemented its class size reduction in grades K-3. The new policy artificially and suddenly boosted the demand for teachers, virtually ensuring a teacher shortage. It also appears that to some extent the policy aggravated inequalities in teachers' years of experience between schools in urban and suburban areas, as some experienced teachers in urban areas moved to new jobs in suburban schools. In light of this side effect of class size reduction, Betts, Rueben and Danenberg (2000, pp. 209-210) state: "We recommend that any future education reforms of this scope be undertaken only after the state has performed a thorough analysis of the consequences of the proposed reforms for the teacher labor market."

Other reforms could reduce shortages of teachers in specific fields and areas. For instance, districts that found themselves with a particular shortage in one area, say, math teachers, should be able to set pay bonuses in such fields. Similarly, in areas with high cost of living, districts may require additional state funding to raise teacher pay to reduce teacher shortages. The Legislative Analyst's Office (1999) evaluates a plan to give differential cost-of-living adjustments to the general purpose funds received by each school district to take regional variations in costs into account. This idea makes good sense.

The review of the link between school resources and earnings in section 6 above suggested that the economic rate of return to staying in school one additional year was far higher than the rate of return to increasing school spending. It is natural to ask whether increasing the school-leaving age might be a policy that would improve average achievement among California youth, while diminishing inequalities in achievement. It is unlikely that California would move to alter the school-leaving age. However, it does seem possible that policymakers could encourage lagging students to spend extra time on schoolwork. Some steps in this direction have already been taken. For instance in San Diego Unified School District recent reforms require students who are far behind grade level in reading to spend several hours per week in special reading classes. Those who do not improve sufficiently in certain grades are being asked to enroll in summer school. At the state level, California has recently required districts to develop alternatives to 'social promotion'. While it is unclear how these statewide reforms will play out, they do bring welcome attention, and possibly additional resources, to the students in the greatest need.

The "wild card" in K-12 reform in California right now is the impact of the sweeping reforms to the state's testing and accountability system. In spring 1998, the state introduced a new statewide test, the Stanford 9, to gauge student performance in each school in California. The state has also introduced content standards in subjects including math and science that clearly indicate the skills and knowledge that students must master in each grade. Then, in an emergency session called by Governor Davis in 1999, the legislature passed a number of education reform bills, the most important of which was the Public School Accountability Act of 1999. This legislation mandated the creation of an Academic Performance Index (API) that measures the progress of individual schools beginning in June 2000. This index will be based on several factors. At present it is based solely on the Stanford 9 test results that are gathered as part of the Standardized Testing and Reporting (STAR) system. In the future, the API may include the planned high school exit examination, as well as graduation rates and attendance rates. The API is being used to rank schools annually into ten deciles based on the above criteria, and it will be used to assign schools to either the High Achieving/Improving Schools Program (HA/IS) or the Immediate Intervention/Underperforming Schools Program (II/USP).

Beginning in the 2000-2001 school year, schools at all deciles that meet growth targets in student performance (HA/IS schools) began to receive financial awards. Schools that do not meet their performance targets may be assigned to the II/USP program.

Given the large inequality in student outcomes across schools, the II/USP program is of particular interest, because it focuses both additional financial resources and increased state oversight on schools that score at the bottom of the pack. Schools may volunteer or may be randomly selected by the California Department of Education for II/USP planning grants, and in later years, implementation grants. However, any school that does not meet its growth target in the 2000-2001 academic year must hold a public hearing and is subject to intervention by the local district board. The potential sanctions escalate if the school fails to improve sufficiently.

It seems likely that the programs in the Public School Accountability Act will alter the dynamics of resource allocation and inequality in student achievement in California in fundamental ways. First, the high profile that the API has already achieved has dramatically increased public awareness about the stark inequalities in achievement across California's schools, even inside districts. It remains to be seen, but these annual revelations may galvanize public support for boosting funding at the schools that lag behind. Second, to a limited extent the II/USP program devotes additional resources to the schools most in need. Similarly, some of the other legislation passed during the 1999 emergency session, such as summer training programs for teachers, gives some preferences to teachers from schools that lag behind.

Third, the new content standards in math and science could go a long way toward easing the supply bottleneck that this report has identified, by motivating students to take a richer and more technical set of high school courses. Statistically based research suggests a strong relation between math courses taken in high school and both earnings a decade after graduation and the probability that high school students will graduate from college. This relation holds up even after controlling for a host of measures of school resources and personal ability and motivation. However, we should not assume that more stringent high school requirements can by themselves increase the number of high school students who graduate ready to enroll in demanding technical subjects in university. It is essential to beef up course requirements in elementary and middle schools as well as high schools. By prescribing a set of skills that students need to master at each grade, the state content standards send strong signals to teachers and parents about content that students should master.

Fourth, and perhaps most important of all, the new state accountability system has the potential to increase the efficiency with which districts spend. Administrators, teachers and students know that the Stanford 9 and the related API have provided both the state and the public with new tools to understand what is happening inside schools.[8] The external pressures created by the new accountability system may well induce school systems to find innovative new programs to boost student achievement. In particular the II/USP program encourages districts to focus on schools in the bottom half of the test-score distribution. This could lead districts, with the cooperation of teachers and their unions, to implement a richer curriculum and boost resources in the very schools that need help the most.

Only time will tell, but the state may have taken the first steps to increase the number of students graduating from high school with the right set of courses to attend college.

In conclusion, this paper has focused on the early stages of the academic pipeline in California. It has found evidence that relatively few college graduates in California were born in California, and that recent high school students fare quite poorly in standardized tests, in university basic skills tests, and in the rate at which they graduate with the college preparatory courses needed to attend either public university system in California. California trails the nation in its educational spending. But there are no quick fixes: additional spending can alleviate some of the current problems but not eradicate them. Perhaps the best hope lies in the state's new accountability system, particularly if it is supplemented by flows of substantial additional funding to improve low-performing schools, especially by improving teachers' level of preparation in these schools. California's new content standards represent one of the most important aspects of the accountability reforms, because they provide teachers, students and parents with clear guidelines about what students should learn in each grade.

8 To be sure, many critics of the current system point out that the Stanford 9 test is not well linked to the new state content standards. Thus, teaching to the test on an exam that does not measure the skills that the state has stipulated on the content standards could conceivably reduce the effectiveness of school spending. But these concerns, however well founded, will probably become less relevant each year. The new high school exit examination, and an add-on to the annual Stanford 9 that is still being tested, suggest that in the future state tests will become better linked to the California content standards.

On the surface, such issues, all focused on K-12 education, seem remote from the issue of the science and engineering workforce in California. But nothing could be further from the truth. After all, less than a third of California high school students currently graduate with the courses needed to attend either public state university system, and many others never graduate at all. Clearly, it is here, at the K-12 level, that California will find the best solution to the problems now afflicting its high-tech labor market.

9. APPENDIX A

Table A.1
Real Expenditures Per Pupil in Public Schools, 1970 to 1996

Area	1970	1975	1980	1985	1990	1995	1996
United States	3,549	4,141	4,873	5,603	6,457	6,474	6,539
California	3,636	3,938	4,821	5,285	5,515	5,379	5,538
Comparison States							
Connecticut	4,124	4,949	5,602	7,075	9,644	9,286	9,105
Illinois	3,876	4,332	5,267	5,640	6,779	6,454	6,707
Massachusetts	3,541		5,727	6,805	7,817	8,018	7,997
Michigan	3,876	4,075	5,916	6,229	7,224	7,547	7,742
New Jersey	4,501	5,644	6,338	8,308	10,752	10,484	10,445
New York	5,667	6,501	7,287	8,966	10,518	10,057	9,880
Ohio	3,218	3,771	4,486	5,261	6,441	6,599	6,667
Pennsylvania	3,921	4,952	5,501	6,451	8,032	7,890	7,862
Texas	2,631	3,264	3,907	4,919	5,450	5,764	5,868
Washington	3,611	4,305	4,951	5,789	6,140	6,397	6,324
Wisconsin	4,041	4,827	5,333	6,217	7,210	7,471	7,568

Sources: National Center for Education Statistics (1999, Table 171, 1976 Table 75, 1971 Table 78.) Data are adjusted to 1997 prices using the CPI, obtained from the Bureau of Labor Statistics, U.S. Department of Labor.

Table A.2
Average Annual Salaries of Teachers in Public Schools, 1969 to 1997

Area	1969	1979	1985	1990	1995	1997
United States	37,724	35,306	37,586	40,664	39,721	39,385
California	45,111	39,838	43,451	48,626	44,505	43,725
Comparison States						
Connecticut	40,505	35,878	39,692	53,796	52,925	50,730
Illinois	41,848	38,911	40,121	42,495	43,094	43,873
Massachusetts	38,328	38,142	39,976	44,773	43,609	43,930
Michigan	42,972	43,404	44,849	48,443	49,321	49,277
New Jersey	39,928	37,939	40,528	47,169	51,342	50,442
New York	45,202	43,799	45,480	51,674	50,672	49,034
Ohio	36,298	33,756	36,572	40,051	39,846	38,977
Pennsylvania	38,739	36,510	38,563	44,278	48,537	47,650
Texas	31,728	31,242	36,490	34,778	33,701	33,648
Washington	40,475	41,606	39,094	40,621	39,865	38,788
Wisconsin	39,198	35,385	39,300	40,781	40,211	39,899

Sources: National Center for Education Statistics (1999, Table 79, 1993 Table 77, 1989, Table 67.) Data are adjusted to 1997 prices using the CPI, obtained from the Bureau of Labor Statistics, U.S. Department of Labor.

Table A.3
Percent of Teachers with Bachelor's as Highest Degree in Public Schools, 1987-1993

Area	1987	1990	1993
United States	**52.2%**	**51.9%**	**52.0%**
California	**55.3%**	**59.1%**	**58.6%**
Comparison States			
Connecticut	**22.7%**	**16.6%**	**19.6%**
Illinois	**51.4%**	**52.4%**	**49.7%**
Massachusetts	**46.5%**	**42.6%**	**38.8%**
Michigan	**39.8%**	**37.7%**	**46.6%**
New Jersey	**57.6%**	**58.6%**	**56.2%**
New York	**32.0%**	**25.9%**	**25.0%**
Ohio	**54.9%**	**54.5%**	**53.2%**
Pennsylvania	**47.7%**	**47.0%**	**46.7%**
Texas	**64.4%**	**64.9%**	**69.7%**
Washington	**69.2%**	**64.0%**	**56.3%**
Wisconsin	**63.2%**	**62.7%**	**59.3%**

Sources: National Center for Education Statistics (1999, Table 69, 1993, Table 67,1990, Table 62.)

Table A.4
Percent of Teachers with Master's Degree or Higher in Public Schools, 1987-1993

Area	1987	1990	1993
United States	**47.2%**	**47.5%**	**47.3%**
California	**44.5%**	**40.5%**	**40.4%**
Comparison States			
Connecticut	**75.0%**	**82.6%**	**79.5%**
Illinois	**47.7%**	**47.5%**	**50.0%**
Massachusetts	**51.3%**	**54.9%**	**59.6%**
Michigan	**59.6%**	**62.4%**	**53.4%**
New Jersey	**40.5%**	**39.7%**	**43.2%**
New York	**67.5%**	**74.0%**	**74.9%**
Ohio	**43.1%**	**44.3%**	**45.3%**
Pennsylvania	**50.4%**	**52.3%**	**52.8%**
Texas	**33.7%**	**34.3%**	**29.5%**
Washington	**29.4%**	**35.1%**	**42.1%**
Wisconsin	**36.6%**	**37.2%**	**40.4%**

Sources: National Center for Education Statistics (1999, Table 69, 1993, Table 67,1990, Table 62.)

Table A.5
Percent of Teachers with Less than Three Years of Experience in Public Schools, 1987-1993

Area	1987	1990	1993
United States	**8.0%**	**9.7%**	**9.7%**
California	**8.9%**	**12.9%**	**9.8%**
Comparison States			
Connecticut		**6.1%**	**6.4%**
Illinois	**6.6%**	**11.7%**	**9.0%**
Massachusetts	**5.9%**	**3.4%**	**8.4%**
Michigan	**7.2%**	**7.6%**	**7.4%**
New Jersey	**6.3%**	**5.9%**	**5.8%**
New York	**7.1%**	**7.4%**	**10.3%**
Ohio	**8.2%**	**7.0%**	**6.8%**
Pennsylvania	**5.1%**	**7.2%**	**6.9%**
Texas	**9.7%**	**11.9%**	**12.1%**
Washington	**6.8%**	**13.0%**	**10.8%**
Wisconsin	**6.6%**	**11.0%**	**9.1%**

Sources: National Center for Education Statistics (1999, Table 69, 1993, Table 67,1990, Table 62.)

Table A.6
Percent of Teachers with More than Twenty Years of Experience in Public Schools, 1987-1993

Area	1987	1990	1993
United States	**21.4%**	**25.3%**	**29.8%**
California	**27.1%**	**25.5%**	**30.7%**
Comparison States			
Connecticut	**26.5%**	**35.4%**	**38.3%**
Illinois	**27.1%**	**28.7%**	**35.1%**
Massachusetts	**23.7%**	**33.5%**	**41.0%**
Michigan	**27.2%**	**37.9%**	**41.9%**
New Jersey	**24.0%**	**31.1%**	**38.5%**
New York	**24.8%**	**30.2%**	**36.1%**
Ohio	**21.2%**	**29.2%**	**31.4%**
Pennsylvania	**26.5%**	**36.4%**	**41.8%**
Texas	**14.8%**	**16.9%**	**20.4%**
Washington	**22.4%**	**24.6%**	**26.9%**
Wisconsin	**25.0%**	**29.6%**	**36.7%**

Sources: National Center for Education Statistics (1999, Table 69, 1993, Table 67,1990, Table 62.)

Table A.7
Pupil-Teacher Ratio in Public Schools, 1970-1997

Area	1970	1975	1980	1985	1990	1995	1997
United States	**22.3**	**18.2**	**18.8**	**17.9**	**17.2**	**17.3**	**16.8**
California	**24.0**	**19.9**	**21.2**	**23.1**	**22.8**	**22.9**	**21.6**
Comparison States							
Connecticut	**21.1**	**15.5**	**15.4**	**14.0**	**13.5**	**14.4**	**14.2**
Illinois	**21.1**	**16.9**	**18.3**	**17.8**	**16.7**	**17.1**	**16.8**
Massachusetts	**21.1**	**15.9**	**15.7**	**14.9**	**15.4**	**14.6**	**14.1**
Michigan	**23.4**	**20.3**	**22.1**	**19.5**	**19.8**	**19.7**	**18.8**
New Jersey	**20.5**	**15.7**	**16.3**	**15.0**	**13.6**	**13.8**	**13.9**
New York	**19.6**	**15.1**	**18.5**	**15.8**	**14.7**	**15.5**	**15.0**
Ohio	**23.2**	**19.0**	**19.5**	**18.3**	**17.2**	**17.1**	**16.7**
Pennsylvania	**22.1**	**16.2**	**17.4**	**16.6**	**16.6**	**17.0**	**16.8**
Texas	**21.9**	**18.7**	**18.2**	**17.3**	**15.4**	**15.6**	**15.3**
Washington	**24.5**	**21.6**	**21.3**	**20.7**	**20.1**	**20.4**	**20.2**
Wisconsin	**19.7**	**15.8**	**17.1**	**16.5**	**16.2**	**15.8**	**15.4**

Sources: National Center for Education Statistics (1999, Table 67, 1996 Table 65, 1990, Table 60 1982, Tables 26 and 44, 1976, Tables 31 and 50, 1971 Tables 27 and 52.)

Table A.8
Pupil-counselor Ratio in Public Schools, 1980-1997

Area	1980	1985	1990	1995	1997
United States	**640.6**	**591.5**	**515.5**	**512.3**	**508.2**
California	**1346.2**	**869.7**	**868.8**	**1082.4**	**1070.4**
Comparison States					
Connecticut	**376.7**	**250.6**	**277.3**	**464.1**	**467.4**
Illinois	**800.1**	**675.0**	**653.5**	**688.5**	**696.0**
Massachusetts	**406.3**	**417.4**	**457.7**	**437.8**	**425.8**
Michigan	**470.2**	**465.8**	**542.1**	**571.7**	**573.7**
New Jersey	**532.7**	**481.9**	**363.5**	**380.1**	**388.9**
New York	**705.2**	**547.9**	**440.7**	**515.6**	**514.8**
Ohio	**626.6**	**624.0**	**548.5**	**570.4**	**565.4**
Pennsylvania	**540.7**	**533.8**	**496.5**	**486.3**	**482.5**
Texas	**629.8**	**611.4**	**412.6**	**456.0**	**446.3**
Washington	**651.5**	**639.1**	**595.1**	**544.1**	**532.6**
Wisconsin	**576.6**	**584.2**	**534.2**	**452.0**	**445.1**

Sources: National Center for Education Statistics (1999, Tables 40 and 84, 1998, Table 85, 1993 Table 83, 1982, Tables 26 and 45.)

Table A.9
Pupil-Instructional aide Ratio in Public Schools, 1985-1997

Area	1985	1990	1995	1997
United States	**128.5**	**104.1**	**90.7**	**82.9**
California	**93.7**	**91.7**	**97.4**	**97.7**
Comparison States				
Connecticut		**76.3**	**68.9**	**60.3**
Illinois	**183.3**	**134.9**	**92.0**	**76.3**
Massachusetts	**117.9**	**105.4**	**71.1**	**63.8**
Michigan	**139.5**	**137.1**	**114.6**	**86.0**
New Jersey	**150.3**	**113.5**	**85.9**	**79.9**
New York	**125.0**	**106.9**	**100.5**	**91.8**
Ohio	**250.9**	**198.1**	**181.9**	**155.6**
Pennsylvania	**180.4**	**147.2**	**120.5**	**103.7**
Texas	**118.4**	**107.3**	**87.1**	**80.0**
Washington	**171.5**	**84.7**	**111.5**	**104.7**
Wisconsin	**148.7**	**109.2**	**104.1**	**78.4**

Sources: National Center for Education Statistics (1999, Tables 40 and 84, 1998, Table 85, 1993 Table 83.)

Table A.10
Pupil-Librarian Ratio in Public Schools, 1980-1997

Area	1980	1985	1990	1995	1997
United States	**853.5**	**831.0**	**825.8**	**881.6**	**884.1**
California	**6109.8**	**3820.1**	**4286.1**	**6179.0**	**6058.2**
Comparison States					
Connecticut	**962.8**	**804.9**	**696.0**	**770.7**	**750.6**
Illinois	**802.7**	**835.9**	**877.8**	**1001.4**	**1038.6**
Massachusetts	**789.7**	**1279.3**	**1271.8**	**1497.6**	**1403.9**
Michigan	**1063.6**	**1050.3**	**1004.1**	**1132.0**	**1088.0**
New Jersey	**761.6**	**702.5**	**645.9**	**672.3**	**708.0**
New York	**1027.9**	**841.8**	**778.9**	**938.4**	**901.1**
Ohio	**1002.2**	**1047.3**	**1051.1**	**1127.8**	**1104.0**
Pennsylvania	**920.1**	**883.1**	**751.3**	**811.8**	**827.3**
Texas	**983.7**	**936.5**	**872.8**	**881.5**	**893.2**
Washington	**690.0**	**687.2**	**715.3**	**757.4**	**763.7**
Wisconsin	**717.0**	**723.4**	**822.3**	**614.5**	**604.8**

Sources: National Center for Education Statistics (1999, Tables 40 and 84, 1998, Table 85, 1993 Table 83, 1982, Tables 26 and 45.)

10. APPENDIX B

Table B.1
Real Expenditures per Pupil in Public Schools, 1970-1996, as a Percentage of Values in California

Area	1970	1975	1980	1985	1990	1995	1996
United States	**97.60%**	**105.20%**	**101.10%**	**106.00%**	**117.10%**	**120.40%**	**118.10%**
California	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Comparison States							
Connecticut	**113.40%**	**125.70%**	**116.20%**	**133.90%**	**174.90%**	**172.60%**	**164.40%**
Illinois	**106.60%**	**110.00%**	**109.30%**	**106.70%**	**122.90%**	**120.00%**	**121.10%**
Massachusetts	**97.40%**		**118.80%**	**128.80%**	**141.70%**	**149.10%**	**144.40%**
Michigan	**106.60%**	**103.50%**	**122.70%**	**117.90%**	**131.00%**	**140.30%**	**139.80%**
New Jersey	**123.80%**	**143.30%**	**131.50%**	**157.20%**	**195.00%**	**194.90%**	**188.60%**
New York	**155.90%**	**165.10%**	**151.20%**	**169.60%**	**190.70%**	**187.00%**	**178.40%**
Ohio	**88.50%**	**95.80%**	**93.10%**	**99.50%**	**116.80%**	**122.70%**	**120.40%**
Pennsylvania	**107.80%**	**125.70%**	**114.10%**	**122.10%**	**145.60%**	**146.70%**	**142.00%**
Texas	**72.40%**	**82.90%**	**81.00%**	**93.10%**	**98.80%**	**107.20%**	**106.00%**
Washington	**99.30%**	**109.30%**	**102.70%**	**109.50%**	**111.30%**	**118.90%**	**114.20%**
Wisconsin	**111.10%**	**122.60%**	**110.60%**	**117.60%**	**130.70%**	**138.90%**	**136.70%**

Sources: National Center for Education Statistics (1999, Table 171, 1976 Table 75, 1971, Table 78.) Data are adjusted to 1997 prices using the CPI, obtained from the Bureau of Labor Statistics, U.S. Department of Labor.

Table B.2
Average Annual Salaries of Teachers in Public Schools, 1969-1997,
as a Percentage of Values in California

Area	1969	1979	1985	1990	1995	1997
United States	**83.60%**	**88.60%**	**86.50%**	**83.60%**	**89.30%**	**90.10%**
California	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Comparison States						
Connecticut	**89.80%**	**90.10%**	**91.30%**	**110.60%**	**118.90%**	**116.00%**
Illinois	**92.80%**	**97.70%**	**92.30%**	**87.40%**	**96.80%**	**100.30%**
Massachusetts	**85.00%**	**95.70%**	**92.00%**	**92.10%**	**98.00%**	**100.50%**
Michigan	**95.30%**	**109.00%**	**103.20%**	**99.60%**	**110.80%**	**112.70%**
New Jersey	**88.50%**	**95.20%**	**93.30%**	**97.00%**	**115.40%**	**115.40%**
New York	**100.20%**	**109.90%**	**104.70%**	**106.30%**	**113.90%**	**112.10%**
Ohio	**80.50%**	**84.70%**	**84.20%**	**82.40%**	**89.50%**	**89.10%**
Pennsylvania	**85.90%**	**91.60%**	**88.80%**	**91.10%**	**109.10%**	**109.00%**
Texas	**70.30%**	**78.40%**	**84.00%**	**71.50%**	**75.70%**	**77.00%**
Washington	**89.70%**	**104.40%**	**90.00%**	**83.50%**	**89.60%**	**88.70%**
Wisconsin	**86.90%**	**88.80%**	**90.40%**	**83.90%**	**90.40%**	**91.20%**

Sources: National Center for Education Statistics (1999, Table 79, 1993 Table 77, 1989, Table 67.) Data are adjusted to 1997 prices using the CPI, obtained from the Bureau of Labor Statistics, U.S. Department of Labor.

Table B.3
Percent of Teachers with Bachelor's as Highest Degree in Public Schools, 1987-1993, as a Percentage of Values in California

Area	1987	1990	1993
United States	**94.40%**	**87.80%**	**88.70%**
California	**100.00%**	**100.00%**	**100.00%**
Comparison States			
Connecticut	**41.00%**	**28.10%**	**33.40%**
Illinois	**92.90%**	**88.70%**	**84.80%**
Massachusetts	**84.10%**	**72.10%**	**66.20%**
Michigan	**72.00%**	**63.80%**	**79.50%**
New Jersey	**104.20%**	**99.20%**	**95.90%**
New York	**57.90%**	**43.80%**	**42.70%**
Ohio	**99.30%**	**92.20%**	**90.80%**
Pennsylvania	**86.30%**	**79.50%**	**79.70%**
Texas	**116.50%**	**109.80%**	**118.90%**
Washington	**125.10%**	**108.30%**	**96.10%**
Wisconsin	**114.30%**	**106.10%**	**101.20%**

Sources: National Center for Education Statistics (1999, Table 69, 1993, Table 67,1990, Table 62.)

Table B.4
Percent of Teachers with Master's Degree or Higher in Public Schools, 1987-1993 as a Percentage of Values in California

Area	1987	1990	1993
United States	**106.10%**	**117.30%**	**117.10%**
California	**100.00%**	**100.00%**	**100.00%**
Comparison States			
Connecticut	**168.50%**	**204.00%**	**196.80%**
Illinois	**107.20%**	**117.30%**	**123.80%**
Massachusetts	**115.30%**	**135.60%**	**147.50%**
Michigan	**133.90%**	**154.10%**	**132.20%**
New Jersey	**91.00%**	**98.00%**	**106.90%**
New York	**151.70%**	**182.70%**	**185.40%**
Ohio	**96.90%**	**109.40%**	**112.10%**
Pennsylvania	**113.30%**	**129.10%**	**130.70%**
Texas	**75.70%**	**84.70%**	**73.00%**
Washington	**66.10%**	**86.70%**	**104.20%**
Wisconsin	**82.20%**	**91.90%**	**100.00%**

Sources: National Center for Education Statistics (1999, Table 69, 1993, Table 67,1990, Table 62.)

Table B.5
Percent of Teachers with less than Three Years of Experience in Public Schools, 1987-1993, as a Percentage of Values in California

Area	1987	1990	1993
United States	**89.90%**	**75.20%**	**99.00%**
California	**100.00%**	**100.00%**	**100.00%**
Comparison States			
Connecticut		**47.30%**	**65.30%**
Illinois	**74.20%**	**90.70%**	**91.80%**
Massachusetts	**66.30%**	**26.40%**	**85.70%**
Michigan	**80.90%**	**58.90%**	**75.50%**
New Jersey	**70.80%**	**45.70%**	**59.20%**
New York	**79.80%**	**57.40%**	**105.10%**
Ohio	**92.10%**	**54.30%**	**69.40%**
Pennsylvania	**57.30%**	**55.80%**	**70.40%**
Texas	**109.00%**	**92.20%**	**123.50%**
Washington	**76.40%**	**100.80%**	**110.20%**
Wisconsin	**74.20%**	**85.30%**	**92.90%**

Sources: National Center for Education Statistics (1999, Table 69, 1993, Table 67,1990, Table 62.)

Table B.6
Percent of Teachers with more than Twenty Years of Experience in Public Schools, 1987-1993 as a Percentage of Values in California

Area	1987	1990	1993
United States	**79.00%**	**99.20%**	**97.10%**
California	**100.00%**	**100.00%**	**100.00%**
Comparison States			
Connecticut	**97.80%**	**138.80%**	**124.80%**
Illinois	**100.00%**	**112.50%**	**114.30%**
Massachusetts	**87.50%**	**131.40%**	**133.60%**
Michigan	**100.40%**	**148.60%**	**136.50%**
New Jersey	**88.60%**	**122.00%**	**125.40%**
New York	**91.50%**	**118.40%**	**117.60%**
Ohio	**78.20%**	**114.50%**	**102.30%**
Pennsylvania	**97.80%**	**142.70%**	**136.20%**
Texas	**54.60%**	**66.30%**	**66.40%**
Washington	**82.70%**	**96.50%**	**87.60%**
Wisconsin	**92.30%**	**116.10%**	**119.50%**

Sources: National Center for Education Statistics (1999, Table 69, 1993, Table 67,1990, Table 62.)

Table B.7
Pupil-Teacher Ratio in Public School, 1970-1997,
as a Percentage of Values in California

Area	1970	1975	1980	1985	1990	1995	1997
United States	92.90%	91.50%	88.70%	77.50%	75.40%	75.50%	77.80%
California	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Comparison States							
Connecticut	87.90%	77.90%	72.60%	60.60%	59.20%	62.90%	65.70%
Illinois	87.90%	84.90%	86.30%	77.10%	73.20%	74.70%	77.80%
Massachusetts	87.90%	79.90%	74.10%	64.50%	67.50%	63.80%	65.30%
Michigan	97.50%	102.00%	104.20%	84.40%	86.80%	86.00%	87.00%
New Jersey	85.40%	78.90%	76.90%	64.90%	59.60%	60.30%	64.40%
New York	81.70%	75.90%	87.30%	68.40%	64.50%	67.70%	69.40%
Ohio	96.70%	95.50%	92.00%	79.20%	75.40%	74.70%	77.30%
Pennsylvania	92.10%	81.40%	82.10%	71.90%	72.80%	74.20%	77.80%
Texas	91.30%	94.00%	85.80%	74.90%	67.50%	68.10%	70.80%
Washington	102.10%	108.50%	100.50%	89.60%	88.20%	89.10%	93.50%
Wisconsin	82.10%	79.40%	80.70%	71.40%	71.10%	69.00%	71.30%

Sources: National Center for Education Statistics (1999, Table 67, 1996 Table 65, 1990, Table 60, 1982, Tables 26 and 44, 1976, Tables 31 and 50, 1971 Tables 27 and 52.)

Table B.8
Pupil-Counselor Ratio in Public Schools, 1980-1997,
as a Percentage of Values in California

Area	1980	1985	1990	1995	1997
United States	47.60%	68.00%	59.30%	47.30%	47.50%
California	100.00%	100.00%	100.00%	100.00%	100.00%
Comparison States					
Connecticut	28.00%	28.80%	31.90%	42.90%	43.70%
Illinois	59.40%	77.60%	75.20%	63.60%	65.00%
Massachusetts	30.20%	48.00%	52.70%	40.40%	39.80%
Michigan	34.90%	53.60%	62.40%	52.80%	53.60%
New Jersey	39.60%	55.40%	41.80%	35.10%	36.30%
New York	52.40%	63.00%	50.70%	47.60%	48.10%
Ohio	46.50%	71.70%	63.10%	52.70%	52.80%
Pennsylvania	40.20%	61.40%	57.10%	44.90%	45.10%
Texas	46.80%	70.30%	47.50%	42.10%	41.70%
Washington	48.40%	73.50%	68.50%	50.30%	49.80%
Wisconsin	42.80%	67.20%	61.50%	41.80%	41.60%

Sources: National Center for Education Statistics (1999, Tables 40 and 84, 1998, Table 85, 1993 Table 83, 1982, Tables 26 and 45.)

Table B.9
Pupil-Instructional Aide Ratio in Public School, 1985-1997,
as a Percentage of Values in California

Area	1985	1990	1995	1997
United States	**137.10%**	**113.50%**	**93.10%**	**84.90%**
California	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Comparison States				
Connecticut	.	**83.20%**	**70.70%**	**61.70%**
Illinois	**195.60%**	**147.10%**	**94.50%**	**78.10%**
Massachusetts	**125.80%**	**114.90%**	**73.00%**	**65.30%**
Michigan	**148.90%**	**149.50%**	**117.70%**	**88.00%**
New Jersey	**160.40%**	**123.80%**	**88.20%**	**81.80%**
New York	**133.40%**	**116.60%**	**103.20%**	**94.00%**
Ohio	**267.80%**	**216.00%**	**186.80%**	**159.30%**
Pennsylvania	**192.50%**	**160.50%**	**123.70%**	**106.10%**
Texas	**126.40%**	**117.00%**	**89.40%**	**81.90%**
Washington	**183.00%**	**92.40%**	**114.50%**	**107.20%**
Wisconsin	**158.70%**	**119.10%**	**106.90%**	**80.20%**

Sources: National Center for Education Statistics (1999, Tables 40 and 84, 1998, Table 85, 1993 Table 83, 1976 Table 31.)

Table B.10
Pupil-Librarian Ratio in Public Schools, 1980-1997,
as a Percentage of Values in California

Area	1980	1985	1990	1995	1997
United States	**14.00%**	**21.80%**	**19.30%**	**14.30%**	**14.60%**
California	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Comparison States					
Connecticut	**15.80%**	**21.10%**	**16.20%**	**12.50%**	**12.40%**
Illinois	**13.10%**	**21.90%**	**20.50%**	**16.20%**	**17.10%**
Massachusetts	**12.90%**	**33.50%**	**29.70%**	**24.20%**	**23.20%**
Michigan	**17.40%**	**27.50%**	**23.40%**	**18.30%**	**18.00%**
New Jersey	**12.50%**	**18.40%**	**15.10%**	**10.90%**	**11.70%**
New York	**16.80%**	**22.00%**	**18.20%**	**15.20%**	**14.90%**
Ohio	**16.40%**	**27.40%**	**24.50%**	**18.30%**	**18.20%**
Pennsylvania	**15.10%**	**23.10%**	**17.50%**	**13.10%**	**13.70%**
Texas	**16.10%**	**24.50%**	**20.40%**	**14.30%**	**14.70%**
Washington	**11.30%**	**18.00%**	**16.70%**	**12.30%**	**12.60%**
Wisconsin	**11.70%**	**18.90%**	**19.20%**	**9.90%**	**10.00%**

Sources: National Center for Education Statistics (1999, Tables 40 and 84, 1998, Table 85, 1993 Table 83, 1982, Tables 26 and 45.)

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