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ABSTRACT

The validity of American College Testing Program (ACT) test scores and self-reported high school grades for predicting grades in specific college freshman courses was studied. Specific course grades are typically used to place students in remedial, standard, or advanced classes. These placement decisions, in turn, have immediate implications for student performance, satisfaction, and persistence in college. Prediction equations were developed for 18 out of 2,812 specific college courses in English, mathematics, social studies, and natural science using ACT research data from 1980 to 1984 for 233 colleges. The predictive accuracy of these equations was then examined using cross-validation techniques. An additional analysis determined whether the predictive validity statistics varied among types of institutions. Implications of the results for course placement were examined. Eleven tables present study data. Appendix A contains the taxonomy of course codes; and Appendix B contains the cover letter, directions, and questionnaire for the survey of the colleges. (SLD)

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PREDICTING GRADES IN SPECIFIC COLLEGE FRESHMAN COURSES FROM ACT TEST SCORES AND SELF-REPORTED HIGH SCHOOL GRADES

Julie Noble
Richard Sawyer

ABSTRACT

This report is concerned with the validity of ACT test scores and self-reported high school grades for predicting grades in specific college freshman courses. Specific course grade predictions are typically used to place students in remedial, standard, or advanced classes. These placement decisions, in turn, have immediate implications for student performance, satisfaction, and persistence in college.

Prediction equations were developed for 18 specific college courses in English, mathematics, social studies, and natural sciences using ACT research data from 1980 to 1984. The predictive accuracy of these equations was then examined using cross-validation techniques. An additional analysis determined whether the predictive validity statistics varied among types of institutions. Implications of the results for course placement were examined.

PREDICTING GRADES IN SPECIFIC COLLEGE FRESHMAN COURSES FROM ACT TEST SCORES AND SELF-REPORTED HIGH SCHOOL GRADES

Through ACT's Standard Research Service (SRS), postsecondary institutions can develop predictions of their students' grades in specific freshman courses. These predictions are based on the students' ACT subtest scores (in English, mathematics, social studies, and natural sciences) and on their self-reported high school grades in the same subject areas:

$$\hat{Y} = a_0 + a_1\text{*ACT English Usage score} \tag{1}$$
$$+ a_2\text{*ACT Mathematics Usage score}$$
$$+ a_3\text{*ACT Social Studies Reading score}$$
$$+ a_4\text{*ACT Natural Sciences Reading score}$$
$$+ a_5\text{*HS English grade}$$
$$+ a_6\text{*HS Mathematics grade}$$
$$+ a_7\text{*HS Social Studies grade}$$
$$+ a_8\text{*HS Natural Sciences grade}$$

In this equation, $\hat{Y}$ is the predicted course grade and $a_0,\ldots,a_8$ are regression weights unique to the institution and to the course grade being predicted. The weights are calculated from the college course grades supplied by each institution through its participation in SRS, and from students' ACT test scores and high school grades. Institutions may choose to base their predictions on the ACT test scores alone, but rarely do so.

About 150 institutions each year develop prediction equations for specific course grades. The regression weights are reported to the institutions; the weights may then be used, through Equation (1), to calculate predicted grades for future students. At the request of the institutions, ACT also reports predictions in terms of grade expectancies (chances of earning a given grade or higher) on the ACT score reports of future students. For details on how ACT calculates grade expectancies, see Your College Freshmen (ACT, 981).

Specific course grade predictions are typically used for course placement. For example, students with low predicted chances of success in a standard freshman English course might be advised or required to enroll in a remedial English course. On the other hand, students with high predicted chances of success in an honors English course might be encouraged to enroll in it. In this paper we present evidence supporting the use of ACT scores and high school grades for placement in first-year English, mathematics, social studies, and natural sciences courses at the postsecondary level.

We assume that the placement decision is based on a specific course grade prediction equation like Equation (1). Moreover, the selection rule is assumed to have the following general form: If a student has a small predicted chance of succeeding at a given level of a course, then the student is selected for a lower level. Not all colleges' placement procedures have this form; our choice of placement model for this discussion is based on the belief that it yields the most relevant predictions. The other placement procedures tend to be used for their practical advantages, such as their greater ease of operation, or their greater ease of explanation to staff and students.

The justification for using ACT test scores and high school grades for placement rests on the following basic assumptions:

1. Successful work in any college course requires that students have previously acquired a set of academic skills and knowledge particular to the course.

2. ACT test scores and high school grades either directly measure or are closely related to the required skills and knowledge.

3. The college course grades are of sufficient reliability and validity so that they measure real and relevant educational outcomes, rather than random or irrelevant factors.

The degree to which these assumptions are true affects the accuracy of specific course grade predictions. Prediction accuracy is therefore a relevant factor in determining the suitability of using ACT test scores and high school grades for placement. For further discussion of how prediction accuracy and other factors are related to the outcomes of placement decisions based on grade predictions, see Sawyer (1987).

Each year ACT publishes the Research Services Summary Tables (ACT, 1985), which summarize data collected through SRS during the previous 3 years. The Research Services Summary Tables contain (among other information) frequency distributions of correlation coefficients and standard errors of estimate for predicting grades in English, mathematics, social studies, and natural sciences courses. These distributions are derived from the regression statistics developed for the individual institutions that participated in SRS.

The predictive validity data provided in the Summary Tables pertain to broad subject areas, rather than to specific kinds of courses. For example, the tables do not provide information on how well ACT Assessment data predict grades in English composition, analytic geometry, or history, but instead only in the broad areas of English, mathematics, and social studies. The major purpose of this study was to collect predictive validity data with respect to more specific course groupings than are provided in the Summary Tables.

In the actual operation of the ACT Research Services, prediction equations developed from the grades of one freshman class are applied to future freshman classes. Because these classes may differ in their test scores, high school grades, or college grades, predictive validity statistics developed from a single year's data may be overly optimistic. In crossvalidation, predictions calculated from equations developed from one freshman class are compared to the grades earned by a subsequent class. This procedure models the actual use of prediction equations by institutions, and avoids the tendency of estimates of predictive accuracy based on a single year's data to be overly optimistic. A second purpose of this study, therefore, was to determine the crossvalidated predictive accuracy of specific course grade predictions.

Earlier Research

Numerous studies have examined the relationships between admissions and placement test scores and specific course grades. Predictor variables have included ACT scores, SAT scores, and high school grades, as well as subject-specific tests, like the Nelson-Denny Reading Test. These studies, however, were limited in two important respects. First, the data the authors used were predominantly from single institutions (we found only one study that used data from two institutions). Second, the criteria examined in the studies were either grades from a single specific course, or grades from a small cluster of courses. None of the studies examined a full spectrum of specific courses representative of freshman curricula. In addition, the content of these courses was often not specified in sufficient detail to permit comparing the results across institutions or courses.

The existing research published since 1970 that we were able to find is summarized by subject area in Table 1. The course grade used as a criterion, the author(s) and date of publication, the predictor variables, the sample size, and the correlation coefficient are presented for each study. For a complete description of the predictor variables used in a each study, see the specific articles cited.

For the English predictive validity studies, the correlations between test scores and English course grades were generally low; they ranged from .13 to .38. The one exception was a study by Gorrell (1983), which reported a correlation of .61 between ACT English scores and final English essay ratings.

The mathematics validity studies comprised a large proportion of the research on predicting specific course grades. A variety of predictors were used, including ACT subtest and Composite scores; SAT-V, SAT-M, and SAT-Total scores; high school rank; and scores on specially developed mathematics placement tests. The correlation coefficients ranged from .04 to .75; the largest correlations were associated with tests specifically designed for placement in mathematics, as in the Bridgeman (1982) and Burnham and Hewitt (1971) studies.

The studies on the relationship between social studies course grades and test scores generally resulted in moderate positive correlations (.32 to .52). The criteria for these studies, however, were limited to grades in psychology and sociology courses.

The research on predictions of natural sciences grades was limited to biology, chemistry, and physics courses. In the studies we were able to locate, correlations ranging from .14 to .61 were reported between test scores and grades in these courses.

TABLE 1

Summary of Earlier Research on Predicting Specific Course Grades

Subject area	Author(s)	Course	Predictor(s)	N	R
English	Correll (1983)	English (essay ratings)	ACT English	103	.61
	Wood (1982)	English	ACT Composite	919	.24
		Speech	ACT Composite	719	.21
	Schoenfeldt and Brush (1975)	Speech/Journalism	SAT-Verbal	1032	.23
		Speech/Journalism	SAT-Mathematics	1032	.13
	Burnham and Hewitt (1971)	English	SAT-V, pred. GPA, CEEB-Eng., Adv. Pl.-Eng.	25	.22
		English	SAT-V, pred. GPA, CEEB-Eng., Adv. Pl.-Eng.	87	.38
Mathematics	Edge and Friedberg (1984)	Calculus	ACT English	392	.25
		Calculus	ACT English	397	.27
		Calculus	ACT Mathematics	392	.36
		Calculus	ACT Mathematics	397	.47
		Calculus	ACT Composite	392	.30
	Bridgeman (1982)	Preparatory College Math	SAT-M, DTMS	48	.04,.41
		Elementary Algebra	SAT-M, DTMS	73	.21,.46
		Elementary Algebra	SAT-M, DTMS	198	.26,.47
		Math Analysis	SAT-M, DTMS	41	.18,.52
		Elementary Functions	SAT-M, DTMS	40	.39,.37
		Calculus	SAT-M, DTMS	19	.55,.75
		Elementary Algebra	SAT-M, HS Algebra Grades	162	.36
	Troutman (1978)	Finite Math	SAT-Mathematics	123	.40
	Gussett (1974)	Mathematics	SAT-Verbal	142	.48
		Mathematics	SAT-Mathematics	142	.62
		Mathematics	SAT-Total	142	.63
	Kohler (1973)	Algebra	Cooperative Math. Test	158	.53
		Algebra	ACT Mathematics	161	.52
		Algebra	ACT Composite	161	.40

ued on next page

TABLE 1

Summary of Earlier Research on Predicting Specific Course Grades
(Continued)

Subject area	Author(s)	Course	Predictor(s)	N	R
(Mathematics continued)					
	Burnham and Hewitt (1971)	Mathematics	SAT-M, Adv. Pl.-Math.	21	.64
		Mathematics	SAT-M, Adv. Pl.-Math.	71	.41
		Mathematics	SAT-M, Adv. Pl.-Math.	30	.39
	Howlett (1969)	Analytic Geometry	ACT Math, HS Rank	397	.38
		Analytic Geometry	ACT Math, HS Rank	497	.47
Social Studies	Wood (1982)	Psychology	ACT Composite	738	.43
		Sociology	ACT Composite	899	.32
	Gerow and Murphy (1980)	Psychology	Nelson-Denny	36-136	.40-.64
	Zimmerman, Wise, and South (1974)	Psychology	ACT English	164	.40
		Psychology	ACT Mathematics	164	.36
		Psychology	ACT Social Studies	164	.42
		Psychology	ACT Natural Sciences	164	.53
		Psychology	ACT Composite	164	.56
Natural Sciences	Craney and Armstrong (1985)	Chemistry	Toledo Exam	304	.52
		Chemistry	SAT-Mathematics	304	.45
		Chemistry	HS Chemistry grad	304	.39
		Chemistry	Toledo Exam, SAT-M	304	.61
		Chemistry	HS Chemistry grade	304	.61
	Crooks (1980)	Physics	ACT Composite	495	.40
		Physics	SCAT-Q, HS-PR, ACT-M, ACT-NS	495	.54
		Physics	ACT-C, HS-PR	495	.48

continued on next page

TABLE 1

Summary of Earlier Research on Predicting Specific Course Grades
(Continued)

Subject area	Author(s)	Course	Predictor(s)	N	R
(Natural Sciences continued)					
	Ozsogomonyan and Loftus (1979)	Chemistry	SAT-Mathematics	1148	.51
	Pederson (1975)	Chemistry	SAT-Verbal	325	.32
		Chemistry	SAT-Mathematics	325	.14
		Chemistry	SAT-Total	325	.43
	Schoenfeldt and Brush (1975)	Biological Sciences (GPA)	SAT-Verbal	1854	.30
		Biological Sciences (GPA)	SAT-Mathematics	1855	.28
	Reiner (1971)	Chemistry	ACT Math, HS Rank	250	.53

Data for the Study

This study was based on student records submitted by institutions that participated in ACT's Standard Research Service (SRS) between 1980 and 1984. Each student record contained ACT subtest scores and self-reported high school grades in the areas of English, mathematics, social studies, and natural sciences. In addition, each record contained an ACT Composite score (the average of the four subtest scores) and a high school average (the average of the four self-reported high school grades). ACT test scores are reported on a standard scale ranging from 1 to 36; high school grades are reported on a 0(F) to 4(A) scale. Additional descriptive and technical information about ACT test scores and self-reported high school grades may be found in The ACT Assessment Program Technical Manual (1987).

Each student record also contained grades for one or more specific freshman courses chosen by the individual institutions. Most institutions, when submitting their documentation to the SRS, used names like "Math 101" or "Freshman English" to identify their course grades. To develop predictive information for specific types of courses within general subject areas, it was necessary to determine the contents of individual courses. This was accomplished by surveying the SRS participants.

To determine the types of courses that could be studied, we reviewed the SRS reports produced between 1980 and 1984 and listed all of the freshman courses for which prediction equations were developed. From the 277 institutions that participated in SRS between 1980 and 1984, we identified 2,918 courses and organized them into six general content categories: English, foreign languages, mathematics, social studies, natural sciences, and miscellaneous.

We next examined the catalogs from several of the SRS participating institutions to determine the contents of the courses. Using this information, we developed a taxonomy of course content codes. This taxonomy served as the basis for identifying the contents of the courses reported by the other SRS participants. (See Appendix A for a list of content codes.)

Other factors were also considered in identifying courses. In several cases, institutions reported grades for developmental/remedial courses or honors courses in addition to, or instead of, standard freshman courses. Furthermore, some courses were specific to a particular discipline, particularly in agriculture, business, engineering, and health sciences. For example, Business Math may have had content similar to the typical Algebra I course, and as such, was assigned the content code M1. However, because the material in the course emphasized business applications, a business emphasis was also identified. Thus, two additional sets of codes were created, one to identify the placement level of the course, and the other to identify the disciplinary emphasis.

Several of the courses reported by the institutions were not specific courses, per se, but were combinations of courses. For example, some colleges pooled the grades of all students enrolled in different courses and reported them under a single course heading. Other institutions reported for each student a grade point average computed from several related courses. To differentiate these types of course grades from specific course grades, an additional set of course identifiers was created.

Each participating institution received a questionnaire that listed the names of the specific courses it had studied through SRS, as well as the year, number of students, and SRS course grade area (E, M, S, or N). Institutional personnel were then asked to select for each course the specific code or codes that best identified the course content. In addition, they were requested to check the pooled or GPA columns if the grades were from multiple courses, and to specify the placement level and disciplinary emphasis codes for each course. Finally, they were asked to respond to two additional items concerning their use of predictive information for course sectioning and placement.

A pilot questionnaire, cover letter, and directions were submitted to three SRS users to review and to complete. Copies were also distributed to ACT staff for review and comment. Following the pilot testing, the comments and suggestions of the reviewers were studied, and a final questionnaire form was developed. Examples of the questionnaire, instruction sheet, and cover letter are contained in Appendix B.

Questionnaire forms were mailed in October 1985 to the 277 institutions that participated in SRS between 1980 and 1984 and that had developed prediction equations for specific courses. Institutions that failed to respond by the return date of November 15 were contacted initially by letter, and then by telephone, where necessary. Of the 277 questionnaires mailed, 210 (or 76%) were returned. Of that number, nine were unusable; either institutional personnel were unable to provide the information requested or all of the grades reported were pooled from several areas, rather than from specific courses. We were able, however, to identify the content of the courses from 23 of the 67 non-responding institutions by examining their catalogs. As a result, we obtained data for 233 (or 84%) of the 277 institutions we surveyed.

We next analyzed the survey data to determine the specific course grades to use as criterion variables. In an initial review of the data, we determined that only a few course grades were pooled grades or GPAs. To retain data as specific as possible, we deleted all pooled grades from the analysis. Moreover, we retained GPAs only if the grades that were averaged had the same specific course content (e.g., biology). The final resulting course grade data file consisted of 2,812 specific courses; 2,143 courses were identified by individual institutions, and 669 courses were identified from college catalogs.

Frequency distributions were developed for all possible combinations of course content codes within each of the six subject areas (English, foreign languages, mathematics, social studies, natural sciences, and miscellaneous). If at least 10 institutions reported a particular content code, or combination of codes for a specific course, that code or set of codes was identified as a course group for the analyses. For example, courses that were coded E1 were assigned to the course group Grammar/Linguistics (see Appendix A). Those courses coded as E1 and E5 were assigned to the course group Grammar & Writing. A total of 18 separate course groups were identified; a list of the course groups is given in Table 2. (Note that Accounting was subsumed under the mathematics heading; it was the only miscellaneous course with a sufficient number of participating institutions to warrant analysis).

Several institutions reported grades for different courses in the same course group in the same year (e.g., two separate chemistry courses in 1984). For the analyses, such courses were treated as separate units of analysis. There were 95 such courses among the 2,812 courses studied in the entire file.

TABLE 2

College Course Groups Selected For Prediction of Specific Course Grades

Subject Area	Code	Description
English	E1	Grammar/Linguisitics
	E5	Writing (Creative, Expository, Journalism, etc.)
	E1E5	Grammar/Linguistics & Writing
	E1E2E5	Grammar/Linguistics & Literature (American, English, Classics, etc.) & Writing
	E1E3E5	Grammar/Linguistics & Reading & Writing
Mathematics	M1	Algebra
	M4	Calculus
	M5	Computer Science/Numerical Analysis/Graphics
	ACCTG	Accounting
	M1M3	Algebra & Arithmetic Skills
	M1M9	Algebra & Trigonometry
	M2M4	Analytic Geometry & Calculus
Social Studies	S5	History (American, World, Western Civilizations, Etc.)
	S8	Psychology (Child, Abnormal, Adult, etc.)
	S10	Sociology
	S5S7	History & Political Science (World Problems, Theory, etc.)
Natural Sciences	N3	Biology/Life Sciences/Microbiology
	N5	Chemistry

For each subject area (English, mathematics, social studies, and natural sciences), the questionnaire data were matched, by year and ACT college code, with individual student records from the SRS data files. The resulting matched file contained the questionnaire course group information and each student's college grades, ACT subtest scores, self-reported high school grades, and demographic and background characteristics. The final file contained one or more years' data for 576 distinct courses distributed across 18 course groups and 233 institutions.

It should be noted that because the data in this study were collected from institutions participating in the ACT predictive research services, they are in some respects not representative of students nationally:

* Colleges using the ACT Assessment are located mainly in the Rocky Mountains, Great Plains, Southwest, Midwest, and South, with comparatively fewer on the East Coast and West Coast.

* Public institutions are relatively over-represented among colleges that use the ACT Assessment, and private institutions are under-represented.

* Participation in ACT's predictive research services is voluntary, and, as such, the colleges represented are self-selected even among colleges that use the ACT Assessment.

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

Method

The analysis of the specific course data was conducted in two parts. In the first part, we computed regression statistics for each specific course grade using the most recent year's data from each institution. This was done to maximize the numbers of institutions and students for which prediction equations could be calculated. In the second part of the study, we crossvalidated prediction equations for ourses from institutions where more than one year's data were available.

In both parts of the study, the predictor variables were the four ACT subtest scores and the four self-reported high school grades in the corresponding subject areas. The criterion variables were grades from the 18 specific course groups identified from the questionnaire data. Both high school and college grades were reported on a 0.0-4.0 scale.

As is usually the case in predictive validity studies, the college grades collected for this study may reflect prior selection or treatment made on the basis of the predictor variables. For example, in colleges that used test scores and high school grades for course placement, the students' grades reflect these interventions. Where placement has occurred, the variability in predictor variables among students in the course will be less than the variability among all freshmen, had they enrolled in the course. As a result, the predictive validity statistics for the course grades underestimate the relationship between the predictor variables and the criterion in a population where intervention does not take place.

Part 1 (Analysis of Predictions Based on Most Recent Data)

For each college, multiple linear regression prediction equations were calculated using the most recent year's data for each course group in each college. There were 576 separate courses across all course groups and colleges. The predictor variables were ACT subtest scores and self-reported high school grades used in three combinations:

(a) four ACT subtests,

(b) four high school grades, and

(c) four ACT subtest scores and four high school grades.

Descriptive statistics were also calculated for the specific course grades, ACT Composite scores, high school averages, and student sample sizes from each institution. The regression and descriptive statistics were then summarized across institutions. Regression and descriptive statistics based on student sample sizes smaller than 25 were deleted from the summaries.

For this study, the predictions using both the ACT subtest scores and high school grades were based on eight-variable multiple regression equations. The TH Index, reported in the Standard Research Summary Tables, is the average of the predictions based on ACT subtest scores alone and the predictions based on self-reported high school grades alone. Sawyer and Maxey (1979) found, however, that the difference in the predictive accuracy of the two methods is negligible.

We calculated for each prediction equation the associated multiple correlation (R) and standard error of estimate (SEE). R ranges from 0 to 1, with larger values indicating more accurate prediction. SEE is the square root of the average squared difference between actual and predicted course grades. (In order that it have the statistical property of being "unbiased," SEE is calculated by dividing the sum of squared differences by N-p-1, where N is the sample size and p is the number of predictors, rather than dividing it by N.) Smaller values of SEE indicate more accurate prediction.

Neither R nor SEE completely and directly measures the overall effectiveness of a placement system in making correct decisions; determining this would require knowledge of the overall failure rate that would occur in the absence of a placement system, as well as the selection rate for each course section, and the costs and benefits of correct and incorrect placement decisions. Nevertheless, both statistics are relevant to the overall validity of a placement system because they measure prediction accuracy. Other things being equal, a placement system based on more accurate predictions will be more valid than one based on less accurate predictions. For a discussion of variables affecting placement validity and how they are related to R and SEE, see Sawyer (1987).

Correlations between predictive validity statistics and mean test scores and grades. We also determined whether the mean course grade, ACT Composite score, or high school average of students enrolled in a course was related to the predictive validity statistics for the course. This information provides one way for institutional personnel to determine the applicability of the predictive validity results to their particular institution. We therefore computed for each course the correlation of mean course grade, mean ACT Composite score, and mean high school average with the multiple R and SEE associated with the ACT + HSG model.

Statistical theory would lead one to expect that the standard deviations of course grade, ACT Composite score, and high school average would also be related to thepredictive validity statistics. To keep the scope of this study within reasonable bounds, we have deferred to the future an analysis of standard deviations.

Part 2 (Crossvalidation Analysis)

We selected from the original data file courses from all institutions for which data were available for two or more years, and for which there was at least one year's lag between the base year and the crossvalidation year (e.g., 1980-81 and 1982-83). The reason for the lag in time is that prediction equations developed from a given year's data are, in actual practice, applied to freshmen 2 to 4 years later. As in Part 1, the minimum sample size for each institution was set at 25 for each year. Of the original pool of 18 course groups taken from 576 specific courses from 233 institutions, 10 course groups from 208 institutions were identified.

The three combinations of predictor variables described in Part 1 above were also used in this portion of the study. For each combination of predictors, we used the regression equations developed from the base year data to predict the grades of students enrolled in the same course during the crossvalidation year 2 to 4 years later. We then compared the predicted and actual grades observed during the crossvalidation year and computed the following measures of prediction accuracy for each college and specific course:

* RMSE (observed root mean squared error), the square root of the average squared difference between predicted and earned specific course grades. Smaller values of RMSE correspond to more accurate prediction than do larger values of RMSE. 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.

* CVR (crossvalidated correlation), the Pearson correlation between predicted and earned specific course grades. This coefficient can be compared with the multiple correlation coefficient calculated from the base year data to give an indication of the stability of the predictions over time.

* BIAS (prediction bias), the average difference between predicted and earned specific course grades. Positive values of BIAS correspond to overprediction, and negative values correspond to underprediction.

These crossvalidation statistics were summarized across institutions for each specific course group.

Results

Part 1 (Analysis of Predictions Based on Most Recent Data)

Descriptive statistics. Tables 3 through 6 contain descriptive statistics for the courses from institutions in each specific course group. The number of colleges in each course group is reported, along with the minimum, median, and maximum of the following institutional statistics: mean and standard deviation of course grade; mean and standard deviation of ACT Composite score; and mean and standard deviation of high school average.

The means for each course group were compared to analogous data reported in the 3-year Research Services Summary Tables for 1981 through 1984 (ACT, 1985). The Summary Tables are based on data obtained from all institutions that participated in SRS during those years (number of colleges = 262; number of students = 191,626). For institutions that participated more than once, only the most recent year's data are included. The median institutional mean ACT Composite score from these 3-year norms was 19.4, and the median institutional high school average was 2.95. The median institutional mean course grades were: English, 2.49; mathematics, 2.38; social studies, 2.41, and natural sciences, 2.26. By comparing these medians with the descriptive statistics in Tables 3-6, one can judge how similar the students who enrolled in specific courses were to students in general.

As shown in Table 3, the median English course grade means were within 0.2 grade units of the median English grade averages from the 3-year norms. As measured by their median ACT Composite mean scores, students enrolled in Grammar, Grammar & Writing, and Grammar & Literature & Writing courses were less academically able than students in general (for whom the median institutional mean was 19.4), and students enrolled in Writing courses were more able. The median high school average means for all the English course groups were close to the 3-year norms median of 2.95.

According to the results in Table 4, median course grades for all mathematics courses (except for Algebra & Arithmetic Skills and Computer Science) were similar to the Summary Table median of 2.38. The grades in Algebra & Arithmetic Skills courses (median = 1.83) tended to be lower than those in the Summary Tables, while the grades in Computer Science courses (median = 2.66) tended to be higher. The median ACT Composite mean score for students enrolled in Algebra & Arithmetic skills indicate that they were less academically able than students in general; the median ACT Composite means for Calculus (24.8), Analytic Geometry & Calculus (24.8), and Algebra & Trigonometry (21.8) indicate that students enrolled in those courses were more academically able. The median statistics for the other mathematics courses were all closer to the medians in the Summary Tables.

The results for the social studies course groups, reported in Table 5, were similar to the results from the Summary Tables. For the Chemistry course group, summarized in Table 6, the median ACT Composite score (22.5) and high school average (3.26) were higher than the corresponding medians in the Summary Tables for natural sciences courses. The corresponding medians for Biology were similar to those in the 3-year norms.

TABLE 3

Distribution, Across Colleges, of Means and Standard Deviations of College Course Grade, ACT Composite Score, and High School Average for English Courses

Course group	Number of colleges	Quantile	Number of students in course	Course grade Mean	Course grade SD	ACT Composite Mean	ACT Composite SD	High school average Mean	High school average SD
Grammar	29	Min.	74	1.47	.66	10.9	2.54	2.24	.41
		Med.	254	2.32	.97	18.4	4.66	2.94	.65
		Max.	2285	3.09	1.22	23.2	5.46	3.35	.75
Writing	46	Min.	57	2.07	.63	10.1	2.78	2.31	.41
		Med.	264	2.63	.87	20.5	4.48	3.05	.60
		Max.	3876	3.34	1.21	25.2	5.45	3.42	.71
Grammar & Writing	54	Min.	33	1.75	.73	11.0	3.70	2.37	.51
		Med.	283	2.46	.92	17.9	4.65	2.95	.62
		Max.	1832	3.09	1.31	25.2	5.51	3.33	.79
Grammar & Literature & Writing	20	Min.	97	1.77	.61	15.5	3.23	2.60	.49
		Med.	393	2.49	.92	17.8	4.79	2.91	.64
		Max.	2283	2.87	1.22	23.6	5.66	3.28	.74
Grammar & Reading & Writing	14	Min.	75	1.93	.63	13.5	3.15	2.51	.56
		Med.	342	2.44	.93	18.7	4.56	2.89	.62
		Max.	1097	2.67	1.14	21.3	5.58	3.11	.89

TABLE 4

Distribution, Across Colleges, of Means and Standard Deviations of College Course Grade, ACT Composite Score, and High School Average for Mathematics Courses

Course group	Number of colleges	Quantile	Number of students in course	Course grade Mean	Course grade SD	ACT Composite Mean	ACT Composite SD	High school average Mean	High school average SD
Algebra	69	Min.	52	1.38	.91	12.8	3.24	2.48	.51
		Med.	215	2.26	1.22	18.7	4.41	2.96	.61
		Max.	1234	2.75	1.50	23.5	6.04	3.41	.75
Calculus	20	Min.	60	1.83	.86	21.4	1.91	2.92	.33
		Med.	161	2.42	1.12	24.8	3.59	3.39	.48
		Max.	1009	2.77	1.37	28.4	4.40	3.73	.62
Computer Science	11	Min.	55	2.10	1.00	17.6	3.36	2.71	.43
		Med.	103	2.66	1.13	21.4	4.39	2.95	.59
		Max.	361	2.74	1.40	25.6	5.18	3.46	.78
Accounting	10	Min.	46	1.82	.90	15.3	3.82	2.62	.50
		Med.	129	2.28	1.25	18.0	4.54	2.94	.56
		Max.	510	3.11	1.54	23.3	5.34	3.30	.72
Algebra & Arithmetic Skills	11	Min.	37	1.20	.97	14.3	3.48	2.51	.51
		Med.	166	1.83	1.28	17.4	4.28	2.83	.59
		Max.	490	2.94	1.46	22.5	5.26	3.18	.79
Algebra & Trigonometry	12	Min.	56	1.78	.94	15.4	2.36	2.61	.43
		Med.	232	2.19	1.17	21.8	3.75	3.18	.56
		Max.	1189	2.67	1.35	24.6	5.56	3.41	.64
Analytic Geometry & Calculus	10	Min.	63	1.78	.94	16.0	3.10	2.83	.43
		Med.	152	2.29	1.22	24.8	3.81	3.37	.51
		Max.	1700	2.89	1.44	26.6	5.17	3.60	.66

TABLE 5

Distribution, Across Colleges, of Means and Standard Deviations of College Course Grade, ACT Composite Score, and High School Average for Social Studies Courses

Course group	Number of colleges	Quantile	Number of students in course	Course grade Mean	Course grade SD	ACT Composite Mean	ACT Composite SD	High school average Mean	High school average SD
History	59	Min.	34	1.33	.59	11.4	2.31	2.42	.33
		Med.	160	2.26	1.07	18.6	4.80	3.03	.64
		Max.	1639	3.10	1.30	27.4	5.88	3.74	.77
Psychology	58	Min.	55	1.41	.56	11.2	1.72	2.26	.45
		Med.	193	2.42	1.05	18.5	4.73	2.92	.62
		Max.	2798	3.31	1.32	27.7	5.59	3.57	.76
Sociology	18	Min.	43	1.79	.75	15.1	3.68	2.48	.47
		Med.	353	2.56	.99	18.5	4.70	2.92	.62
		Max.	976	3.11	1.28	23.6	5.46	3.49	.72
History & Political Science	11	Min.	59	1.86	.91	17.0	2.80	2.79	.50
		Med.	466	2.43	1.05	19.7	4.89	3.03	.64
		Max.	554	2.73	1.22	22.3	5.29	3.22	.71

TABLE 6

Distribution, Across Colleges, of Means and Standard Deviations of College Course Grade, ACT Composite Score, and High School Average for Natural Sciences Courses

Course group	Number of colleges	Quantile	Number of students in course	Course grade Mean	Course grade SD	ACT Composite Mean	ACT Composite SD	High school average Mean	High school average SD
Biology	77	Min.	25	0.94	.73	12.2	2.84	2.41	.41
		Med.	123	2.24	1.09	19.0	4.65	3.01	.63
		Max.	991	2.81	1.45	24.0	5.68	3.58	.74
Chemistry	47	Min.	25	1.22	.76	15.9	2.66	2.71	.43
		Med.	148	2.28	1.07	22.5	4.20	3.26	.55
		Max.	1773	2.86	1.47	26.9	6.04	3.58	.74

Predictive validity statistics. The results of the multiple regression analyses for the course groups are reported in Tables 7 through 10. In these tables, multiple correlations (R) and standard errors of estimate (SEE) are summarized across institutions within each specific course group. The tables contain separate statistics for each prediction model: ACT subtests only (ACT), high school grades only (HSG), and ACT subtests and high school grades (ACT + HSG).

Table 7 contains the multiple Rs and SEEs for predicting specific English courses. For each of the three prediction models, the multiple Rs were similar across the five English course groups. In addition, no large differences in SEE were found among the course groups.

In comparing the three prediction models, we found that the ACT model resulted in slightly higher median multiple Rs (.41 to .47) than the HSG model (.38 to .46) for all English courses. The combined ACT + HSG model had the largest multiple Rs, ranging from .48 to .55. Using the combined model also resulted in smaller SEEs (.74 to .84), when compared to the ACT (.77 to .88) and the HSG (.78 to .89) models.

The multiple regression statistics for predicting specific mathematics course grades are reported in Table 8. Of the seven mathematics course groups, Accounting had the largest multiple Rs (median = .56); however, differences in multiple R among the other course groups did not exceed .10. Mathematics course groups differed in their SEEs, with Algebra & Arithmetic Skills obtaining consistently larger SEEs than other course groups.

No large differences were found between the multiple correlations for the ACT and the HSG models; median multiple Rs for both models ranged from .36 to .46. Multiple Rs for the combined ACT + HSG model were about .1 higher than those for the separate models, and ranged from .46 to .56. The standard errors for the ACT and HSG models were similar, with median values ranging from 1.03 to 1.20. As expected, the combined model showed smaller standard errors, with median values ranging from .99 to 1.14.

Table 9 contains the results for predicting specific social studies course grades. For each of the three prediction models, the multiple Rs and SEEs were similar for all of the course groups.

The median multiple Rs associated with the ACT prediction model (.42 to .49), were consistently larger than those associated with the HSG prediction model (.37 to .44), particularly for History & Political Science (ACT median multiple R = .49; HSG median multiple R = .38). For all specific social studies courses, the combined ACT + HSG model resulted in somewhat larger median multiple Rs (.50 to .56) and somewhat smaller standard errors (.83 to .90) than did the ACT or HSG models.

The results for predicting specific natural sciences courses are reported in Table 10. Under both the ACT and HSG models the multiple Rs for both the Biology and Chemistry course groups were similar, with medians ranging from .46 to .51. The combined ACT + HSG model resulted in increased multiple Rs (.56 to .61), and some decrease in SEEs (.90 to .92), when compared to the ACT and HSG models (.95 to .98). In general, the ACT + HSG predictions for Biology tended to be more accurate than those for Chemistry.

TABLE 7

Distribution, Across Colleges, of Multiple Correlation and Standard Error of Estimate in Predicting English Grades

Course group	Quantile	Multiple correlation: ACT sub-tests only	Multiple correlation: High school grades only	Multiple correlation: ACT subtests and high school grades	Standard error of estimate: ACT sub-tests only	Standard error of estimate: High school grades only	Standard error of estimate: ACT subtests and high school grades
Grammar	Min.	.13	.13	.18	.61	.63	.57
	Med.	.45	.43	.51	.88	.89	.84
	Max.	.68	.64	.76	1.07	1.04	1.04
Writing	Min.	.16	.08	.20	.57	.57	.54
	Med.	.41	.38	.49	.77	.78	.74
	Max.	.64	.62	.71	1.13	1.14	1.12
Grammar & Writing	Min.	.21	.22	.29	.60	.66	.60
	Med.	.42	.38	.48	.85	.85	.83
	Max.	.77	.63	.79	1.20	1.28	1.27
Grammar	Min.	.28	.27	.35	.57	.58	.56
& Literature	Med.	.47	.46	.55	.81	.81	.76
& Writing	Max.	.62	.65	.71	1.12	1.15	1.10
Grammar & Reading	Min.	.18	.31	.37	.63	.59	.59
& Writing	Med.	.47	.41	.52	.82	.84	.79
	Max.	.54	.51	.61	1.10	1.09	1.08

TABLE 8

Distribution, Across Colleges, of Multiple Correlation and Standard Error of Estimate in Predicting Mathematics Grades

Course group	Quantile	Multiple correlation: ACT subtests only	Multiple correlation: High school grades only	Multiple correlation: ACT subtests and high school grades	Standard error of estimate: ACT subtests only	Standard error of estimate: High school grades only	Standard error of estimate: ACT subtests and high school grades
Algebra	Min.	.08	.14	.17	.86	.82	.78
	Med.	.39	.42	.51	1.13	1.10	1.05
	Max.	.65	.67	.77	1.42	1.44	1.41
Calculus	Min.	.20	.25	.35	.80	.83	.79
	Med.	.36	.39	.48	1.05	1.05	1.01
	Max.	.63	.53	.64	1.30	1.26	1.25
Computer Science	Min.	.30	.20	.39	.95	.94	.92
	Med.	.39	.36	.46	1.03	1.04	.99
	Max.	.48	.62	.63	1.38	1.43	1.38
Accounting	Min.	.32	.29	.39	.83	.81	.77
	Med.	.43	.46	.56	1.09	1.14	1.07
	Max.	.62	.61	.71	1.45	1.35	1.36
Algebra & Arithmetic Skills	Min.	.27	.20	.33	.94	.95	.92
	Med.	.39	.38	.47	1.17	1.20	1.14
	Max.	.62	.54	.71	1.38	1.41	1.36
Algebra & Trigonometry	Min.	.22	.15	.26	.88	.87	.83
	Med.	.38	.43	.53	1.13	1.07	1.03
	Max.	.48	.54	.63	1.35	1.36	1.37
Analytic Geometry & Calculus	Min.	.25	.27	.37	.85	.81	.80
	Med.	.38	.39	.50	1.13	1.16	1.10
	Max.	.51	.58	.62	1.34	1.37	1.28

TABLE 9

Distribution, Across Colleges, of Multiple Correlation and Standard Error of Estimate in Predicting Social Studies Grades

		Multiple correlation			Standard error of estimate		
Course group	Quantile	ACT subtests only	High school grades only	ACT subtests and high school grades	ACT subtests only	High school grades only	ACT subtests and high school grades
History	Min.	.03	.19	.32	.55	.55	.54
	Med.	.49	.44	.55	.93	.96	.89
	Max.	.68	.67	.74	1.31	1.21	1.28
Psychology	Min.	.23	.22	.32	.54	.52	.51
	Med.	.49	.44	.56	.91	.95	.90
	Max.	.71	.63	.75	1.28	1.28	1.26
Sociology	Min.	.08	.25	.35	.62	.71	.62
	Med.	.42	.37	.50	.87	.92	.83
	Max.	.67	.51	.71	1.20	1.21	1.17
History & Political Science	Min.	.31	.25	.38	.88	.88	.84
	Med.	.49	.38	.52	.92	.97	.89
	Max.	.54	.44	.59	1.13	1.14	1.11

TABLE 10

Distribution, Across Colleges, of Multiple Correlation and Standard Error of Estimate in Predicting Natural Sciences Grades

		Multiple correlatic			Standard error of estimate		
Course group	Quantile	ACT subtests only	High school grades only	A[illegible] subtests and high school grades	ACT subtests only	High school grades only	ACT subtests and high school grades
Biology	Min.	.19	.09	.29	.41	.61	.44
	Med.	.51	.49	.61	.95	.97	.90
	Max.	.93	.73	.93	1.49	1.37	1.32
Chemistry	Min.	.27	.17	.31	.71	.71	.[illegible]7
	Med.	.46	.46	.56	.95	.98	.92
	Max.	.66	.75	.82	1.36	1.33	1.23

Correlations between predictive validity statistics and mean test scores and grades. Neither mean course grade, mean ACT Composite score, nor mean high school average was significantly correlated ($p < .10$) with multiple R across all course groups. Moreover, for no course group was multiple R significantly correlated with all course characteristics. The correlation coefficients typically ranged between -.20 and .30.

We found somewhat stronger relationships between these three course characteristics and SEE. Correlations of these variables with SEE varied from -.30 to -.54 for the English course groups, .00 to -.45 for mathematics, -.20 to -.55 for social studies, and -.2J to -.50 for natural sciences. For the Accounting course group, the three correlations ranged from -.58 to -.82; for Analytic Geometry & Calculus, they ranged from -.57 to -.92. Thus, higher levels of general educational development in a specific course group, as measured by mean course grade, ACT Composite score, or high school average, were generally associated with more accurate predictions for that course group, as measured by SEE, though not as measured by multiple R. Note that this statement pertains to courses within specific course groups; it is not true across course groups.

Part 2 (Crossvalidation Analysis)

For each course within each of 10 course groups, we computed the differences between the crossvalidated correlation (CVR) and base year multiple R, and between the crossvalidated oot mean square error (RMSE) and base year standard error of estimate (SEE). These statistics measure the change in prediction accuracy when a prediction equation from the base year data is applied to freshmen in future years. We also computed for each course the average difference between the predicted grade and actual grade earned (BIAS). Positive values of BIAS indicate overprediction, and negative values indicate underprediction. We then summarized these statistics across the courses within each course group.

Table 11 contains, for each course group, the medians of the differences CVR-base year R, and RMSE-SEE, and the median BIAS. Because the results for the ACT and HSG prediction models were very similar to those of the ACT + HSG model, we have reported only the results for the ACT + HSG model.

As shown in Table 11, there was typically a slight decrease in R from base year to crossvalidation year. The largest differences between CVR and base year R occurred in Calculus (-.08) and in Grammar & Literature & Writing (-.08). Conversely, there was no change in R for Grammar and very small differences were found for Psychology and Biology.

Table 11 shows that the RMSEs for almost all of the course groups were typically somewhat larger than their corresponding SEEs. Algebra, Calculus, and Chemistry had the largest median increase in errors of prediction (.06); Grammar & Literature & Writing, Writing, and History had only a slight median increase (.02 to .03) in prediction errors; and Grammar had no median change.

The results for crossvalidated BIAS show that course grades were typically overpredicted for Grammar & Literature & Writing, Algebra, Calculus, and Biology, with median BIAS ranging from .06 to .20. The largest median BIAS was found for Calculus (.20). The grade predictions for the other course groups typically had biases near zero.

TABLE 11

Median Differences Between Crossvalidation Year and Base Year Statistics for the ACT + HSG Prediction Model

Course group	Number of colleges	Number of students: Base year	Number of students: Crossval. year	Median statistic: Crossval. R - base year R	Median statistic: Crossval. RMSE - base year SEE	Median statistic: Crossval. BIAS
Grammar	11	525	493	.00	.00	-.03
Writing	22	513	578	-.05	.02	.01
Grammar & Writing	27	308	320	-.05	.04	-.00
Grammar & Literature & Writing	12	532	435	-.08	.03	.07
Algebra	29	183	244	-.06	.06	.08
Calculus	10	203	207	-.08	.06	.20
History	17	168	160	-.07	.03	-.01
Psychology	23	299	313	-.03	.04	-.01
Biology	31	161	196	-.02	.04	.06
Chemistry	26	183	188	-.05	.06	.03

In summary, a small decrease in prediction accuracy was found between the base year and crossvalidation year, as measured by CVR-base year R and RMSE-SEE. Algebra, Calculus, and Chemistry showed some decrease in accuracy as measured by both CVR and RMSE; Calculus also had a relatively large median BIAS. Grammar, on the other hand, showed virtually no decrease in prediction accuracy.

Institutions' Uses of Prediction Equations

We included an additional item, concerning institutions' use of SRS data, in the questionnaire we sent to the SRS users (see Appendix B). Of the 233 institutions that responded to this item, 65 (or 28%) indicated they use SRS information in one way or another for placement and sectioning. Seventy-eight institutions (33% of the respondents) identified other uses they made of SRS information. The other uses identified were: counseling/advising (17%), admissions/general measure of readiness (3%), planning/research/statistical review (6%), and instructor/administrator information (3%). The remaining 90 institutions (39%) did not identify how they used SRS information.

Of the 2,812 specific course predictions developed by all institutions through their participation in SRS, 252 (or 9%) were explicitly used for placement and sectioning: 44% were in English; 33% were in mathematics; 11% were in Social Studies; 10% were in natural sciences; and 3% were in miscellaneous.

One should keep in mind when interpreting these statistics that they pertain only to the SRS user institutions that developed specific course predictions. McNabb (1987) surveyed more general classes of ACT-participating institutions about their course placement practices. She found, for example, that 34% of all ACT-participating institutions use individual ACT test scores directly (rather than grade predictions based on ACT scores and high school grades) for placement.

Summary and Conclusions

For every course group, predictions based on ACT test scores alone had equivalent or higher median multiple Rs than predictions based on self-reported high school grades alone. Moreover, the combined ACT test score and high school grade prediction model had higher median multiple Rs and smaller SEEs than both the ACT or high school grade models. Therefore, only the results for the combined model will be summarized here.

In comparing the prediction results across subject areas, we noted that prediction accuracy, as measured by median multiple R, was fairly constant across all courses in the English, mathematics, and social studies course groups (.46 to .56). Somewhat larger median multiple Rs were obtained for natural sciences (.56 to .61). There was greater variability, however, in the corresponding SEEs. SEEs ranged from .74 to 1.14, with the greatest prediction accuracy obtained for the English course groups (median SEE = .74 to .84) and the least prediction accuracy for the mathematics course groups (median SEE = .99 to 1.14).

English

Prediction accuracy, as measured by median multiple R and SEE, was very similar for all of the English course groups (median multiple R = .48 to .55; median SEE = .74 to .84). The greatest predictive accuracy occured in Grammar & Literature & Writing courses (multiple R = .55; SEE = .76). Prediction accuracy appeared to remain fairly stable on crossvalidation, with only a slight decrease in multiple R, a slight increas in SEE, and little or no prediction bias (except for Grammar & Literature & Writing, which tended to be overpredicted).

The median multiple Rs for the English course groups were consistently larger than those reported in earlier studies. Correll (1983) obtained a larger multiple R of .61, but the criterion variable he used was not a course grade, but an essay rating. The median multiple Rs for English course groups were somewhat lower than those obtained in predicting overall GPA (TH Index median multiple R = .568), as given in the SRS Summary Tables (ACT, 1985). The SEEs also tended to be somewhat larger than those for overall GPA (TH Index median SEE = .67).

Mathematics

There was greater variation in predictive accuracy among mathematics course groups (median multiple R = .46 to .56; median SEE = .99 to 1.14). The greatest predictive accuracy was found for Algebra & Trigonometry and for Accounting; the least predictive accuracy was found for Algebra & Arithmetic Skills. On crossvalidation, the Algebra and Calculus course groups showed some decrease in median multiple R and an increase in SEE; grades in these courses also tended to be overpredicted. (Crossvalidation statistics were obtained for only these two mathematics courses).

While the median correlations for the mathematics courses in this study were similar to the median correlation from the earlier studies that examined mathematics grades, there was a large range of correlations reported in the earlier studies. Gussett (1974), for example, obtained multiple Rs of .63, which is near the high end of the distribution of correlations we found for the mathematics course groups. His results might be attributed to the fact that his sample was composed of women from a single institution; the grades of women are more predictable than those of men (Munday, 1967).

In comparison to the SRS Summary Table statistics for predicting overall GPA, smaller multiple Rs and larger standard errors were obtained for the mathematics course groups. An explanation of why this occurred is given later in the paper.

Social Studies

The results for social studies courses indicated a fairly consistent degree of predictive accuracy across the course groups (median multiple R = .50 to .56; median SEE = .83 to .90).

The multiple Rs for the social studies course groups were similar to the median multiple R for overall GPA, as reported in the SRS Summary Tables. The median SEEs for all the social studies course groups, however, were larger than the median SEE fo overall GPA.

Natural Science

Predictive accuracy, as measured by SEE, was fairly similar for the two natural sciences courses (median SEE = .90, .92). However, the median multiple R for Biology (.61) was slightly higher than that for Chemistry (.56). The crossvalidation results indicated only a small decrease in predictive accuracy, and a tendency for Biology grades to be slightly overpredicted.

We found greater predictive accuracy for Biology than Schoenfeldt & Brush (1975). The results for Chemistry were consistent with those of Reiner (1971), who used a similar prediction model (ACT scores plus high school grades). The median multiple R for Biology was larger than the SRS Summary Table multiple R for overall GPA, and the median SEE was larger than the SEE for overall GPA.

Factors Related to Variation in Predictive Validity Statistics

One can attribute prediction error to three general sources: unreliability in the predictors, unreliability in the criterion, and imperfect relationships between the true scores of predictors and criterion. We shall examine the differences in the predictive validity statistics with respect to this interpretation.

The ACT Assessment Program Technical Manual (ACT, 1987) reported mean KR20 reliabilities of ACT test scores over 15 forms of the ACT Assessment administered between 1983 and 1986. These mean reliabilities ranged from .84 to .91 for the four subtests.

Rather limited evidence is available on the reliability of self-reported high school grades. The accuracy with which students report courses taken and grades received was studied by Valiga (1987), who found a correlation of .93 between non-certified self-reported grades and grades from students' transcripts. "Test-retest" reliability of grades was estimated by Bligh (1968), who found a correlation of .96 between students' grades reported over a 2-week time interval (N=440).

Although the reliability of college freshman GPA has been estimated to be between .80 and .82 (Munday, 1970; Millman, Slovacek, Kulick, and Mitchell, 1983), the reliability of specific course grades has proven to be difficult to determine. As students do not typically retake courses unless required to do so, "test-retest" reliability estimates are not feasible. The research on the reliability of specific course grades is somewhat limited as a result. Where such studies have been pursued, it has been assumed that grades in different courses could be treated as repeated measurements of a single domain, so that an overall GPA reliability could be stepped down, via a reverse Spearman-Brown formula, to a single course reliability coefficient. We found two such studies, which reported single course reliabilities of .30 and .44 (Etaugh, Etaugh, and Hurd, 1972) and .39 to .76 (Schoenfeldt and Brush, 1975). Schoenfeldt and Brush reported reliabilities for 12 specific course areas, including reliabilities of .39 for Speech/Journalism, .72 for humanities, .36 for social sciences, .64 for biological sciences, and .75 for physical sciences. Note that the reliabilities of single course grades are typically lower than those reported for overall GPA. If these estimates are reasonably accurate, then one cannot expect correlations between single ACT scores and course grades to exceed .85 (assuming ACT subtest reliabilities of .96 and course grade reliabilities less than .75). Assuming more typical reliabilities of .88 for the ACT subtests and .44 for course grades, correlation coefficients could not be expected to exceed .62.

The strength of the relationship between ACT test scores, high school grades, and freshman course grades will also be influenced by the degree of content overlap among the three measures. Though the ACT tests may not measure all of the knowledge and skills required for a specific college course, it is likely that for many freshman courses the tests measure a majority of the most important/necessary skills and knowledge. This will result in a strong relationship between ACT test scores and students' performance in such courses. If the ACT tests do not directly measure a required skill or knowledge, they may measure a closely-related one; for students in these courses, we could expect a significant relationship between the two sets of skills and/or knowledge.

Multiple R is also influenced by the variability in both the predictors and the criterion; by increasing their heterogeneity, multiple R will increase (Nunnally, 1978). Conversely, if the variability in the predictors or criterion is restricted, then multiple correlations will decrease. In practice, the variability in ACT scores, high school grades, or course grades may be affected by preselection, placement, or college grading practices.

Given a fixed value of multiple R, SEE increases as the criterion standard deviation increases. For criterion/predictor relationships with homoscedastic errors, SEE is not directly affected by changes in the standard deviation of the predictors.

The SRS Summary Tables report a standard deviation of .86 for overall freshman GPA among students nationally. We found that the standard deviations of specific course grades were much larger, with median values of .87 to 1.28 across the 18 course groups. Among the subject areas, mathematics course grades had the largest standard deviations (median values 1.12 to 1.28).

The standard deviation of ACT Composite score in the SRS Summary Tables is 5.64, which is considerably larger than the median standard deviations of 3.59 to 4.89 for the 18 course groups. The mathematics course groups tended to have smaller median ACT Composite score standard deviations (3.59 to 4.54) than those of the other course groups.

The standard deviation of high school average in the SRS Summary Tables is .64, which is also larger than most of the median standard deviations for the 18 course groups (.48 to .65). The mathematics course groups again tended to have smaller high school average standard deviations (.48 to .61).

It appears, therefore, that greater prior selection has occurred for students in the mathematics courses represented in this study than for students in the other course groups. This prior selection may have occurred either through actual placement or through students' self-selection, but in either case, tended to decrease the standard deviation of their ACT scores and high school grades.

In addition, grading standards appear to have been more stringent in mathematics courses than in other courses. As shown in Tables 3 through 6, the median average ACT Composite scores and high school averages for the mathematics course groups were typically higher than those of other course groups. At the same time, the median course grade means for mathematics were typically lower than those of other course groups. The larger mathematics grade standard deviations suggest that the more stringent grading standards are the result of a larger proportion of very low grades and a smaller proportion o middle or average grades, rather than the result of a uniform shift to lower gra es.

The median multiple Rs for some of the mathematics course groups we e smaller than the median multiple Rs for the other course groups. This is probably due, at least in part, to the effects of prior selection, as expressed through smaller deviations of the predictor variables.

The median standard errors of estimate for all of the mathematics course groups were considerably larger than the median standard errors of estimate for the other course groups. This is a direct effect of the much larger course grade standard deviations, the result of more stringent grading.

The ACT Mathematics Usage test is constructed according to the same procedures used for the other subtests; in particular, the same effort is made to ensure a close match between its content and the skills and knowledge required for typical freshman mathematics courses. Moreover, the typical reliability of the ACT mathematics subtest is very similar to that of the other subtests. It is unlikely, therefore, that the lesser predictive accuracy for the mathematics course groups is the result of either the content or the length of ACT mathematics subtest. The lesser predictive accuracy is more likely due to greater prior selection and to the characteristics of the mathematics course grades themselves.

Results for Different Types of Institutions

Mean course grades, mean ACT Composite score, and mean high school average of courses were generally not significantly related to better or worse specific course grade predictions as measured by multiple R. There was a stronger relationship between the standard errors of estimate and mean course grades, mean ACT Composite scores and mean high school averages. Courses in which students had relatively high average ACT Composite scores and high school averages appeared to obtain greater predictive accuracy, as measured by SEE, than courses with low averages. This was particularly the case for Accounting and Analytical Geometry & Calculus grade predictions.

Further analyses revealed that courses whose students had relatively high mean ACT Composite scores tended to have less variation in their grades than did courses with low ACT Composite scores. With similar multiple Rs, as was observed here, one would expect that the SEEs for courses with high mean ACT Composite scores would, as a result, also be smaller.

Implications for Course Placement

Institutions sometimes base their placement decisions on single ACT subtest scores, on the four ACT subtest scores alone, or on high school grades alone. As we have noted earlier, the full eight-variable prediction model (the four ACT subtest scores and four self-reported high school grades combined) should be used to maximize the accuracy of placement decisions.

The degree to which students have been preselected on the basis of ACT test scores and/or high school grades, either for placement purposes or admissions, will affect the predictive accuracy of specific course grade predictions. Preselection typically results in underestimates of the strength of the relationship between the predictors and the criterion in the unselected population.

The multiple Rs and standard errors of estimate reported here do not fully measure the validity of placement decisions for specific courses. As we indicated earlier, this would require knowing the overall failure rate that would occur without course placement, the selection rate for each course, the benefits in making correct placement decisions, and the costs incurred in making incorrect ones. College researchers can make some assumptions about failure and selection rates, though, and can estimate from correlation coefficients the resulting proportions of correct and incorrect decisions.

Finally, one must note that there is variability in the predictive accuracy of specific course grade predictions within each course group, as well as across courses and subject areas. As a result, local course grade prediction equations need to be developed to be assured of maximum predictive accuracy and correct placement decisions

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Appendix A

Taxonomy of Specific Courses Codes

ACT Standard Research Service
Specific Course Grade Prediction Survey

CODE LIST

COURSE CONTENT

ENGLISH:

E1 - Grammar/Linguistics
E2 - Literature (American, English, Classics, etc.)
E3 - Reading
E4 - Speech (public speaking, rhetoric, oral interpretation, etc.)
E5 - Writing (creative, expository, journalism, etc.)
E6 - Other (please specify on questionnaire)

FOREIGN LANGUAGES:

F1 - Chinese
F2 - French
F3 - German
F4 - Italian
F5 - Japanese
F6 - Russian
F7 - Spanish
F8 - Other (please specify on questionnaire)

MATHEMATICS:

M1 - Algebra
M2 - Analytic Geometry
M3 - Arithmetic Skills
M4 - Calculus
M5 - Computer Science/ Numerical Analysis/Graphics*
M6 - Geometry
M7 - Logic
M8 - Statistics/Probability
M9 - Trigonometry
M10 - Other (please specify on questionnaire)
M11 - Pre Calculus*/Finite Math
M12 - Linear Algebra*

SOCIAL STUDIES:

S1 - Anthropology (cultural, physical)
S2 - Archaeology
S3 - Economics
S4 - Geography
S5 - History (American, World, Western Civilizations, etc.)
S6 - Law
S7 - Political Science (world problems, theory, etc)
S8 - Psychology (child, abnormal, adult, etc.)
S9 - Religion
S10 - Sociology
S11 - Other (please specify on questionnaire)
S12 - Intro to Business*/Business*
S13 - Social Welfare*/Social Work

NATURAL SCIENCE:

N1 - Anatomy/Physiology
N2 - Astronomy
N3 - Biology/Life Sciences/Microbiology*
N4 - Botany/Plant Science*
N5 - Chemistry (organic, inorganic, analysis, etc.)
N6 - General Science
N7 - Geology
N8 - Health Sciences (Nursing, Medicine, Pharmacology, Veterinary Medicine, etc.)
N9 - Meteorology
N10 - Physics, Biophysics/Mechanics*
N11 - Zoology
N12 - Other (please specify on questionnaire)
N13 - Physical Science*
N14 - Conservation*/Ecology*
N15 - Engineering*

MISCELLANEOUS:

X1 - Accounting
X2 - Architecture
X3 - Art
X4 - Drama
X5 - Management/ Administration
X6 - Music
X7 - Study Skills
X8 - Teacher Education
X9 - Philosophy*
X10 - Research*/Library Use*
X11 - Navigation*
X12 - Humanities*
X13 - History of Art*
X14 - Agriculture*

DISCIPLINARY EMPHASIS (where applicable)

1 - Agriculture
2 - Business
3 - Engineering
4 - Health Sciences
5 - Other (please specify on questionnaire)
6 - Architecture*
7 - Education*
8 - Technical*

* Added following the survey administration

Appendix B

Cover Letter, Directions, and Questionnaire
for Survey of SRS Users

Date

ACT

Name
Institution name
Address
City, State Zip

Dear-------------:

An important feature of ACT's Standard Research Service (SRS) is the ability to develop prediction equatio s for grades in specific freshman cou.. es, as well as for overall freshman GPA. I note from our records that your institution has utilized this feature of SRS over the past several years. I hope you have found it to be useful in developing course sectioning and placement policies.

We have, in the last several years, received requests for validity data about specific kinds of freshman courses, suc as writing or college algebra or history. We have data in our SRS magnetic tape files on hundreds of specific courses. Unfortunately, the information we collect from colleges when they design their SRS specific course grade predictions is often not informative enough to determine exactly what kind of course is being studied. For example, a college may simple designate its mathematics course as "Mathematics 150" or just "Freshman Math"; we cannot tell just from these names very much about the content of the courses.

To address this need, we have decided to survey SRS participants from the past four years to learn more about the kinds of specific courses they have been using for course grade predictions. I have enclosed a roster that lists the specific courses your institution has studied. Would you please take the time to tell us the content of these courses? Complete, detailed instructions for filling out the forms are enclosed. If you are no longer supervising your institution's participation in SRS, please pass these materials on to the appropriate person.

I know that time is at a premium for all our users, but I do hope you will be able to complete the enclosed form. I am confident that you will find it very easy to fill out. I will send you an advance copy of the results as soon as they are available.

If you have any questions or concerns, please call either Julie Noble at 319/337-1442 or Richard Sawyer at 319/337-1101, collect. On behalf of ACT and the colleges that use the Standard Research Service, thank you in advance for your generous help.

Sincerely,

James Maxey, Director and
Senior Research Scientist
Institutional Services
Research Division

2201 North Dodge Street, P.O Box 168
Iowa City, Iowa 52243
(319) 337-1000

ACT Standard Research Service
Specific Course Grade Prediction Survey

DIRECTIONS

Between 1980 and 1984 your institution participated in ACT's Standard Research Service (SRS). As part of your SRS analyses, you requested the prediction of grades in several of your specific courses. We have listed all these courses on the attached questionnaire.

The first column on the questionnaire is a **Sequence Number**, which we have used to identify your courses. Following the Sequence Number, the **subgroup**, course **name**, **N-count** (sample size) and **SRS subject area** for each course are listed by year. Subgroups are identified either by the letter 'S' (for Summary Group) or by a number between 1 and 9. The SRS subject area is coded as follows: **E** = English, **M** = Mathematics, **S** = Social Studies, and **N** = Natural Sciences. This information was taken directly from your SRS Report(s).

Please begin by writing your name and telephone number in the spaces provided at the top of the questionnaire. (We would like to be able to call you if we need further clarification.) Then, verify the subgroup, course name, N-count, and SRS subject area of each course against the appropriate SRS report for your institution. Finally, for **each course within each year**, please supply the information requested below. (An example has been provided on page 3.)

Course Content

Content Codes

Please refer to the course content code list attached to this survey. Then, circle the appropriate code(s) on the questionnaire that best identify the course content. **Circle all relevant course content codes.** If you circle a code corresponding to "Other", please write a brief description of the course in the space provided.

The course content codes we have provided might not correctly identify the content of a course; if the codes supplied are inappropriate, cross them out. In some cases we could not determine the exact subject area of a course, and so we left the code section blank. In either case, consult the code list and write in the code section all the codes that are appropriate. (Be sure to note the Miscellaneous codes we have provided on the code list.) If you cannot locate an appropriate content code, please write a brief description of the course.

The following sources of information may be helpful in determining the appropriate course content codes:

* College catalog of courses
* Your own internal documents related to SRS
* Departmental personnel

Please try to determine the course content codes for every course listed on the questionnaire, particularly those with nonspecific names (e.g., "English").

Pooled Grades

Colleges often pool the grades of students enrolled in different courses and report them under a single SRS subject area. (For example, the grades of students enrolled in Biology, Chemistry, or Anatomy might be pooled under "Natural Sciences".) If your institution has done this, please circle all the relevant course content codes for all the courses. Then check the "Pooled" column to indicate your data were pooled.

GPAs

Instead of reporting a specific course grade for each student, colleges sometimes report a grade point average (GPA) computed from several courses.

* If a course listed on your questionnaire represents a GPA of more than one related course (e.g., first and second semester English GPA), circle all the relevant course content codes, and check the column labelled "GPA".

* If a course listed on your questionnaire represents an overall GPA of several unrelated courses, leave the course content section blank, and check the column labelled "GPA".

Primary Content

Using the codes you selected for course content, write in the one or two course content codes that best describe the **primary** content of each course.

Placement Level

Colleges often have courses into which students with particular levels of preparation or ability are placed:

*DR - These courses provide skills and information typically acquired by students **before** they enroll at your institution. They are often designated as **Developmental** or **Remedial** courses.

*ST - These courses require skills and information typical of students following the **standard** curriculum sequence at your institution. They are the courses usually taken by most of your students.

*HO - These courses require skills and information **beyond** those of the typical freshman student at your institution. They are often designated as **Honors** courses.

For each course, circle the one code (DR, ST, or HO) that best describes its placement level.

Disciplinary Emphasis

Colleges of Agriculture, Business, Engineering, or Health Sciences frequently offer courses in writing, art, or mathematics with emphasis on the specific college or discipline. The disciplinary emphasis codes have been included to help identify such courses. For example, Business Math may have content similar to that of the typical Algebra I course, and as such, should have similar course content codes. However, because the material in the course emphasizes business applications, "Business" (Code 2) should be indicated as the disciplinary emphasis of the course.

Where appropriate, please circle the code that identifies the disciplinary emphasis of the course. If you select the "Other" category (Code 5) for Disciplinary Emphasis, please write a brief description to clarify the exact nature of the course. **Most courses will not have a disciplinary emphasis and so this area will usually be left blank.**

Uses of SRS Data

We also want to determine how the information in SRS reports is used. An additional question has been included at the end of the questionnaire to address this issue. Please be as specific as possible in identifying your uses of the specific course grade information provided in the SRS report.

A sample questionnaire is provided on the next page to illustrate the steps involved in filling out the questionnaire. If you have additional questions, please call Julie Noble (319/337-1442) or Richard Sawyer (319/337-1101) collect. Please return the questionnaire in the enclosed envelope by November 15, 1985. Thank you very much for your cooperation.

A Sample Questionnaire

John Allen from Congressional College participated in ACT's Standard Research Service in 1980-81. "Freshman English" and "Mathematics" were designated as course grade criteria in the SRS report for his institution. "Freshman English" was identified for the summary group, with an N-count of 200; "Mathematics" was identified for Subgroup 1, with an N-count of 125. The documentation of this information would appear as follows on the questionnaire:

Seq. No.	Year	Sub-group	Course Name	N-Count	SRS Area	Course Content: Codes	Course Content: Check if Pooled	Course Content: Check if GPA	Course Content: Primary Content	Placement Level	Disciplinary Emphasis
1	80-81	S	Freshman English	200	E	E1 E2 E3 E4 E5 E6 Comments:				DR ST ID	1 2 3 4 5
2	80-81	1	Mathematics	125	M	M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 Comments:				DR ST ID	1 2 3 4 5

To determine the content of the course "Freshman English", John Allen referred to internal documents related to the SRS and conferred with the English Department staff. He found that this course was an introductory English course emphasizing English literature, writing, and grammar. The subject matter of the course was predominantly English literature and writing. To complete the questionnaire, John Allen first went to the course content code list, and determined that the appropriate codes for English literature, writing, and grammar were E2, E5, and E1, respectively. He then circled these codes in the course content code section of the questionnaire. The grades reported under "Freshman English" were from students enrolled in a single course; therefore, the "Pooled" and "GPA" columns were left blank. As English literature and writing comprised the primary content of the course, their codes (E2 and E5) were written in the primary content area. As the course was a standard freshman course, "ST" was circled under the placement level section of the questionnaire. The course did not emphasize a specific discipline and so the disciplinary emphasis column was left blank.

The next course is an example of an irregular situation. The second course name listed in the SRS Report for Congressional College was "Mathematics'. Therefore, mathematics codes (M1-M10) were provided in the content code space. John Allen determined from reviewing his internal records that the grades reported in this area were not for a mathematics course at all, but were first-year English GPAs for students enrolled in a two-semester remedial reading and writing program. To complete the questionnaire, John Allen marked out the mathematics content codes we provided and wrote in the English codes E3 and E5, together with an explanation of the situation. The grades were not pooled from students enrolled in different courses, so the "Pooled" column was left blank. As the grades were first year English GPAs, John Allen checked the "GPA" column. The primary content of the course was noted as E3 and E5. The code "DR" was circled in the Placement Level section, as the course was intended for students with reading and writing deficiencies. There was no particular disciplinary emphasis, so this column was left blank.

After completing the specific course grade information, John Allen answered the question on "Uses of SRS Data". SRS information for the course "Freshman English" was used in sectioning and placement at Coı ressional College. Therefore, John Allen circled the "Yes" response to this ‹juestion and circled the Sequence Number (1) of the Freshman English course. SRS information for the remedial reading/writing GPA was not used in sectioning or placement, and so the Sequence Number (2) for this course was not circled.

The completed survey would appear as follows:

ACT Standard Research Service
Specific Course Grade Prediction Survey
Questionnaire

College Code: 9999 | Your Name John Allen

College Name: Congressional College | Phone (319) 337-1000

Seq. No.	Year	Sub-group	Course Name	N-Count	SRS Area	Course Content: Codes	Course Content: Check if Pooled	Course Content: Check if GPA	Course Content: Primary Content	Placement Level	Disciplinary Emphasis
1	80-81	S	Freshman English	200	L	E1 E2 E3 E4 E5 E6 Comments:			E2, E5	DR ST HD	1 2 3 4 5
2	80-81	1	Mathematics	125	M	~~M1 M2 M3 M4 M5 M6 M7 M8 M9 M10~~ E3. E5 Comments: English GPA		✓	E3, E5	DR ST HD	1 2 3 4 5

Uses of SRS Data

Does your institution use SRS course grade information for course sectioning or placement? (Circle one response)

a. Yes. Circle the Sequence Number (first column) of the specific courses listed above that you have used in sectioning or placement.

b. No. What use do you make of SRS data on specific courses? (please be specific)

ACT Standard Research Service
Specific Course Grade Prediction Survey
Questionnaire

College Code:

Your Name

Phone

Seq. No.	Year	Sub-Group	Course Name	N-Count	SRS Area	Course Content: Codes	Check If: Pooled	Check If: GPA	Primary Content	Placement Level	Disciplinary Emphasis
1	81-82	S	ENGLISH	1305	E	E1 E2 E3 E4 E5 E6 Comments:				DR ST HO	1 2 3 4 5
2	81-82	S	MATHEMATICS	1072	M	M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 Comments:				DR ST HO	1 2 3 4 5
3	81-82	S	SOCIAL SCIENCE	1186	S	S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 Comments:				DR ST HO	1 2 3 4 5
4	81-82	S	NATURAL SCIENCE	1251	N	N1 N2 N3 N4 N5 N6 N7 N8 N9 N20 N11 N12 Comments:				DR ST HO	1 2 3 4 5

Uses of SRS Data

Does your institution use SRS course grade information for course sectioning or placement?(Circle one response)

a. Yes. Circle the Sequence Number (first column) of the specific courses listed above that you have used in sectioning or placement.

b. No. What use do you make of SRS data on specific courses? (please be specific)

____

____

____