C-R-E-S-S-T

National Center for Research on Evaluation, Standards, and Student Testing

Technical Report

You can view this document on your screen or print a copy.

- UCLA Center for the Study of Evaluation

in collaboration with:

- University of Colorado
- NORC, University of Chicago
- LRDC, University of Pittsburgh
- The RAND Corporation

Linking Statewide Tests to the National Assessment of Educational Progress: Stability of Results

CSE Technical Report 375

Robert L. Linn and Vonda L. Kiplinger
CRESST/University of Colorado at Boulder

May 1994

National Center for Research on Evaluation, Standards, and Student Testing (CRESST)
Graduate School of Education & Information Studies
University of California, Los Angeles
Los Angeles, CA 90024-1522
(310) 206-1532

The research reported herein was supported under the National Center for Education Statistics Contract No. RS90159001 as administered by the U.S. Department of Education.

The findings and opinions expressed in this report do not reflect the position or policies of the National Center for Education Statistics or the U.S. Department of Education.

LINKING STATEWIDE TESTS TO THE NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS: STABILITY OF RESULTS

Robert L. Linn and Vonda L. Kiplinger

CRESST/University of Colorado at Boulder

Abstract

The adequacy of linking statewide standardized test results to the National Assessment of Educational Progress (NAEP) by using equipercentile equating procedures was investigated. Statewide mathematics test data for eighth-grade students in 1990 and in 1992 were obtained from four states. NAEP data for samples from these four states were obtained from the results of the Trial State Assessment administrations in same years. Equating functions for males and females in two states providing gender identification were similar at the low end of the scale but diverged at the high end of the scale. Applications of the equating functions obtained for 1990 data to the statewide test results obtained in 1992 provided estimates that were generally similar to actual NAEP results near the median, but not in the tails of the distribution. These results suggest that such linking, while reasonable for estimating average performance for the state, is not sufficiently trustworthy to use for making comparisons based on the tails of the distribution.

During the past few years there has been considerable discussion among educational policy makers and measurement specialists regarding the possibility of linking data from different assessments. In addition, several states have expressed an interest in linking their statewide assessments to the National Assessment of Educational Progress (NAEP). There also is a desire to link NAEP to international assessments such as the 1991 International Assessment of Educational Progress (IAEP) (Lapointe, Meed, & Askew, 1992) or the Third International Mathematics and Science Study (TIMSS) that is planned for 1995 (International Association for the Evaluation of Educational Achievement, 1992). It is hoped that through linking, the results of a state's own assessment can be compared to national results provided by NAEP and possibly even to international results through a linking of NAEP to IAEP or TIMSS.

It has long been a common practice to equate results of different forms of a test and then treat the results from administrations of different forms as interchangeable. For example, different forms of college admissions tests are given on different administration dates for reasons of test security, but because the scores on the different forms have been equated the results can be treated as if a single form of the test had been administered. In a similar fashion, achievement test publishers routinely publish alternate forms of an achievement test that are equated to a common scale so that users can obtain comparable results using a particular form one year and another form the next year.

As has been discussed by a number of authors, the claim that two test forms have been equated is a strong one, and stringent criteria must be satisfied for the test form if the claim is to be defensible (see, for example, Linn, 1993; Lord, 1980; Mislevy, 1992). The claim implies that the form of the test used should be a matter of indifference to anyone taking one of the test forms and to anyone using the results. This indifference property of equated test forms is important for the equitable use of the results. Though never perfectly realized in practice, it can be reasonably approximated, but only if certain conditions are satisfied. As Porter (1991, p. 35) has stated quite clearly, "[e]quating can be done only when tests measure the same thing." In addition, the tests must measure the domain in question with equal precision.

Even tests that are designed with these constraints in mind only approximate these stringent conditions. Tests or assessments constructed for different purposes using different content frameworks or specifications will almost surely violate the conditions required for a strict equating. A question remains, however, whether results can be obtained that are sufficiently trustworthy for a particular purpose by using either statistical procedures developed for purposes of equating or other statistical procedures designed to serve more modest goals.

Types of linking that have less stringent requirements and, in turn, yield weaker results that support comparisons in more limited circumstances are discussed by Linn (1993) and by Mislevy (1992) under the headings of calibration, prediction (or projection), statistical moderation, and social moderation. We will not review those distinctions here, but simply note that validity of comparisons across tests or assessments may depend on the context

of assessments, the groups used to calculate statistics, and the time of administration. For example, an equation that would enable a state to use its statewide assessment to predict with reasonable accuracy the results that would be obtained on NAEP in one year might yield quite inaccurate results in another year.

Although the theoretical restrictions on equating are well known, there is less empirical information regarding the seriousness of violations of conditions assumed for equating of the type that may be encountered with the actual assessments that educational policy makers would like to have linked. The purpose of this study is to add to the available empirical results to provide a better understanding of the degree to which existing statewide assessments may be linked to NAEP despite violations of basic underlying assumptions that the assessments are measuring the same thing with equal precision.

Related Studies

Two recent studies have attempted to link either the 1990 or 1992 NAEP mathematics assessment to the 1991 IAEP mathematics assessment (Beaton & Gonzalez, 1993; Pashley & Phillips, 1993). Beaton and Gonzalez used linear equating procedures (see, for example, Petersen, Kolen, & Hoover, 1989) with 1990 NAEP data for eighth-grade students and the 1991 IAEP data for the U.S. sample of 13-year-olds to express the 1991 IAEP results on the NAEP scale. Pashley and Phillips, on the other hand, used a projection technique based on linear regression for a special sample of students in 1992 that was assessed with both the 1991 IAEP and the 1992 NAEP instruments to express results from different countries in terms of predicted performance on NAEP.

The results obtained by Beaton and Gonzalez were similar to those obtained by Pashley and Phillips for countries with average performance near that of U.S. students. The estimates of the percentage of students in Spain exceeding 294 on the NAEP scale (the minimum score for the proficient achievement level set by the National Assessment Governing Board [NAGB]) were 10.7% in the Beaton and Gonzalez analysis and between 10.4% and 13.0% in the Pashley and Phillips analysis. Spain and the U.S., where the linking was performed, both had average percent correct scores of 55 on the IAEP mathematics assessment.

For countries with very high performance on the IAEP, for example, Korea and Taiwan (both with average percent correct scores on the IAEP of 73), the two analyses yielded quite discrepant results. The estimate of the percentage of students scoring at the proficient level or higher in Taiwan was 54.1 in the Beaton and Gonzalez analysis, as compared to between 34.6 and 39.3 in the Pashley and Phillips analysis. The corresponding figures for Korea were 52.2%, as compared to between 38.2% and 43.1%. Using a higher cut score of 331, which corresponds to NAGB's minimum score for the advanced achievement level, results in an even larger discrepancy. Beaton and Gonzalez, for example, estimated that 24.4% of students in Taiwan performed at the advanced level, whereas Pashley and Phillips estimated that only between 5.3% and 7.5% were at that level. The results are obviously sensitive to differences in the data bases and the techniques used to link IAEP results to NAEP.

Another recent study (Ercikan, 1993) is more closely related to the present one. Ercikan used equipercentile equating procedures (see, for example, Petersen et al., 1989) to convert statewide results on one of the standardized tests published by CTB Macmillan/McGraw-Hill into predicted performance on the 1990 NAEP scale. Data were obtained from four states that participated in the NAEP Trial State Assessment (TSA) in mathematics at Grade 8 in 1990. In addition to the NAEP-TSA results for those states, data also were obtained from statewide administrations of the California Achievement Tests, Form E (CAT/E), or the Comprehensive Tests of Basic Skills, Form E or Form 4 (CTBS/E or CTBS/4). The CAT/E was the statewide test in one state, and the other three states used either the CTBS/E or the CTBS/4.

The CAT/E and CTBS scores were first converted to the Normal Curve Equivalent (NCE) scale of the CAT/5, which is the latest edition of the CAT. The resulting NCE scores for the standardized tests were then converted to the NAEP scale using an equipercentile equating procedure. Within-state equatings were performed using the results from each individual state. In addition, an equating was performed using the combined data from all four states. Finally an equating was performed for the combined data from the three states using one of the forms of the CTBS.

If the conditions for equating were fully satisfied, the results of the six equatings (four within-state and two combined data sets) would be expected to

be identical except for sampling error. The results showed considerably greater divergence than would be expected due to sampling error alone. For example, an NCE score of 90 on the CAT predicted NAEP scores ranging from a low of 305 in one state to a high of 325 in another state. Twenty points on the NAEP mathematics scale corresponds to almost two-thirds of a standard deviation for the national sample at Grade 8. Although not presented by Ercikan, standard errors of equating for samples of the size used would be roughly only a couple of points.

One likely reason for the divergence of results among the different states is that NAEP and the standardized tests do not measure the same thing. A recent investigation of the content convergence between NAEP and three standardized mathematics tests at Grade 8 was conducted by Bond and Jaeger (1993) to evaluate that possibility. One of those tests, the CAT, was used by both Ercikan and one of the states in the present study. A second test analyzed by Bond and Jaeger, the Stanford Achievement Test (SAT), also was used by two of the states participating in the present study.

Bond and Jaeger enlisted the assistance of a group of content experts in mathematics to independently classify items from each of the standardized tests into one of the NAEP subject matter categories or an "unclassifiable" category. The five subject matter categories are Numbers & Operations; Measurement; Geometry; Data Analysis, Statistics, & Probability; and Algebra & Functions. The judges also classified the standardized test items according to the three "ability" categories of the NAEP framework (Conceptual Understanding, Procedural Knowledge, and Problem Solving). The results indicated that a disproportionately large number of items from all three standardized tests were classified into either the Numbers & Operations/ Procedural Knowledge category or the Numbers & Operations/Conceptual Understanding category. The Bond and Jaeger results for the CAT and SAT are quite relevant to the present study and will be discussed in greater detail below.

Procedure

The present study is similar to the Ercikan study in that statewide results for standardized tests, together with NAEP-TSA results, were obtained from four states and equipercentile equating procedures were used. The present

study differs in the standardized tests used and, more importantly, in that data were obtained for both 1990 and 1992. Having data from two statewide assessments in Grade 8 mathematics and two administrations of NAEP as part of the TSA makes it possible to obtain an equating function that converts the statewide results in 1990 to the 1990 NAEP-TSA results and then use the data collected in 1992 to evaluate the accuracy of that conversion when used two years later.

Data sources. Data from statewide administrations of standardized tests in Grade 8 mathematics in 1990 and 1992 were obtained from four states that participated in both the 1990 and 1992 Trial State Assessments in mathematics at Grade 8. The standardized tests used each year and the sample size available for analysis for the four states providing data for this study are listed in Table 1. Two states used the Stanford Achievement Test (SAT), albeit different forms, one state used the Iowa Tests of Basic Skills (ITBS), and one used the California Achievement Test (CAT).

The number of years that a particular standardized test form had been used varied among the four states. Form K of the SAT was used for the first time in 1990 and the third time in 1992 in State 1. Form L of the SAT was administered for the first time in 1992 in State 2. Prior to that time, Form E of

Table 1

Statewide Tests, Forms, and Sample Sizes for the Four Participating States

State	Year	Test	Form	Sample size	
				Statewide test[a]	NAEP TSA
1	1990	SAT	K	48,991	2,531
	1992	SAT	K	50,413	2,623
2	1990	SAT	E	11,121	2,551
	1992	SAT	L	11,242	2,454
3	1990	ITBS	G	15,309	2,716
	1992	ITBS	G	16,364	2,645
4	1990	CAT	E	76,881	2,843
	1992	CAT	E	80,065	2,769

[a] Actual numbers of eighth-grade students present on the testing date.

the SAT had been used for several years. In both States 3 and 4 the 1990 data collection was the fifth year that the form had been used and 1992 was the seventh year. These varied patterns are potentially relevant because of findings that scores tend to show a decline the year a new test form is introduced and then increase most rapidly during the first two or three years of use with small or negligible changes in subsequent years (see, for example, Linn, Graue, & Sanders, 1990).

Analyses. The 1990 statewide test results and the 1990 TSA results were used in the main equating analyses. For the NAEP-TSA the average percentile values were obtained from the NAEP contractor, Educational Testing Service. Those percentiles are based on estimations from the five plausible values used in NAEP statistical analyses and take the sampling weights and complex sample design into account to produce estimates for a state. The percentiles for the statewide tests were computed using the scaled scores that were provided by the state. Since the statewide test administrations are intended to be a census, the use of sampling weights was not required to obtain statewide results.

The standardized test results were converted to the NAEP scale using the 1990 data. As is illustrated in Figure 1, the resulting conversion tables were then applied to the 1992 results on the statewide test to obtain estimated 1992 results for the state on NAEP. The estimated NAEP results were then compared to the actual NAEP scores obtained in the 1992 TSA administration. For State 2, where different forms of the SAT were used in the two years, the 1992 SAT results were first expressed in terms of the 1990 SAT scale using conversion tables provided by the state, then those results were converted to the NAEP scale in same manner as the other states.

Results

The equating functions for the 1990 SAT Total Mathematics and the NAEP Overall Proficiency scores using the data from State 1 are displayed in Figure 2 for the state total and for males and females. As can be seen in Figure 2, a given score on the SAT would be converted to a somewhat higher score on the NAEP if the equating function for males was used rather than the equating function for females. Also, the difference between the two equating functions tends to be larger at the low end of the distribution than at the high end.

Figure 1.

Schematic Representation of Study Design

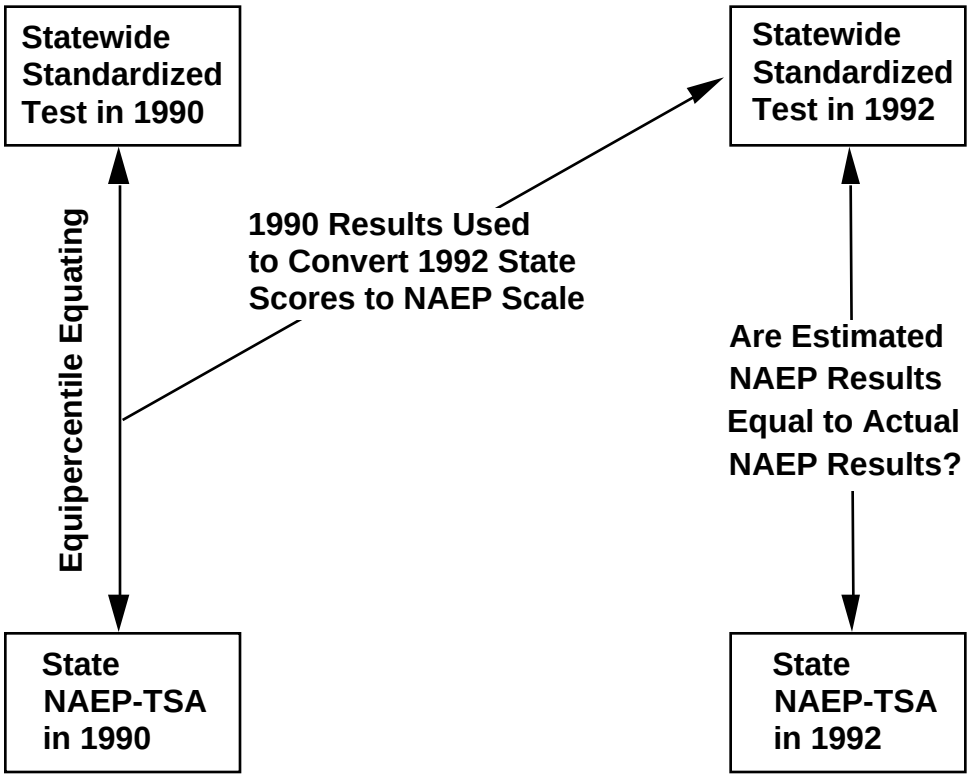
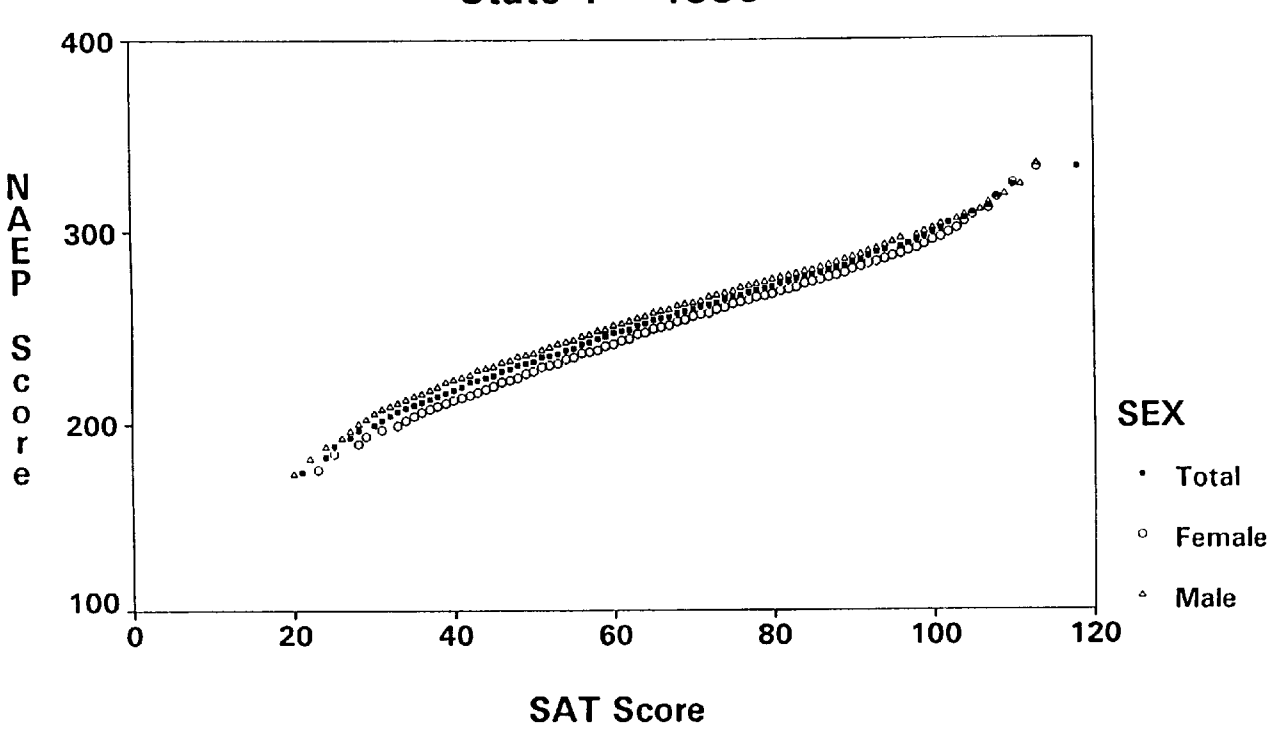


Figure 2. Equating Functions for NAEP Math Scores* and SAT Total Math Scores**



* NAEP scores are average overall mathematics proficiency scores.

**SAT scores are total mathematics scores.

The magnitude of the difference at selected percentile points for the total group from State 1 is shown in Table 2. Columns 2 and 3 of Table 2 list the SAT Total Mathematics and the NAEP Overall Mathematics Proficiency scores corresponding to total group percentiles of 95, 90, 75, 50, 25, 10, and 5. Estimated NAEP scores based on the separate male and female equating functions are shown in columns 4 and 5. Finally, the differences between the putatively equivalent scores from the male and female equatings are shown in column 6.

If all conditions that are required for equating are satisfied, then, except for sampling error, the equating functions should be invariant across subpopulations. Approximate standard errors of equating were computed for various percentiles using the formula given by Petersen et al. (1989, p. 251) for the two-group equipercentile case. For State 1, the standard error of equating for males or females varies from a low of approximately 1.1 points at the 50th percentile to a high of approximately 1.9 points at the 5th or 95th percentile. The standard error of the difference for the independent samples ranges from about 1.6 at the 50th percentile to approximately 2.6 at the 5th or 95th percentiles. Thus, as noted in Table 2, the differences for all but the 95th percentile are more than twice their standard errors.

The equating functions for the NAEP Overall Proficiency scores and SAT Total Mathematics scores for State 2 are presented in Figure 3. As shown in Figure 3, the equating functions for State 2 are similar to those for State 1 in that a given score on the SAT generally would be transformed to a slightly higher score on the NAEP if the equating function for males rather than the function for females was used. Also, the differences between the male and female equating functions are larger at the lower end of the distributions. However, unlike the functions for State 1, the differential all but disappears for SAT scores of 91 or higher.

The differences between the male and female equatings of the SAT and NAEP average Overall Proficiency scores at selected percentiles for State 2 are presented in Table 3. As is indicated, only the differences at the 10th and 25th percentiles exceed twice their standard errors. Also shown in Table 3 are the SAT scores and the equivalent NAEP scores corresponding to the selected percentiles (95, 90, 75, 50, 25, 10, and 5) for the total group.

Table 2

Scores Corresponding to Selected Percentiles on the SAT for the Total Population in State 1 and Equivalent NAEP Average Overall Proficiency Scores From Total, Male, and Female Equatings, 1990

Total group percentile	State total SAT	Equivalent NAEP scores			Difference males minus females
		State total	Males	Females	
95	105	309	311	308	3
90	99	297	299	293	6[a]
75	84	276	279	273	6[a]
50	65	253	258	250	8[a]
25	47	229	233	223	10[a]
10	34	209	213	202	11[a]
5	28	196	200	189	11[a]

Note. The SAT scores are for Total Mathematics at Grade 8 on the Stanford Achievement Test, Form K. The NAEP scores are for the Grade 8 Overall Mathematics Proficiency scale based on the average of 5 plausible values.

[a] Difference greater than twice the standard error.

Table 3

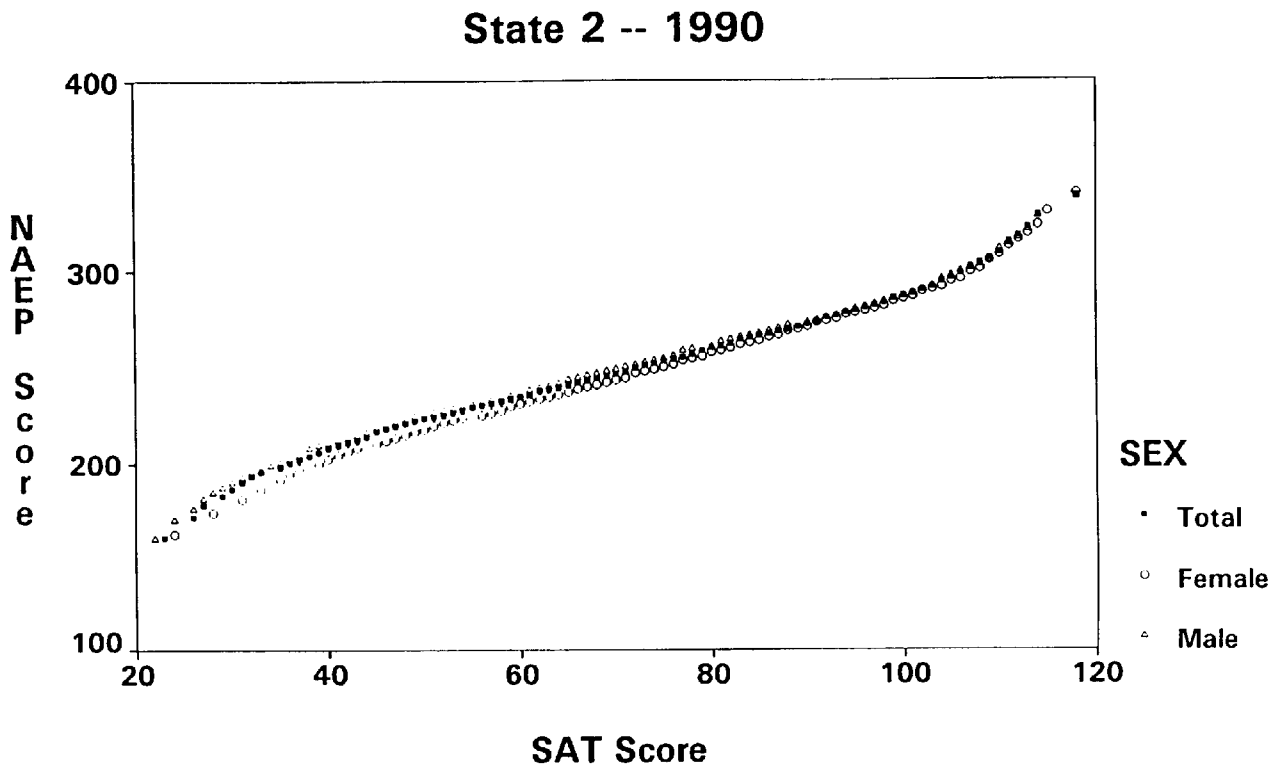
Scores Corresponding to Selected Percentiles on the SAT for the Total Population in State 2 and Equivalent NAEP Average Overall Proficiency Scores From Total, Male, and Female Equatings, 1990

Total group percentile	State total SAT	Equivalent NAEP scores			Difference males minus females
		State total	Males	Females	
95	111	315	314	313	1
90	107	302	301	299	2
75	95	279	280	278	2
50	73	251	252	248	4
25	50	224	225	218	7[a]
10	36	200	203	195	8[a]
5	30	187	190	186	4

Note. The SAT scores are for Total Mathematics at Grade 8 on the Stanford Achievement Test, Form E. The NAEP scores are for the Grade 8 Overall Mathematics Proficiency scale based on the average of 5 plausible values.

[a] Difference greater than twice the standard error.

Figure 3. Equating Functions for NAEP Math Scores* and SAT Total Math Scores** -- 1990



* NAEP scores are average overall mathematics proficiency scores.

**SAT scores are total mathematics scores.

The content analyses conducted by Bond and Jaeger (1993) suggested that the majority of the items on the standardized tests belong to one of the five NAEP content areas, namely, Numbers & Operations. Consequently, separate equipercentile equatings were performed using the SAT Total Mathematics scores as before, but the NAEP Numbers & Operations scores rather than the Overall Mathematics Proficiency scores were used. The results of those equatings are shown in Figure 4 and Table 4 for State 1 and in Figure 5 and Table 5 for State 2.

The equating functions relating the SAT Total Mathematics scores and NAEP Numbers & Operations scores for State 1, presented in Figure 4, are similar to those relating the SAT Total Mathematics scores and NAEP Overall Mathematics Proficiency scores shown in Figure 2. As illustrated in the figures and shown by comparison of Tables 2 and 4, the equating functions for males and females are most divergent at the low end of the distribution when either the NAEP Numbers & Operations scores or the NAEP Overall Mathematics Proficiency scores were used. The differences are greater than twice their standard errors for scores corresponding to the 75th percentile or lower.

As with State 1, the equating functions relating the SAT Total Mathematics scores and NAEP Numbers & Operations scores for State 2 are similar to those relating the SAT Total Mathematics scores and NAEP Overall Mathematics Proficiency scores. These equating functions are presented in Figures 5 and 3, respectively. Comparison of Tables 3 and 5 also indicates that the equating functions for males and females in State 2 are more divergent at the lowest reported percentile (5th) in the equating using the NAEP Numbers & Operations scores than in the equating with the NAEP Overall Mathematics Proficiency scores. Otherwise, the results for the male-female differences are reasonably similar for the two different NAEP scores.

Gender identification was not available for the statewide test data provided by States 3 and 4. Hence, there is no check on the total group equating from the 1990 data alone. For all four states, however, the primary check on equating is based on the application of equating functions derived from the 1990 to the data obtained in 1992.

Table 4

Scores Corresponding to Selected Percentiles on the SAT for the Total Population in State 1 and Equivalent NAEP Numbers & Operations Scores From Total, Male, and Female Equatings, 1990

Total group percentile	State total SAT	Equivalent NAEP scores			Difference males minus females
		State total	Males	Females	
95	105	314	318	313	5
90	99	302	304	300	4
75	84	282	283	279	4[a]
50	65	259	261	256	5[a]
25	47	236	237	230	7[a]
10	34	216	218	209	9[a]
5	28	204	206	196	10[a]

Note. The SAT scores are for Total Mathematics at Grade 8 on the Stanford Achievement Test, Form K. The NAEP scores are for the Grade 8 Numbers & Operations scale based on the first plausible value.

[a] Difference greater than twice the standard error.

Table 5

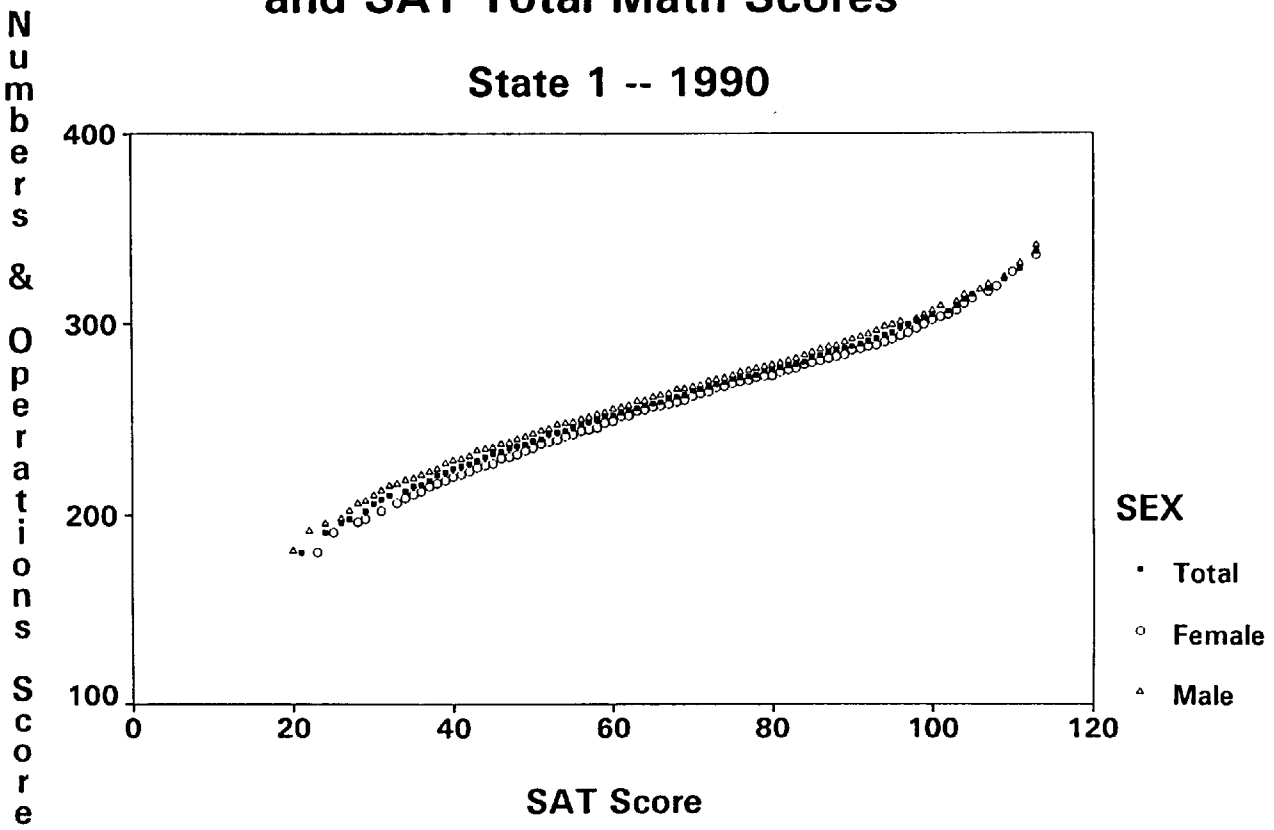
Scores Corresponding to Selected Percentiles on the SAT for the Total Population in State 2 and Equivalent NAEP Numbers & Operations Scores From Total, Male, and Female Equatings, 1990

Total group percentile	State total SAT	Equivalent NAEP scores			Difference males minus females
		State total	Males	Females	
95	111	319	319	317	2
90	107	306	306	305	1
75	95	284	283	283	0
50	73	257	257	254	3
25	50	229	230	225	5[a]
10	36	207	209	204	5
5	30	194	199	188	11[a]

Note. The SAT scores are for Total Mathematics at Grade 8 on the Stanford Achievement Test, Form E. The NAEP scores are for the Grade 8 Numbers & Operations scale based on the first plausible value.

[a] Difference greater than twice the standard error.

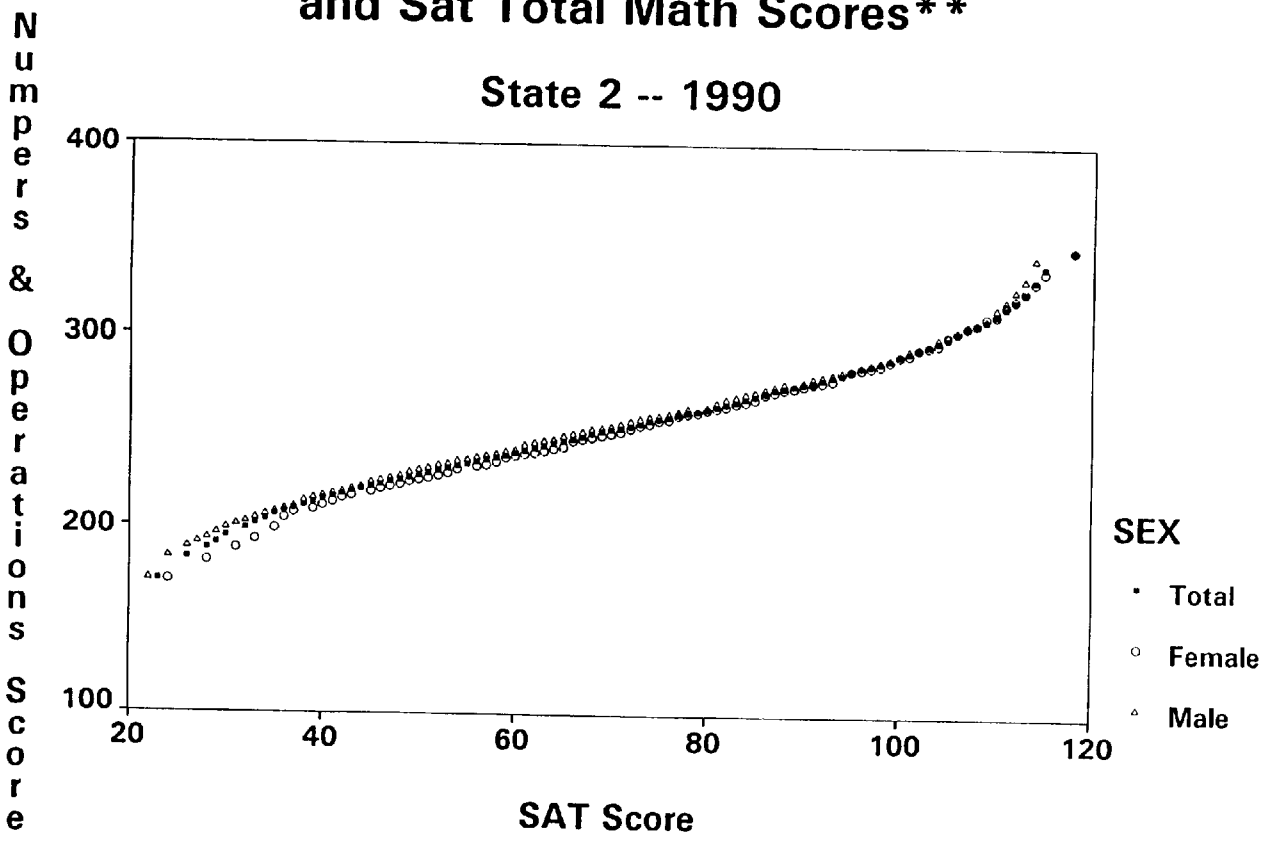
Figure 4. Equating Function for NAEP Math Scores* and SAT Total Math Scores**



* NAEP scores are the 1st plausible value on numbers & operations items.

**SAT scores are total mathematics scores.

Figure 5. Equating Function for NAEP Math Scores* and Sat Total Math Scores**



* NAEP scores are the 1st plausible value on numbers & operations items.

** SAT scores are total mathematics scores.

The scores on the statewide tests corresponding to percentiles of 5, 10, 25, 50, 75, 90, and 95 in 1992 were obtained in each state. Those statewide test scores were then converted to estimates of the corresponding 1992 NAEP scores using the 1990 equating functions. The resulting estimates of the 1992 NAEP scores were then compared to the 1992 NAEP scores that were actually observed in the Trial State Assessment for those selected percentiles for each state.

Table 6 lists the results comparing estimated and observed 1992 NAEP Overall Proficiency scores for State 1. In general, the differences between estimated and obtained scores were reasonably small. Only at the low end of the distribution (5th and 10th percentiles) did the differences between observed and estimated NAEP scores exceed two standard errors.

The results of the comparison of estimated and observed NAEP Overall Proficiency scores for State 2 are shown in Table 7. Since a new form of the SAT was used in 1992, the new form first had to be equated to the form used in 1990 and then mapped into the NAEP scale using the 1990 SAT to NAEP conversion. As can be seen in Table 7, estimated and observed performance on NAEP was similar for the bottom half of the distribution; however, the observed performance was higher than the estimated performance for the top half of the distribution.

Table 6

Estimated and Actual 1992 NAEP Scores at Selected Percentile Points for State 1 Based on Equipercentile Equatings of 1990 Stanford Achievement Test (SAT) Grade 8 Total Mathematics Scores With 1990 NAEP Overall Mathematics Proficiency Scores

Percentile	SAT score	Estimated equivalent NAEP score	Observed NAEP score	Observed minus estimated
95	106	313	311	-2
90	99	297	299	2
75	84	276	276	0
50	64	252	251	-1
25	47	229	227	-2
10	35	210	206	-4[a]
5	29	199	193	-6[a]
Mean	65.6	255	251	-4[a]

[a] Difference greater than twice the standard error.

Table 7

Estimated and Actual 1992 NAEP Scores at Selected Percentile Points for State 2 Based on Equipercentile Equatings of 1990 Stanford Achievement Test (SAT) Grade 8 Total Mathematics Scores With 1990 NAEP Overall Mathematics Proficiency Scores

SAT Form L percentile	Equated SAT Form E score	Estimated equivalent NAEP score	Observed NAEP score	Observed minus estimated
95	110	307	317	10[a]
90	106	295	305	10[a]
75	94	275	283	8[a]
50	76	252	257	5[a]
25	55	239	231	2
10	39	210	208	-2
5	31	197	194	-3
Mean	79.8	256	257	1

[a] Difference greater than twice the standard error.

A comparison of the estimated and observed 1992 NAEP Overall Proficiency scores for State 3 is presented in Table 8. In this state, equipercentile equating underestimates the 1992 NAEP Overall Proficiency scores in mathematics, particularly at or above the 75th percentile.

The estimated and observed 1992 NAEP Overall Proficiency scores for State 4 are compared in Table 9. This table indicates that the 1992 NAEP Overall Mathematics Proficiency scores are substantially overestimated by the equipercentile equating procedure, particularly above the median and at the 5th percentile.

Discussion

If the conditions required for equating are completely satisfied, then equating functions for different subgroups (e.g., males and females) should be the same except for sampling error. The results obtained in this study for the two states where gender identification is available for the statewide test data yield differences larger than would be expected based on sampling error alone for some parts of the distributions. The differences in the region between the 5th and 95th percentiles are as large as 11 points for State 1 and 8 points for State 2. These extreme differences are not only statistically significant; they

Table 8

Estimated and Actual 1992 NAEP Scores at Selected Percentile Points for State 3 Based on Equipercentile Equatings of 1990 Iowa Test of Basic Skills (ITBS) Grade 8 Total Mathematics Scores With 1990 NAEP Overall Mathematics Proficiency Scores

Percentile	ITBS score	Estimated equivalent NAEP score	Observed NAEP score	Observed minus estimated
95	196	318	323	5[a]
90	189	307	313	4[a]
75	179	292	296	4[a]
50	166	271	275	2
25	154	251	254	2
10	142	231	235	2
5	136	218	223	1
Mean	166	271	274	3[a]

[a] Difference greater than twice the standard error.

Table 9

Estimated and Actual 1992 NAEP Scores at Selected Percentile Points for State 4 Based on Equipercentile Equatings of 1990 California Achievement Test (CAT) Grade 8 Total Mathematics Scores With 1990 NAEP Overall Mathematics Proficiency Scores

Percentile	CAT score	Estimated equivalent NAEP score	Observed NAEP score	Observed minus estimated
95	838	320	315	-5[a]
90	827	308	303	-5[a]
75	806	286	282	-4[a]
50	783	258	258	0
25	760	233	234	1
10	738	214	212	-2
5	722	202	199	-3[a]
Mean	782	256	258	2

[a] Difference greater than twice the standard error.

are relatively large substantively compared to within-state standard deviations of 30 in State 1 and 35 in State 2.

Results from the content analyses reported by Bond and Jaeger (1993) suggest that the failure to obtain essentially the same equating functions for different subgroups may be due to differences in the content coverage of the NAEP and statewide tests. Given their analysis, one might expect that the equating functions would be more similar when the statewide tests are equated to the Numbers & Operations scale than when equated to the Overall Mathematics Proficiency scale. The differences in the male and female equating functions are of similar magnitude for the two types of NAEP scales, however.

The main comparisons of this study focused on the accuracy of the estimates when 1990 equating functions were used with 1992 statewide test data to estimate the 1992 NAEP results. These comparisons reveal differences that are larger than expected based on sampling error in one or both tails of the distribution in all four states. If conditions required for equating are completely satisfied, then any changes in the mathematics achievement of students within a state between 1990 and 1992 should have comparable effects on both NAEP and the statewide test results and, therefore, the equating obtained with 1990 data should still hold in 1992.

The obtained differences between the estimated and actual 1992 results indicate that there are violations of assumptions required for a strict equating in all four states. For some purposes, however, the differences might be considered to be acceptably small. Results at or near the median, for example, were small for three of the four states. Consequently, the linking might be considered adequate for purposes of estimated average achievement on the NAEP scale, but not for estimating achievement at the lower or upper ends of the distribution.

For two of the states the magnitude and sign of the differences between actual and estimated 1992 performance on NAEP varied from state to state in accord with what might be expected from the length of time a particular form had been used in each state. State 1, where observed scores were lower than estimated, administered the standardized test form for the first time in 1990 and the third time in 1992. Previous research (e.g., Linn et al., 1990) has shown that relatively large increases are frequently observed between the first and second or third year of test administration. To the extent that gains during the first few years that a new form is used are the result of increased

familiarity with and emphasis on the specific content of the test, one would expect that the gains would not generalize to other measures such as NAEP. This expectation is consistent with the results obtained for State 1.

In State 2, where a new form was used for the first time in 1992, results show the opposite pattern. That is, for the upper half of the distribution, the observed NAEP scores are higher than the estimated scores. The commonly observed decline in scores when a new form is first introduced provides a plausible explanation of this finding. That is, the apparent dip in performance on the standardized test is largely an artifact of somewhat inflated results in 1990 due to the repeated use of the old form. Neither NAEP nor the new standardized test form is subject to that inflation. Hence, the equating function derived in 1990 leads to overestimates of NAEP performance in 1992 when it is applied to the 1992 standardized test results.

Both States 3 and 4 used a standardized test form for the fifth time in when it was administered in 1990 and for the seventh time when administered in 1992. Whatever inflation in test scores results from familiarity with and emphasis on test-specific content is likely already to have been realized by the fifth administration. Thus, there seems to be little reason to expect the estimates or 1992 NAEP scores to be either too high or too low, and we lack any substantive hypothesis as to why the NAEP scores tended to be underestimated in State 3 and overestimated in State 4, especially at the higher end of the distribution.

No matter what the substantive explanation for the lack of stability of the equating function from 1990 to 1992, it seems clear that there is substantial uncertainty in the estimates. The lack of stability suggests that linking standardized tests to NAEP using equipercentile equating procedures is not sufficiently trustworthy to use for other than rough approximations.

In considering the results of this study, it should be recalled that the tests were not designed with the purpose of linking in mind. The content differences between the standardized tests and the NAEP framework identified by Bond and Jaeger (1993) are substantial. Much better results might be expected if the tests being linked were designed in accordance with a common framework. If linking is an important goal, then it would seem wise to assure, at a minimum, that the tests share a common content framework.

References

Beaton, A. E., & Gonzalez, E. J. (1993). ***Comparing the NAEP Trial State Assessment results with the IAEP International results.*** **Report prepared for the National Academy of Education Panel on the NAEP Trial State Assessment, Stanford CA: National Academy of Education.**

Bond, L., & Jaeger, R. M. (1993). ***Final report on the judged congruence between various statewide assessment tests in mathematics and the 1990 National Assessment of Educational Progress.*** **Report prepared for the National Academy of Education Panel on the NAEP Trial State Assessment, Stanford CA: National Academy of Education.**

Ercikan, K. (1993). ***Predicting NAEP.*** **Unpublished manuscript. Monterey, CA: CTB Macmillan/McGraw-Hill.**

International Association for the Evaluation of Educational Achievement. (1992). ***The Third International Mathematics and Science Study: Project overview.*** **Vancouver, BC: IEA TIMSS International Coordinating Center.**

Lapointe, A. E., Mead, N. A., & Askew, J. M. (1992). ***Learning mathematics.*** **Princeton, NJ: Educational Testing Service.**

Linn, R. L. (1993). Linking results of distinct assessments. ***Applied Measurement in Education, 6,*** **83-102.**

Linn, R. L., Graue, M. E., & Sanders, N. M. (1990). Comparing state and district test results to national norms: The validity of claims that "everyone is above average." ***Educational Measurement: Issues and Practice, 9,*** **5-14.**

Lord, F. M. (1980). ***Applications of item response theory to practical testing problems.*** **Hillsdale, NJ: Erlbaum.**

Mislevy, R. J. (1992). ***Linking educational assessments: Concepts, issues, methods, and prospects.*** **Princeton, NJ: Educational Testing Service, Policy Information Center.**

Pashley, P. J. & Phillips, G. W. (1993). ***Toward world-class standards: A research study linking international and national assessments.*** **Princeton, NJ: Educational Testing Service.**

Petersen, N. S., Kolen, M. J., & Hoover, H. D. (1989). Scaling, norming, and equating. In R. L. Linn (Ed.), ***Educational measurement*** **(3rd ed., pp. 221-262). New York: Macmillan.**

Porter, A. C. (1991). Assessing national goals: some measurement dilemmas. In T. Wardell (Ed.), ***The assessment of national goals. Proceedings of the 1990 ETS Invitational Conference.*** **Princeton, NJ: Educational Testing Service.**