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ABSTRACT

This study is the first in a series of reports on the findings of a cooperative effort between the Nevada Department of Education and the Council of Chief State School Officers to implement a system of indicators of progress in math and science education. Achievement information from the Nevada Proficiency Examination Program is also included. The report provides three categories of indicators derived from various sources. First, student achievement indicators were taken from the 1989-90 school year results of the statewide assessment program that examined mathematics achievement of all third, sixth, and ninth grade students in Nevada. Second, instruction time and student participation in science and mathematics courses were examined. Third, indicators of teacher characteristics and preparation in math and science were derived from results of the Schools and Staffing Survey. A summary of results indicates that Nevada students perform, on the average, above national norms in mathematics at grades three, six, and nine. The amount of time spent on mathematics in Nevada's elementary schools and Nevada's eighth grade enrollments in algebra compares well with other states studied. Three concerns regarding mathematics and science education were raised: (1) effective means of encouraging students to take mathematics and science upper level courses must be established; (2) female students should be encouraged to participate in upper level mathematics and science courses, and qualified minority and female mathematics and science teachers should be recruited; and (3) attention should be directed toward the high number of mathematics teachers teaching without certification in mathematics. (MDH)

INDICATORS OF SCIENCE AND MATHEMATICS EDUCATION IN NEVADA

SCHOOL YEAR 1989-90

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and
John N. Carpenter, PhD

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October, 1991

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Executive Summary

The present study is the first in a series of reports on the findings of a cooperative effort between the Nevada Department of Education and the Council of Chief State School Officers to implement a system of indicators of progress in math and science education. Also, the present study includes achievement information from the Nevada Proficiency Examination Program. Findings for School Year 1989-90 are reported here.

The results suggest that the state's public elementary and middle/junior high schools, as a whole, do a good job in providing quality math and science education to Nevada's students. Among the major findings in this regard are:

- On the average, Nevada school children in grades three, six, and nine scored higher than national norms in mathematics competency tests, but there was a great deal of variability between districts in average achievement scores, some of which fell well below the norms.

- Statewide, there were fewer Nevada school children than would be expected in lower achievement groups on mathematics competency tests and more than expected in the higher achievement groups at grades three, six, and nine. Again, there was considerable variability between districts in this regard, and in most districts, it was more often the case that there were fewer students than expected in the low mathematics achievement group than that there were more students than expected in the higher achievement group.

- The amount of time spent on mathematics in Nevada's elementary schools compared well with other states, as did the amount of time spent on science education in grades 4-6, although the amount of time spent on science education in grades 1-3 was relatively low.

- The percentage of Nevada's eighth graders enrolled in algebra 1 or in accelerated math compared well with other states.

At the high school level, however, there are a number of indications that reflect less favorably on student outcomes in math and science education in Nevada. Such findings include:

- In 1990, 92.6 percent of the 10,294 juniors taking the Nevada High School Proficiency Examinations for the first time passed the mathematics section, down from 95.1 percent of such juniors passing in 1987.

- Nevada was near the bottom of the states studied on the percent of public school students enrolled in any mathematics courses in grades 9-12. Again, there was large variability between the districts, with as few as 50 percent of students enrolled in mathematics courses in one district to as many as 95 percent of students enrolled in math courses in another.

- Only two states had lower percentages of students enrolled in upper level mathematics courses (e.g., geometry, algebra 2, trigonometry, and calculus). In one Nevada district, there were as few as 10 percent of students enrolled in upper level mathematics courses.

- Enrollments in Nevada's public high school science courses were lower than enrollment in math courses. Nevada was at the lower end of the ranking of states in percentage of high school students taking upper level science courses (chemistry, physics, and advanced science courses), and only three states studied had lower percentages of high school students enrolled in any science course. One school district had only 30 percent of high school students enrolled in any science class and only 11 percent enrolled in upper level science classes.

- A high percentage (92) of Nevada's students are projected to have taken algebra 1 by graduation, but only one other state studied had a lower percentage of students than Nevada (33 percent) projected to have taken algebra 2 by graduation. Only five percent of Nevada's students are projected to have taken calculus by graduation.

- Nevada ranked in the bottom five among states studied in the percentage of students projected to have taken first year biology by graduation (83 percent) and in the bottom half of state rankings in percentages of students projected to have taken first year chemistry (45 percent) and first year physics (16 percent) by graduation.

- Female students were well represented in the percentages of students taking initial classes in formal mathematics, but their percentages dropped in more advanced classes. Nevada, in fact, had the lowest percentages of female enrollments among the states studied in both trigonometry (44 percent) and calculus (36 percent).

- The "gender gap" in enrollment was even greater for science classes at the advanced level. Nevada's figures closely matched those of other states except in second year physics where no females were reported as enrolled in Nevada.

- Females and racial/ethnic minorities were severely under-represented among math and science teachers nationally and in the state of Nevada.

- In terms of Nevada's future teacher supply, there were considerably more teachers over 50 years than under 30 years of age in math and science subjects, except in chemistry. However, this imbalance is characteristic of teachers in general across the country.

- In terms of teacher preparation, Nevada had very few teachers teaching science without the proper certification. However, the percentage of Nevada teachers (17 percent) assigned to teach mathematics that were not certified in mathematics was high -- nearly doubling the total percentage among the states studied. More than half of these Nevada mathematics teachers teaching out-of-field had the teaching of mathematics courses as their primary assignment. Compounding this problem, none of the other states reporting required fewer credits in mathematics for mathematics certification than the minimum requirements in Nevada.

These and other findings, including district level results, are discussed in the present report, and broad conclusions are drawn to address the issues raised.

Indicators of Science and Mathematics Education in Nevada

Advancing technology continues to shape occupational demands, yet the "talent pool" available in mathematics and science (cf. Berryman, 1983) has not kept pace with the increased need for individuals proficient in those areas. The educational community has responded over the last decade with policy reforms directed toward improving math and science education at the elementary and secondary levels. Efforts most often have taken the form of curriculum revisions, increased graduation requirements, and tightened standards for teacher certification. Likewise, improvement in mathematics and science education was featured recently in the national education goals proposed by President Bush and the nation's governors. One of the six goals proposed for American education by the year 2000 is for U.S. students to be first in the world in science and mathematics achievement. (For a broader treatment of the "America 2000" strategy, including goals and objectives for math and science education, see U.S. Department of Education, 1991.)

Assessing the rate at which progress is made toward state and national goals of improving mathematics and science education requires the identification of indicators to track progress (Blank & Dalkilic, 1991). The Nevada Department of Education (NDE) has joined with the Council of Chief State School Officers' (CCSSO) cooperative effort to develop and report such a system of indicators. The present report combines the data resulting from this cooperative effort with other, norm-referenced measures of student achievement in order to provide an initial glimpse at the condition of science and mathematics education in Nevada's public schools.

Method

The present report provides three broad categories of indicators derived from various sources. First, student achievement indicators were taken from the 1989-90 school year results of the statewide assessment program operated under the Planning, Research, & Evaluation Branch of the NDE. Results are reported here from the mathematics portion of the Comprehensive Test of Basic Skills (CTBS/4) required of all third, sixth, and ninth grade students in Nevada. Also reported are the results of the mathematics section of the Nevada High School Proficiency Examination, a test given to all eleventh grade students as a requirement for high school graduation in Nevada. Unfortunately, similar information on students' achievement in science education is not available since there is no comparable statewide testing strictly for science achievement. (For the reading and language/writing proficiency results, see Klein, 1990.)

A second set of indicators involve instructional time and student

participation in science and mathematics courses. Elementary class time spent on science and math is taken from the results of the National Center for Educational Statistics' 1988 Schools and Staffing Survey as reported by Blank & Dalkilic (1991). Student enrollment patterns in Nevada's secondary science and mathematics education courses for the 1989-90 school year are derived from the data reported to CCSSO by NDE and comparative information from other states as reported by CCSSO (Blank & Dalkilic, 1991).

The procedure for data collection on secondary enrollment was initiated in Fall, 1989 when NDE staff sent a data request to individual school districts in Nevada requesting a list of math and science - including computer science which is not reported here - courses offered, the number of classroom periods each course was offered, and the enrollment by sex of student in each course. The returned list of courses was coded using standard definitions provided by CCSSO. Science courses were categorized according to content area, and mathematics courses were categorized according to level. For mathematics courses, there were three categories (review, informal, and formal mathematics) with five levels for each category. In the formal mathematics category, for example, levels one, three, and five were most often algebra 1, algebra 2, and calculus, respectively. The coded list of classes and the definitions for coding the classes then were sent to science, math, and computer curriculum coordinators within each school district for verification of the accuracy of coding the classes offered within their district.

Finally, indicators involving teacher characteristics and preparation in the subject areas in math and science were derived from results of the Schools and Staffing Survey as reported by Blank and Dalkilic (1991) and from data regarding teacher assignments reported to CCSSO by NDE.

Results

Student Achievement in Mathematics

In the 1989-90 school year, Nevada changed over from the Stanford Achievement Test to the Comprehensive Test of Basic Skills (CTBS/4) for testing the academic proficiency of students in grades three, six, and nine. Since the CTBS/4 is a norm-referenced test, it is possible to compare the performance of Nevada students to a national reference group on the mathematics section of the examination. The present report will discuss the mathematics achievement scores on the CTBS/4 in terms of mean Normal Curve Equivalence (NCE) scores and stanines.

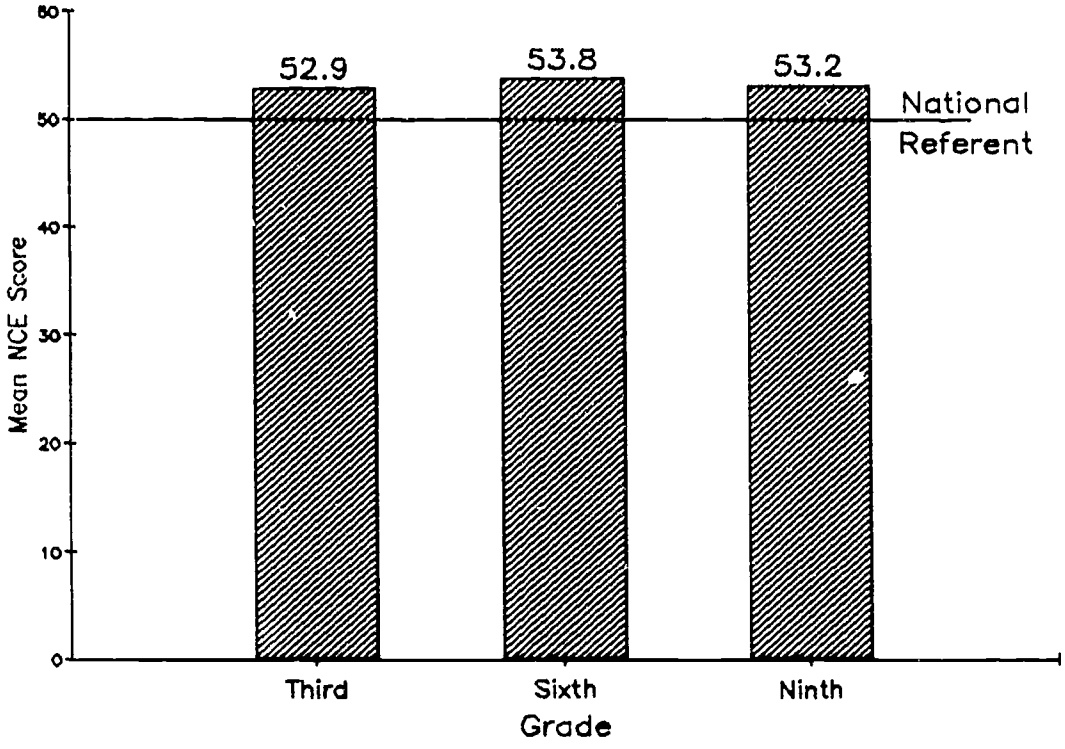
For NCE scores, the scores of the reference group are transformed into a normal (bell-shaped) distribution with a mean, or average score, of 50. Thus, a reported mean NCE score over 50 is above the national group's average and

a mean NCE score under 50 is below the group's average. *Figure 1* illustrates the results for Nevada students on the mathematics section of the CTBS/4. In terms of mean NCE scores, Nevada public school students, as a group, fared somewhat better than the national reference group at each grade. Interestingly, students who were home schooled also did better than the national group at grade levels three (mean NCE = 51.8) and six (mean NCE = 54.0), but their performance declined by grade nine (mean NCE = 42.7). However, by grade nine, the number of tested students who were home schooled dropped by about 69 percent down to 18 students.

Tables 1-3 (third column) provide mean NCE scores on the mathematics section of the CTBS/4 for each of the county school districts in Nevada. Mean NCE scores among the school districts range from 46 to 61 for third grade, from 37.4 to 58.9 for sixth grade, and 41.9 to 61.7 for ninth grade. Twelve of the 17 districts in Nevada averaged above the national reference mean of 50 on the third grade mathematics section of CTBS/4. The number of districts averaging above the referent mean dropped to nine for the sixth grade mathematics section, but rose to a very respectable 14 of the 16 districts tested at the ninth grade level.

Figure 1

Statewide Mean Normal Equivalence Scores
Comprehensive Test of Basic Skills/4
Mathematics Section



Stanines form a scale that divides a range of scores into nine groups, with the first stanine being the lowest scoring group (lowest four percent of scores), the ninth being the highest (four percent) scoring group, and the fifth stanine being average (the middle 20 percent of scores). Stanines are clustered here in groups of three: LOWER (stanines 1-3), MIDDLE (stanines 4-6), and UPPER (stanines 7-9) scoring groups. The cut scores that separate

Table 1. **GRADE 3 district-level results in mean NCE scores and stanine clusters for mathematics section of CTBS/4, School Year 1989-90.**

	Number Tested	Mean NCE Score	Percentage of 3rd Grade Students in: Lower Group (Stanines 1-3)	Middle Group (Stanines 4-6)	Upper Group (Stanines 7-9)
(Referent)*		(50.0)	(23.0)	(54.0)	(23.0)
Statewide	**14483**	**52.9**	**16.1**	**55.9**	**28.1**
Carson City	458	49.1	22.7	56.6	20.7
Churchill	242	52.7	16.1	62.4	21.5
Clark	8492	53.2	16.6	52.2	31.2
Douglas	429	53.3	11.9	49.2	38.9
Elko	613	51.8	15.2	65.5	19.2
Esmeralda	12	61.0	16.6	33.3	50.1
Eureka	21	54.5	9.5	66.7	23.8
Humboldt	230	55.7	12.6	59.1	28.3
Lander	128	52.1	13.2	66.4	20.4
Lincoln	77	51.7	19.4	57.2	23.4
Lyon	291	48.9	22.0	61.5	16.4
Mineral	107	47.1	23.3	61.7	14.9
Nye	259	49.4	14.7	70.6	14.7
Pershing	61	46.0	26.2	59.1	14.8
Storey	33	53.6	12.1	66.6	21.2
Washoe	2902	53.0	14.2	61.2	24.7
White Pine	128	51.4	14.1	71.9	14.1

*Expected mean score or expected percentage of students within each cluster of stanines

Table 2. **GRADE 6 district-level results in mean NCE scores and stanine clusters for mathematics section of CTBS/4, School Year 1989-90.**

	Number Tested	Mean NCE Score	Percentage of 6th Grade Students in: Lower Group (Stanines 1-3)	Middle Group (Stanines 4-6)	Upper Group (Stanines 7-9)
(Referent)*		(50.0)	(23.0)	(54.0)	(23.0)
Statewide	**12358**	**53.8**	**16.1**	**53.0**	**30.9**
Carson City	438	50.2	19.2	60.9	19.9
Churchill	215	48.9	21.4	60.9	17.7
Clark	7216	55.9	14.4	47.7	38.0
Douglas	307	57.9	7.8	63.2	29.0
Elko	498	57.6	7.8	61.9	30.3
Esmeralda	22	37.4	36.3	63.6	0.0
Eureka	25	46.0	36.0	44.0	20.0
Humboldt	197	51.6	21.3	53.9	24.9
Lander	111	52.5	6.3	75.6	18.0
Lincoln	57	58.9	7.1	54.4	38.6
Lyon	284	46.6	24.9	64.1	11.0
Mineral	87	43.6	28.6	59.7	11.4
Nye	213	46.5	20.2	70.4	9.4
Pershing	59	39.0	32.2	66.1	1.7
Storey	27	46.0	22.2	70.3	7.4
Washoe	2494	50.0	20.7	58.0	21.5
White Pine	108	51.7	14.8	65.7	19.5

*Expected mean score or expected percentage of students within each cluster of stanines

the three groups are determined by the scores that break the national referent group into the three stanine groups such that the MIDDLE group contains the middle 54 percent of reference scores and twenty-three percent of the reference group's scores fall within each of the LOWER and UPPER groups. Ideally, one would like to see the percentages of Nevada students in the

LOWER, potentially at-risk, group under the 23 percent expected *and*, at the same time, above the 23 percent expected in the UPPER scoring group.

The statewide and district-level percentages of Nevada students falling within each of the three clusters are provided in the last three columns on the

Table 3. **GRADE 9 district-level results in mean NCE scores and stanine clusters for mathematics section of CTBS/4, School Year 1989-90.**

	Number Tested	Mean NCE Score	Percentage of 9th Grade Students in: Lower Group (Stanines 1-3)	Middle Group (Stanines 4-6)	Upper Group (Stanines 7-9)
(Referent)*		(50.0)	(23.0)	(54.0)	(23.0)
Statewide	**11151**	**53.2**	**17.7**	**52.9**	**29.4**
Carson City	390	57.8	10.0	57.9	32.0
Churchill	184	59.8	15.8	42.4	41.9
Clark	6736	52.1	19.5	50.9	29.4
Douglas	329	55.7	13.1	54.7	32.2
Elko	397	56.0	10.8	64.7	24.5
Esmeralda**	–	---	---	---	---
Eureka	16	61.7	0.0	56.4	43.8
Humboldt	197	52.5	19.8	53.8	26.4
Lander	81	52.2	13.6	65.4	20.9
Lincoln	51	54.7	12.0	62.0	26.0
Lyon	207	53.4	15.0	61.4	23.7
Mineral	55	41.9	32.8	54.5	12.8
Nye	180	48.5	21.1	60.6	18.3
Pershing	42	51.1	19.1	64.2	16.7
Storey	16	50.3	31.3	56.4	12.6
Washoe	2160	55.0	15.1	53.7	31.2
White Pine	110	51.0	20.0	56.4	23.7

*Expected mean score or expected percentage of students within each cluster of stanines

**Esmeralda County School District does not provide instruction in grades 9-12.

right in *Tables 1-3*. As can be seen from the **Statewide** rows on each of these tables, the percentage of Nevada public school students in the LOWER scoring group at each of the three grades tested on the CTBS/4 was lower than would be expected if they were performing at the level of the national reference group, and, conversely, there was a higher percentage of Nevada public school students in the UPPER achievement group at each grade level tested.

At the district-level, there were four school districts (Clark, Douglas, Humboldt, and Lincoln) that had a smaller than expected percentage of students in the LOWER achievement level *and* a higher percentage than expected in the UPPER achievement level for *each* of the three grades tested on the mathematics section of the CTBS/4. The number of districts displaying this ideal pattern ranged from five of 17 districts tested at grade six to 11 of 16 districts tested at grade nine. Conversely, one district, Mineral, showed higher than expected percentages of students in the LOWER achievement group and lower than expected percentages of students in the UPPER group in each of the three grades tested. This undesirable pattern was displayed by three additional districts on the sixth grade mathematics testing. Another consistent pattern that emerges in the data analyzed at the district-level is that student performance in mathematics is consistently good across the different districts at the ninth grade level, and much poorer within individual districts at the sixth grade level.

Superiority over the reference percentages can be traced more frequently at the district-level to reduced percentages of students in the LOWER level than to increased percentages of students in the UPPER level. At each of the three grade levels, a substantial majority of Nevada school districts have lower than expected percentages of students in the LOWER achievement level group. A majority of districts (11 of 16 districts tested) had higher than expected percentages of students in the UPPER achievement level at grade nine. However, a majority of the 17 districts tested at the third grade (10) and the sixth grade (12) had *lower* percentages of students in the UPPER achievement group than expected from the national reference figures.

Testing on the mathematics section of the CTBS/4 stops with the ninth grade. Beyond that examination, mathematics achievement is measured statewide by the Nevada High School Proficiency Examination. In the 1989-90 school year, 92.6 percent of the 10,294 juniors taking the Nevada High School Proficiency Examinations for the first time passed the mathematics section. The percentage passing the mathematics section is lower than the 95.1 percent that passed in 1987. Comparisons in the upcoming year will be difficult since the minimum score for passing the Proficiency Examinations was raised for 1991. However, the present figures reflect a real drop in performance by students in mathematics.

High School Enrollments in Science and Mathematics

In this section and in the results sections to follow, *actual* statewide and district-level data collected by NDE will be reported, whereas all *comparative* data that places Nevada results within the context of results from other states are taken from the CCSSO report by Blank and Dalkilic (1991). With regard to the actual enrollments, the data submitted to CCSSO on enrollments in Nevada was incomplete for certain districts, and other statistics reported in the CCSSO report were erroneous (e.g., Table 7 in the CCSSO paper reports New York's data for Nevada). The reader is cautioned therefore that on every occasion in which the enrollment numbers reported in this report conflict with the enrollment numbers reported in the CCSSO report, the present figures should be taken as accurate.

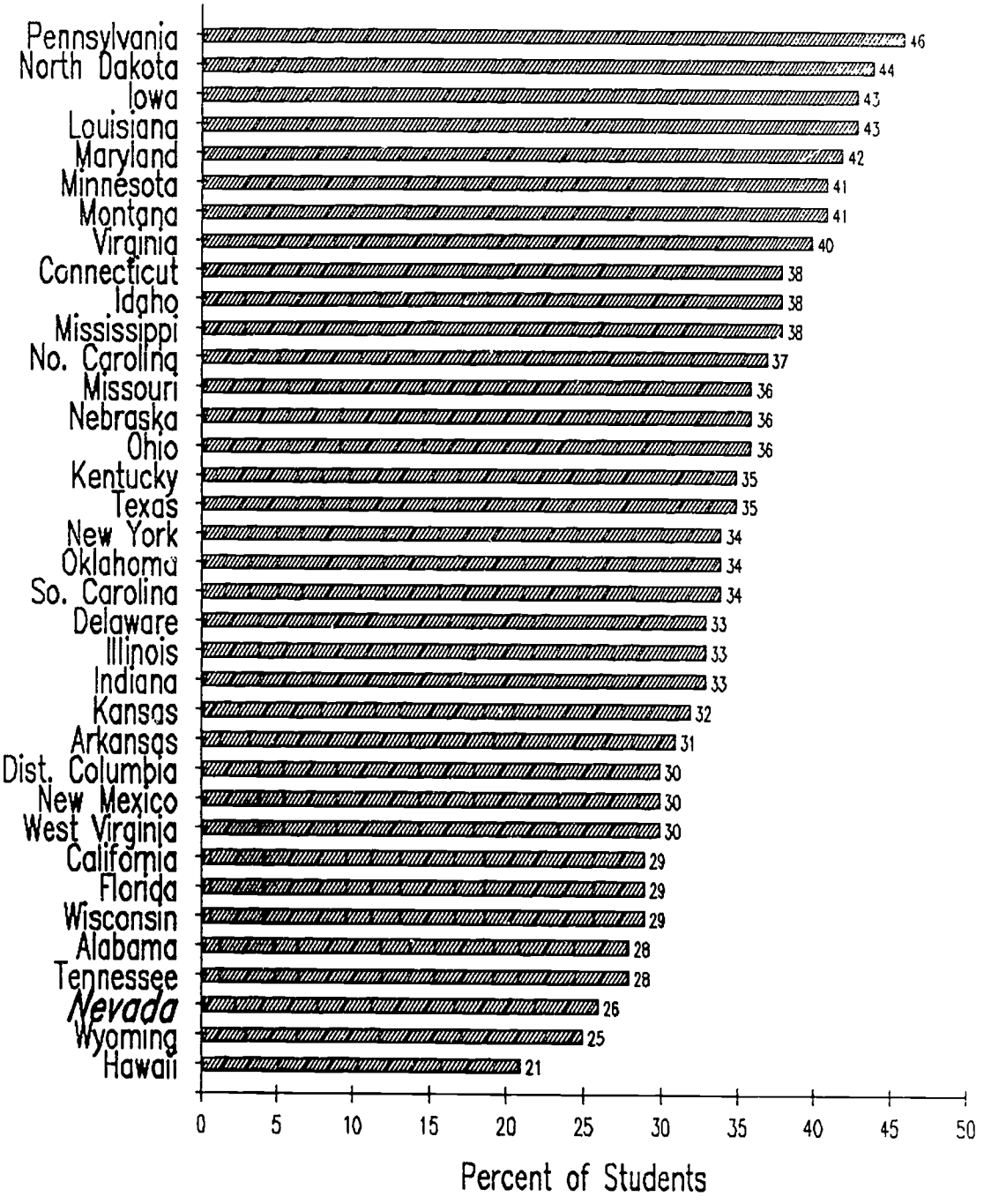
Actual enrollments for fall, 1989 indicate that 75 percent of Nevada public school students in grades 9-12 were enrolled in mathematics courses, compared to a 36 state total of 84 percent of all students in grades 9-12. Of the 36 states reported, five states had a lower percentage of students taking math in grades 9-12. Twenty-six percent of Nevada students in grades 9-12 were enrolled in review and informal math, 22 percent were enrolled in algebra 1, and 26 percent were enrolled in upper level mathematics, e.g., geometry, algebra 2, trigonometry, and calculus. The percent of Nevada's high school students enrolled in upper level mathematics is eight percent lower than the 36 state total. Only Wyoming and Hawaii had a lower percentage of high school students enrolled in upper level mathematics courses (see *Figure 2*).

Table 4 contains statewide and district-level results for mathematics course enrollments in Nevada public high schools. The percentages of 9-12 grade students enrolled in mathematics classes ranged from 50 percent in Carson City School District to 95 percent in both Eureka and Lander County School Districts. For 9-12 grade enrollments in upper level mathematics courses, the percentages range from 10 percent in Mineral County School District to 44 percent in both Douglas and Storey County School Districts. Lincoln County School District clearly had the largest percentage (77) of high school students enrolled in review and informal mathematics courses while having only 14 percent enrolled in upper level mathematics courses.

Enrollments in science for the same period are much lower. Sixty-three percent of Nevada public high school students were enrolled in science courses, compared to a 36 state total of 72 percent of high school students. Only California, Idaho, and Illinois had lower percentages of high school students enrolled in science courses. Nevada does not even fare well against states with lower graduation requirements. Seven states require fewer science credits (one credit or less) for graduation than Nevada (two credits), yet of these states, all but Illinois had considerably higher percentages of students enrolled in science courses.

Figure 2

Percent of Grade 9-12 Students Taking Upper Level Math Courses, October, 1989



Adapted from Blank & Dalkilic (1991) by permission.

Table 4. **Percent of Nevada students in grades 9-12 taking mathematics courses.**

School District	Percentage of 9-12 Grade Students Taking Mathematics: Total	Upper Level	Review & Informal
National (36 states)	84	34	27
Statewide	**75**	**26**	**26**
Carson City	50	33	8
Churchill	82	31	34
Clark	74	27	29
Douglas	85	44	22
Elko	76	34	22
Eureka	95	37	42
Humboldt	92	31	41
Lander	95	31	46
Lincoln	91	14	77
Lyon	80	23	40
Mineral	68	10	35
Nye	69	28	20
Pershing	74	25	25
Storey	89	44	11
Washoe	76	19*	15
White Pine	79	32	27

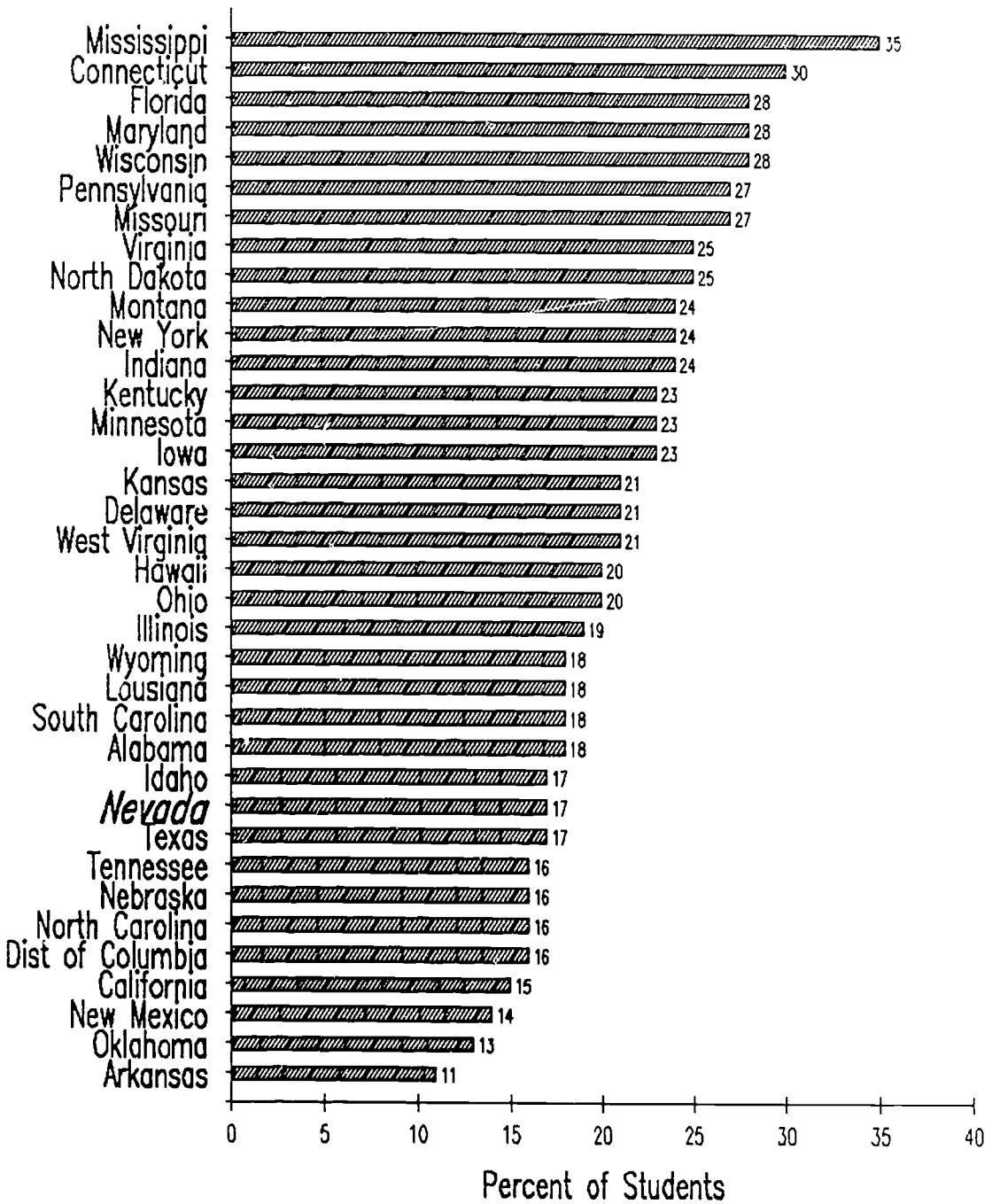
Upper Level are courses at Formal Math Levels 2-5 (e.g., geometry, algebra 2, trigonometry, calculus). Review & Informal are courses in general math, applied math, or pre-algebra.

*Does not include Algebra 2 enrollments.

Eighteen percent of Nevada's public high school students were enrolled in introductory science courses, 21 percent were enrolled in first year biology, 17 percent were enrolled in upper level science (i.e., chemistry, physics, and advanced/second year science courses), and six percent were enrolled in other science courses. Eight of the 36 states ranked lower than Nevada in the percent of high school students taking upper level science classes (see *Figure 3*).

Figure 3

Percent of Grade 9-12 Students Taking Upper Level Science Courses, October, 1989



Adapted from Blank & Dalkilic (1991) by permission.

Table 5 provides statewide and district-level science enrollments. Total school district enrollment in science courses ranged from a low of 30 percent of high school students in Carson City to a high of 89 percent in Eureka County. Storey County School District had the highest high school enrollment in upper level science courses (33 percent), while Carson City again had the lowest enrollment (11 percent). Nearly one-half (47 percent) of high school students in Lincoln County School District were enrolled in introductory science courses.

Table 5. **Percent of Nevada students in grades 9-12 taking science courses.**

School District	Percentage of 9-12 Grade Students Taking Science: Total	Upper Level	Introductory
National (36 states)	72	21	23
Statewide	**63**	**17**	**18**
Carson City	30	11	0
Churchill	63	19	0
Clark	63	17	18
Douglas	46	27	5
Elko	70	22	19
Eureka	89	27	40
Humboldt	80	14	43
Lander	72	23	16
Lincoln	83	16	47
Lyon	83	22	28
Mineral	63	18	16
Nye	48	13	14
Pershing	70	14	24
Storey	71	33	19
Washoe	69	16*	22
White Pine	64	20	26

Upper Level are first year chemistry or physics courses or advanced or second year science courses. Introductory are first year earth, physical, or general science courses.

*Washoe did not indicate Biology 2 enrollments.

Projected High School Enrollments in Science and Mathematics Courses

Based upon enrollments in mathematics courses in grades 9-12 in Nevada during fall, 1989, it is estimated[1] that 92 percent of Nevada's public high school students will have taken an algebra 1 (i.e., a Formal Math Level 1) course by graduation. This figure compares favorably with the estimated 81 percent nationally taking algebra 1 by graduation. However, Nevada does not fare as well in estimated enrollments in advanced mathematics courses. Only 33 percent of Nevada high school students are projected to have taken an algebra 2 (i.e., Formal Math Level 3) course by graduation compared to an estimate of 49 percent nationally. In this regard, Nevada is tied with Hawaii for 36th rank out of the 38 states reporting data in the CCSSO project (see *Figure 4*). Five percent of Nevada's high school students are estimated to have taken a calculus (i.e., Formal Math Level 5) course by graduation. The national estimate is that 9 percent will have taken a calculus course by graduation.

Although the estimated percentages are inflated somewhat for algebra 1 and deflated somewhat for algebra 2 by an inability to separate algebra 1 and algebra 2 enrollments in Washoe County, the conclusion remains fairly clear: Nevada's students are taking their fair share of introductory formal mathematics courses, but they are lagging far behind in taking advanced mathematics courses.

The picture for Nevada is not improved greatly when considering estimates of high school enrollment in science classes. It is estimated that 83 percent of Nevada public high school students will have taken the most popular of science courses -- first year biology -- by graduation. The U.S. total is over 95 percent of students, and Nevada ranks 34th among the 38 reporting states in this regard. The estimate for chemistry is somewhat better. Forty-three percent of Nevada high school students are projected to have taken a first year chemistry course by graduation compared to 45 percent of high school students estimated nationally. This figure places Nevada 23rd among the 38 reporting states (see *Figure 5*). Likewise, an estimated 16 percent of Nevada

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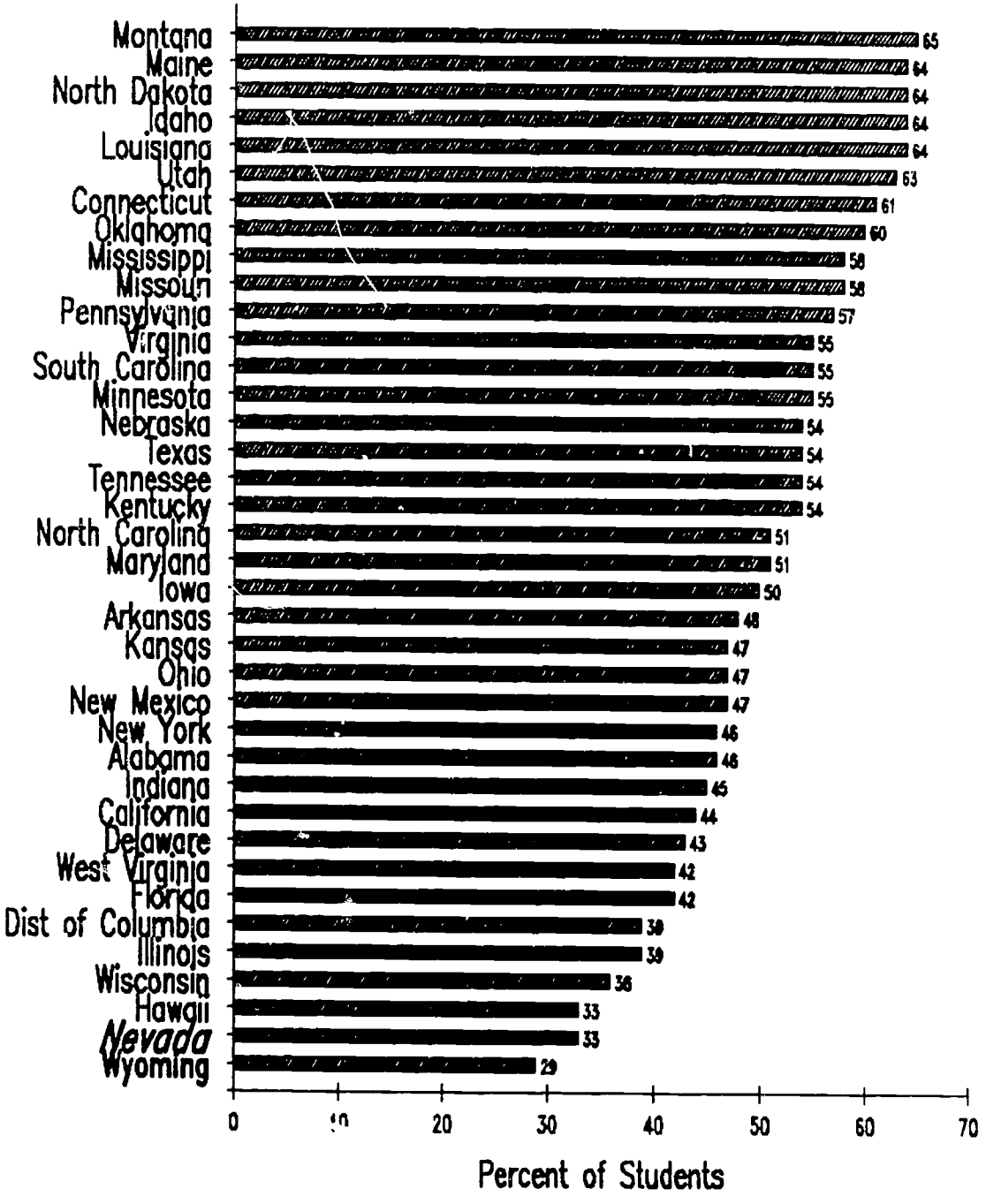
[1]The percentages provided in this section are statistical estimates of course taking of Nevada high school students by the time they graduate. Their computation is based on the total course enrollment for Nevada in grades 9-12 as of Fall, 1989 divided by the estimated number of students in a grade cohort during four years of high school. The denomenator in the equation, the grade cohort was developed from CCD and regional weights based on NAEP transcript study. For greater discussion of rationale behind selection of this estimation method and for the actual formula used in computation, see Blank and Dalkilic (1991), p. 73.

As noted in the previous section, the actual enrollments in science and mathematics courses in Nevada for Fall, 1989 were greater than those reported to CCSSO. Therefore, the present percentage estimates are revisions of those reported for Nevada by Blank and Dalkilic. To calculate the present percentages, the actual enrollments were divided by the cohort figure that was regenerated algebraically from the enrollments reported to CCSSO and the percentage estimates provided by Blank and Dalkilic. The revision did not change greatly the figures reported for Nevada in Blank and Dalkilic on estimates of mathematics course enrollments, but the figures provided in estimate of science course enrollments were changed considerably.

Figure 4

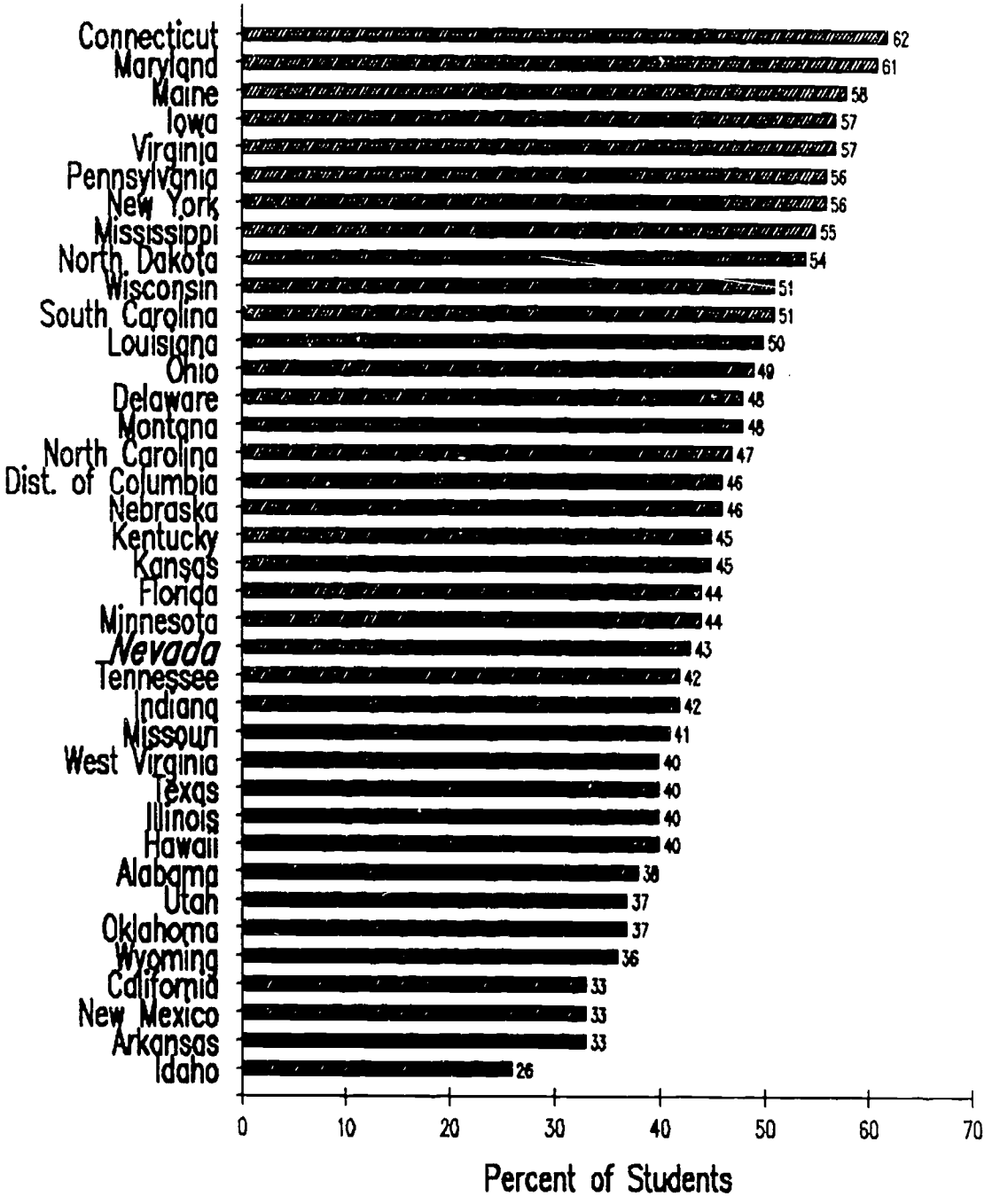
Estimated Percent of Public High School Students Taking Algebra 2 by Graduation



Adapted from Blank & Dalkilic (1991) by permission.

Figure 5

Estimated Percent of Public H. S. Students Taking 1st Year Chemistry by Graduation



Adapted from Blank & Dalkilic (1991) by permission.

high school students are projected to have taken a physics course by graduation compared to a national estimate of 20 percent of high school students - tied with California, Missouri, South Carolina, and Wyoming for 24th out of the 38 reporting states.

High School Science and Mathematics Enrollments by Sex of Student

It is common knowledge, and the subject of considerable research interest (e.g., Friedman, 1989; Linn & Hyde, 1989; Maple & Stage 1991), that women are severely under-represented in the much-needed technical careers that require advanced training in science and mathematics. Perhaps the most significant variable in women's decision to pursue a specific field of study is the mathematics and science courses taken in high school (Ethington & Wolfe, 1988). Female enrollment traditionally drops as the level of science or mathematics courses increases. This finding clearly is supported in the present study.

Using the median percentage of male and female enrollment from 16 states, equal percentages of high school males and females (50 percent each) were enrolled in Algebra 1 level mathematics courses, and slightly more females (52% of the total) were enrolled in Algebra 2 level courses. The percentages for Nevada exactly match these 16 state figures. The median percentage of female enrollment in the 16 states drops when continuing on to trigonometry (48 percent) and calculus (45 percent) level courses. Nevada, in fact, had the *lowest* percentages of female enrollments among the 16 states in both trigonometry (44 percent) and calculus (36 percent) level courses. Nevada's high school mathematics course enrollment percentages by sex of student are presented in *Figure 6*.

The "gender gap" in enrollment in advanced technical courses is even greater for science classes. Again, both the sixteen state median percentages and Nevada's enrollment percentages indicate equal percentages of males and females in first year biology, and slightly more females (51 percent) than males (49 percent) enrolled in first year chemistry courses. Females also outnumber males in second year and advanced biology courses (55 percent among the 16 states, 54 percent in Nevada). However, both the 16 state median and Nevada percentages of females enrollment drops for first year physics (40 percent in each) and second year and advanced chemistry (45 percent median, 44 percent in Nevada). By second year and advanced physics, the 16 state median percentage of females enrolled drops to 30 percent, and, in Nevada, *no* females were reported as enrolled in second year and advanced physics courses. Nevada's high school science course enrollment percentages by sex of student appear in *Figure 7*.

Figure 6

Nevada's High School Mathematics Course Enrollment Percentages by Sex of Student

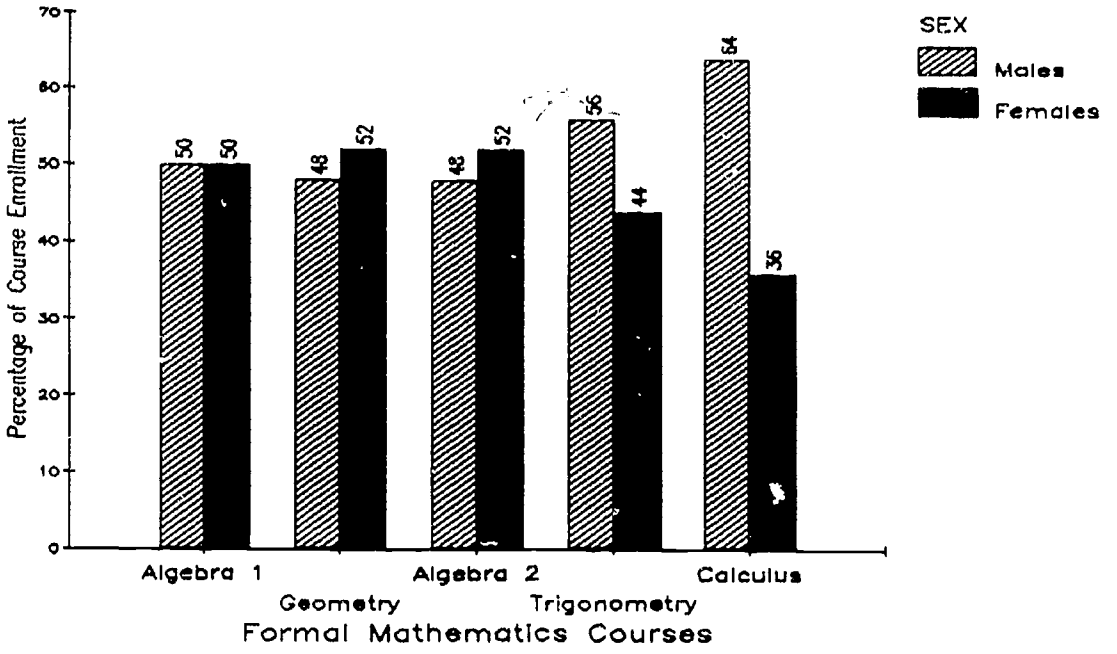
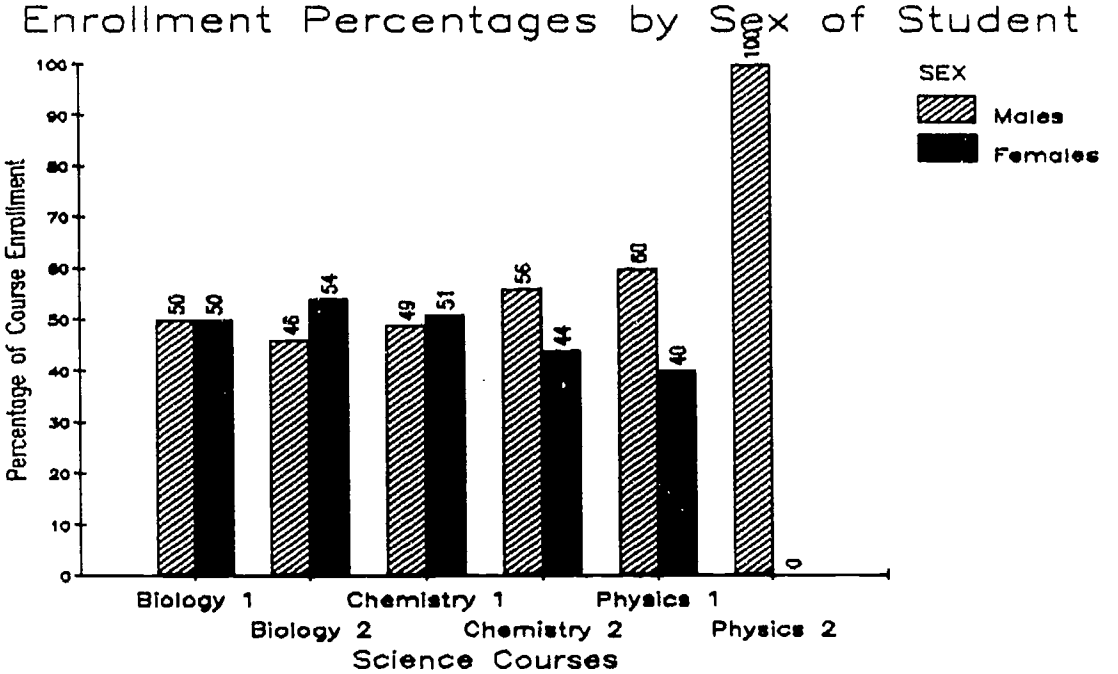


Figure 7

Nevada's High School Science Course Enrollment Percentages by Sex of Student



'1' are first year courses. '2' are second year and advanced courses.

Algebra and Accelerated Mathematics in Eighth Grade

Data was collected on the level of mathematics being taught in the eighth grade. As Blank and Dalkilic (1991) note, to complete a five course college preparatory mathematics sequence ending in calculus by high school graduation, students usually must take algebra 1 in eighth grade. Further, they cite the Second International Mathematics Study indicating that the proportion of United States students being taught algebra in eighth grade as a major contributor to low U.S. mathematics achievement scores.

For comparisons at the eighth grade level, algebra 1 and accelerated mathematics (pre-algebra) are considered. Although Blank and Dalkilic report that 23 percent of Nevada's eighth graders were enrolled in accelerated math or algebra 1 in Fall, 1989, the actual number is larger, boosting the percent of students enrolled in these courses to slightly over 30 percent. This 30 percent figure for eight grade students enrolled in accelerated math or algebra 1 is a conservative one and is high when compared to a median percentage of 13 percent among the 28 states reporting to CCSSO. Only Colorado reported a higher figure. Thus, unlike the evidence at the high school level, Nevada public schools appear to be doing a good job of getting students enrolled in advanced mathematics courses in the middle or junior high school years. For Nevada statewide and district-level results, see *Table 6.*

Elementary Class Time on Science and Mathematics

Using data from the Schools and Staffing Survey of 1988, Blank and Dalkilic (1991) report state-by-state comparisons on elementary class time spent on science and mathematics. Class time spent on science in grades 1-3 ranges from 1.3 hours per week (Rhode Island) to 3.5 hours (Texas). The figure reported for Nevada is 1.9 hours per week, under the national median of 2.3 hours per week and low enough to place Nevada in a three-way tie with Washington and West Virginia for 45th among the fifty states and the District of Columbia. By grades 4-6, the range of class time spent on science increases from 2.2 (Utah) to 4.1 (New Hampshire) hours per week. In Nevada, 3.2 hours per week is reported as spent on science in grades 4-6, above the national median of 3.0 hours per week and high enough to place Nevada in a five-way tie for nineteenth among the fifty states and D.C.

The time spent on mathematics/arithmetic in grades 1-3 ranges from 4.2 (Ohio) to 6.0 (D.C.) hours per week. Nevada is reported to spend 4.9 hours per week in grades 1-3 on mathematics/arithmetic, slightly above the national median of 4.8 hours per week. In grades 4-6, the time spent on mathematics/ arithmetic ranges from 4.1 (Ohio) to 5.5 (Hawaii and Tennessee) hours per week. Nevada is reported to spend 4.8 hours per week on mathematics/ arithmetic in grades 4-6, just under the national median of 4.9 hours per week.

Table 6. **Percent of GRADE 8 students taking accelerated mathematics and algebra 1, School Year 1989-90.**

School Districts	Total Enrollment	*Students in accelerated math/algebra 1* Number	Percentage
Statewide	**13,198**	**4,020**	**30%**
Carson City	413	66	16
Churchill	252	42	17
Clark	8,013	2,539	32
Douglas	358	154	43
Elko	452	199	44
Esmeralda*	16	—	—
Eureka	18	0	0
Humboldt	178	48	27
Lander	118	0	0
Lincoln	75	6	8
Lyon	295	75	25
Mineral	83	0	0
Nye	205	0	0
Pershing	52	0	0
Storey*	30	—	—
Washoe	2,520	839**	33**
White Pine	120	52	43

*Math classes not reported or accelerated math and algebra courses not identified.
**Data may include some seventh grade enrollments.

Indicators of Current Teacher Supply

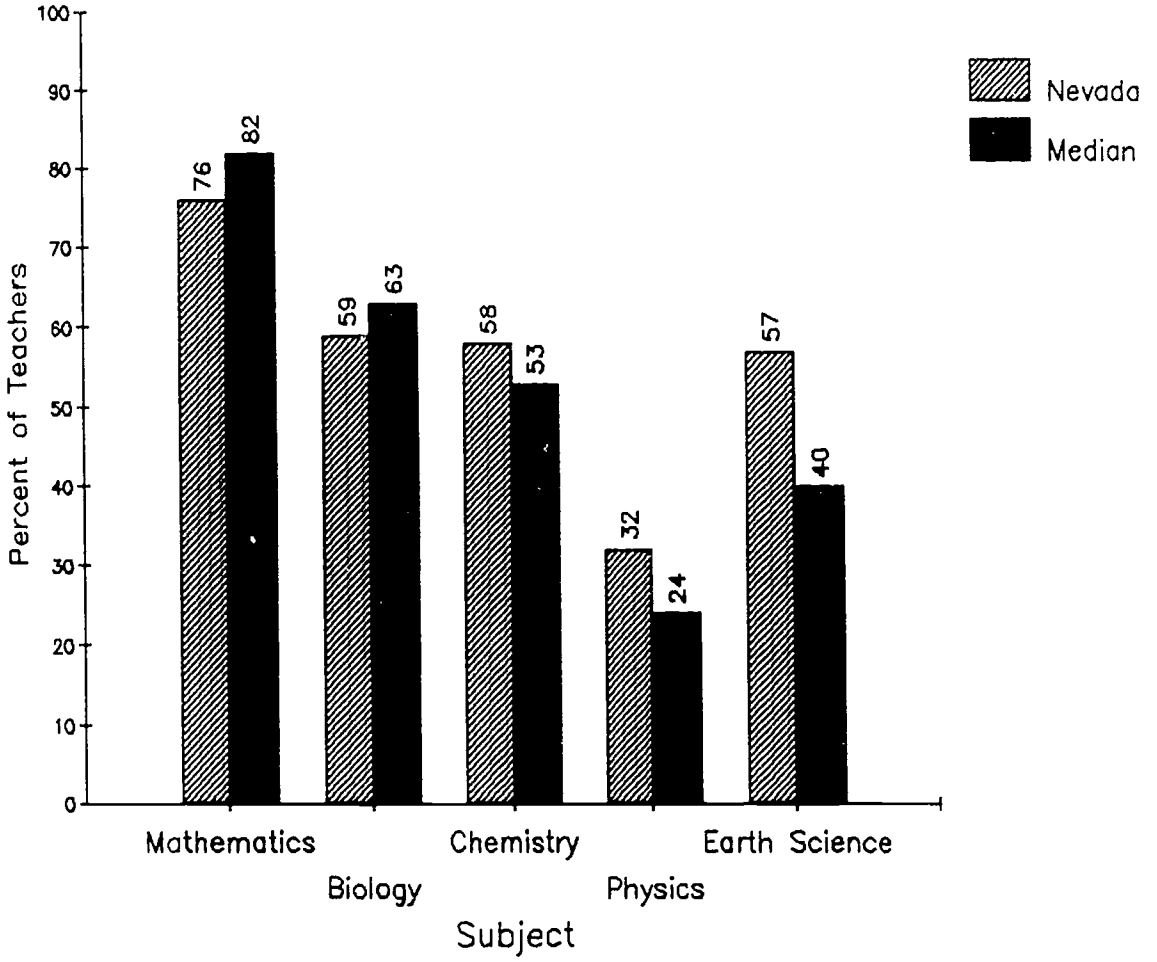
A major concern during the previous decade was potential shortages of science and mathematics teachers as these teachers were leaving the teaching profession at a higher rate than the number of new college graduates entering the teaching profession (cf. Blank & Dalkalic's, 1991, pp. 25-26 discussion). *Figure 8* shows the median percentage of teachers in states participating in the study and the percentage of Nevada teachers in each of five subjects that have their primary assignment in those subjects. The pattern of findings on teaching

in one's primary area was much the same in Nevada as in other states. Mathematics had the highest percentage of teachers assigned to mathematics as their primary teaching area, and physics had the lowest percentage of teachers assigned to physics as their primary teaching area.

As illustrated in *Figure 8*, Nevada had a higher percentage of chemistry, physics, and, especially, earth science teachers teaching in each of those areas as their primary assignment when compared to the median among states participating in the study. On the other hand, Nevada had a lower than the median percentage of mathematics and biology teachers teaching mathematics and biology, respectively, as their primary assignment.

Figure 8

Percent of Teachers in Each Subject With Primary Assignment in the Subject

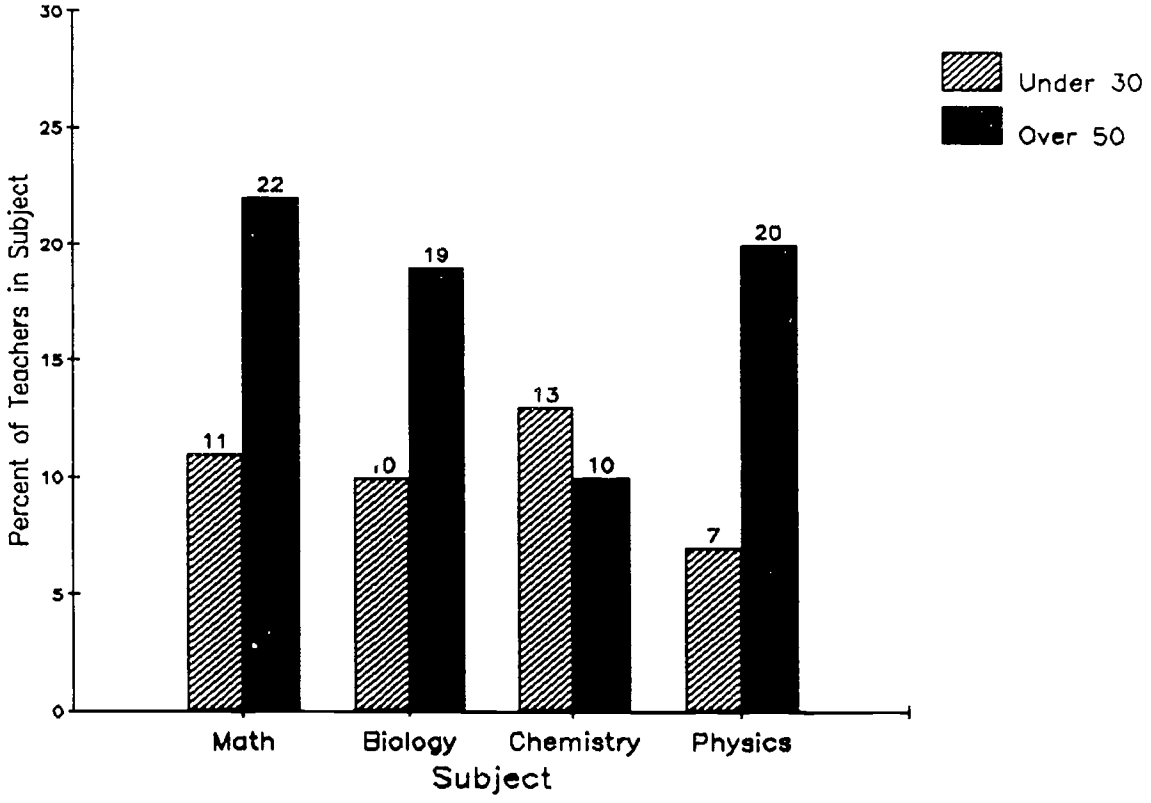


Median is median of percentages from all participating states.

The age of current science and mathematics teachers is a relevant indicator of future teacher supply. As noted by Blank and Dalkilic (1991), the age distributions provide useful information on possible shortage fields as teachers near retirement age. *Figure 9* illustrates the percentage of Nevada teachers in each subject under 30 and over 50 years of age. In only one area, chemistry, was there a higher percentage of teachers under 30 (13 percent) than the percentage of teachers over 50 (10 percent), suggesting the potential for a shortage of math and other science teachers in the future. In mathematics, Nevada had a lower percentage of its teachers in the under 30 category (11 percent) and a higher percentage in the over 50 category (22 percent) than the total of the 36 participating states (13 percent under 30 and 19 percent over 50). Nevada ranked 10th highest among the 36 states in the number of mathematics teachers age 50 and over. The percentages of young teachers in biology (10 percent) and physics (seven percent) were also below corresponding totals in participating states (under 30: 12 percent in biology and 11 percent in physics). However, when the age statistics for *all* high school teachers are considered (21 percent over 50 and 10 percent under 30), Nevada's math and science teachers are not over-represented in the over 50 category or under-represented in the under 30 category.

Figure 9

Nevada Math & Science Teachers
Under Age 30 & Over Age 50



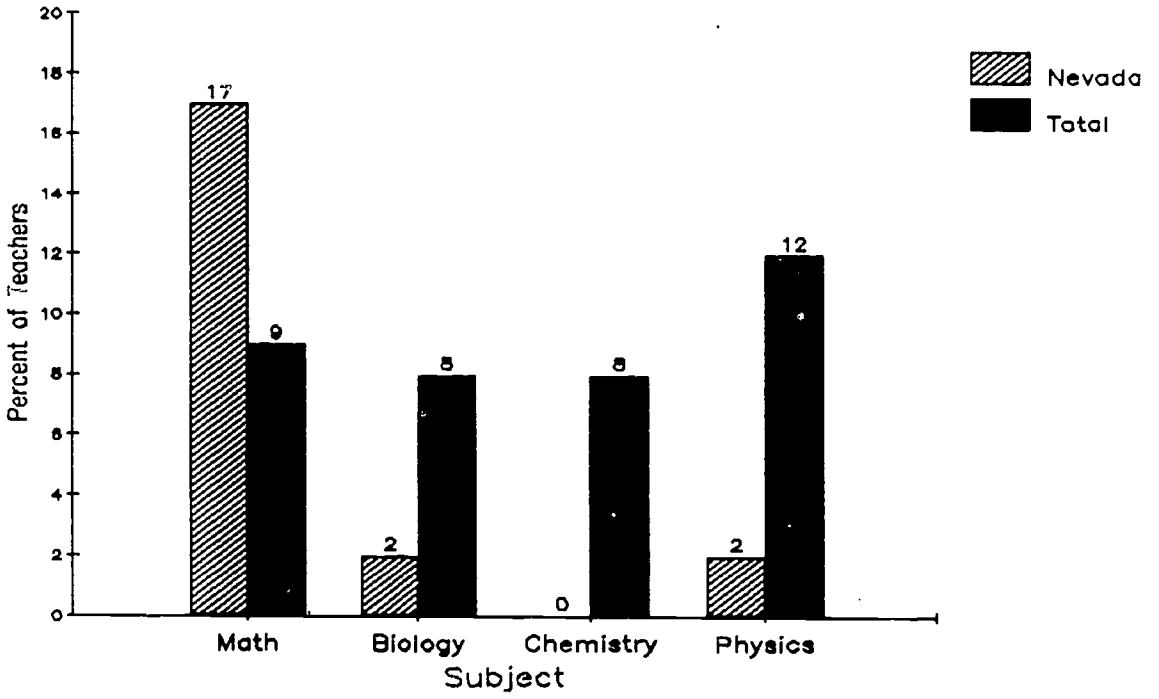
Indicators of Teacher Preparation

In addition to the potential of math and science teacher shortages, there was concern during the previous decade about problems with underqualified teachers in science and mathematics classrooms. As noted in the CCSSO report, teacher certification for a specific teaching assignment is a common indicator of the extent to which teachers meet the basic state requirements for knowledge and preparation. *Figure 10* shows the percentages of teachers assigned to teach in each subject that were not certified in that subject. As can be seen in that figure, Nevada had very few teachers teaching science out-of-field. However, the percentage of Nevada teachers assigned to mathematics that were not certified in mathematics is high -- nearly doubling the 30 state total percentage of math teachers teaching out-of-field, and high enough to place Nevada fourth among those states in this regard.

There are few explanations for the finding for mathematics teachers that would justify such a state of affairs. For example, one might suspect that the bulk of Nevada's percentage was comprised of teachers with a few, incidental assignments teaching in mathematics, but surprisingly, more than half of those Nevada mathematics teachers teaching out-of-field had the teaching of mathematics courses as their primary assignment. Ten percent of all mathematics teachers in Nevada are teaching mathematics out-of-field as their primary assignment.

Figure 10

Percent of Mathematics & Science Teachers Assigned Out-of-Field



Total = 30 states for Math; 27 for Biology; and 26 for Chemistry & Physics.

Further, the high level of teachers teaching mathematics without a math certificate is not due to stiffer requirements for math certification in Nevada than in other states. Indeed, in terms of semester course credit hours required in mathematics to get a certificate to teach math, ***none*** of the other 39 states reporting required fewer credits in mathematics for mathematics certification than does Nevada (a minimum of 16 semester credits in mathematics). Also, only three states had lower minimum course credit requirements in a specific area of science in order to be certified in that specific area (i.e., biology, chemistry, physics) than Nevada.

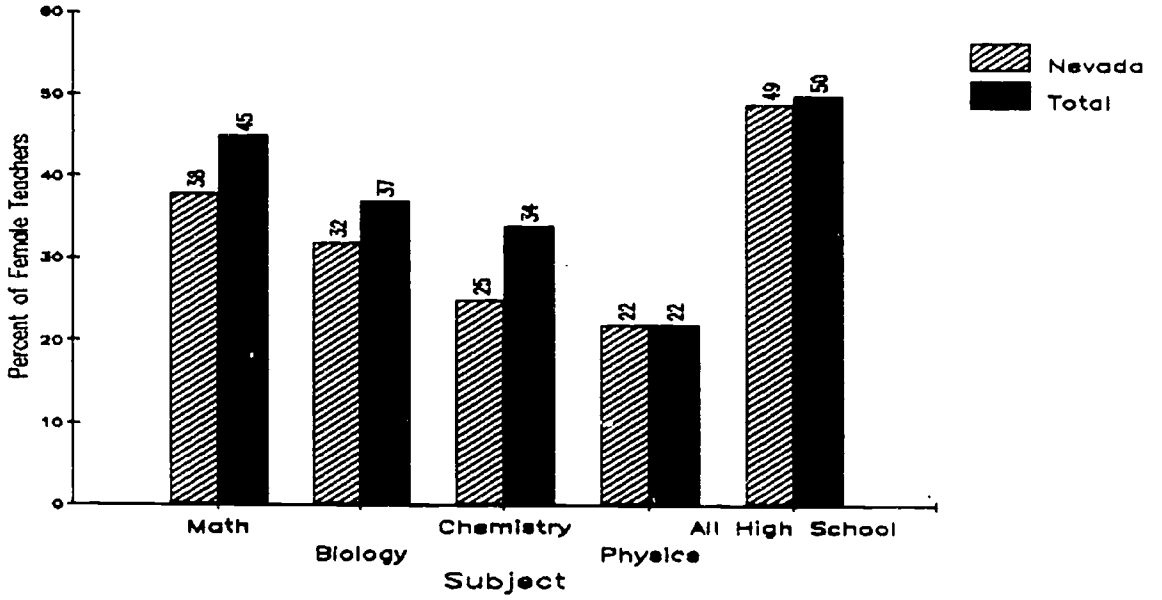
A third unlikely explanation for the high level of teachers teaching mathematics out-of-field is the rapid increase in population in the state that increases the demand for teachers and, thus, increases the likelihood of teachers teaching out-of-field. Such an explanation is insufficient since it does not account for the low number of teachers teaching science without an appropriate science certification.

Equity in Math and Science Teaching

The sex and race/ethnic characteristics of the teaching force provides an indicator of the match between teacher characteristics and characteristics of the student population. Although approximately 50 percent of all high school teachers in the country are female, considerably less than half of all mathematics and science teachers are female (Blank & Dalkilic, 1991). The percentages of the math and science teaching force in Nevada that are female were even lower (see *Figure 11*).

Figure 11

Percent of Female Math & Science Teachers



Total based on total percentage for 40 participating states.

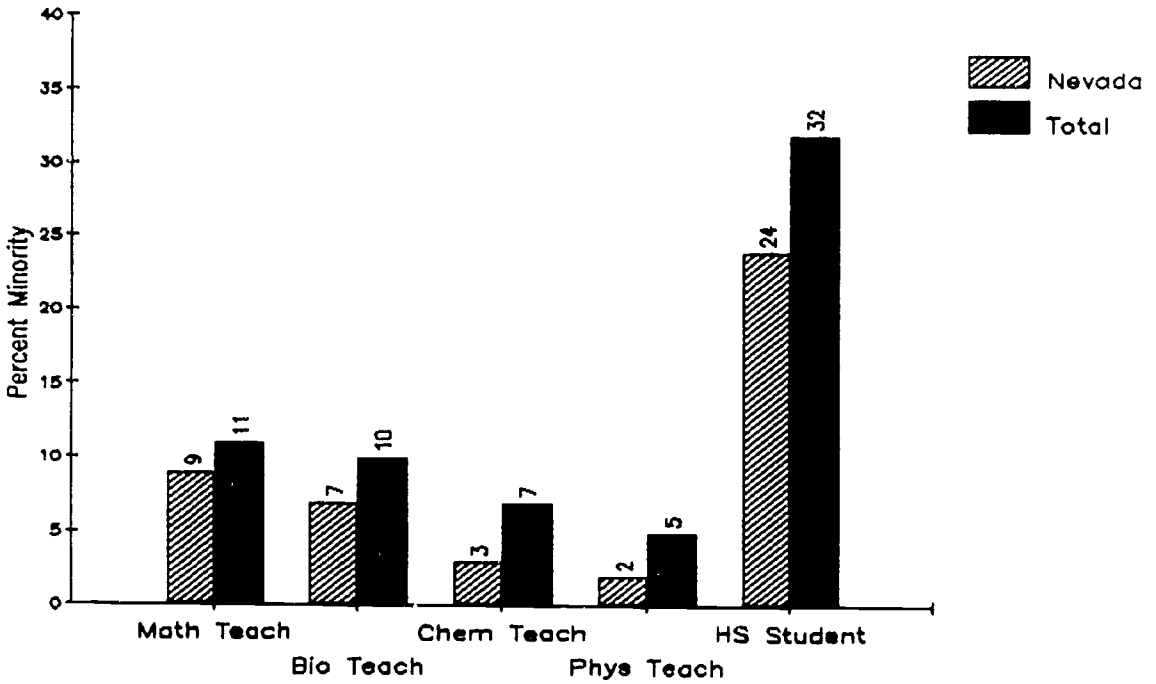
As with sex, the racial/ethnic minority composition of the nation's math and science teaching force does not match the minority characteristics of the overall student population (Blank & Dalkilic, 1991). In Nevada, the percentages of math and science teachers who are from racial/ethnic minority groups were lower still (see *Figure 12*). However, it should be kept in mind that the racial/ethnic minority composition of K-12 students in Nevada (24 percent) was lower than the racial/ethnic minority composition of K-12 students nationally (32 percent).

Indicators of School Conditions

Nevada's statewide average high school class sizes for math, science, and English for the 1989-90 school year are comparable to national figures reported by Blank & Dalkilic (1991) from data collected for the Schools and Staffing Survey of the National Center for Educational Statistics. The median figures of the states' average number of students per class nationally were 21, 22, and 22 for math, science, and English, respectively. The average numbers of students per class for Nevada's high schools round to 22 in each of the three subjects (Smith, 1991). The figures for individual counties in Nevada reveal that, for the most part, the smaller, rural districts had lower average numbers of high school students per class than the urban districts. In Eureka

Figure 12

Percent of Minority Teachers in Math & Science With Percent of Minority Students



Total based on total percentage for 33 states.

County School District, for example, there were average numbers of students per class of under 12 in science and slightly over 8 math. Average numbers of students per class in Washoe County and Carson City School Districts appear high compared to the rest of the state. The high school class size statistics for each of Nevada's school districts are provided in *Table 7*.

A second, very general, set of indicators of school conditions relevant to science and mathematics education involve the number of math and science teachers per high school. Statewide, there are approximately 12 math teachers, four biology teachers, one chemistry teacher, and less than one physics teacher per high school. These numbers reflect the number of

Table 7. **Average number of students per class by subject (Grades 9-12) School Year 1989-90.**

School Districts	*Average number of students per class:* Mathematics	Science	English
Statewide	**22**	**22**	**22**
Carson City	26	25	24
Churchill	23	23	23
Clark	21	21	21
Douglas	24	22	23
Elko	19	23	21
Eureka	8	12	10
Humboldt	19	18	20
Lander	18	16	18
Lincoln	13	11	15
Lyon	21	21	22
Mineral	20	16	21
Nye	20	19	22
Pershing	18	19	17
Storey	12	11	9
Washoe	27	27	25
White Pine	21	18	19

Statistics from *Nevada Education in 1990/91: A Status Report.*

teachers with either primary or secondary assignments in each subject. Clearly there were few advanced science teachers in Nevada, especially in physics where there were 15 more high schools than teachers assigned to teach physics in the state during the 1989-90 school year. In some school districts, physics classes were not taught during that year.

Summary and Conclusions

The indicators of the status of math and science education used in the present study suggest that Nevada elementary and middle/junior high schools are doing reasonably good job of providing science and mathematics education. Nevada public school students perform, on the average, above national norms in mathematics at grades three, six, and nine. There is a smaller percentage falling within the low achievement, potentially at-risk group and a larger percentage falling in to the high achievement group than is the case for the national referent group. Unfortunately, the eleventh grade mathematics exam is not nationally norm referenced, and no comparable data are available for student achievement in science.

The amount of time spent on mathematics in Nevada's elementary schools compares well with other states studied, as does the percentage Nevada's eighth grade enrollments in algebra and accelerated math courses. The amount of time spent on science during grades 1-3 in Nevada is relatively low, but the amount increases in the second half of elementary school education.

However, aside from average class sizes in mathematics and science that are comparable to other states, the findings for mathematics and science education at the high school level in Nevada are cause for considerable concern. Given the importance of technology to the present and future economy of the state and the nation, the concerns reviewed in the present report regarding mathematics and science education at the secondary level deserve immediate attention. Specifically:

1. *Some effective means of encouraging more students to take more mathematics and science courses, especially upper level courses, must be established.*

Nevada was near the bottom among the states studied both in the percentage of grades 9-12 students enrolled in *any* mathematics courses and in the percentage of such students enrolled in upper level mathematics courses like geometry, algebra 2, trigonometry, and calculus. Likewise, estimates of the percentage of students that will have taken mathematics courses beyond algebra 1 by the time of graduation from high school places Nevada near the bottom of other states.

Total enrollments in grades 9-12 science courses were much lower than in math, and, again, Nevada did not compare well with other states on the percent of students enrolled in *any* high school science courses or on the percent of students enrolled in upper level high school science courses like chemistry, physics, and advanced classes. Projections for enrollments in advanced science courses by graduation are not as bad when compared to other states, but similar projections for enrollment in first year biology are very low compared to other states, suggesting that a relatively large percentage of Nevada students may graduate from high school without ever having taken a science course beyond physical or earth science.

In considering strategies to encourage student enrollment, it should be noted that additional increases in requirements in math and science for graduation need not result necessarily in increased enrollments in upper level math and science classes. In fact, Blank and Dalkilic (1991) could not find a significant relationship across states between enrollments in upper level math and science classes and state requirements in math and science for graduation.

2. *Female students especially should be encouraged to participate in upper level science and mathematics classes, and efforts to hire qualified female and minority science and mathematics teachers should be intensified.*

There was a clear sex effect on student enrollment in high school math and science courses. In both subject areas, females appeared to enroll in initial level courses in reasonable numbers, but the percentages of females enrolled in science and math classes dropped dramatically for advanced level courses. In advanced math courses, the percentages of female students in Nevada were the lowest of the reporting states. Similarly, the percentages of female math and science teachers in Nevada's high schools were low, as were percentages of ethnic/racial minority teachers in math and science.

3. *Serious attention should be directed toward the high number of mathematics teachers teaching without certification in mathematics. Also, to assure the adequate preparation of Nevada's science and mathematics teachers, the sufficiency of the minimum number of credits required in mathematics or in a specific area of science in order to be certified in those subjects may deserve review in the context of such requirements in other states.*

In terms of teacher supply, Nevada compares well with other states in the percent of teachers in each subject with their primary assignment in that subject. For the future, however, the percentage of math and science (other than chemistry) teachers that are over 50 years old is considerably higher than

the percentage under 30 years old. In terms of teacher preparation, a further complication is the inordinately high percentage of teachers assigned to teach mathematics who are not certified in mathematics. This is somewhat surprising since Nevada has one of the lowest set of requirements in terms of the number of mathematics credits necessary for certification.

Extensive efforts have been made recently to diversify the economy of the state, to improve the capacity of the state's postsecondary institutions to provide training in technical fields, and to expand students' exposure to core academic areas prior to graduation. Success in each case is tied to some extent to enlarged enrollment of secondary students in quality science and mathematics classes. Hopefully, future studies like the present one will provide indications of progress in addressing the issues identified here that pertain to the successful delivery of math and science education in Nevada's public schools.

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