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ABSTRACT

Colleges and universities commonly require multiple tests for their various admissions and placement decisions. The point of this analysis was to determine the degree to which three standardized tests involving eight subtests all administered to the same applicants provided nonredundant information. The instruments were the California Basic Education Skills Test (CBEST), given to teacher candidates to measure reading, mathematics and writing competencies, the Scholastic Assessment Test, and the Graduate Record Examination. Data were available for 88 students for all 3 measures. Analyses indicate that the eight subtests are related, some rather closely. Nearly 62% of the variability in all subtest scores could be explained by one component, and the fact that all subtest scores are substantially correlated with the component suggests a common element to all of the subtests. Findings suggest that it is feasible that committees could reduce the number of tests required of students and sacrifice little by way of predictive validity or diagnostic accuracy. (Contains 3 tables and 16 references.) (SLD)

Admissions and Placement Testing: Enough is Enough!

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Standardized testing became a fixture in colleges and universities as a mechanism for assuring that admissions decisions were based upon the applicants' potential for accomplishment rather than because of their privileged circumstances. Besides more objective selection decisions, the tests also provided an economy. They allowed large numbers of applicants to be classified quickly, and when administrative costs are passed along to the applicant, with minimal cost to the institution.

As the practice of relying on tests to help sort applicants has taken hold, different tests have been produced to allow the admissions decision makers to evaluate what are ostensibly different circumstances: tests for undergraduate admissions, tests for placement in university courses, tests for admission to advanced degree programs, and so on. Short of accepting the claims of the developers, however, the degree to which the various admissions and competency tests actually measure separate traits is an open question.

This paper represents an empirical study of the degree to which three different test batteries administered to the same group of students at a Central California university yield unique information. The issue is relevant to most post-secondary settings since the practice of using standardized tests to make admissions and placement decisions is common and many colleges and universities rely on the same tests.

Method

Data from three different test batteries involving eight subtests were used in this analysis. The Scholastic Assessment Test (SAT) and the Graduate Record Exam (GRE) both provide general measures of verbal and mathematical ability. The GRE also provides a measure of analytical ability. The third test battery is the California Basic Educational Skills Test (CBEST), which measures of basic reading, math, and writing competencies among teacher candidates.

The Instruments

In spite of the fact that each test provides measures verbal and mathematical ability, on paper at least the SAT, GRE, and CBEST have different purposes. The SAT and GRE scores are intended to inform admissions decisions for potential undergraduate and graduate students respectively. The fact that one test does not serve both purposes implies that the abilities that predict undergraduate success are significantly different from those that predict success in graduate school, or that the measured abilities substantially change during the course of the student's experience.

The CBEST is used to gauge basic reading, writing, and mathematics competency prior to candidates' reception of primary or secondary school teaching credentials. Requiring this battery assumes that the information

about student literacy and competency is not available from other available sources, such as SAT scores.

The registration bulletin for the SAT indicates that the test is intended to provide information regarding “how well prepared [the applicant is] to do college work” (The College Board, 2001, p. 3). In fact, the predictive validity of SAT scores for first year college and university students’ grades is what gives the test its value. Studies generally indicate that SAT verbal and SAT mathematics tests correlate with freshman year grade point averages at levels ranging from $r = .3$ to $r = .5$ (Fincher, 1974; Ford and Campos, 1977; Ramist, Lewis, and McCamley-Jenkins, 1994; Willingham and Breland, 1982; Wilson, 1980; and Wilson 1981). The amount of variance in freshman year grades that SAT scores will explain ranges from approximately 10 to 25%. In his review of the test, Cronbach (1985) noted that SAT scores combined with the applicants’ rankings in their high school classes “predicts college grades as well as can be hoped for” (p. 363). The test underwent a substantial revision before the 1995 administration. Bridgeman, McCamley-Jenkins, and Ervin (2000) found that predictive validity is unchanged in the revised form of the test.

The GRE measures verbal, quantitative, and analytical skills “that have been acquired over a long period of time and that are not related to any specific field of study” (GRE, 2001, p. 8). The purposes of the GRE include

testing the ability to analyze and evaluate written material and synthesize information obtained from the material, test elementary mathematics and quantitative reasoning, and problem solving skills. Cohn (1985) noted that the test was designed to offer a global measure of those abilities which graduate school applicants develop over a lengthy period. Although the GRE may be “the best documented instrument of its type” (Jaeger, 1985, p. 624), and a test in which users have great confidence (Ibid.), its predictive validity is low compared to the SAT. Morrison and Morrison (1995) found that GRE-V correlated with graduate grade-point average $r = .28$. GRE-Q correlated with graduate GPA $r = .22$. To a substantial degree, the low correlations are a casualty of range attenuation. Graduate students’ abilities are less diverse than those of undergraduates in their first year of study.

Unlike the SAT and GRE, the point of CBEST is not predictive validity. The three subtests were designed to assess basic reading, writing, and mathematics proficiency among candidates applying for elementary and secondary school teaching credentials. The reading subtest measures the test-taker’s “ability to comprehend information presented in written passages, tables, and graphs . . . None of the questions requires outside knowledge” (CBEST, 2001, p. 35). The mathematics section is primarily word problems drawn from a) estimation, measurement, and statistical principles, b) computation and problem solving, and c) numerical and graphic relationships.

The criteria for the writing section are not specified beyond indicating that one must be able to write effectively. There are two items, one requiring the respondent to analyze a situation or statement, the other requiring the individual to write about a personal experience (CBEST, 2001).

In the effort to accommodate these tests to a variety of circumstances, they have been substantially removed from content knowledge. Cronbach (1985) noted of the SAT,

In general, difficulty is achieved by requiring precise and complex thought. Analogy and antonym items do not bring in rare words; they ask for close comparisons among plausible answer options. Few mathematics items ask for content knowledge above the eighth-grade level, and the four geometric theorems that examinees may need to know are laid out in the orientation booklet. (p. 363)

The SAT is typically administered to students during the fall of one of their final two years of secondary school. Because it is associated with graduate study, students usually sit for the GRE during the final year of baccalaureate study. The CBEST might be administered at any time after the junior year in high school but typically during the year immediately prior to application to the teacher credential program.

The Analysis

Principal components analysis (PCA) is designed to determine whether the number of components required to explain a set of test scores can be fewer than the number of tests. If two tests measure the same underlying construct, for example, PCA results will indicate that they can both be explained by the same principal component. Pedhazur and Schmelkin (1991) noted that to be useful, the first few components ought to explain at least 50% of the variance in the scores. A solution verifying distinct purposes will indicate that a significant portion of the variance in test scores can only be explained by multiple principal components, or that the first few significant components explain only relatively small proportions of the variance in scores.

Results

There were SAT and GRE scores available from university records for 88 subjects who were administered the CBEST between February, 1999 and August, 2000 at a Central California university location. This group generally had lower mean scores and less variability than is typical of both SAT and GRE nationally (Table 1) where $M = 500$, $SD = 100$. The CBEST scores are modestly higher than the means of 45.78 for reading and similar to the mean of 49.04 for mathematics gathered at this location from a broader cross-

section of students for an earlier study (Tanner, 1995). This may reflect the fact that those who pursue teaching credentials are not identical to the population of students who took SAT as an entrance requirement (the SAT is not required of transfer students), and who also anticipate graduate study.

Place Table 1 About Here

The correlation matrix (Table 2) indicates that there are statistically significant relationships between any two of the test scores because of their subjects. The correlation coefficients range from .272 between the CBEST writing and math subtest scores, to .848 between the verbal portions of the SAT and the GRE.

Place Table 2 About Here

The correlation matrix suggests a good deal of shared variability between tests. One might have expected the scores to form into groups with the mathematics-related tests (SAT-M, CBEST mathematics, and GRE-Q) creating an aggregation and the verbal tests (SAT-V, GRE-V and the CBEST reading and writing tests) forming a second grouping, but all test scores are correlated with all others at least at the level $p = .005$.

The strength of the relationship between any one test and all others is also reflected in the average correlations (Table 2). They range from .397 (CBEST Writing with all others) to .640 (GRE-V with all others). It might be noted that in this group of eight tests, CBEST Writing and GRE-Analytical are anomalies. The CBEST Writing test is not machine-scored, as are the others, and while correlation statistics indicate that the analytical ability test scores are clearly related to both verbal and mathematical abilities, at least in name, the analytical test has no direct equivalent among the other tests.

Because those who do well on one measure also do well on the other, and those who struggle with one also do so on the other does not necessarily indicate that the tests are related. The correlation data lead logically to principal components analysis. This procedure will indicate the degree to which the eight scores reflect common underlying components and the strength of the relationship between each measure and those components (Table 3).

Place Table 3 About Here

The usual default for indicating useful components is an eigenvalue 1.0, or greater. Although there are eight test scores, PCA yields just one component with an eigenvalue meeting this criterion. However, it explains

nearly 62% of the variability in the eight tests of verbal, writing, mathematics, and analytical performance. The amount of variance the component explains in individual test scores ranges from .336 for the CBEST Writing test, to .783 for the GRE Verbal scores.

Discussion

Colleges and universities commonly require multiple tests for their various admissions and placement decisions. The point of this analysis was to determine the degree to which three standardized tests involving eight subtests all administered to the same applicants provide non-redundant information. If the data that each test provides are essentially unique and relevant (although the interest in this study is on only uniqueness), the practice of requiring multiple tests is justified. If the information is redundant, the practice of requiring multiple tests is at least questionable.

The CBEST was included in the analysis because its stated purpose is different from both the SAT and the GRE used in admissions decisions. The CBEST is a basic literacy screening device required of elementary and secondary school teacher candidates as a prerequisite to state certification. The SAT and GRE might also be argued to have a screening function but they produce general measures of verbal, mathematics, and quantitative ability where the CBEST is intended to assess more specific competencies in basic

reading, writing, and mathematics. Although only California and Oregon use the CBEST in large numbers, other tests that universities use to detect deficiencies in mathematics and literacy may not be substantially different.

By any of the measures reflected in Tables 2 and 3, the eight subtests are related, some rather closely. The verbal portion of the GRE, for example, has an average correlation with each of the other five measures of .640. The lowest average correlation is the correlation of writing (mean correlation = .397) with the other subtests. This comparatively low correlation may be partly a reflection of the difference between machine- and conventional scoring.

Principal components analysis is the heart of this study. The finding that nearly 62% of the variability in all subtest scores can be explained by one component, and the fact that all subtests are substantially correlated with the component suggest a substantial common element to all of the subtests. The correlation between the component and an individual subtest is highest for the GREV ($r = .885$, 78.3% of the variance in GREV scores), marginally higher than for SATV ($r = .879$, 77.2% of the variance in scores), but even the lowest value is $r = .580$ (the correlation of the component with writing scores, 33.6% of the variance in those scores). While there is no universally-accepted gauge for what constitutes a large proportion of explained variance, a single component explaining nearly 62% of the variance in eight different subtests is

substantial (Pedhazur and Schmelkin, 1991). This seems particularly noteworthy when the data from the subtests come from three different batteries designed for quite different decisions.

As will be the case with any study, this one imposes limitations. The number of participants ($n = 88$) is relatively small for a stable factor solution, but that drawback is partially offset by the fact that the solution in this case is particularly simple. Clearly a solution in which a single component will explain more than half of the variance in eight subtest scores ought to be noted in spite of a relatively small group of subjects.

It might be argued that it is potentially deceptive to analyze scores that come from tests taken years apart. The suggestion here, however, is not that the students' abilities have not changed over time, but that the underlying trait that explains those abilities has remained quite stable and that having demonstrated this, there ought to be some consideration to paring the amount of testing required for institutional or program admissions decisions. Since such decisions are invariably based on more than just test scores, it seems feasible that committees could reduce the number of tests required of students and sacrifice little by way of predictive validity or diagnostic accuracy.

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Table 1**Subtest Scores for SAT, CBEST, and GRE**

| Test | N | Mean | Std Dev |
|-------------|----|--------|---------|
| SAT-V | 88 | 459.77 | 113.41 |
| SAT-M | 88 | 463.52 | 100.41 |
| CBEST-read | 88 | 48.07 | 12.55 |
| CBEST-math | 88 | 49.10 | 12.27 |
| CBEST-write | 88 | 44.50 | 8.86 |
| GRE-V | 88 | 382.16 | 86.23 |
| GRE-Q | 88 | 438.86 | 106.81 |
| GRE-An | 88 | 454.66 | 120.24 |

Table 2**The Correlations Between Scores**

| Test | SATV | SATM | Read | Math | Write | GREV | GREQ | GREAn |
|-------|------|------|------|------|---------|------|------|--------|
| SATV | | .703 | .737 | .475 | .575 | .848 | .570 | .546 |
| SATM | | | .552 | .581 | .340*** | .648 | .664 | .625 |
| Read | | | | .481 | .422 | .748 | .470 | .528 |
| Math | | | | | .272* | .488 | .668 | .499 |
| Write | | | | | | .505 | .382 | .286** |
| GREV | | | | | | | .617 | .625 |
| GREQ | | | | | | | | .637 |
| Avg. | .636 | .593 | .563 | .495 | .397 | .640 | .573 | .540 |

* $p=.005$

** $p=.003$.

*** $p=.001$.

All other correlations are significant at $p<.001$

Table 3**Principal Components Analysis**

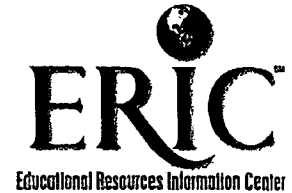
| Test | Component Score | Communality |
|-------|--------------------|-------------|
| SATV | .879 | .772 |
| SATM | .831 | .691 |
| Read | .795 | .632 |
| Math | .707 | .500 |
| Write | .580 | .336 |
| GREV | .885 | .783 |
| GREQ | .800 | .640 |
| GREAn | .768 | .590 |

| Component | Initial Eigenvalues | | |
|-----------|---------------------|------------|-------------|
| | Total | % variance | cum. % var. |
| 1 | 4.944 | 61.806 | 61.806 |
| 2 | .951 | 11.882 | 73.688 |
| 3 | .623 | 7.785 | 81.473 |
| 4 | .491 | 6.143 | 87.615 |
| 5 | .362 | 4.525 | 92.141 |

| | | | |
|---|------|-------|--------|
| 6 | .294 | 3.672 | 95.813 |
| 7 | .214 | 2.673 | 98.486 |
| 8 | .121 | 1.514 | 100.00 |



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