ACT Research Report Series 91-3

Predicting College Grades From ACT Assessment Scores and High School Course Work and Grade Information

Julie P. Noble

July 1991

ACT

PREDICTING COLLEGE GRADES FROM ACT ASSESSMENT SCORES AND HIGH SCHOOL COURSE WORK AND GRADE INFORMATION

Julie P. Noble

ABSTRACT

This study examined the accuracy of predictions of English, mathematics, social studies, and natural sciences course grades, and of overall freshman GPA. The predictions were based on ACT Assessment test scores and on high school course work and grade information from the ACT Assessment Course Grade Information Section (CGIS). Estimates of prediction accuracy were compared to those obtained using ACT scores and the four self-reported grades from the registration folder (TH index), ACT Assessment scores alone, and CGIS information alone as predictors.

Base-year prediction models were developed using student records from the 1986-87 and 1987-88 Prediction Research Services history files; these models were then crossvalidated using data from the same institutions for 1988-89. Separate models were developed and crossvalidated for juniors and seniors. In addition, total group prediction models were developed and crossvalidated separately for juniors and seniors.

The results showed that most ACT/CGIS models slightly increased prediction accuracy in some subject areas over that obtained by the TH index. The model based on the four ACT scores and an average of 23 grades improved prediction accuracy over that of the TH index for more than 50% of the institutions. The amount of improvement was modest, however. The results clearly supported the use of prediction models based jointly on ACT scores and high school grades, rather than on either ACT scores or grades alone.

PREDICTING COLLEGE GRADES FROM ACT ASSESSMENT SCORES AND HIGH SCHOOL COURSE WORK AND GRADE INFORMATION

Julie P. Noble

College admissions or placement decisions are often based in part on predictions of students' performance during their freshman year (e.g., course grades or GPA). Students whose predicted performance falls above a certain level of performance are admitted into the college or course; students whose predicted performance falls below the specified level may be denied admission or may be admitted under special conditions.

The Prediction Research Services (formerly Standard Research and Basic Research Services) provided by ACT allows institutions to develop predictions of students' grades in specific college courses. The predictions are based on regression models composed of students' ACT test scores (in English, mathematics, social studies, and natural sciences; in English and mathematics during the transition to the enhanced ACT Assessment) and their self-reported high school grades in the same subject areas.

Predicted grades and regression weights in the Prediction Research Services are derived for each institution using the TH index, which is calculated using two prediction models:

(1) $Y_T = a_0 + a_1 *$ ACT English Usage score
$+ a_2 *$ ACT Mathematics Usage score
$+ a_3 *$ ACT Social Studies Reading score
$+ a_4 *$ ACT Natural Sciences Reading score

(2) $Y_H = b_0 + b_1 *$ HS English grade
$+ b_2 *$ HS Mathematics grade
$+ b_3 *$ HS Social Studies grade
$+ b_4 *$ HS Natural Sciences grade

For these equations, Y_T and Y_H are the predicted course grades for the two models; the subscript T refers to the test models, or T index, and the H refers to the high school grade model, or H index. The TH index is the average of the two college grade predictions, the T index and the H index. The TH index resembles an 8-variable prediction model and has been shown to yield predictions of comparable accuracy (ACT, 1965). The values a_0, a_1, a_2, a_3, a_4, b_0, b_1, b_2, b_3, and b_4 are regression weights; all values are specific to an institution and the course grade being predicted. The weights are

calculated from the college course grades, ACT test scores, and self-reported high school grades for students from each institution participating in the Prediction Research Services.

The self-reported grades in the four major subject areas are those traditionally collected on the ACT Assessment Registration Folder (RF). There are several limitations in using the RF grades to predict college grades: first, a postsecondary institution cannot determine the exact content of the courses taken in a particular subject area, and thus cannot determine their appropriateness for predicting college course grades. In addition, the institution is limited to high school grades for courses in the four major subject areas (English, mathematics, social studies, natural sciences). The Registration Folder does not include course work in foreign languages or fine arts. Further, each of the four self-reported grades is a single measure, and thus may be less reliable than information derived from multiple measures.

In the fall of 1985, the ACT Assessment Registration Folder was revised to include the High School Course Grade Information Section (CGIS), in which students report the courses they have taken or plan to take in high school and the grades they earned. The CGIS collects information on 30 specific high school courses in English, mathematics, social studies, natural sciences, languages, and the arts. Given the greater specificity in reported course work and grades collected in the CGIS compared to the four self-reported grades, it might be assumed that a better estimate of students' knowledge and skill might be obtained using CGIS data, and thus a stronger relationship with college grades might be found. The purpose of this study, therefore, was to determine the accuracy of college course grade predictions in English, mathematics, social studies, natural sciences, and overall freshman GPA using ACT test scores and information from the CGIS as predictors. The results were compared to those obtained using the four self-reported grades, high school average based on the four self-reported grades, or using ACT scores or CGIS information alone.

The prediction equations developed for one freshman class are typically applied to the test scores and high school grades of future freshman classes.

Because the students enrolled in courses may differ over time in their test scores, high school grades, or college grades, predictive validity statistics developed from one years' data may mis-state the strength of the relationship associated with actual use of the predictions. Crossvalidation analysis compares the predicted grades calculated from equations developed from one freshman class with the actual grades earned by a subsequent class. This procedure models the actual use of prediction equations by institutions, and it avoids the tendency of estimates of predictive accuracy based on a single years' data to be overly optimistic. A second purpose of this study, therefore, was to determine the crossvalidated predictive accuracy of college course grade predictions.

Students typically take the ACT Assessment as high school juniors or seniors, or after graduating from high school (on national test dates and through "residual" testing on college campuses). Only high school juniors and seniors were included in this study; therefore, students will be identified as either "juniors" or "seniors." Approximately 35% of students nationally take the ACT Assessment as juniors, and 65% as seniors (ACT, 1988).

ACT-tested juniors tend to be more academically able than their senior counterparts: The average ACT Composite score of juniors was about 2.7 ACT score units higher than that of seniors in 1988 (ACT, 1988). As a result, the course work and grades reported by juniors and seniors might be expected to differ, both as a result of differences in educational development and when the test was taken. With one more year of high school than juniors, seniors typically have taken at least one more English course and Social Studies course than juniors, and slightly more mathematics and natural sciences course work (Noble and McNabb, 1989). Seniors also have grades for these courses, whereas juniors can only indicate their intent to take or not take additional courses. Therefore, for this study, course grade predictions were examined by grade level (juniors vs. seniors), as well as for the total group.

The utility of ACT test scores and high school course work, as measured by grades or courses taken by students, for predicting college course grades rests on several assumptions:

1. ACT test scores and high school course work and grades either directly measure or are closely related to the academic skills and knowledge required for success in particular courses.
2. College course grades are of sufficient reliability and validity so that they measure real and relevant educational outcomes, rather than random or irrelevant factors.

If these assumptions are true, then there should be a statistical relationship between ACT scores, high school course work, and college freshman grades. Prediction accuracy is therefore a relevant factor in determining the suitability of using test scores and high school grades for making admissions and placement decisions.

Earlier Research

Many studies have been conducted that examined the relationships among college admissions/placement test scores, high school performance, and college grades. Test predictor variables have included ACT scores, SAT scores, and subject-specific tests like the Mathematics Achievement or CEEB-English tests. High school predictors have included high school rank, high school GPA, and four self-reported grades in English, mathematics, social studies, and natural sciences. These studies were limited, however, both in the nature of the high school predictors used and in the criteria being measured. The high school predictors were typically a single value, (e.g., high school rank or GPA) or a set of individual values (e.g., four self-reported grades). Comprehensive measures that took into account the specific nature of the courses or the number of courses taken in each subject area were not used. In addition, the exact nature of the high school information was frequently not specified in sufficient detail to permit comparing the results across institutions.

The criteria examined in the studies were typically freshman GPA, grades from a single specific course, or grades from a small cluster of courses. In addition, for all studies except Noble and Sawyer (1987) and Sawyer and Maxey (1979), the results were based on one years' data and were not crossvalidated. Their results could thus be overly optimistic.

Noble and Sawyer (1987) examined specific college course grade predictions using ACT Assessment test scores and the four RF high school grades as predictors. They included a comprehensive review of the research conducted on the topic. Their findings are summarized below; for a more detailed description of each study see Noble and Sawyer.

The studies on the relationship between English course grades and test scores alone reported relatively low correlations, with values ranging from .13 to .38. Higher multiple R values were reported by Noble and Sawyer (1987), who reported medium multiple Rs of .41 to .47 (four ACT scores), .38 to .46 (four self-reported grades), and .48 to .55 (four ACT scores and four high school grades) when predicting college English grades. Under cross-validation, however, multiple R for the combined model decreased by .00 to .08 across selected English courses.

For the mathematics validity studies, a variety of predictors were used to predict mathematics course grades; the resulting correlations ranged from .04 to .75. Two studies included high school grades, and reported multiple Rs of .36 to .47 between high school grades and college mathematics grade (Bridgeman, 1982; Howlett, 1969). Noble and Sawyer (1987) found median multiple Rs of .36 to .43 using the four ACT scores, .36 to .46 using four self-reported high school grades, and .46 to .56 using test scores and high school grades for predicting mathematic grades. Multiple R typically decreased by .07 for selected mathematics courses when crossvalidated, however.

Social studies validity studies generally showed moderate positive correlations (.32 to .52); these results were based only on test scores. Noble and Sawyer (1987) reported median multiple correlations of .50 to .56 when four ACT scores and four self-reported high school grades were used to predict social studies grade, with a typical decrease in multiple R of .03 to .07 under crossvalidation.

The studies on the relationship between natural sciences grades, test scores, and high school performance reported correlations of .14 to .61. Median multiple correlations of .46 to .51 were reported by Noble and Sawyer

(1987) when ACT scores were used to predict Biology and Chemistry grades; median multiple R increased to .56 and .61 when the four high school grades were added to the prediction model. For the combined model, typical decreases in multiple R of .02 to .05 were found under crossvalidation, however.

Each year ACT publishes the Prediction Research Services Summary Tables (ACT, 1988), which summarize regression statistics derived through the Prediction Research Services during the previous three years. These tables include frequency distributions of correlation coefficients and standard errors of estimate for predicting grades in English, mathematics, social studies, and natural sciences courses, as well as for predicting college freshman GPA. Across the four subject areas, median multiple Rs of .39 to .47 were reported between ACT test scores and college course grade (T index), .40 to .47 between high school grades and college grade (H index), and .48 to .56 between ACT scores, high school grades, and college grade (TH index).

The research published since 1975 on predicting overall GPA is summarized in Table 1. The authors and date of publication, the criterion used, the test and/or high school course work variables used as predictors, the sample size, and the correlation coefficients are presented for each study. For a complete description of the samples and the predictor variables used in each study, see the specific articles cited.

The research on the prediction of college GPA using test scores and high school grades showed somewhat larger correlations than models using test scores or grades alone. Lenning (1975) and Sawyer and Maxey (1979) reported multiple correlations of .53 to .63 for predicting college GPA from the four ACT scores and four self-reported high school grades.

The correlations between high school rank or high school record alone and college GPA were typically between .41 and .56, though Willingham and Breland (1982) reported correlations as low as .25 using high school rank. Sawyer and Maxey (1979) reported crossvalidated correlations of .48 between the four self-reported high school grades and college freshman GPA.

When test scores alone were used to predict college GPA, the correlations ranged from .40 to .50 for ACT scores, and from .27 to .42 for

SAT scores. There were three exceptions: Willingham and Breland (1982) and Cameron (1989) reported correlations of .57 to .61 between SAT scores and college GPA, and Lenning (1975) reported correlations ranging from .50 to .59 between the five ACT scores and college GPA. Sawyer and Maxey (1979) reported median crossvalidated correlations of .48 to .50 between ACT scores and college freshman GPA.

Data for the Study

The analyses in this study were based on student records submitted by institutions through their participation in ACT's Prediction Research Services. Each student record contained the four ACT test scores in English, mathematics, social studies, and natural sciences, plus the ACT Composite score (the average of the four test scores). Scores are reported on a standard scale of 1 to 36. In addition, each record contained two sets of high school course work information: the four RF grades in English, mathematics, social studies, and natural sciences, and the course-taking and grade information from the CGIS (see page 2). High school grades (RF and CGIS) were reported on a 0 (F) to 4 (A) point scale. A high school average (HSA) based on the four RF high school grades was also included.

The ACT scores used for this study were those of students who tested prior to the introduction of the enhanced ACT Assessment in Fall 1989. This study will be replicated when there is a sufficient number of student records with "enhanced" ACT scores and college grades.

The CGIS collects information on 30 specific courses typically found in college preparatory high school curricula. Students are asked to identify the courses they have taken, the courses they plan to take in high school, and the grades they earned. Data are collected for four English courses, seven mathematics courses, seven social studies courses, four natural sciences courses, four foreign language courses, and three fine arts courses. The CGIS is reproduced in Appendix A.

Each student record in the Prediction Research Services also contains grades for one or more specific freshman courses chosen by individual institutions. Detailed descriptions of courses used in this study (e.g.,

"college algebra") were not possible, however; instead, college course grades were classified in the four general subject areas of English, mathematics, social studies, and natural sciences. All other courses reported by institutions (e.g., Religion or Agriculture) were not included in the study. All course grades were reported on a 0.0-4.0 scale.

Sample

Student records from the 1986-87, 1987-88, and 1988-89 Prediction Research Services history files were used for the study. Since the CGIS was not added to the ACT Assessment until 1985, the earliest CGIS data were available for students who took the ACT Assessment in 1985-86 as seniors and enrolled as freshmen in 1986-87. The 1987-88 and 1988-89 files contained records for both juniors and seniors. The 1986-87 file contained records for 87,780 freshmen from 171 colleges who took the ACT as seniors in 1985-86. The 1987-88 file contained records from 175 institutions, with 32,375 students who took the ACT as juniors (1985-86) and 85,922 who took the ACT in 1986-87 as seniors; the 1988-89 file contained records from 168 institutions with 43,672 students who took the ACT as juniors (1986-87) and 112,906 who took it as seniors.

It should be noted that the data in this study pertain only to ACT-tested students and to institutions participating in the Prediction Research Services. As a result, they are in some respects not representative of students nationally:

* Participating in ACT's Prediction Research Services is voluntary; the colleges represented are therefore self-selected even among colleges that use the ACT Assessment.
* Private institutions are relatively underrepresented among college that use the ACT Assessment, and public institutions are over-represented.
* Colleges that use the ACT Assessment are located mainly in the Rocky Mountains, Great Plains, Southwest, Midwest, and South, with comparatively fewer in the East Coast and West Coast.

Therefore, the results of the study cannot be claimed to represent precisely the results that would be obtained if test score and course grade data from all colleges in the United States could somehow be collected.

Creation of New CGIS Variables

Several new variables were created from information provided in the CGIS:

1. Number of courses taken (1), or not taken (0) in the six subject areas (English, mathematics, social studies, natural sciences, languages, and fine arts).
2. Number of courses taken/planned to take (1), or planned not to take (0) in the six subject areas.
3. Average grade in each of the six subject areas.
4. Sum of all grades in each of the six subject areas.
5. Sum of grades for each of 21 specific course clusters. The clusters included one or more courses in a subject area that were selected to reflect both typical high school course sequences and those that maximized the differences in course-taking among students. (For example, English 9 & English 10 was not included because virtually all students take these courses.) A list of the clusters studied is provided in Appendix B.
6. Dummy variables representing whether a student took all of the courses in a given course cluster (1), or did not take all courses in the cluster (0).
7. Average of all reported CGIS grades for each student.
8. Average of the CGIS grades in English, mathematics, social studies, and natural sciences.
9. Average of each students' average grades in the four major content areas.
10. Dummy variables representing whether a student completed a core curriculum of four courses in English and three in mathematics, social studies, and natural sciences (1); or did not complete a core curriculum (0).
11. Dummy variables representing whether a student completed a core curriculum of four courses in English, three in mathematics, and two in social studies and natural sciences (1); or did not complete a core curriculum (0).
12. Dummy variables representing whether a student completed a core curriculum of four courses taken in English and two in mathematics, social studies, and natural sciences (1); or did not complete a core curriculum (0).

Creation of New RF Variables

New course work variables, paralleling those for the CGIS, were developed from the four RF grades and from other data collected in the registration folder (RF). The RF collects, among other data, self-reported number of years in high school course work in English, mathematics, social studies, natural sciences, French, German, Spanish, and other foreign languages. The scale ranged from 0 (none) to 4 (four or more years).

Using the RF course-taking variables, the total number of years taken in each subject areas was computed. The number of years of French, Spanish,

German, and other languages were combined into the total number of years of foreign languages taken. In addition, three dummy variables were developed to represent whether the student had completed a core curriculum. The same core curriculum definitions were used here as were used for the CGIS variables; however, the number of years of courses taken was used in the RF variables, rather than the number of courses taken.

Analysis

Descriptive Analysis

Descriptive statistics were calculated, by grade level, for college course grades and GPA, ACT Composite score, high school average (RF), average of the 23 high school grades (CGIS) and student sample sizes for each institution that participated in the Prediction Research Services in 1987-88. The descriptive statistics were then summarized across institutions. Descriptive statistics based on student sample sizes smaller than 50 were deleted from the summaries.

Selection of Predictor Variables

There were 161 CGIS and RF variables that could potentially be used as predictors of college course grades and GPA. Viable predictors were identified initially by correlating all CGIS and RF course grade and course-taking variables with college course grades and overall freshman GPA.

A representative sample of 10 colleges was drawn from the 1986-87 data to study the relationship between the CGIS and RF course-taking information and college grades. Institutions were chosen according to region, college type, control, and admissions policy, as identified in the College Planning/Search Book (ACT, 1986).

The CGIS and RF variables used for this analysis included the following:

CGIS

1. Each of the 30 courses taken or not taken.
2. Grades reported for each of the 30 CGIS courses taken.
3. Number of courses taken in a subject area.
4. Average of the grades received in a subject area.
5. Sum of grades received in a subject area.
6. Sum of grades for each of the 21 course clusters.
7. Each of the 21 course clusters taken or not taken.
8. Average of all reported grades.
9. Average of the grades in English, mathematics, social studies, and natural sciences.

10. Average of the four average grades in English, mathematics, social studies, and natural sciences.
11. Sum of all grades.
12. Core or more (all three definitions).

RF

1. Number of years of courses taken in a subject area.
2. Four self-reported grades in English, mathematics, social studies, and natural sciences.
3. Average of the four self-reported grades.
4. Core or more (all three definitions).

Correlation coefficients were computed for each institution and then summarized across institutions. Institutions with sample sizes less than 25 for a given pair of variables were deleted from the summary for that correlation.

Of the possible CGIS predictor variables, 36 variables had consistently high correlations with college grade and GPA, relative to other predictors. Appendix C contains the median correlation coefficients for those CGIS and RF predictor variables most highly related to course grades and GPA.

Selection of Prediction Models

From the CGIS and RF course work variables most highly related to college performance, 15 preliminary prediction models were judgementally identified. The numbers of courses taken in each subject area were also included in these preliminary models.

Initial prediction models were developed using the sample of 10 colleges. Multiple correlations (R) and standard errors of estimate (SEE) were calculated for each model and college and then summarized across institutions. R ranges from 0 to 1, with larger values indicating more accurate prediction. SEE is the square root of the average squared differences between actual and predicted course grades. Smaller values of SEE indicate more accurate prediction.

All but three models were then estimated from the complete 1986-87 data file of 171 institutions and 87,780 freshmen who took the ACT Assessment as seniors in 1985-86. These three models were eliminated because they showed less prediction accuracy than the other 12 models. The results for the total group of institutions, as reported in Appendix D, were similar to those found for the sample of 10 colleges.

For the final set of analyses, 13 additional models were estimated to explore further the relationships among high school course work, ACT test scores, and performance in college. In particular, the added models differentiated between courses taken and courses taken/plan to take. Separate models were also developed for the CGIS variables alone, in order to determine the incremental validity of combined test score and CGIS models over that of ACT test score, RF, or CGIS models alone. Due to relatively low base-year prediction accuracy, one model was dropped from the final analyses, resulting in 24 models to be crossvalidated.

Crossvalidation Analysis

For each college, 24 simple or multiple linear regression prediction equations were developed for each college grade and GPA. The models were estimated from the 1987-88 data (base-year), and were developed separately for juniors and seniors. The 24 models were:

ACT

1. ACT score in the corresponding college subject area.
2. Four ACT scores.

RF

3. Four high school grades.

ACT/RF

4. TH Index.
5. Four ACT scores & HSA.
6. ACT Composite & HSA.

CGIS

7. Average grade in the corresponding subject area.
8. Average grade in the corresponding subject area & numbers of courses taken in mathematics and science.
9. Four high school grade averages.
10. Four high school grade averages & four numbers of courses taken.
11. Four high school grade averages & four numbers of courses taken/plan to take.
12. Average grade in corresponding subject area & numbers of courses taken/plan to take in mathematics and science.

ACT/CGIS

13. ACT score and average grade in the corresponding subject area.
14. ACT score and average grade in the corresponding subject area & numbers of courses taken in mathematics and science.
15. Four ACT scores & four high school grade averages.
16. Four AcT scores & four high school grade averages & four numbers of courses taken.

17. Four ACT scores & four high school grade averages & numbers of courses taken in mathematics and science.
18. Four ACT scores & average of 23 high school grades.
19. ACT Composite & average of 23 high school grades.
20. Four ACT scores & average of 30 high school grades.
21. ACT Composite & average of 30 high school grades.
22. Four ACT scores & four high school grade averages & four numbers of courses taken/plan to take.
23. Four ACT scores & four high school grade averages & numbers of courses taken/plan to take in mathematics and science.
24. ACT score and average grade in corresponding subject area & numbers of courses taken/plan to take in mathematics and science.

Institutions from the 1987-88 data file were then identified that had also participated in ACT's Prediction Research Services in 1988-89. The minimum sample size for each institution was set at 50 for both years to reduce sampling error. Of the 175 institutions from 1987-88 and 168 institutions from 1988-89, 81 institutions were identified as having reported college freshman GPA for at least 50 students per year.

The 24 regression equations developed from the base-year data were used to predict the grades of students enrolled in the same course during the crossvalidation year (1988-89). Predicted and actual grades were then compared and the following measures of prediction accuracy were computed for each college, grade level, and course grade or GPA:

* CVR (crossvalidated correlation), the Pearson correlation between predicted and earned course grade/GPA. This coefficient can be compared with the correlation coefficient calculated from the base-year data to give an indication of the stability of the predictions over time.
* RMSE (observed root mean squared error), the square root of the average squared different between predicted and earned college grade/GPA. Smaller values of RMSE correspond to more accurate prediction than do larger values. This statistic can be compared with the standard error of estimate calculated from the base-year data to give an indication of the stability of the predictions over time.
* MAE (mean absolute error), the average of the absolute value of the difference between predicted and earned college grade/GPA. This statistic has immediate relevance for the quality of grade

predictions. For example, if the MAE is .32 for predicting freshman GPA, then, on average, there is an average absolute discrepancy of .32 grade units between predicted and earned GPA at the college.

* BIAS (prediction bias), the average difference between predicted and earned college grade/GPA. Positive values of BIAS corresponding to overprediction, and negative values correspond to underprediction.

These crossvalidation statistics were summarized across institutions; minimum, median, and maximum institutional values were computed for each grade level and subject area grade or GPA.

Total Group Prediction Model

The use of total group prediction models, rather than separate models for each grade level, was also examined. Using the most parsimonious models identified in the crossvalidation analysis, total group linear regression prediction equations were developed for each college grade and GPA using the 1987-88 data (base-year). The total group models were then crossvalidated by grade level using the 1988-89 data for the same institutions. Each institution was required to have a minimum sample size of 50 students per year in order to be included in the analyses. This analysis would provide evidence regarding the validity of using one total group model to predict college grades instead of separate models for each grade level.

CVR, RMSE, MAE, and BIAS statistics were computed for each model, by institution, grade level, and subject area/GPA. The statistics were then summarized across institutions (minimum, median, maximum) for each grade level and subject area/GPA. Total group median crossvalidation statistics were compared across models and grade levels, and were also compared to the statistics based on separate regression equations for each grade level.

Incremental Validity Analysis

The incremental validity of test score and/or high school course work models for each grade level were compared by calculating, by institution and grade level, the differences in CVR and RMSE for the most parsimonious models.

The differences were then summarized across institutions. This analysis would help determine any improvement in prediction accuracy by using ACT/CGIS predictor models rather than ACT/RF models, and by using combined test score/high school course work models rather than test scores or high school course work alone.

Results

Descriptive Statistics

Tables 2 and 3 contain descriptive statistics for each subject area from institutions reporting grades in those areas. The number of institutions in each area is reported, along with the minimum, median, and maximum of the following institutional statistics: number of students, mean, and standard deviation of course grade/GPA, ACT Composite, and high school average (RF); and number of students, mean, and standard deviation of the averages of 23 high school grades (CGIS). The minimum and maximum values illustrate the range of values obtained across institutions; the median values illustrate the results for the typical, or average, institution.

In order to maximize the sample sizes from each institution, the statistics related to the ACT Assessment and RF data were calculated independently of the CGIS data. Approximately 5% of the students failed to complete all or part of the CGIS; the missing information may be noted in Table 2 by comparing the median number of students with college course grade data and those with the CGIS averages. However, the number of colleges pertains to those institutions that had at least 50 students with ACT Assessment, RF, CGIS, and college course grade/GPA data.

As shown in Tables 2 and 3, English course grades were consistently higher than those from other subject areas for both juniors and seniors. Median grades for mathematics and natural sciences were at least .20 grade units lower than the median English grade for juniors and seniors, and the median overall freshman GPA for seniors. The median standard deviations for mathematics grade were also somewhat larger than those for other subject areas; mathematics grade standard deviations were .15 to .39 score units

larger for juniors and seniors. Conversely, median standard deviations were somewhat smaller for English grade and GPA.

The median ACT Composite score was relatively low for ACT-tested juniors and seniors in English courses, as compared to other subject areas. Smaller median ACT Composite standard deviations were also found for students in mathematics and natural sciences courses, compared to other subject areas. The median ACT Composite standard deviation for students in English courses tended to be smaller than that for students with overall freshman GPAs.

Median high school average (RF) differed somewhat across subject areas and grade levels, though median high school average standard deviations were similar. Median high school average (RF) was slightly higher for students in mathematics and natural sciences courses than those in other subject areas. The median high school average from the CGIS was slightly higher for ACT-tested juniors and seniors in mathematics and natural sciences courses, relative to those in English courses and freshman GPA. Median standard deviations were similar across subject areas, however. It may also be noted that the median CGIS high school average was slightly higher than the median RF average for all subject areas and grade levels.

Across grade levels, median college course grades were consistently higher for juniors than for seniors, particularly in natural sciences (2.54 vs. 2.23) and social studies (2.60 vs. 2.30). Median course grade standard deviations were slightly larger for seniors, however, particularly in English (.95 vs. .85).

As expected, ACT Composite scores typically were higher for juniors than for seniors by 1.5 to 2.2 score units, and had consistently smaller standard deviations. Juniors' median high school average (RF) was also slightly higher than that for seniors in natural sciences (3.20 vs. 3.04) and for overall GPA (3.05 vs. 2.90). The corresponding median standard deviations were similar, however.

The median CGIS high school averages were fairly similar across grade levels and subject areas except for mathematics, where the median high school

average for juniors was slightly higher than that for seniors. Median CGIS average standard deviations were similar for juniors and seniors, however.

Crossvalidation Results

The crossvalidation analysis revealed that using courses taken/planned to take (as compared to courses taken) did not increase prediction accuracy across regression models. In addition, including the four numbers of courses taken, or the number of courses taken in mathematics and science, did not increase prediction accuracy over and above that for the four ACT scores, the four high school grades, or the single ACT test score and corresponding high school grade models. Further, the models including HSA (RF) did not yield greater prediction accuracy than the TH index. Therefore, the regression statistics for these models will not be reported. Detailed results for these models are available from the author.

The crossvalidation analysis by grade level revealed that CVR, RMSE, MAE, and BIAS did not differ substantially between juniors and seniors, although the median CVRs, RMSEs, and MAEs for seniors were slightly larger than those for juniors. Course grades and GPA tended to be slightly overpredicted for juniors, as compared to those for seniors. The separate grade level crossvalidation analysis therefore will not be reported here. For a complete discussion of the separate grade level results, see Appendix E.

Five prediction models were selected from the 24 models used for juniors and seniors to conduct the total group regression analysis. Since the crossvalidation results by grade level for the models using 23 grades versus those using 30 grades were similar for most subject areas, the models based on 30 grades were not included in this analysis. The models used for this analysis included:

M1. TH index

M2. ACT test score & corresponding high school grade average

M3. Four ACT scores & four high school grade averages

M4. Four ACT scores & average of 23 high school grades

M5. ACT Composite & average of 23 high school grades

Tables 4 through 8 contain the results of the total group crossvalidation analysis. The total group base-year results are available from the author.

As shown in Tables 4 through 8, the minimum, median, and maximum crossvalidation results (CVR, RMSE, MAE, and BIAS) are reported for each prediction model. The minimum and maximum institutional statistics show the variability in crossvalidated prediction accuracy across institutions. The medians illustrate the typical crossvalidated prediction accuracy obtained across the institutions.

The results for predicting English grade for juniors (Table 4) showed a relatively large median CVR for the four ACT scores & four grade averages model (.45; M3), as compared to the results for the TH index (M1) and ACT Composite & average of 23 grades (M5) models (.39 and .40). The median CVRs for the other ACT/CGIS models were similar. Median RMSE and MAE were similar across all of the models, but the median BIAS results showed that all models tended to underpredict English grade, with median BIAS values ranging from -.05 to -.08.

In contrast, for seniors all crossvalidation statistics were similar across the models. Compared to the results for juniors, median RMSE and MAE were somewhat larger for seniors across all models. Median CVR was slightly larger for juniors for the ACT English & English grade average (M2) and four ACT scores & four high school grade averages (M3) models, with CVR median differences of .03. The most noticeable difference was in the median BIAS statistics for all models; English grade was more likely to be underpredicted for junior-tested students than for seniors. BIAS median differences ranged from .05 to .07.

Table 5 contains the crossvalidation results for predicting mathematics grade. Median CVRs for juniors were fairly similar across the models, with a somewhat smaller median CVR for the ACT Composite & average of 23 grades model (.42; M5). Median RMSE ranged from 1.07 to 1.10, and median MAE from .87 to .90, with the TH index (M1) and ACT Mathematics & Mathematics grade average (M2) models having slightly less prediction accuracy (median RMSE = 1.10; median MAE = .90) than the four ACT score & average of 23 grades model (median

RMSE = 1.07; median MAE = .87). The TH index (M1) tended to slightly underpredict mathematics grade for juniors (median BIAS = -.04), as did the two models using the average of 23 high school grades (median BIAS = -.03).

For seniors, median CVR was similar across all models. However, median RMSE was slightly smaller for the four ACT scores & average of 23 grades model (1.08; M4) than for the TH index (1.11; M1). The TH index (M1) also had a slightly larger median MAE (.92), particularly when compared to the two models including the average of 23 grades (median MAE = .87; M4 and M5). Median BIAS was near zero for all models.

In comparison to juniors, median CVRs for the ACT Mathematics & Mathematics grade average (M2) and ACT Composite & average of 23 grades (M5) models were slightly larger for seniors (median CVR difference=.03). Median RMSE and MAE, however, tended to be fairly similar for juniors and seniors. As was the case for English grade, however, all prediction models tended to underpredict mathematics grade for juniors, as compared to seniors (BIAS median difference = .02 to .07).

The results for social studies grade are reported in Table 6. For juniors, the crossvalidation statistics were similar across all models except for the ACT Social Studies & Social Studies grade average model (M2) and the TH index (M1). The former model had smaller median CVR (.42) and somewhat larger median RMSE (.92) and MAE (.74) than the other models. The TH index (M1) was more likely to underpredict social studies grade (median BIAS = -.07) than the other models.

As was found for juniors, the median CVR for the ACT Social Studies & Social Studies grade average model for seniors (.42; M2) was smaller than those of other models. However, median RMSE and MAE were similar across the models. The median BIAS results showed a tendency for most of the models to slightly overpredict social studies course grade for seniors, particularly the TH index (median BIAS = .05; M1).

The results for seniors, compared to those for juniors, showed similar prediction accuracy across the models, as measured by median CVR. However, median RMSE and MAE were consistently larger for seniors, with RMSE and MAE

median differences ranging from .03 to .06. Typically, median BIAS differences ranged from .03 to .12. The models tended to underpredict social studies grade for juniors and overpredict for seniors.

Natural Science grade crossvalidation results are reported in Table 7. It should be noted that one institution was eliminated from the analyses for Natural Sciences grade, based on extreme BIAS values and confirmation from the institution that the courses used in 1987-88 and in 1988-89 were not the same courses. The results for juniors were similar to those found for Social Studies grade: the ACT Natural Sciences & Natural Sciences grade average model (M2) typically had smaller CVRs (median CVR = .44) and somewhat larger RMSEs (median RMSE = .92) than the other models. This model and the TH index (M1) tended to have somewhat larger median MAEs (.73); the TH index was also more likely to underpredict Natural Sciences grade (median BIAS = -.06) than other models.

For seniors the results were similar for all models except the ACT Natural Sciences & Natural Science grade average model (M2) and the TH index (M1). The ACT Natural Sciences & Natural Sciences grade average model yielded a smaller median CVR (.42), and a somewhat larger median RMSE (.98) and MAE (.79) than other models. Both models had a slightly larger median BIAS (.04 and .05) than did other models. The four ACT scores & average of 23 grades model (M10) had the largest median CVR (.52) and the smallest median RMSE (.93) and MAE (.75).

The differences between the results for juniors and seniors were fairly consistent across the prediction models. Median RMSE and MAE were generally larger for seniors, with differences in medians ranging from .03 to .06. Positive median BIAS was typical for ACT-tested seniors; for juniors, Natural Sciences grade was more likely to be underpredicted. Overall, BIAS median differences ranged from .03 to .11. With median CVR, however, slight differences between juniors and seniors were found for the TH index (M1) and four ACT scores & average of 23 grades models (M1 and M5). Seniors had slightly higher median CVRs than juniors for these models (CVR median difference = .03).

The results for predicting college freshman GPA for juniors and seniors are reported in Table 8. The results for juniors were similar for all prediction models, except for the TH index (M1). The TH index had the smallest median CVR (.51), the largest median RMSE (.68) and MAE (.54), and was more likely to underpredict college freshman GPA for juniors (median BIAS = -.07) than were the other models. All of the ACT/CGIS models tended to slightly underpredict college GPA, with median BIAS values of -.03 to -.04.

For seniors, no differences were found in the results across all models. In contrast to juniors, however, median RMSE was typically larger for seniors (RMSE median difference = .03, .04) for all models, and college freshman GPA was more likely to be underpredicted for juniors than for seniors.

Total Group Versus Grade Level Models. The use of total group models, rather than separate grade level models, influenced the crossvalidation results for juniors. In English and mathematics, the median CVRs associated with the total group models for juniors were actually larger than the CVRs associated with the separate grade level models. Moreover, all models but one ACT/CGIS model were more accurate when predicting English grades from the total group data.

The results for seniors showed no differences in median CVR using total or separate group models. For both juniors and seniors, no differences were found in median RMSE and MAE for all subject areas except English for juniors, where median RMSE decreased slightly for the ACT/CGIS models when using the total group data.

Differences between total group and separate grade level models were shown in the BIAS statistics. Across all models and subject areas, most of the total group models for juniors showed much lower and more negative median BIAS values than the separate grade level models; median changes in BIAS ranged from -.02 to .08 for juniors. For seniors, however, median BIAS values were somewhat larger and more positive using the total group models than were those using separate grade level models.

Incremental Validity of Selected Prediction Models

Of the separate grade level prediction models used in the crossvalidation analysis, seven had the greatest prediction accuracy in one or more subject areas for juniors and seniors:

M1. TH index

M2. ACT test score & corresponding high school grade average

M3. Four ACT scores & four high school grade averages

M4. Four ACT scores & average of 23 high school grades

M5. ACT Composite & average of 23 high school grades

M6. Four AcT scores & average of 30 high school grades

M7 ACT Composite & average of 30 high school grades

Two other models were added to this analysis to help determine the incremental validity of each model; these included the ACT test score for the relevant subject area (M8) and the four CGIS high school grade averages (M9). Due to the similarity in median crossvalidation statistics for the models using 23 or 30 high school grades, only the high school average based on 23 grades was retained for this analysis.

Most of the ACT/CGIS models did not increase CVR over that of the TH index (M1) across institutions, grade levels, and subject areas. The only model that showed any increase in CVR over the TH index was the four ACT scores & average of 23 grades model (M4), with median CVR increases of .00 to .02.

In comparison to using the four high school grade averages alone, the four ACT scores & four high school grades (M3) and four ACT scores & average of 23 grades (M4) models typically increased CVR by .03 to .05 units across all four subject areas and GPA, and decreased RMSE by .00 to .03 for both juniors and seniors. The ACT Composite & average of 23 high school grades (M5) model typically yielded larger CVRs than the four high school grade averages model (median CVR difference = .03 to .06; M6), but only for social studies, natural sciences, and freshman GPA.

Larger differences in CVR and RMSE were found when the results for the combined ACT/CGIS models or the TH index were compared with those based on

individual ACT scores alone. Using the four ACT scores & four grade averages (M3) or the four ACT scores & average of 23 grades models (M4) increased CVR, in general, by .04 to .13 across the four subject areas. RMSE typically decreased by .03 to .07 units using these models for mathematics, social studies, and natural sciences grade. The four high school grade averages model (M9), when compared to models based on individual ACT scores (M8), typically had larger CVRs by .04 to .07 units and smaller RMSEs by .02 to .03 units, but only for mathematics, social studies, and natural sciences. The ACT Composite typically obtained similar CVRs and RMSEs as the four high school grade averages when predicting college freshman GPA.

In aggregate, relatively small increases in prediction accuracy were found using ACT/CGIS models rather than the TH index. The practical utility of ACT/CGIS models over the TH index model for individual institutions required further investigation. A second method for examining the incremental validity of these models was therefore used to determine the proportion of institutions that increased CVR and/or decreased RMSE using one model rather than another. For this analysis, the CVRs and RMSEs from the ACT/CGIS models were compared with those for the TH index. The proportions of institutions in each subject area for which CVR was larger and RMSE was smaller using an ACT/CGIS model rather than the TH index was then determined. The results showed that the four ACT scores & average of 23 high school grades (M4) model was the only model that increased CVR or reduced RMSE over those for the TH index for more than 50% of the institutions, across grade levels and all four subject areas and freshman GPA. Typically, 60% to 72% of the institutions showed an increase in CVR and 70% to 83% showed a decrease in RMSE.

Summary and Conclusions

The ACT/CGIS models only slightly increased prediction accuracy in some subject areas over that obtained by the TH index, as measured by median CVR, RMSE, or MAE. The four ACT scores & average of 23 grades model was the only model to improve prediction accuracy over that of the TH index for a least 50% of the institutions, across all subject areas and grade levels. The four ACT scores & average of 23 grades (M4) and four ACT scores & four grade averages

(M3) models yielded similar or slightly greater prediction accuracy, as measured by CVR and RMSE, than the TH index model, particular for English grade and GPA. The four ACT scores & average of 23 grades model had greater prediction accuracy than the ACT Composite & average of 23 grades model for English and mathematics, where median differences in CVR favored the four ACT scores model. The single ACT test score & single grade average model (M2) had the greatest prediction accuracy for predicting English grade, but typically had less prediction accuracy than other ACT/CGIS models for predicting mathematics, social studies, and natural science course grades.

Across subject areas and grade levels, prediction models based on ACT scores and high school grades (either CGIS or RF) had higher median CVRs than predictions based on CGIS average grades, RF grades, or ACT scores alone. The CGIS grade averages typically had somewhat greater prediction accuracy, as measured by CVR, than the four grades or high school average from the registration folder, and somewhat smaller median RMSEs and MAEs for mathematics grade. Moreover, the CGIS grade averages had larger median CVRs and slightly smaller median RMSEs and MAEs than the four ACT scores for most subject areas and grade levels.

In addition, inclusion of courses taken or courses taken/plan to take did not increase prediction accuracy over that obtained using CGIS grades and ACT scores. Further, no differences in prediction accuracy were found for models using courses taken, as compared to those using courses taken/plan to take.

The results of this study were similar to or slightly better, in terms of prediction accuracy, than those of earlier studies, except for those for college English courses and those from the Prediction Research Services Summary Tables. These results are positive in that the other studies typically used only base-year data and did not differentiate students by grade level. Statistics based on one year's data and on a more heterogeneous group of students (all students rather than separated by grade level) would tend to yield greater prediction accuracy. In comparison to the results for Noble and Sawyer (1987), prediction accuracy was similar for all four subject areas except English, for which this study showed lesser prediction accuracy. The

results for predicting freshman GPA were similar to those obtained by Sawyer and Maxey (1979).

Factors Related to Variation in Predictive Validity Statistics

The use of ACT scores and CGIS course work and grade information for predicting college grades increased prediction accuracy only slightly over that obtained using ACT scores and four self-reported grades. The failure to increase prediction accuracy to a large degree might be attributed to unreliability in the predictors (ACT scores and high school grades), unreliability in the criteria (college grades or GPA), and less than perfect relationships between the true scores of predictors and criteria.

The reliabilities of ACT test scores have been estimated between .84 and .91 for the four tests (ACT, 1987). These were KR20 reliabilities calculated across 15 forms of the ACT Assessment administered between 1983 and 1986.

The reliability of specific course grades has proven to be difficult to determine. Students do not typically retake courses unless required to do so, and thus "test-retest" reliability estimates are not feasible. The research that has been done on college course grade reliabilities has predominantly relied on other methods to estimate reliabilities, including using a Spearman-Brown formula to step down an overall GPA reliability to a single course reliability estimate (Etaugh, Etaugh, and Hurd, 1972; Schoenfeldt and Brush, 1975). All of these studies examined the reliability of college grades, rather than high school grades. Etaugh, et al. reported single course reliabilities of .30 and .44; Schoenfeldt and Brush obtained single course reliabilities ranging from .39 to .76 for 12 specific course areas. The reliability of college freshman GPA has been estimated to be much higher than single course reliabilities, with estimates ranging between .80 and .82 (Millman, Slovacek, Kulick, and Mitchell, 1983; Munday, 1970).

The accuracy with which students report courses taken and grades received was studied by Sawyer, Laing, and Houston (1988), who concluded that students report their course grades and courses taken with a high degree of accuracy. Similar results were found by Maxey and Ormsby (1971), who compared the four self-reported grades with actual grades, and found that 97.8% of the grades

were reported within one grade point of their actual value. Accuracy of the high school average based on the four self-reported grades was also estimated at .92 (ACT, 1965).

The relationship between ACT scores, high school course work and grades, and freshman course grades is also influenced by the degree of content overlap between the three measures. As noted by Olson (1989), high school grades tend to not only measure academic skills and knowledge, but may include other factors such as socially acceptable behavior, motivation, or effort. Similar findings have been noted for college grades: students' grades are often influenced by class participation, effort, or other factors (e.g., Pedulla, Airasian, and Madaus, 1980). In addition, differential standards of grading can be found across disciplines and instructors (e.g., Duke, 1983).

One may conclude, then, that the CGIS and RF information both accurately represent course work and grades, as reported in the high school transcript. However, the validity and reliability of high school grades as measures of academic achievement is limited, as are the reliability and validity of college grades. The extent to which level of achievement is distorted by other characteristics of the student, or by unreliability in course grading, will impact on errors of prediction, regardless of whether self-reported or actual grades are used. The slight increase in prediction accuracy by using CGIS grades rather than RF grades could be attributed to the greater reliability of grade averages based on CGIS variables, as compared to the RF individual course grades.

An additional factor for the college grades used here is that, in participating in ACT's Prediction Research Services, institutions are free to report any course at any level (developmental, standard, honors) in a given subject area. The criteria lack the precision of specific course grades, which will directly impact prediction accuracy for any given subject area.

Although the ACT Assessment tests may not measure all of the knowledge and skills required for performance in college, it is likely that they measure a majority of the most important or necessary skills and knowledge required in college courses. This will result in a strong relationship between ACT test

scores and students' performance in college. If the ACT tests do not directly measure the requisite skills or knowledge for a specific course, they may measure closely related ones; for students in such courses, we could expect a significant relationship between the two sets of measured skill and/or knowledge.

The relationship between test score, high school grades, and college grades is also influenced by the variability in both the predictors and the criterion; by increasing their heterogeneity, CVR will increase (Nunnally, 1978). Conversely, if the variability in the predictors or criterion is restricted, then CVR will decrease. Given a fixed value of CVR, RMSE increases as the criterion standard deviation increases. For predictor/criterion relationships with homoscedastic errors, RMSE is not directly affected by changes in the standard deviation of the predictors. In practice, the variability in ACT scores, high school grades, or college course grades may be affected by preselection, placement, or college grading practices.

Across the four subject areas and GPA, median CVR, RMSE, and MAE were typically smaller for English grade than for the three other subject area grades for both juniors and seniors. Median RMSE and MAE were similar for college GPA and English grade, however. These results could be attributed to placement or preselection of students into English courses.

The median standard deviations found for English grade were smaller than those of other subject areas, with the exception of freshman GPA, which had similar standard deviations. The reduced variability in English grades or GPA are reflected in reduced median RMSE and MAE. For English grade, however, median CVR was smaller than those for other subject areas, whereas for GPA, median CVR was similar to or larger than those for other subject areas. Further, the standard deviation for ACT Composite score for students in English was smaller than that for GPA. The restriction of range in the predictor and in the criterion would tend to reduce median CVR.

The restriction of range in ACT scores is likely due to placement of students into English courses. The reduced variability in English grades, accompanied by relatively high course grade averages, compared to other

subject areas, would suggest that grading standards for English courses are more lenient than in other subject areas, with relatively little variation in grading.

Mathematics grade median RMSEs and MAEs were larger than those for other subject areas. These larger medians might be attributed to the grading standards used for mathematics courses. The larger median standard deviations for mathematics grade would suggest greater variability in grading for mathematics courses, compared to other subject areas. This result was also noted by Noble and Sawyer (1987); however, they noted greater differences in mean course grade than was found here, with lower median grades in mathematics than in the other three subject areas.

Implications

The results found here support the use of combined prediction models using ACT scores and high school grades, rather than ACT test scores or grades alone, for admissions and placement. Using high school grade averages based on several courses rather than four course grades will slightly improve the accuracy of placement or admissions decisions. In order to maximize prediction accuracy, combined prediction models should be used in making such decisions; in particular, the four ACT scores & average of 23 CGIS high school grades model would maximize prediction accuracy across all subject areas and GPA.

Thorndike (1969), Hills (1981), and Stiggins, et al. (1989) advance the notion that grades students receive should reflect, as much as possible, relatively pure measures of achievement. As noted above, this is often not the case for either high school or college grades. Tests like the ACT Assessment provide a relatively distortion-free (i.e., valid) measure of academic development. In combination with high school grades, they appear to provide greater accuracy for making college placement and admissions decisions, in comparison to using either test scores or grades alone.

One must also note that there is variability in the predictive accuracy of the course grade predictors across models, grade levels, and subject areas. As a result, local course grade and GPA prediction equations need to be

developed to be assured of maximum predictive accuracy and correct placement and admissions decisions.

Recommendations for Further Study

The test scores used in this study were from the ACT Assessment administered prior to October, 1989. A new version of the ACT Assessment was implemented beginning in October, 1989 (ACT, 1989). The general character of the ACT Assessment was maintained in the new version, in that its contents are achievement-oriented and curriculum-based; the contents, however, incorporate recent changes in secondary and postsecondary curricula. It is likely, therefore, that the relationship between scores on the new ACT tests, high school course work and grades, and college grades will be stronger than those reported here. This study will by replicated to determine whether similar or increased prediction accuracy may be obtained using enhanced ACT Assessment test scores.

Though they estimate prediction accuracy, multiple regression prediction equations do not directly address the results of making admissions or placement decisions based on test scores and/or high school course work. Additional research will be conducted using alternative statistical methods that estimate the proportions of true and false positives and negatives resulting from using ACT/CGIS models in making admissions and placement decisions.

REFERENCES

American College Testing Program (1965). ACT Technical Report, 1965 edition. Iowa City, Iowa: Author.

American College Testing Program (1986). College planning/search book. Iowa City, Iowa: Author.

American College Testing Program (1987). The ACT Assessment program technical manual. Iowa City, Iowa: Author.

American College Testing Program (1988). The high school profile report. Iowa City, Iowa: Author.

American College Testing Program (1989). Preliminary technical manual for the Enhanced ACT Assessment. Iowa City, Iowa: Author.

Aleamoni, L. M., & Oboler, L. (1978). ACT vs SAT in predicting first semester GPA. Educational and Psychological Measurement, 38, 393-399.

Bridgeman, B. (1982). Comparative validity of the College Board Scholastic Aptitude Test-Mathematics and the Descriptive Tests of Mathematics Skills for predicting performance in college mathematics courses. Educational and Psychological Measurement, 42, 361-366.

Cameron, R. G. (1989). The common yardstick: A case for the SAT. CEEB: New York.

Crouse, J., & Trusheim, D. (1988). The case against the SAT. University of Chicago Press: Chicago.

Crouse, J., & Trusheim, D. (1989). The SAT's use in college admissions: Does the gain to colleges justify the harm to women? A paper presented at the American Educational Research Association national conference in San Francisco.

Dalton, S. (1976). A decline in the predictive validity of the SAT and high school achievement. Educational and Psychological Measurement, 36, 445-448.

Duke, J. D. (1983). Disparities in grading practice, some resulting inequities, and a proposed new index of academic achievement. Psychological Reports, 53, 1023-1080.

Durio, H., Kidow, C., & Slover, J. (1980). Ethnicity and sex differences in use of college entrance examinations, mathematics achievement, and high school rank as predictors of performance and retention among engineering students. A paper presented at the American Education Research Association national conference in Boston.

Educational Testing Service (1980). Test use and validity. Princeton, NJ: Author.

Etaugh, A. R., Etaugh, C. F., & Hurd, D. E. (1972). Reliability of college grades and grade point averages: Some implications for prediction of academic performance. Educational and Psychological Measurement, 32, 1045-1050.

Ford, S., & Campos, S. (1977). Summary of validity data from the Admissions Testing Program Validity Study Service. Princeton: CEEB.

Hedges, L., & Majer, K. (1976). An attempt to improve predictions of college success of minority students by adjusting for high school characteristics. Educational and Psychological Measurement, 36, 953-957.

Hills, J. R. (1981). Measurement and evaluation in the classroom (2nd edition). Columbus, Ohio: Charles E. Merrill.

Howlett, J. (1969). A study of placement methods for entering freshmen in the proper mathematics sequence of Michigan Technological University. The Mathematics Teacher, 62, 651-659.

Humphreys, L., Levy, J., & Taber, T. (1973). Predictability of academic grades for students of high and low academic promise. Educational and Psychological Measurement, 33, 385-392.

Lenning, O. (1975). Predictive validity of the ACT tests at selective colleges (ACT Research Report No. 69). Iowa City, Iowa: The American College Testing Program.

McCornack, R., & McLeod, M. (1988). Gender bias in the prediction of college course performance. Journal of Educational Measurement, 25, 321-331.

Maxey, E. J., & Ormsby, V. J. (1971). The accuracy of self-report information collected in the ACT test battery: high school grades and items of nonacademic achievement. (ACT Research Report No. 45). Iowa City, Iowa: Author.

Millman, J., Slovacek, S. P., Kulick, E., & Mitchell, K. J. (1983). Does grade inflation affect the reliability of grades? Research in Higher Education, 19, 423-429.

Munday, L. (1970). Factors influencing the predictability of college grades. American Educational Research Journal, 7, 99-107.

Noble, J., & McNabb, T. (1989). Differential course work and grades in high school: Implications for performance on the ACT Assessment (ACT Research Report No. 89-5). Iowa City, Iowa: The American College Testing Program.

Noble, J., & Sawyer, R. (1987). Predicting grades in specific college freshman courses from ACT test scores and self-reported high school grades (ACT Research Report No. 87-20). Iowa City, Iowa: The American College Testing Program.

Nunnally, J. L. (1978). Psychometric theory. New York: McGraw-Hill Book Company.

Olson, G. (1989). On the validity of performance grades: The relationship between teacher-assigned grades and standard measures of subject matter acquisition. A paper presented at the annual meeting of the National Council on Measurement in Education in San Francisco.

Pedulla, J. J., Airasian, P. W., & Madaus, G. F. (1980). Do teacher ratings and standardized test results of students yield the same information? American Educational Research Journal, 17, 303-307.

Rowan, R. W. (1978). The predictive value of the ACT at Murray State Education University over a four-year college program. Measurement and Evaluation in Guidance, 11, 143-149.

Sawyer, R., Laing, J., & Houston, M. (1988). Accuracy of self-reported high school course work and grades of college-bound students (ACT Research Report No. 88-1). Iowa City, Iowa: The American College Testing Program.

Sawyer, R., & Maxey, E. J. (1979). The validity over time of college freshman grade prediction equations (ACT Research Report No. 80). Iowa City, Iowa: The American College Testing Program.

Schoenfeldt, L., & Brush, D. (1975). Patterns of college grades across curricular areas: Some implications for GPA as a criterion. American Educational Research Journal, 12, 313-321.

Stiggins, R. J., Frisbie, D. A., & Griswold, P. A. (1989). Inside high school grading practices: Building a research agenda. Educational Measurement Issues and Practice, 8, 5-14.

Sue, S., & Abe, J. (1988). Predictors of academic achievement among asian american and white students (College Board Report No. 88-11). New York: CEEB.

Thorndike, R. L. (1969). Marks and marking systems. In R. L. Ebel (Ed.). Encyclopedia of Educational Research (4th Edition). New York: Macmillan.

Trusheim, D., & Middaugh, M. (1987). Population validity issues and the prediction of freshman grades. A paper presented at the Association for Institutional Research Annual Forum in Kansas City.

Willingham, W., & Breland, H. (1982). Personal qualities and college admissions. New York: CEEB.

Appendix A

ACT Assessment
Course Grade Information Section

USE A SOFT LEAD PENCIL ONLY

HIGH SCHOOL COURSE/ GRADE INFORMATION

This section lists 30 high school courses. Indicate whether or not you have taken or plan to take each course and, if you have taken it, the last grade you earned. You may wish to refer to your previous high school grade reports or a copy of your current high school transcript. The information you provide will be sent to the colleges you indicate on page 4 of this folder.

For further instructions, see page 4 of *Registering for the ACT Assessment*. After you have completed this section, sign the certification statement at the top of this page.

STUDENT'S SIGNATURE: I hereby certify that the course and grade information provided below is accurate and complete to the best of my knowledge. (I realize that this information may be verified at a later time by college personnel.)

Student's Signature _____ *Date* _____

COURSES TAKEN OR PLANNED

Indicate whether or not you have taken each of the high school courses listed below and, if not, whether you plan to take the courses before you finish high school. Be sure to blacken one oval for **EACH** subject, **even those you have not taken.**

GRADES EARNED

For each course you have completed or have taken for a full term (semester, quarter, etc.) indicate the final grade (last grade) you received. If you took the course for more than one term, report only the **LAST** term grade you received. Convert numeric grades to the corresponding letter grades. Round to the closest letter grade if necessary. Leave blank if you have not yet completed a full term of the subject or if a grade was not awarded for the course.

		HAVE TAKEN OR AM TAKING: (I have completed or am now enrolled in this subject.)	HAVE NOT TAKEN, BUT WILL: (I have not taken this subject, but plan to take it prior to graduation.)	HAVE NOT TAKEN, AND WILL NOT: (I have not taken and do not plan to take this subject.)	A	B	C	D	F
ENG.	English taken during the 9th grade	0	0	0	0	0	0	0	0
	English taken during the 10th grade	0	0	0	0	0	0	0	0
	English taken during the 11th grade	0	0	0	0	0	0	0	0
	English taken during the 12th grade	0	0	0	0	0	0	0	0
	Speech	0	0	0	0	0	0	0	0
MATH	First-year Algebra (Algebra I; not pre-Algebra)	0	0	0	0	0	0	0	0
	Second-year Algebra (Algebra II)	0	0	0	0	0	0	0	0
	Geometry	0	0	0	0	0	0	0	0
	Trigonometry	0	0	0	0	0	0	0	0
	Calculus (not pre-Calculus)	0	0	0	0	0	0	0	0
	Other Math beyond Algebra II	0	0	0	0	0	0	0	0
	Computer Math/Computer Science	0	0	0	0	0	0	0	0
NAT. SCI.	General/Physical/Earth Science	0	0	0	0	0	0	0	0
	Biology	0	0	0	0	0	0	0	0
	Chemistry	0	0	0	0	0	0	0	0
	Physics	0	0	0	0	0	0	0	0
SOC. STUDIES	U.S. History (American History)	0	0	0	0	0	0	0	0
	World History/World Civilization	0	0	0	0	0	0	0	0
	Other History (European, State, etc.)	0	0	0	0	0	0	0	0
	American Government/Civics	0	0	0	0	0	0	0	0
	Economics (Consumer Economics)	0	0	0	0	0	0	0	0
	Geography	0	0	0	0	0	0	0	0
	Psychology	0	0	0	0	0	0	0	0
LANG.	Spanish	0	0	0	0	0	0	0	0
	French	0	0	0	0	0	0	0	0
	German	0	0	0	0	0	0	0	0
	Other Language	0	0	0	0	0	0	0	0
ARTS	Art (painting, etc.)	0	0	0	0	0	0	0	0
	Music (vocal or instrumental)	0	0	0	0	0	0	0	0
	Drama/Theater (if taken as a course)	0	0	0	0	0	0	0	0

INTEREST INVENTORY

The ACT Interest Inventory and the Student Profile Section (on page 5) are important parts of the ACT Assessment. The items in each deal with you—your educational interests, goals, plans, and accomplishments.

You should complete the Interest Inventory and the Student Profile Section as carefully and accurately as you can. Much of the information on the reports sent to you and to the colleges you select is based on your responses to these two sections.

1	0	0	0	31	0	0	0	61	0	0	0
2	0	0	0	32	0	0	0	62	0	0	0
3	0	0	0	33	0	0	0	63	0	0	0
4	0	0	0	34	0	0	0	64	0	0	0
5	0	0	0	35	0	0	0	65	0	0	0
6	0	0	0	36	0	0	0	66	0	0	0
7	0	0	0	37	0	0	0	67	0	0	0
8	0	0	0	38	0	0	0	68	0	0	0
9	0	0	0	39	0	0	0	69	0	0	0
10	0	0	0	40	0	0	0	70	0	0	0
11	0	0	0	41	0	0	0	71	0	0	0
12	0	0	0	42	0	0	0	72	0	0	0
13	0	0	0	43	0	0	0	73	0	0	0
14	0	0	0	44	0	0	0	74	0	0	0
15	0	0	0	45	0	0	0	75	0	0	0
16	0	0	0	46	0	0	0	76	0	0	0
17	0	0	0	47	0	0	0	77	0	0	0
18	0	0	0	48	0	0	0	78	0	0	0
19	0	0	0	49	0	0	0	79	0	0	0
20	0	0	0	50	0	0	0	80	0	0	0
21	0	0	0	51	0	0	0	81	0	0	0
22	0	0	0	52	0	0	0	82	0	0	0
23	0	0	0	53	0	0	0	83	0	0	0
24	0	0	0	54	0	0	0	84	0	0	0
25	0	0	0	55	0	0	0	85	0	0	0
26	0	0	0	56	0	0	0	86	0	0	0
27	0	0	0	57	0	0	0	87	0	0	0
28	0	0	0	58	0	0	0	88	0	0	0
29	0	0	0	59	0	0	0	89	0	0	0
30	0	0	0	60	0	0	0	90	0	0	0

Appendix B

High School Course Clusters

Cluster
English 11 & English 12
English 11 & Speech
English 11 & English 12 & Speech
Algebra II & Trigonometry
Geometry & Trigonometry
Algebra II & Geometry & Trigonometry
Algebra II & Geometry & Trigonometry & Calculus
World History & American Government
World History & Geography
World History & American Government & Economics
World History & American Government & Economics & Geography
American Government & Economics
American Government & Economics & Geography
Biology & Chemistry
Biology & Chemistry & Physics
Chemistry & Physics
Spanish
Spanish & French
Art
Music
Art & Music

Appendix C

Median Simple Correlations Between Selected Predictor Variables, Course Grades, and Overall GPA

Predictor variable	Grade/GPA				
	English	Mathematics	Social Studies	Natural Sciences	Overall
CGIS					
English 9	.39	.31	.27	.35	.40
English 10	.38	.28	.30	.32	.36
English 11	.36	.33	.32	.37	.40
English 12	.29	.33	.29	.30	.37
Speech	.39	.19	.23	.23	.30
Algebra I	.32	.33	.25	.36	.34
Algebra II	.32	.29	.32	.43	.38
Geometry	.26	.35	.31	.36	.35
Trigonometry	.25	.34	.28	.30	.33
Beginning Calculus	.31	.50	.04	.56	--
Other Advanced Mathematics	.32	.13	.30	.36	.29
Computer Science	.20	.10	.24	.11	.27
U.S. History	.30	.26	.36	.34	.40
World History	.30	.23	.36	.34	.36
Other History	.35	.27	.25	.37	.39
American Government	.29	.28	.35	.38	.38
Economics	.28	.29	.32	.41	.35
Geography	.30	.16	.22	.36	.37
Psychology	.39	.31	.25	.36	.35
General Science	.31	.28	.29	.34	.36
Biology	.32	.30	.36	.42	.41
Chemistry	.26	.34	.33	.42	.39
Physics	.32	.26	.23	.26	.39

(Continued on next page)

Predictor variable	Grade/GPA				
	English	Mathematics	Social Studies	Natural Sciences	Overall
English grade average	.45	.36	.34	.41	.47
Mathematics grade average	.37	.42	.36	.44	.40
Social Studies grade average	.32	.30	.37	.42	.46
Natural Sciences grade average	.38	.33	.38	.40	.45
Sum of grades in					
English	.32	.24	.22	.31	.32
Mathematics	.30	.38	.33	.45	.38
Social Studies	.16	.08	.16	.18	.19
Natural Sciences	.24	.27	.26	.35	.33
Foreign Languages	.18	.16	.13	.25	.21
Average of 30 high school grades	.44	.42	.40	.53	.54
Average of 23 high school grades	.45	.42	.38	.53	.53
Average of 4 grade averages	.45	.42	.40	.54	.54
Sum of all grades	.36	.36	.35	.49	.45
RF					
self-reported grades in					
English	.36	.33	.32	.36	.40
Mathematics	.30	.33	.29	.36	.33
Social Studies	.35	.24	.35	.34	.40
Natural Sciences	.35	.34	.32	.36	.39
Average of 4 self-reported grades	.42	.39	.42	.48	.48

Appendix D

Median Multiple R and SEE for Predicting College Grades and GPA 1986-87 Preliminary Models

	English (K=131)*		Mathematics (K=95)		Social Studies (K=101)		Natural Sciences (K=81)		College GPA (K=156)	
	Mult. R	SEE	Mult. R	SEE	Mult. R	SEE	Mult. R	SEE	Mult. R	SEE
ACT										
4 ACT scores	.40	.85	.38	1.09	.46	.96	.46	.96	.45	.73
RF										
4 high school grades (RF)	.40	.86	.41	1.07	.44	.96	.47	.94	.48	.72
ACT/RF										
4 ACT scores & 4 high school grades (RF)	.48	.82	.50	1.03	.54	.91	.55	.90	.55	.69
4 ACT scores & high school average (RF)	.46	.83	.48	1.04	.52	.92	.54	.91	.55	.69
Th index	.47	.83	.49	1.04	.53	.92	.54	.91	.55	.69
ACT/CGIS										
4 ACT scores & 4 high school grade averages (CGIS)	.50	.81	.53	1.00	.55	.91	.58	.90	.57	.67
4 ACT scores & average of 30 high school grades	.48	.82	.50	1.00	.53	.90	.57	.90	.56	.68
4 ACT scores & average of 23 high school grades	.48	.82	.49	1.00	.53	.90	.56	.90	.56	.68
ACT Composite & average of 30 high school grades	.43	.82	.44	1.05	.52	.90	.55	.90	.55	.68
ACT Composite & average of 23 high school grades	.43	.83	.44	1.04	.52	.90	.55	.90	.55	.68
4 ACT scores & 4 high school grade averages & 4 numbers of courses taken	.51	.81	.54	.99	.57	.90	.60	.89	.58	.67
4 ACT scores & 4 high school grade averages & numbers of courses taken in mathematics & science	.50	.81	.54	.99	.56	.90	.59	.90	.58	.67

* K = number of colleges

Appendix E

Crossvalidation Results Using Separate Grade Level Prediction Models

Tables E-1 through E-8 contain the median CVR, RMSE, MAE, and BIAS statistics for each regression model by grade level and subject area. Minimum and maximum values are also reported, along with the total number of institutions included in the analysis.

Eleven institutions were found to have BIAS values exceeding ±.50 across the subject areas. These institutions were contacted by telephone to determine whether (a) different courses were used in 1988-89 than in 1987-88, (b) different grading standards were used in 1988-89 than in 1987-88, or (c) different samples of students were used (changes in admissions standards, including honors courses the second year, etc.). Using these criteria, eight of the eleven institutions were eliminated from the analysis: two because different courses were used, three because different grading standards were used or different grading schemes were used to report grades, and four because of differences in the student samples. For the other three institutions, no evidence could be found to support their elimination from the sample, and so were retained for the crossvalidation analysis.

As shown in Table E-1, the crossvalidation statistics for juniors were, in general, similar across the prediction models for English grade. The largest median CVRs occurred for the ACT English & English grade average model (.41; M7). All ACT/CGIS models (M7-M12) had similar or slightly higher median CVRs than the TH index (.38; M4). The ACT English & English grade average model (M7) also had the least prediction error, as measured by median RMSE (.80); median MAE was slightly higher for the ACT (M1 and M2) and RF (M3) models. Median BIAS was similar across the models, typically showing no overprediction or underprediction (Median BIAS = -.01 to .01).

For seniors, several ACT/CGIS models and the TH index model (M4) had comparable median CVRs of .41. Slightly lower median CVRs were found for models using CGIS predictors alone (Median CVR = .36 to .38; M5 and M6) or RF (M3) or ACT (M1 and M2) variables alone (.31 to .35). Median RMSE was fairly similar across the models for seniors, with values ranging from .86 to .88 for all models using CGIS or RF variables. Median MAE was similar across prediction models, as was median BIAS.

The median CVRs for the ACT and RF models for seniors were .02 to .05 units larger than those for juniors; the CVRs for the ACT/CGIS models were typically .00 to .03 units larger for seniors. Median RMSE and MAE were, in general, slightly larger for seniors than for juniors, with median RMSE and MAE differences ranging from .02 to .05 across all models. Median BIAS differences showed that the models were slightly more likely to underpredict grades for seniors than for juniors.

The results for mathematics grade are provided in Table E-2. For juniors, the largest median CVR was found for the TH index (.45; M4); median CVRs of .44 were obtained for three ACT/CGIS models (M8-four ACT scores & four grade averages, M9-four ACT scores & average of 23 grades, and M11-four ACT scores & average of 30 grades). Median RMSE was, in general, larger for models using ACT scores or RF variables alone, or when mathematics grade average was used alone (median RMSE = 1.14 to 1.16; M1) to predict mathematics grade. The largest median MAEs were shown for the models using ACT scores alone (.95; M1 and M2). The smallest median MAEs were found for the four ACT scores & average of 23 (M9) or average of 30 grades (M11) models (.88). The BIAS results showed that, in general, most models tended to overpredict mathematics grade, with median values ranging from .01 to .06. The models with the largest median BIAS values were the ACT/CGIS models (.05, .06).

The crossvalidation results for seniors showed somewhat larger median CVR values for the ACT/CGIS models using either the four high school grade averages (M8) or the average of 23 high school grades (.48; M9-M12), when compared to other models. These models also had the smallest median RMSEs (1.08, 1.09) and median MAEs (.86, .87). Much smaller median CVRs were found for four high school grades (median CVR = .39; M3) or ACT scores alone (median CVR = .35, .36; M1 and M2). Conversely, these models had the largest median RMSEs (1.14, 1.15) and MAEs (.94). The median BIAS results revealed that most models typically did not overpredict or underpredict mathematics grade.

Median CVRs for seniors were typically .03 or .04 units larger than those for juniors, except for the RF (M3) and TH index (M4) models, for which median CVRs were similar for juniors and seniors. Median RMSE and MAE were also

similar for juniors and seniors, with median differences of -.03 to .01 across the prediction models. However, differences were found in median BIAS between the models for juniors and seniors; median BIAS differences ranged from -.05 to -.07 for the ACT/CGIS models, with these models tending to overpredict mathematics grade for juniors and not for seniors.

Table E-3 contains the crossvalidation results for predicting college social studies grade. For juniors, the smallest median CVRs were found for the models using ACT scores (M1 and M2) or RF (M3) variables alone and the CGIS model using high school Social Studies grade average alone (.34 to .39; M5). The largest median CVRs occurred for the four ACT scores & average of 23 or 30 grades models (.47; M9 and M11). The TH index and ACT/CGIS models had much larger median CVRs than separate ACT, RF, or CGIS models, particularly when all four ACT scores were used. The converse was true for median RMSE and MAE, where the separate models had somewhat larger median values (median RMSE = .95 to .98; median MAE = .74 to .78) than the combined models. Median BIAS for juniors ranged from -.00 to .04, with slightly larger values for all but two of the ACT/CGIS models (.03, .04).

For seniors similar differences were found among the prediction models, as measured by median CVR, RMSE, and MAE. Median CVR values were similar for the TH index and all ACT/CGIS models except the ACT Social Studies & Social Studies grade average model (.47 to .49; M7). Separate CGIS (M5 and M6), ACT (M1 and M2), and RF (M3) models had smaller median CVRs (.35 to .42) and somewhat larger median RMSEs (.99 to 1.02) and MAEs (.79 to .82) than the combined models. All ACT/CGIS models but one had slightly smaller median RMSEs (.94, .95) and MAEs (.75, .76) than the TH index model (median RMSE = .97; median MAE = .78). Median BIAS values ranged from -.02 to .02.

In comparison to juniors, median CVRs for seniors tended to be slightly larger for the four ACT scores (M2) and the Social Studies grade average (M5) models, with median differences of .04. Median RMSE and MAE were consistently larger for seniors, with values from .02 to .07 grade units larger than those for juniors. Social studies grade tended to be somewhat overpredicted for juniors using the ACT/CGIS models, compared to seniors, with median

differences of .02 to .03. The two exceptions were the ACT Social Studies & Social Studies grade average (M7) and ACT Composite & average of 30 grades (M12) models, where median BIAS values were similar.

The median crossvalidation statistics for natural sciences grade are provided in Table E-4. As was the case for predicting social studies grade, the TH index model and the ACT/CGIS models using four ACT scores or the ACT Composite (M8 through M12) had the largest median CVRs, with values ranging from .48 to .50. The largest median CVRs were found for the ACT Composite & average of 23 or 30 high school grades models (.50; M10 and M12). These models also had the smallest median RMSEs (.89, .90) and MAEs (.71). Models based on high school Natural Sciences grade average alone (M5) or in combination with ACT Natural Sciences Reading (M7) had the largest median RMSEs (.92, .93) and MAEs (.73, .75). Grades in natural sciences courses tended to be slightly overpredicted for juniors using the ACT/CGIS models, with median BIAS values ranging from .03 to .05.

Similar results were found for seniors. The largest median CVRs were found for the TH index and all ACT/CGIS models except the ACT Natural Sciences Reading & Natural Sciences grade average model (median CVR = .49 to .51; M7). These models also had the smallest median RMSEs (.93 to .96) and MAEs (.75 to .77). Median BIAS values showed that the CGIS models (M5 and M6) and the model using a single ACT score and grade average (M7) tended to slightly overpredict natural sciences grade, with median values of .03 and .04.

Seniors and juniors had similar median CVRs across all models except the four high school grade averages model (M6), where the median CVR for seniors was slightly larger (.45) than that for juniors (.42). Median RMSE and MAE were typically larger for seniors than for juniors; median values were from .03 to .08 grade units larger for seniors than for juniors. Conversely, median BIAS values tended to be slightly smaller for seniors; however, for both juniors and seniors, the ACT Natural Sciences & Natural Sciences grade average model (M7) tended to overpredict natural sciences grade. One major difference was found using four ACT scores alone as predictors (M2); median BIAS was .05 grade units larger for juniors than for seniors.

Table E-5 contains the results for predicting college freshman GPA. Prediction accuracy for juniors, as measured by median CVR, was greatest for the ACT/CGIS models using four ACT scores and four high school averages (M8) or four ACT scores and averages of 23 or 30 high school grades (median CVR = .52, .53; M9 and M11). Note that the median CVR for the ACT Composite & average of 23 or 30 grades was .03 units larger than the TH index (ACT/RF) model. The smallest median RMSEs and MAEs were also found for these models (median RMSE = .66, .67; median MAE = .52). In comparison, the models based on ACT Composite score (M1), all four ACT scores (M2), or RF grades (M3) alone had smaller median CVRs (.37 to .46) and somewhat larger median RMSEs (.70, .72) and median MAEs (.55, .56). Median BIAS for juniors was similar across the CGIS, ACT/CGIS, and TH index models (median BIAS = .00 to .02). The ACT Composite score and four ACT scores models (M1 and M2) tended to slightly overpredict college GPA, with median BIAS values of .03.

For seniors the ACT/CGIS models had the largest median CVRs (.52 and .53); the smallest median values were found when using the ACT Composite (M1), the four ACT scores (M2), or the RF (M3) models (median CVR = .38 to .44). As was the case for juniors, the ACT Composite or four ACT scores & average of 23 or 30 high school grades models (M9 through M12) yielded somewhat larger median CVRs (.52 and .53) than the corresponding TH index model (.50). Median RMSE and MAE were somewhat larger for the ACT (M1 and M2) and RF (M3) models, compared to the other models, with median RMSEs of .73 and .75 and median MAE values ranging from .57 to .59. The ACT Composite & average of 23 or 30 high school grades (M10 and M12) models yielded both the smallest median RMSEs (.68) and median MAEs (.53). No differences were found in median BIAS across the models.

No differences in median CVR were found between juniors and seniors for all prediction models for college GPA. Slightly larger median RMSEs were found for seniors for the TH index (M4), ACT Composite alone (M1), four high school grade averages (CGIS; M6), and four high school grades (RF; M3) models (median difference = .03). Median MAE was similar across all models except the ACT Composite model (M1); seniors had a larger median MAE value for this

model. The ACT Composite and the four ACT score models tended to slightly overpredict college freshman GPA for juniors, but not for seniors. Median BIAS was similar across all other models.

Table E-1

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College English Grades
(Juniors; Number of institutions = 45)

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT									
M1 ACT English Usage	Max	.49	1.20	.92	.41	.59	1.18	.98	.39
	Med	.27	.85	.65	.00	.31	.90	.69	-.02
	Min	.07	.54	.41	-.34	-.07	.54	.43	-.23
M2 Four ACT scores	Max	.51	1.21	.93	.42	.59	1.17	.97	.38
	Med	.26	.85	.65	-.00	.31	.90	.69	-.02
	Min	.08	.54	.41	-.38	-.04	.53	.43	-.26
RF									
M3 Four high school grades	Max	.52	1.26	.99	.31	.55	1.36	1.22	.35
	Med	.33	.84	.64	-.00	.35	.88	.68	-.03
	Min	.00	.50	.39	-.41	.01	.52	.43	-.27
ACT/RF									
M4 TH index	Max	.54	1.18	.91	.36	.60	1.20	1.06	.37
	Med	.38	.82	.63	-.00	.41	.87	.66	-.03
	Min	.19	.50	.37	-.38	.07	.51	.42	-.23
CGIS									
M5 English grade average	Max	.52	1.22	.94	.30	.57	1.33	1.17	.36
	Med	.35	.82	.63	-.00	.36	.87	.67	-.02
	Min	.13	.52	.41	-.31	.07	.52	.42	-.26
M6 Four high school grade averages	Max	.53	1.22	.94	.30	.59	1.32	1.16	.35
	Med	.36	.83	.62	-.00	.38	.86	.66	-.02
	Min	.17	.50	.41	-.30	.05	.52	.42	-.27

(continued on next page)

Table E-1 (continued)

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT/CGIS									
M7 ACT English & English grade average	Max	.54	1.16	.90	.36	.62	1.15	.94	.37
	Med	.41	.80	.62	.00	.41	.85	.65	-.02
	Min	.17	.52	.41	-.32	.14	.51	.42	-.23
M8 Four ACT scores & four high school grade averages	Max	.56	1.16	.89	.37	.63	1.15	.93	.40
	Med	.38	.83	.61	-.00	.41	.85	.66	-.02
	Min	.21	.52	.41	-.39	.09	.51	.42	-.24
M9 Four ACT scores & average of 23 high school grades	Max	.57	1.18	.90	.37	.64	1.15	.94	.37
	Med	.39	.83	.61	-.00	.41	.85	.65	-.03
	Min	.25	.51	.41	-.47	.08	.52	.42	-.25
M10 ACT Composite & average of 23 high school grades	Max	.61	1.19	.94	.36	.62	1.23	1.04	.35
	Med	.38	.82	.63	-.00	.41	.86	.67	-.02
	Min	.23	.45	.38	-.38	.16	.52	.43	-.26
M11 Four ACT scores & average of 30 high school grades	Max	.58	1.18	.90	.37	.63	1.15	.93	.37
	Med	.39	.83	.61	-.00	.41	.85	.65	-.02
	Min	.25	.52	.41	-.46	.08	.52	.42	-.26
M12 ACT Composite & average of 30 high school grades	Max	.60	1.19	.93	.36	.62	1.22	1.03	.35
	Med	.39	.82	.64	-.00	.40	.86	.66	-.02
	Min	.24	.47	.39	-.38	.16	.52	.42	-.26

Table E-2

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College Mathematics Grades
(Number of institutions: 30 (juniors), 53 (seniors))

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT									
M1 ACT Mathematics Usage	Max	.56	1.47	1.26	.42	.62	1.47	1.31	.33
	Med	.32	1.16	.95	.03	.35	1.15	.94	-.01
	Min	.12	.78	.65	-.31	.13	.82	.67	-.40
M2 Four ACT scores	Max	.56	1.50	1.26	.42	.63	1.45	1.29	.34
	Med	.33	1.16	.95	.04	.36	1.14	.94	-.00
	Min	.14	.79	.65	-.30	.19	.82	.68	-.43
RF									
M3 Four high school grades	Max	.53	1.43	1.22	.43	.54	1.44	1.27	.51
	Med	.38	1.14	.93	.01	.39	1.15	.94	-.00
	Min	.06	.76	.64	-.54	.02	.84	.69	-.50
ACT/RF									
M4 TH index	Max	.66	1.43	1.23	.42	.66	1.43	1.28	.42
	Med	.45	1.10	.92	.03	.45	1.13	.91	-.01
	Min	.20	.77	.63	-.42	.23	.84	.68	-.46
CGIS									
M5 Mathematics grade average	Max	.56	1.42	1.22	.40	.59	1.43	1.28	.42
	Med	.36	1.14	.93	.04	.40	1.13	.91	-.01
	Min	.09	.76	.64	-.39	.16	.84	.68	-.46
M6 Four high school grade averages	Max	.58	1.40	1.21	.40	.61	1.42	1.25	.50
	Med	.41	1.10	.91	.04	.44	1.11	.89	.00
	Min	.13	.75	.63	-.39	.17	.83	.67	-.50

(continued on next page)

Table E-2 (continued)

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT/CGIS									
M7 ACT Mathematics & Mathematics grade average	Max	.65	1.41	1.22	.36	.66	1.43	1.27	.36
	Med	.43	1.11	.91	.05	.46	1.10	.89	-.02
	Min	.25	.75	.63	-.30	.24	.80	.65	-.45
M8 Four ACT scores & four high school grade averages	Max	.65	1.44	1.23	.37	.67	1.41	1.24	.39
	Med	.44	1.10	.89	.06	.48	1.09	.87	.00
	Min	.28	.76	.63	-.29	.24	.80	.65	-.48
M9 Four ACT scores & average of 23 high school grades	Max	.62	1.43	1.23	.42	.67	1.41	1.24	.37
	Med	.44	1.09	.88	.05	.48	1.08	.86	-.01
	Min	.29	.76	.63	-.32	.27	.79	.65	-.40
M10 ACT Composite & average of 23 high school grades	Max	.62	1.41	1.23	.44	.60	1.42	1.25	.41
	Med	.41	1.10	.89	.05	.45	1.10	.87	-.00
	Min	.10	.75	.63	-.41	.15	.82	.66	-.41
M11 Four ACT scores & average of 30 high school grades	Max	.62	1.43	1.23	.40	.67	1.41	1.25	.37
	Med	.44	1.10	.88	.06	.48	1.09	.86	-.01
	Min	.30	.75	.62	-.31	.25	.79	.65	-.39
M12 ACT Composite & average of 30 high school grades	Max	.61	1.42	1.23	.42	.61	1.42	1.25	.41
	Med	.41	1.10	.89	.05	.45	1.10	.87	-.00
	Min	.11	.75	.62	.40	.16	.82	.66	-.40

Table E-3

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College Social Studies Grades
(Number of institutions: 33 (juniors), 60 (seniors))

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT									
M1 ACT Social Studies Reading	Max	.50	1.17	.96	.38	.64	1.25	1.04	.49
	Med	.34	.98	.78	.02	.35	1.02	.82	-.02
	Min	.12	.69	.54	-.38	.10	.73	.57	-.43
M2 Four ACT scores	Max	.62	1.16	.93	.39	.66	1.21	1.02	.41
	Med	.37	.97	.75	.03	.41	.99	.79	.02
	Min	.11	.68	.54	-.39	.13	.72	.56	-.41
RF									
M3 Four high school grades	Max	.56	1.40	1.14	.39	.58	1.53	1.25	.50
	Med	.39	.96	.74	-.00	.39	1.01	.81	.01
	Min	.12	.66	.52	-.44	-.01	.70	.55	-.43
ACT/RF									
M4 TH index	Max	.62	1.14	.92	.39	.71	1.18	.97	.45
	Med	.46	.92	.73	.02	.48	.97	.78	-.01
	Min	.22	.65	.50	-.40	.21	.69	.53	-.42
CGIS									
M5 Social Studies grade average	Max	.51	1.22	.98	.50	.57	1.20	1.01	.45
	Med	.33	.97	.78	-.00	.37	1.01	.82	.01
	Min	.18	.68	.52	-.43	.12	.72	.57	-.41
M6 Four high school grade averages	Max	.54	1.18	.92	.49	.66	1.17	.97	.39
	Med	.41	.95	.74	-.00	.42	.99	.79	.00
	Min	.24	.66	.52	-.44	.14	.70	.55	-.41

(continued on next page)

Table E3 (continued)

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT/CGIS									
M7 ACT Social Studies & Social Studies grade average	Max	.53	1.17	.94	.50	.73	1.19	.98	.46
	Med	.41	.93	.74	.01	.44	.97	.78	.00
	Min	.09	.67	.51	-.39	.24	.72	.56	-.41
M8 Four ACT scores & four high school grade averages	Max	.61	1.14	.90	.48	.70	1.15	.95	.38
	Med	.45	.92	.72	.03	.47	.95	.76	.00
	Min	.24	.64	.51	-.41	.26	.69	.54	-.39
M9 Four ACT scores & average of 23 high school grades	Max	.63	1.15	.91	.49	.73	1.15	.94	.40
	Med	.47	.91	.71	.04	.48	.94	.75	.01
	Min	.26	.64	.50	-.41	.27	.69	.54	-.39
M10 ACT Composite & average of 23 high school grades	Max	.62	1.15	.90	.52	.72	1.13	.94	.38
	Med	.46	.91	.72	.03	.48	.95	.75	.01
	Min	.28	.65	.51	-.40	.26	.69	.53	-.40
M11 Four ACT scores & average of 30 high school grades	Max	.64	1.14	.90	.48	.72	1.15	.94	.40
	Med	.47	.91	.72	.03	.48	.94	.74	.01
	Min	.27	.64	.50	-.41	.27	.69	.54	-.39
M12 ACT Composite & average of 30 high school grades	Max	.63	1.14	.89	.51	.72	1.14	.94	.38
	Med	.46	.91	.71	.02	.49	.95	.75	.02
	Min	.30	.65	.51	-.40	.25	.69	.53	-.40

Table E-4

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College Natural Sciences Grades
(Number of institutions: 28 (juniors), 54 (seniors))

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT									
M1 ACT Natural Sciences Reading	Max	.46	1.19	.99	.35	.46	1.23	1.04	.38
	Med	.33	.96	.79	-.00	.32	1.03	.83	.01
	Min	.11	.66	.55	-.35	-.03	.72	.57	-.41
M2 Four ACT scores	Max	.61	1.09	.91	.33	.62	1.20	1.00	.37
	Med	.39	.93	.75	.04	.41	.98	.79	-.01
	Min	.28	.62	.51	-.39	.07	.74	.59	-.41
RF									
M3 Four high school grades	Max	.63	1.22	.98	.40	.60	1.23	1.02	.38
	Med	.42	.92	.74	.03	.42	.99	.79	.02
	Min	.27	.61	.49	-.37	.17	.70	.57	-.42
ACT/RF									
M4 TH index	Max	.67	1.10	.89	.37	.69	1.15	.97	.37
	Med	.48	.89	.71	.03	.50	.96	.77	.02
	Min	.36	.57	.47	-.38	.20	.69	.55	-.40
CGIS									
M5 Natural Sciences grade average	Max	.52	1.23	1.00	.35	.55	1.20	1.01	.29
	Med	.36	.93	.75	.02	.38	1.01	.82	.04
	Min	.14	.65	.52	-.33	.05	.72	.58	-.44
M6 Four high school grade averages	Max	.62	1.25	1.03	.38	.65	1.21	1.03	.29
	Med	.42	.91	.72	.03	.45	.97	.78	.03
	Min	.22	.62	.50	-.38	.13	.69	.56	-.44

(continued on next page)

Table E-4 (continued)

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT/CGIS									
M7 ACT Natural Sciences & Natural Sciences grade average	Max	.59	1.15	.92	.36	.61	1.19	1.00	.32
	Med	.43	.92	.73	.03	.42	.98	.79	.04
	Min	.30	.62	.49	-.37	.04	.70	.56	-.46
M8 Four ACT scores & four high school grade averages	Max	.64	1.12	.91	.34	.69	1.25	1.03	.32
	Med	.49	.90	.71	.04	.49	.94	.76	.02
	Min	.35	.59	.46	-.40	-.03	.69	.53	-.46
M9 Four ACT scores & average of 23 high school grades	Max	.65	1.12	.91	.34	.69	1.18	.96	.30
	Med	.48	.89	.71	.05	.50	.93	.76	.02
	Min	.35	.58	.46	-.40	.11	.68	.54	-.46
M10 ACT Composite & average of 23 high school grades	Max	.67	1.10	.90	.34	.71	1.14	.97	.28
	Med	.50	.90	.71	.04	.51	.93	.75	.02
	Min	.37	.58	.46	-.37	.27	.68	.51	-.46
M11 Four ACT scores & average of 30 high school grades	Max	.66	1.11	.91	.34	.69	1.19	.97	.30
	Med	.48	.89	.70	.04	.50	.94	.75	.02
	Min	.37	.58	.46	-.40	.12	.68	.54	-.46
M12 ACT Composite & average of 30 high school grades	Max	.67	1.09	.90	.33	.71	1.14	.98	.27
	Med	.50	.89	.71	.04	.51	.94	.75	.02
	Min	.37	.58	.47	-.38	.27	.68	.52	-.46

Table E-5

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College GPA
(Number of institutions: 56 (juniors), 81 (seniors))

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT									
M1 ACT Composite	Max	.58	1.01	.77	.37	.62	.98	.76	.26
	Med	.37	.72	.56	.03	.38	.75	.59	-.00
	Min	.22	.47	.38	-.20	.15	.52	.44	-.30
M2 Four ACT scores	Max	.61	1.01	.77	.37	.64	1.01	.76	.26
	Med	.40	.72	.56	.03	.40	.73	.58	-.01
	Min	.23	.46	.36	-.22	.14	.53	.42	-.27
RF									
M3 Four high school grades	Max	.63	.98	.75	.34	.67	.99	.76	.25
	Med	.46	.70	.55	-.00	.44	.73	.57	-.00
	Min	.04	.46	.37	-.28	.06	.48	.38	-.38
ACT/RF									
M4 TH index	Max	.65	.94	.72	.36	.73	.93	.73	.24
	Med	.50	.68	.53	.01	.50	.71	.55	-.00
	Min	.28	.44	.35	-.25	.25	.44	.36	-.33
CGIS									
M5 Average of 23 high school grades	Max	.68	.94	.70	.31	.70	.93	.72	.32
	Med	.50	.68	.53	.00	.49	.70	.55	.01
	Min	.29	.43	.34	-.31	.22	.47	.38	-.32
M6 Four high school grade averages	Max	.69	.94	.70	.31	.71	.94	.72	.29
	Med	.49	.67	.53	.00	.49	.71	.55	-.00
	Min	.29	.43	.34	-.29	.24	.45	.37	-.34

(continued on next page)

Table E-5 (continued)

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT/CGIS									
M8 Four ACT scores & four high school grade averages	Max	.70	.93	.69	.36	.75	.93	.69	.29
	Med	.52	.66	.52	.02	.53	.69	.53	-.00
	Min	.30	.42	.31	-.26	.26	.43	.34	-.30
M9 Four ACT scores & average of 23 high school grades	Max	.69	.93	.69	.35	.75	.95	.71	.33
	Med	.52	.67	.52	.02	.53	.69	.54	.00
	Min	.27	.41	.31	-.27	.24	.44	.36	-.28
M10 ACT Composite & average of 23 high school grades	Max	.69	.93	.69	.35	.74	.90	.69	.25
	Med	.53	.66	.52	.01	.52	.68	.53	-.01
	Min	.38	.42	.32	-.26	.31	.46	.37	-.29
M11 Four ACT scores & average of 30 high school grades	Max	.68	.94	.69	.35	.75	.96	.71	.33
	Med	.52	.66	.52	.02	.52	.69	.54	-.00
	Min	.28	.41	.31	-.26	.24	.44	.35	-.28
M12 ACT Composite & average of 30 high school grades	Max	.68	.94	.68	.35	.74	.90	.69	.25
	Med	.53	.67	.52	.01	.53	.68	.53	-.00
	Min	.38	.42	.30	-.25	.30	.45	.37	-.29

Table 1

Summary of Research on Predicting Freshman GPA

Author	Criterion	Predictor variables: Test	Predictor variables: High school information	N	R
ACT (1988)	College GPA	4 ACT tests		269*	.45
			4 HS grades		.48
		4 ACT tests	4 HS grades		.55
Aleamoni & Oboler (1978)	College GPA	SAT-T	HS rank	4,283	.43
		SAT-V, SAT-M	HS rank		.45
		ACT Composite	HS rank		.45
			HS rank		.44
Cameron (1989)	College GPA		HS rank	21,685*	.55, .48
		SAT-T			.57, .42
		SAT-T	HS rank		.65, .55
Crouse & Trusheim (1988)	College GPA	SAT-T		2,470	.37
			HS rank		.41
		SAT-T	HS rank		.46
Crouse & Trusheim (1989)	College GPA	SAT-T, sex		1,010	.48-.54
Dalton (1976)	First semester GPA	SAT-T	HS rank	386-4,863	.47-.64
Durio & Slover (1980)	College GPA	SAT-V, SAT-M, Math Ach.	HS rank	1,379-2,189	.56,.60
ETS (1980)	College GPA	SAT-T		827*	.41
			HS GPA		.52
		SAT-T	HS GPA		.58
Ford & Campos (1977)	College GPA	SAT-V		829*	.40
		SAT-M			.35
			HS rank		.50
		SAT-V, SAT-M	HS rank		.58

(Continued on next page)

* Number of colleges

Author	Criterion	Predictor variables: Test	Predictor variables: High school information	N	R
Hedges & Majer (1976)	College GPA	SAT-M, SAT-V	HS GPA	161	.42
Humphreys, Levy, & Taber (1973)	First-eighth semester GPA		HS rank	2,811	.06-.29
		ACT-English Usage			.03-.16
		ACT-Mathematics Usage			-.02-.16
		ACT-Social Studies Reading			.05-.16
		ACT-Natural Sciences Reading			-.02-.16
		ACT-Composite			.04-.24
Lenning (1975)	GPA	4 ACT tests		40*	.46
		4 ACT tests	4 HS grades		.58
		SAT-V, SAT-M		271, 348	.27, .35
		4 ACT tests			.40, .44
		CEEB-E			.09, .19
		CEEB-M			.29, .35
		SAT-T, CEEB-E, CEEB-M			.29, .40
McCornack & McLeod (1988)	College GPA	SAT-V, SAT-M	HS GPA	50-1,491	.37
	Specific course grades	SAT-V, SAT-M	HS GPA		.31
Rowan (1978)	First semester GPA	4 ACT tests & ACT Composite		1,135	.53, .59
	Second semester GPA	4 ACT tests & ACT Composite		1,154	.50, .56
Sawyer & Maxey (1979)	College GPA	4 ACT tests		260*	.48
			4 HS grades		.48-.50
		4 ACT tests	4 HS grades		.55, .56
Sue & Abe (1988)	College GPA	SAT-V, SAT-M	HS GPA	848, 3,730	.45, .50
		English Comp, Math I	HS GPA	651, 2,510	.45, .47
		English Comp, Math II	HS GPA	172, 1,153	.46, .54
Trusheim & Middaugh (1987)	College GPA	SAT-T, SAT-M, sex		11,868	.57
Willingham & Breland (1982)	College GPA	SAT-T		9*	.29-.61
		SAT-T	HS rank (normalized)		.25-.56
			HS rank (normalized)		.46-.65

* Number of colleges

Table 2

Distributions, Across Institutions, of Base Year Descriptive Statistics for Course Grade/GPA, ACT Composite, High School Average (RF), and Average of 23 High School Grades (CGIS)
(Juniors)

		Course Grade/GPA			ACT Composite		HS average (RF)		Average of 23 HS grades (CGIS)		
Subject area	Quantile	Number of students	Mean	SD	Mean	SD	Mean	SD	Number of students	Mean	SD
English	Min	57	2.34	0.54	16.5	2.25	2.60	0.41	57	2.70	0.36
(60 institutions)	Med	194	2.79	0.85	20.8	4.14	2.98	0.61	179	3.08	0.53
	Max	1577	3.31	1.32	25.9	5.48	3.52	0.72	1478	3.54	0.66
Mathematics	Min	58	1.69	0.73	18.4	2.39	2.51	0.40	56	2.62	0.33
(41 institutions)	Med	169	2.41	1.17	22.1	3.89	3.15	0.58	162	3.24	0.50
	Max	1316	3.06	1.52	26.4	5.18	3.56	0.68	1261	3.58	0.60
Social Studies	Min	57	1.72	0.72	16.8	2.42	2.67	0.41	53	2.77	0.35
(53 institutions)	Med	185	2.60	0.99	21.6	4.11	3.05	0.61	172	3.14	0.52
	Max	1596	3.12	1.51	26.2	5.42	3.53	0.74	1515	3.55	0.64
Natural Sciences	Min	52	0.84	0.77	18.9	2.39	2.57	0.40	52	2.71	0.34
(37 institutions)	Med	157	2.54	1.00	22.4	3.98	3.20	0.59	152	3.25	0.50
	Max	928	2.86	1.30	26.3	5.02	3.51	0.72	888	3.56	0.63
Overall GPA	Min	52	2.22	0.51	16.8	2.45	2.58	0.41	50	2.69	0.35
(80 institutions)	Med	249	2.61	0.79	21.2	4.43	3.05	0.62	242	3.14	0.53
	Max	2002	3.06	1.05	26.3	5.91	3.51	0.74	1903	3.56	0.68

Table 3

Distributions, Across Institutions, of Base Year Descriptive Statistics for Course Grade/GPA, ACT Composite, High School Average (RF), and Average of 23 High School Grades (CGIS)
(Seniors)

		Course Grade/GPA			ACT Composite		HS average (RF)		Average of 23 HS grades (CGIS)		
Subject area	Quantile	Number of students	Mean	SD	Mean	SD	Mean	SD	Number of students	Mean	SD
English	Min	56	1.74	0.59	12.7	3.03	2.42	0.47	51	2.54	0.39
(97 institutions)	Med	382	2.59	0.95	18.6	4.48	2.89	0.64	294	3.01	0.55
	Max	2057	3.26	1.42	24.9	6.46	3.48	0.77	1818	3.53	0.66
Mathematics	Min	56	1.30	0.84	13.0	2.85	2.46	0.44	50	2.55	0.37
(80 institutions)	Med	213	2.25	1.22	19.6	4.35	2.99	0.63	177	3.09	0.54
	Max	1654	2.76	1.49	25.3	6.82	3.55	0.78	1456	3.58	0.63
Social Studies	Min	56	1.23	0.74	13.5	3.05	2.47	0.44	52	2.58	0.39
(93 institutions)	Med	292	2.30	1.06	19.0	4.65	2.94	0.64	246	3.06	0.56
	Max	2167	3.02	1.60	25.1	6.17	3.48	0.75	1922	3.53	0.67
Natural Sciences	Min	53	0.77	0.77	12.4	2.99	2.57	0.46	51	2.65	0.37
(76 institutions)	Med	220	2.23	1.07	19.6	4.50	3.04	0.63	181	3.13	0.54
	Max	1945	2.74	1.37	25.2	6.41	3.51	0.79	1802	3.56	0.67
Overall GPA	Min	66	1.91	0.58	12.1	3.04	2.46	0.47	55	2.58	0.36
(112 institutions)	Med	573	2.42	0.83	18.9	4.83	2.90	0.65	428	3.01	0.57
	Max	2729	3.14	1.07	25.6	6.60	3.48	0.78	2518	3.54	0.68

Table 4

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College English Grades Using Total Group Models
(Number of institutions: 49 (juniors), 74 (seniors))

Model	Quantile	Juniors				Seniors			
		CVR	RMSE	MAE	BIAS	CVR	RMSE	MAE	BIAS
ACT/RF									
M1 TH index	Max	.63	1.18	1.00	.32	.60	1.20	1.05	.40
	Med	.39	.81	.63	-.08	.41	.87	.66	-.01
	Min	.19	.49	.38	-.47	.10	.51	.40	-.21
ACT/CGIS									
M2 ACT English & English grade average	Max	.60	1.15	.92	.33	.62	1.16	.93	.39
	Med	.44	.81	.61	-.07	.41	.85	.65	.00
	Min	.19	.52	.41	-.45	.17	.50	.41	-.20
M3 Four ACT scores & four high school grade averages	Max	.63	1.16	.92	.36	.63	1.15	.92	.37
	Med	.45	.79	.61	-.06	.42	.85	.65	.00
	Min	.22	.46	.36	-.47	.11	.50	.40	-.22
M4 Four ACT scores & average of 23 high school grades	Max	.64	1.17	.94	.35	.65	1.16	.93	.37
	Med	.43	.80	.62	-.06	.42	.85	.65	-.00
	Min	.27	.47	.37	-.47	.13	.50	.41	-.22
M5 ACT Composite & average of 23 high school grades	Max	.62	1.18	.96	.35	.62	1.23	1.04	.35
	Med	.40	.81	.63	-.05	.41	.86	.66	-.00
	Min	.23	.44	.35	-.43	.16	.52	.43	-.24

Table 5

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College Mathematics Grade Using Total Group Models
(Number of institutions: 34 (juniors), 59 (seniors))

Model	Quantile	Juniors				Seniors			
		CVR	RMSE	MAE	BIAS	CVR	RMSE	MAE	BIAS
ACT/RF									
M1 TH index	Max	.67	1.44	1.27	.32	.66	1.43	1.27	.47
	Med	.45	1.10	.90	-.04	.47	1.11	.92	.03
	Min	.21	.75	.62	-.38	.23	.80	.66	-.37
ACT/CGIS									
M2 ACT Mathematics & Mathematics grade average	Max	.65	1.43	1.26	.28	.66	1.43	1.26	.43
	Med	.43	1.10	.90	-.01	.46	1.10	.89	.01
	Min	.24	.75	.63	-.35	.24	.80	.63	-.39
M3 Four ACT scores & four high school grade averages	Max	.65	1.41	1.25	.30	.67	1.41	1.24	.45
	Med	.45	1.08	.88	-.02	.47	1.09	.89	.01
	Min	.30	.76	.62	-.34	.26	.79	.61	-.41
M4 Four ACT scores & average of 23 high school grades	Max	.64	1.42	1.25	.31	.67	1.41	1.24	.44
	Med	.45	1.07	.87	-.03	.47	1.08	.87	.01
	Min	.31	.75	.62	-.35	.28	.79	.60	-.34
M5 ACT Composite & average of 23 high school grades	Max	.62	1.42	1.26	.32	.63	1.42	1.24	.47
	Med	.42	1.09	.88	-.03	.45	1.10	.87	.01
	Min	.12	.75	.63	-.35	.14	.79	.60	-.34

Table 6

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College Social Studies Grade Using Total Group Models
(Number of institutions: 37 (juniors), 61 (seniors))

Model	Quantile	Juniors				Seniors			
		CVR	RMSE	MAE	BIAS	CVR	RMSE	MAE	BIAS
ACT/RF									
M1 TH index	Max	.63	1.13	.94	.34	.77	1.18	.97	.44
	Med	.47	.91	.73	-.07	.48	.97	.78	.05
	Min	.23	.65	.51	-.48	.21	.69	.53	-.35
ACT/CGIS									
M2 ACT Social Studies & Social Studies grade average	Max	.58	1.14	.93	.45	.71	1.19	.98	.47
	Med	.42	.92	.74	-.03	.42	.97	.77	.03
	Min	.21	.66	.54	-.46	.24	.72	.56	-.32
M3 Four ACT scores & four high school grade averages	Max	.64	1.11	.89	.44	.70	1.16	.94	.38
	Med	.47	.89	.71	-.01	.47	.95	.76	.03
	Min	.24	.64	.51	-.43	.23	.69	.53	-.34
M4 Four ACT scores & average of 23 high school grades	Max	.64	1.11	.88	.44	.73	1.15	.94	.37
	Med	.48	.90	.70	-.01	.47	.95	.76	.04
	Min	.27	.64	.50	-.44	.27	.69	.53	-.35
M5 ACT Composite & average of 23 high school grades	Max	.64	1.12	.89	.47	.72	1.14	.94	.35
	Med	.47	.90	.71	-.01	.48	.95	.76	.03
	Min	.31	.65	.51	-.44	.25	.69	.53	-.36

Table 7

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College Natural Sciences Grade Using Total Group Models
(Number of institutions: 31 (juniors), 54 (seniors))

Model	Quantile	Juniors CVR	Juniors RMSE	Juniors MAE	Juniors BIAS	Seniors CVR	Seniors RMSE	Seniors MAE	Seniors BIAS
ACT/RF									
M1 TH index	Max	.67	1.07	.86	.26	.69	1.15	.97	.42
	Med	.48	.89	.73	-.06	.51	.95	.76	.05
	Min	.36	.57	.48	-.36	.20	.69	.55	-.40
ACT/CGIS									
M2 ACT Natural Sciences & Natural Sciences grade average	Max	.59	1.14	.90	.30	.61	1.18	.98	.37
	Med	.44	.92	.73	-.03	.42	.98	.79	.04
	Min	.30	.63	.49	-.37	.01	.68	.55	-.34
M3 Four ACT scores & four high school grade averages	Max	.64	1.06	.87	.26	.70	1.21	1.00	.34
	Med	.49	.89	.70	-.02	.50	.93	.75	.02
	Min	.37	.60	.47	-.37	.00	.69	.53	-.36
M4 Four ACT scores & average of 23 high school grades	Max	.64	1.06	.87	.24	.70	1.17	.96	.35
	Med	.49	.88	.71	-.01	.52	.93	.75	.03
	Min	.37	.59	.48	-.37	.13	.68	.53	-.37
M5 ACT Composite & average of 23 high school grades	Max	.68	1.07	.87	.25	.71	1.13	.95	.31
	Med	.51	.89	.71	-.02	.52	.94	.75	.02
	Min	.37	.59	.47	-.36	.27	.68	.51	-.37

Table 8

Distributions, Across Institutions, of Crossvalidation Statistics for Predicting College GPA Using Total Group Models
(Number of institutions: 60 (juniors), 81 (seniors))

Model	Quantile	Juniors				Seniors			
		CVR	RMSE	MAE	BIAS	CVR	RMSE	MAE	BIAS
ACT/RF									
M1 TH index	Max	.65	.94	.75	.20	.73	.92	.72	.27
	Med	.51	.68	.54	-.07	.50	.71	.55	.02
	Min	.36	.44	.36	-.32	.24	.43	.34	-.30
ACT/CGIS									
M3 Four ACT scores & four high school grade averages	Max	.69	.93	.71	.22	.75	.92	.71	.27
	Med	.54	.65	.51	-.04	.53	.69	.54	.02
	Min	.33	.42	.32	-.28	.25	.40	.32	-.28
M4 Four ACT scores & average of 23 high school grades	Max	.69	.93	.71	.22	.75	.92	.72	.27
	Med	.54	.66	.52	-.04	.53	.69	.53	.02
	Min	.36	.42	.32	-.29	.23	.41	.33	-.26
M5 ACT Composite & average of 23 high school grades	Max	.69	.91	.69	.24	.74	.87	.69	.26
	Med	.53	.66	.52	-.03	.52	.69	.53	.01
	Min	.37	.42	.33	-.29	.30	.44	.36	-.27