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Cheng H. Ang
Julie P. Noble

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INCREMENTAL VALIDITY OF ACT ASSESSMENT SCORES AND HIGH SCHOOL COURSE INFORMATION FOR FRESHMAN COURSE PLACEMENT

Cheng H. Ang and Julie Noble

ABSTRACT

This study examined the separate and joint use of high school course grades, course work taken, and ACT Assessment subject area scores for making course placement decisions. The data for the study were obtained from nine institutions through their participation in a pilot study of the ACT Course Placement Service. College courses included were remedial and standard mathematics courses, reading courses, and English courses.

For standard-level courses, the ACT Assessment subject area score, the high school subject area average, and the overall high school average were all effective for making accurate placement decisions, but the ACT Assessment score was the most effective. Using either the ACT Assessment score and high school subject area average jointly, or the ACT Assessment score and overall high school average jointly, improved the accuracy of placement decisions over that obtained by using a single predictor. The number of high school courses taken in a particular subject area was the least effective variable for making placement decisions for standard-level courses.

INCREMENTAL VALIDITY OF ACT ASSESSMENT SCORES AND HIGH SCHOOL COURSE INFORMATION FOR FRESHMAN COURSE PLACEMENT

Although potential uses of ACT Assessment test scores are many, one typical and important use is course placement (i.e., matching entering college students with appropriate instruction). For example, if standard and remedial courses are provided at an institution, students with a small chance of succeeding in a standard course might, on the basis of low ACT Assessment test scores, be either recommended or required to enroll in a remedial course. Because correct or incorrect course placement decisions have important consequences both for students and institutions, the use of test scores and other relevant information for making course placement decisions should be validated.

One way of validating ACT Assessment test scores for making course placement decisions is to verify that the items in the test adequately represent the entering skills and knowledge required for success in the course of interest (content validation). The ACT Assessment is intended to measure the skills and knowledge students have learned in their high school college-preparatory classes. It is also designed to measure important and essential academic skills and knowledge needed for success in a broad variety of college freshman courses (ACT, 1989). The particular degree of content fit between the ACT Assessment and freshman courses, however, may vary from institution to institution, depending on the contents of specific courses. Determining the content fit between the ACT Assessment and a particular college course is therefore best carried out by individual institutions.

Given that the contents of the ACT Assessment are related to academic success in college, and assuming that college course grades are reliable and valid measures of skills and knowledge taught in the courses, then there should be a statistical relationship between ACT Assessment test scores and college course grades: higher-scoring students should be more successful than lower-scoring students in the course. If studies provide empirical evidence for this statistical relationship, then it is appropriate to consider ACT Assessment test scores for making course placement decisions.

A study was conducted in 1989-90 (ACT, 1991) to determine the effectiveness of the enhanced ACT Assessment for course placement. The enhanced ACT Assessment, implemented in October, 1989, incorporated recent changes in secondary and postsecondary curricula. The results of the study supported the use of enhanced ACT Assessment scores and subscores for placement in college freshman English and mathematics courses. However, the study was limited to using only ACT Assessment test scores as predictor variables.

Although the ACT Assessment is intended to measure the relevant academic skills and knowledge needed to succeed in freshman college courses, it may not measure all the skills and knowledge needed. Because courses taken in high school provide essential academic skills and knowledge needed for success in freshman college courses, high school grades and course work taken may also provide information, separately or jointly with ACT Assessment test scores, for making course placement decisions. A strong predictive relationship between ACT Assessment test scores, high school grades, the number of courses taken in high school, and college freshman grades may facilitate making correct course placement decisions by colleges (e.g., Noble, 1991). Unlike the ACT Assessment, however, high school courses taken and grades received are not standardized measures, because the contents of the high school courses and the grading policies may differ from high school to high school. This study examined the effectiveness of high school grades, course work taken, and enhanced ACT subject area scores for making course placement decisions.

Placement Validity Indices

ACT recently developed placement validity indices, based on logistic regression methods, for determining course placement effectiveness (Sawyer, 1989). Logistic regression can be used to estimate the conditional probability that a student would be successful in a course, given the student's score on the predictor variable. From the conditional probabilities of success, placement validity indices can be estimated. These validity indices can provide information about cutoff scores used to place students into particular courses and the probable results of modifying such cutoff scores. Unlike correlational analyses, this method does not require strong distributional assumptions, and is not limited to linear relationships between test scores and course grades (Houston, 1992).

The conditional probabilities of success estimates generated from logistic regression analysis are based on the test scores and course grades of students who enrolled in a particular course of interest. Placement validity indices, however, pertain to the larger range of students who could have taken the course; i.e., the placement group. Placement validity indices are computed for these students through the conditional probabilities of success, given a specific cutoff score. There are four possible estimated outcomes for a given cutoff score:

A. *True positive*: the student is placed in the standard course and is successful (Correct decision).
B. *False positive*: the student is placed in the standard course and is unsuccessful (Incorrect decision).
C. *True negative*: the student is placed in a lower-level course and would have been unsuccessful in the standard course (Correct decision).
D. *False negative*: the student is placed in a lower-level course, but would have been successful in the standard course (Incorrect decision).

The ratio of (A+C)/(A+B+C+D) is the proportion of students for whom correct decisions would be made using the corresponding cutoff score and success criterion. The ratio is referred to as the accuracy rate (AR). The value of AR depends on the cutoff score, the distribution of scores, and the statistical relationship between the test score and the success criterion. The AR attains a maximum value at or around a conditional probability of success of .50; the cutoff score corresponding to this probability is thus referred to as the optimum cutoff score.

AR can also be influenced by the overall success rate, the ratio of A/A+B. For example, if the overall success rate in the standard course is near 0 or 1, then a high AR can be achieved simply by placing all students in either the remedial or standard course. This issue is addressed by another validity statistic, delta accuracy rate (ΔAR). ΔAR is equal to the difference between the maximum AR value and the "base line" AR value, which is the proportion of correct decisions associated with using the lowest possible score as a cutoff score. This statistic is an indicator of how effective the predictor variable would be for placing some students, and not others, in the standard course, compared to placing all students in the course.

Data

Criterion Variables

The data for the study were obtained from nine four-year public institutions through their participation in a pilot study of the ACT Course Placement Service. The criterion variables were based on grades in mathematics, English, and reading courses. The course grades from the institutions were scaled from A(4) to F(0); courses graded as satisfactory or unsatisfactory (S/U) were not included in the study. Two definitions of course success were studied: B or higher and C or higher grades in the course. Students were considered successful if they achieved the specified success criterion.

For each course, only those institutions with sample sizes of at least 25 were included. There were 13 remedial mathematics, 29 standard mathematics, 15 remedial English/reading, and 15 standard English/reading courses across the nine institutions. Institutions differed in their definitions of the levels of courses (e.g., some lower-level courses were defined as developmental, others as remedial or college-preparatory). In this study, remedial courses consisted of lower-level courses where no credit was given to meet the requirements of a college degree program. Standard courses, however, were those courses that could be used to satisfy the requirements of a college degree program.

Because some schools use course placement cutoff scores to place students for certain remedial courses (eg., Intermediate Algebra), remedial courses were included in this study to determine the accuracy of test scores, course grades, and courses taken for placement into remedial courses.

Predictor Variables

Student records containing course grades were matched with the ACT Assessment history files to obtain their ACT Assessment test scores. The ACT Assessment scores included were the English, Reading, and Mathematics scores, all of which are reported on a score scale of 1 to 36 (ACT, 1989). Information on courses taken and grades earned was obtained from the High School Course Grade Information Section (CGIS) of the ACT Assessment registration folder (ACT, 1989). Grades were scaled from A(4) to F(0).

The predictor variables were classified into two categories: ACT Assessment test scores and CGIS variables. The ACT Assessment test scores used as predictor variables were ACT Mathematics score for mathematics courses, ACT English score for English courses, and ACT English and ACT Reading scores for reading courses. The CGIS variables used were average grade in English, average grade in mathematics, average grade for the 30 courses reported in the CGIS, the number of high school courses taken in English, and the number of high school courses taken in mathematics. These variables were used separately and jointly to predict college course success.

The Estimation Sample and Placement Group

Two types of samples were included in this study: the estimation sample and the placement group. The estimation sample consisted of students who completed the college course of interest with a grade of A-F, and who had the relevant ACT Assessment test score and high school CGIS information. The estimation sample was used to develop the logistic regression model for each course. The sample sizes for the estimation samples for all courses can be found in Column 3 of Table 4. Sample sizes ranged from 26 to 2109; typical sample sizes exceeded 100 students for all courses.

The placement group for each institution consisted of students with grade(s) in any courses from a particular subject area, and who had the relevant ACT Assessment test scores and high school CGIS information. The placement group was used to calculate the estimated placement validity indices. For mathematics courses (remedial and standard), the sample sizes ranged from 290 to 1,960 for the subject area placement group, with a typical sample size of 720 students. For English and reading courses (remedial and standard), the sample sizes ranged from 197 to 2,652, with a typical sample size of 789 students.

Method

Selection of Predictor Variable Models

Descriptive statistics were computed for course grades and for predictor variables that were statistically significantly ($p < .05$) associated with course grades. All statistics were first calculated by institution. Distributions of means and standard deviations were then summarized across the nine institutions, using minimum, median, and maximum values.

For each institution, simple correlations were calculated between all predictor variables and course grades ($n > 25$). The only predictor variables retained for further analysis were those that were statistically significantly ($p < .05$) associated with college course grades. ACT Reading scores were subsequently dropped as predictor variables, because they were not statistically significantly associated with the remedial reading course grades included in this study.

Multiple predictor models were then developed using the statistically significant single predictor variables. However, the multiple predictor models were retained only when both of the predictor variables statistically significantly associated with course grades. Table 1 shows the predictor variables examined, and the eight prediction models that were evaluated for each course. The number of courses with statistically significant course grade/predictor variable correlations are reported in here; course correlations for each institution can be obtained from the authors.

For all predictor variable models (Models 1-8), the logistic regression equation, the regression weight for each predictor variable, and the conditional probabilities of success were computed using the data for students who completed each course (estimation sample). If a predictor model (Models 1-8) was statistically significant ($p < .05$), the regression weights and conditional probabilities of success were applied to the placement group data to compute estimated placement validity indices.

The number of courses across institutions with statistically significant logistic regression models ($p < .05$) were compared by predictor model, subject area, and course level. A predictor model that was statistically significantly associated with course success for the greater number of courses across institutions was determined to be more effective in making placement decisions than models statistically significantly associated with course success for fewer courses.

Optimum Cutoff Scores

Using the conditional probabilities of success from the statistically significant logistic regression models, optimum cutoff scores were identified for every course and institution. These cutoff scores were the scores on the predictor variables corresponding to a .50 conditional probability of success, and were determined for both definitions of course success (B or higher and C or higher). Optimum cutoff scores were then summarized across institutions (minimum, median, and maximum values) for two subject areas and two levels of courses: remedial mathematics, standard mathematics, remedial English, and standard English courses. For standard mathematics courses, minimum, median, and maximum optimum cutoff scores were also computed for Analytic Trigonometry, College Algebra, and Calculus & Geometry.

Placement Validity Indices

For each statistically significant prediction model ($p < .05$), accuracy rates (AR) were computed using the optimum cutoff score (at approximately .50 conditional probability of success) and the relevant placement group. Delta accuracy rates (ΔAR) were also computed, using both the B or higher and C or higher criteria for every course and institution.

Although all statistically significant ($p < .05$) models were included in the computation of placement validity indices, models that yielded a minimum conditional probability of success greater than .50, or models that yielded a maximum conditional probability of success less than .50, were not included in the computation and comparison of placement validity indices.

Comparison of Placement Models

The effectiveness of a placement model was examined relative to the results for the ACT Assessment score model for each course. The number of courses for which the ACT Assessment score model was more effective than the other predictor models (Models 2-8), or vice-versa, was first examined using ΔARs for each course level and subject area across the nine institutions. A placement model with higher ΔARs would be more effective in making placement decisions than models with lower ΔARs.

Given the AR and ΔAR for each model and course, minimum, median, and maximum AR and ΔAR were calculated across the nine institutions for each model, course level, and subject area. Median ARs and ΔARs were then compared across models.

Results

Correlations

Tables 2 and 3 show the number of courses, by course level and subject area, for which at least one predictor variable was statistically significantly ($p < .05$) correlated with course grade. For remedial mathematics courses, for example, at least one predictor variable was statistically significantly ($p < .05$) associated with course grades for 10 of 13 courses. For standard mathematics courses, at least one predictor variable was statistically significantly associated with course grades for 28 of 29 courses.

Descriptive Statistics

Table 4 contains descriptive statistics, summarized across institutions, for course grades and predictor variables. Only those college courses that were statistically significantly associated with at least one predictor variable, and predictor variables that statistically significantly correlated with college courses, are shown. The minimum and maximum values represent the range of values obtained across courses, and the median values represent the typical value for a course. In general, standard courses had higher median mean course grades and predictor variable values than did remedial courses. The standard courses also had larger median sample sizes than the remedial courses, with standard English courses being the largest. There was, however, no consistent pattern of differences in the standard deviations.

Logistic Regression Analysis

Statistically significant predictor variables (from the correlational analysis) also resulted in statistically significant ($p < .05$) logistic regression models, except for three mathematics courses: Model 4 for one remedial mathematics course and Model 2 for two standard mathematics courses. Table 5 shows the overall number of courses, across institutions, with statistically significant ($p < .05$) models, by predictor model, subject area, and course level. For standard and remedial English courses, Model 1 was statistically significant as often or more often than other single predictor models (Models 1-4). In contrast, for remedial mathematics, Model 3 was statistically significant more frequently than the other models. Among the combined models, Models 5 and 6 were most likely to be statistically significant.

The B or higher and C or higher columns in Table 5 show the number of courses used for comparing prediction models. Because only those courses with a minimum conditional probability of success less than .50 and a maximum conditional probability of success greater than .50 were included in this comparison, the number of courses in these columns are equal to or less than the overall number of courses with statistically significant ($p < .05$) models.

Cutoff Score

Tables 6 through 10 show the optimum cutoff scores and placement validity indices for the B or higher and C or higher criteria for remedial and standard mathematics courses. The third, fourth, and fifth columns in each table show the minimum, median, and maximum optimum cutoff scores associated with a .50 conditional probability of success for all models. As expected, the criterion of B or higher resulted in higher optimum cutoff scores than the criterion of C or higher for all models studied, and standard courses had higher optimum cutoff scores than remedial courses. In addition, as the courses increased in difficulty and complexity (e.g., Analytical Trigonometry or College Algebra to Calculus and Geometry), the optimum cutoff scores also increased.

The results for remedial and standard English courses are shown in Tables 11 and 12. As for the mathematics courses, the criterion of B or higher resulted in higher optimum cutoff scores than did the criterion of C or higher for all models studied, and standard courses had higher cutoff scores than remedial courses. Further, the optimum high school average cutoff scores for English courses were lower than those for mathematics courses.

Effectiveness of Placement Models

The effectiveness of the placement models was examined in two ways, and the results are shown in Tables 6 through 12. First, the minimum, median, and maximum AR and ΔAR values were computed across institutions for each model, for each course level and subject area. These results are shown in Columns 6 through 11. Second, the number of courses for which the ACT Assessment score model had greater ΔARs than the other models was calculated. These values are reported in Column 12. The number of courses for which the ACT Assessment score model had lower ΔARs are reported in Column 13.

Column 14 shows the total number of courses in each model (Models 2-8) used for comparison with ACT Assessment score model. Note that the total number of courses compared could be lower than the total number of courses used in the computation of median values (Table 5); this is because ACT Assessment score model might not exist for all courses. For example, eight remedial mathematics courses (Table 6) were used in computing median values for Model 2, but only six of these eight courses had corresponding ACT Assessment score models; therefore, only six courses could be compared.

Remedial mathematics. As shown in Table 6, although the largest median AR was associated with the ACT Assessment score model using the B or higher criterion (Model 1; median AR = .71), the largest median ΔAR was associated with the high school average model (Model 3; median ΔAR = .20). In terms of the number of courses for which Model 1 had greater ΔARs, Model 1 did not result in greater ΔARs for most of the courses, when compared to Models 2, 3, and 4.

Although the combined models (except model 8) had larger median AR values than the ACT Assessment score model for the B or higher success criterion, only Model 8 had a larger median ΔAR than the ACT Assessment score model. In terms of the number of courses for which the combined models had greater ΔARs than Model 1, Model 5 had greater ΔARs for 4 of the 7 courses, Model 6 had greater ΔARs for 3 of the 7 courses, Model 7 had greater ΔARs for 2 of the 3 courses, and Model 8 had greater ΔARs for none of the three courses.

The results for the criterion of C or higher were similar to the criterion of B or higher, except that the ACT Assessment score model resulted in either the same or lower median ΔARs relative to the other models.

Standard mathematics. For standard mathematics courses (Table 7), using the B or higher success criterion, Model 1 was the most effective single predictor model, with median AR and ΔAR values of .72 and .35, respectively. In terms of the number of courses for which Model 1 had greater ΔARs, when compared to Models 2, 3, and 4, Model 1 had greater ΔARs for 15 of the 25 courses, 16 of the 24 courses, and 12 of the 14 courses, respectively.

In general, the combined models were more effective than single predictor models (except model 8), as shown by consistently larger median ΔARs for the B or higher success criterion. In terms of the number of courses for which the combined models had greater ΔARs than Model 1, Models 5, 6, and 7 had greater ΔARs for most of the courses (about 80-90% of the courses). Model 8, however, had greater ΔARs for only four of the nine courses.

The results for the criterion of C or higher were similar to those for the criterion of B or higher, except that median ARs were the same for Models 1 and 2 (AR= .74).

Analytic Trigonometry, College Algebra, and Calculus & Geometry. The results for Analytic Trigonometry, College Algebra, and Calculus & Geometry are shown in Tables 8 through 10. The results were similar to those for the standard mathematics courses as a whole (Table 7) using both the B or higher and C or higher criteria. The ACT Assessment score model was the most effective single predictor model in terms of AR and ΔAR, and the combined models were more effective than single predictor models. In general, for all models, Calculus & Geometry had higher median ARs and ΔARs, compared to those for Analytic Trigonometry and College Algebra (except when compared to Analytic Trigonometry using a criterion of C or higher). College Algebra also had higher median ΔARs than those for Analytic Trigonometry across all models, using the B or higher success criterion.

Remedial English. As shown in Table 11, using a success criterion of B or higher, Model 1 resulted in the largest median AR, but the smallest median ΔAR, relative to the other single predictor models. In terms of the number of courses for which Model 1 had greater ΔARs, when compared to Models 2 and 3, Model 1 had lower ΔARs for all four courses.

The combined models (Models 5 & 6) resulted in equivalent or larger median ARs and ΔARs than Model 1, and Models 5 and 6 had more courses for which they had greater ΔARs than did Model 1 (2 vs. 1).

The results for the criterion of C or higher were similar to those for the criterion of B or higher, except that Model 1 resulted in a larger median AR than the other single predictor models. Median ΔAR was .00 for all models. In addition, the combined models (Models 5 & 6) resulted in slightly larger median ARs, but not median ΔARs, as compared to Model 1.

Standard English. As shown in Table 12, for standard English courses and the criterion of B or higher, Model 1 resulted in the smallest median AR, but the largest median ΔAR, relative to the other single predictor models. In terms of the number of courses for which Model 1 had greater ΔARs, when compared to Models 2 and 3, Model 1 had more courses for which it had greater ΔARs (6 and 5 of the 11 courses, respectively).

The combined models (Models 5-7) also resulted in larger median ΔARs than the ACT Assessment score model. In terms of the number of courses for which the combined models had greater ΔARs, Models 5 and 6 had greater ΔARs than Model 1 for five and six of the nine courses, respectively.

The results for the criterion of C or higher were similar to those for the criterion of B or higher, except that Model 1 resulted in an equivalent or a larger median AR and ΔAR values than the other single predictor models. Also, the combined models (Models 5 & 6) did not result in larger median ARs, as compared to Model 1.

Across all models, even though the results of this study showed that in general, using a criterion of B or higher resulted in more accurate placement decisions (as measured by ΔAR) than the criterion of C or higher, the criterion of C or higher did appear useful when making placement decisions for higher-level and more difficult courses. For example, the median ΔAR for College Calculus and Geometry was larger than that for remedial mathematics courses. This is because for lower-level courses, a large majority of students earned a C or higher grade, regardless of their test scores. For the higher-level courses, however, a smaller proportion of students earned a C or higher grade, resulting in better prediction.

Discussion

For standard courses, the ACT Assessment score model, the high school subject area average model, and the high school average model were similar in terms of the number of courses for which the models were statistically significant (based on logistic regression analyses). For the statistically significant models for standard courses, the ACT Assessment score model, the high school subject area average model, and the high school average model were generally effective placement models. The ACT Assessment score model was more effective than the high school subject area average model or the high school average model. The high school course work model (Model 4), however, was relatively less effective, both in terms of the number of courses for which the models were statistically significant and the number of courses with greater ΔARs.

Among the combined models for standard courses, the combined ACT Assessment score and high school subject area average model, and the combined ACT Assessment score and high school average model, had the largest number of courses for which the models were statistically significant. In addition, based on the number of courses with greater ΔAR, the combined predictor models of ACT Assessment score and high school subject area average, or ACT Assessment score and high school average, improved the accuracy of placement decisions over the ACT Assessment score model. Compared to these combined models (Models 5 & 6), the combined ACT Assessment score and course work model and the combined high school subject area average and course work models were not as effective, both in terms of the number of courses for which the models were statistically significant and the number of courses with greater ΔARs.

For remedial English, the ACT Assessment score model resulted in the largest number of courses for which it was a statistically significant predictor of course success. For remedial mathematics, however, the high school average model had the largest number of courses for which it was statistically significant. With few exceptions, ARs across the models for the remedial courses were about the same as those for the standard courses; ΔARs, however, were generally lower for remedial courses. In contrast, based on the number of courses with greater ΔARs, the ACT

Assessment score model was not as effective as the high school subject area average or the high school average model in making placement decisions for remedial mathematics and English courses. For the combined models, the combined ACT Assessment score and high school subject area average model and the combined ACT Assessment score and high school average model only slightly improved accuracy over the ACT Assessment score model; however, they were less accurate than those for the standard courses.

The results of this study suggest that the ACT Assessment score model was more effective for placement into standard courses than into remedial courses. The differences in effectiveness between standard courses and remedial courses might be attributed to the fact that the ACT Assessment is intended to measure skills and knowledge needed for standard college course work. Thus, the content match between the ACT Assessment tests and remedial course work may be weaker than the match between ACT Assessment test content and standard course work.

As expected, using the criterion of B or higher typically resulted in higher optimum cutoff scores than the criterion of C or higher for all courses studied. Standard courses, on average, also had higher optimum cutoff scores than remedial courses. Further, for mathematics courses, as the courses increased in difficulty and complexity (e.g., Intermediate Algebra to Calculus and Geometry), the optimum cutoff score also increased.

Although the results of this study showed that the criterion of B or higher was more useful than the criterion of C or higher for making placement decisions, the criterion of C or higher could be useful for making placement decisions for higher-level and more difficult courses, such as College Calculus & Geometry. This conclusion is tentative, however, because there were a large number of lower-level courses (using the criterion of C or higher) whose minimum conditional probability of success was greater than .50, and thus were dropped from the study.

Conclusions

For standard courses, ACT Assessment subject area scores, high school grade average, and high school subject area grade averages were effective in making placement decisions, but ACT Assessment subject area scores were the most effective. The combined models were more effective than the single predictor models. Course work models were less effective in predicting college freshman grades than were ACT Assessment subject area scores, high school grade average, or high school subject area grade average models. These findings are consistent with previous research, such as Noble (1991), where combined prediction models using ACT Assessment scores and high school subject area grade averages increased prediction accuracy over using ACT Assessment scores or high school subject area grade averages alone, and high school course work taken was not as effective in predicting college grades. The results of this study are also consistent with other placement accuracy results (ACT, 1991), supporting the use of ACT Assessment scores for placement in freshman English and mathematics courses.

The results of this study were based on data from nine institutions, and thus cannot be generalized to all colleges requiring course placement decisions. In addition, some courses had small sample sizes, which could influence the accuracy of these results.

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Table 1

Models for Course Placement

Model	Description
1	ACT Assessment score in corresponding subject area (Mathematics or English)
2	High School Subject Area Average (Mathematics or English)
3	High School Average (30 high school courses)
4	High School Course Work (Number of high school courses taken in corresponding subject area)
5	Models 1 and 2 combined
6	Models 1 and 3 combined
7	Models 1 and 4 combined
8	Models 2 and 4 combined

Table 2

Mathematics Courses With Grades Statistically Significantly Correlated With At Least One Predictor Variable

Title	No. of remedial courses		No. of standard courses	
	Stat. sig.	Non-stat. sig.	Stat. sig.	Non-stat. sig.
Arithmetic of Ratio, Percent, Decimals, and Measurement	0	2		
Basic of Algebra / Elementary Algebra / Beginning Algebra	4	0		
Introduction to College Mathematics / Developmental Mathematics / Basic Mathematics / Basic Concept Mathematics	5	1		
Introduction to Statistics			1	0
General Mathematics			1	0
Mathematics for Technical Students			1	0
Mathematics for Business and Economics			1	0
Mathematics for Elementary Teacher			1	0
Basic Calculus / Precalculus			2	0
College Mathematics			1	0
Intermediate Algebra	1	0	3	0
Analytical Trigonometry / Trigonometry / Algebra and Trigonometry			4	0
College Algebra / Algebra			9	0
Calculus and Analytical Geometry / Calculus I / Applied Calculus			4	1
Total	10	3	28	1

Note. All courses had a sample size of at least 25.

Table 3

English and Reading Courses With Grades Statistically Significantly Correlated With At Least One Predictor Variable

Title	No. of remedial courses		No. of standard courses	
	Stat. sig.	Non-stat. sig.	Stat. sig	Non-stat. sig.
Communication Skills / English Skills	2	1		
Introduction to College English / Composition	1	1		
Developmental Writing / Basic Writing	5	1		
Developmental Reading	2	0		
Remedial English	2	0		
College English/ College Writing / Varieties of Writing / English Composition / Honors English Composition			14	0
Reading			1	0
Total	12	3	15	0

Note. All courses had a sample size of at least 25.

Table 4

Distributions of Descriptive Statistics for Course Grades and Statistically Significant Predictor Variables (Models 1-4)

College Course type	Quantile	College course grade			ACT subject area score (Model 1)			High school subject area grade (Model 2)			High school subject average (Model 3)			Number of high school courses taken (Model 4)		
		Student N	Mean	SD	Student N	Mean	SD	Student N	Mean	SD	Student N	Mean	SD	Student N	Mean	SD
Remedial Mathematics	Min	72	1.38	1.08	72	14.9	1.5	72	2.05	0.66	72	2.31	0.41	72	0.04	0.81
	Med	133	1.96	1.30	155	16.4	2.2	155	2.27	0.75	133	2.72	0.50	133	2.85	0.99
	Max	235	2.87	1.52	235	20.4	3.0	235	2.51	0.82	235	3.01	0.56	235	3.69	1.13
	Courses	10			8			8			10			8		
Standard Mathematics	Min	26	1.01	0.94	44	17.1	1.6	26	2.50	0.44	26	2.57	0.40	50	3.00	0.90
	Med	196	2.15	1.23	196	21.3	3.1	189	3.00	0.62	203	3.15	0.48	279	3.85	1.00
	Max	826	3.34	1.62	826	27.7	3.6	826	3.60	0.79	826	3.54	0.60	826	4.29	1.18
	Courses	28			27			28			27			14		
Remedial English	Min	33	1.76	0.88	48	11.8	1.8	33	2.14	0.06	33	2.23	0.05	--	--	--
	Med	102	2.08	1.10	110	14.4	2.1	119	2.29	0.58	129	2.34	0.48	--	--	--
	Max	172	2.67	1.62	172	16.8	2.7	172	2.72	0.65	172	2.72	0.54	--	--	--
	Courses	12			9			8			8					
Standard English	Min	34	1.81	0.59	46	18.0	3.0	37	2.66	0.44	37	2.60	0.34	34	3.82	0.39
	Med	405	2.72	1.01	405	22.0	3.3	462	3.07	0.58	405	2.99	0.49	34	3.82	0.39
	Max	2109	3.45	1.32	2109	27.1	4.7	2109	3.70	0.69	2109	3.70	0.61	34	3.82	0.39
	Courses	15			13			12			12			1		

Table 5

Number of Courses with Statistically Significant Logistic Regression Models Across Institutions by Model, Subject Area, and Course Level

Model	Number of remedial mathematics courses			Number of standard mathematics courses			Number of remedial English courses			Number of standard English courses		
	With statistically significant predictors	Used for computation		With statistically significant predictors	Used for computation		With statistically significant predictors	Used for computation		With statistically significant predictors	Used for computation	
		B or higher	C or higher		B or higher	C or higher		B or higher	C or higher		B or higher	C or higher
1	8	8	8	27	27	27	9	8	5	13	12	5
2	8	8	7	26	25	26	8	7	6	12	12	4
3	10	9	9	27	25	27	8	7	5	12	11	4
4	7	6	6	14	14	13	0	0	0	1	0	0
5	7	7	7	21	21	21	4	3	3	9	9	3
6	7	7	7	22	22	22	4	3	2	9	9	3
7	3	3	3	10	10	8						
8	3	3	3	10	9	10						

Note. Number of courses used for computation refers to the number of courses with minimum conditional probability of success less than .50 or maximum conditional probability of success greater than .50. These courses were used in the computation of minimum, median, and maximum placement validity indices.

Table 6

Comparison of Models Across Institutions for All Remedial-Level Mathematics Courses

Success criterion	Model	Optimum cutoff score			Maximum AR			Maximum ΔAR			Number of courses where ΔAR was greater for		Total number of courses compared
		Min	Med	Max	Min	Med	Max	Min	Med	Max	Model 1	Models 2-8	
B or higher	1	14.0	19.5	22.0	.65	.71	.90	.00	.16	.50			
	2	1.3	2.8	3.3	.54	.64	.79	.00	.09	.23	0 (1)	5	6
	3	2.4	3.1	3.9	.62	.67	.79	.01	.20	.49	1 (0)	7	8
	4	3.0	4.0	6.0	.59	.63	.67	.04	.18	.29	0 (0)	5	5
	5				.71	.73	.93	.01	.14	.47	3 (0)	4	7
	6				.71	.72	.93	.01	.15	.48	3 (1)	3	7
	7				.70	.74	.76	.05	.15	.17	0 (1)	2	3
	8				.62	.69	.69	.05	.18	.20	0 (3)	0	3
C or higher	1	10.0	15.5	18.0	.67	.76	.97	.00	.01	.15			
	2	0.3	2.0	2.7	.61	.70	.82	.00	.02	.10	2 (3)	1	6
	3	1.1	2.2	3.0	.65	.70	.92	.00	.02	.13	1 (3)	4	8
	4	1.0	2.5	4.0	.57	.67	.70	.00	.02	.08	1 (2)	2	5
	5				.71	.79	.98	.00	.03	.17	1 (2)	4	7
	6				.74	.79	.98	.00	.02	.19	1 (2)	4	7
	7				.77	.79	.80	.01	.01	.04	0 (1)	2	3
	8				.71	.74	.75	.01	.01	.05	0 (3)	0	3

Note. 1. The values in parenthesis refer to the number of courses having the same ΔAR.
2. AR = accuracy rate and ΔAR = delta accuracy rate.

Table 7

Comparison of Models Across Institutions for All Standard-Level Mathematics Courses

Success criterion	Model	Optimum cutoff score			Maximum AR			Maximum ΔAR			Number of courses where ΔAR was greater for		Total number of courses compared
		Min	Med	Max	Min	Med	Max	Min	Med	Max	Model 1	Models 2-8	
B or higher	1	18.0	22.0	29.0	.61	.72	.88	.04	.35	.76			
	2	2.0	3.3	4.0	.59	.68	.76	.06	.29	.46	15 (4)	6	25
	3	2.1	3.4	3.8	.62	.69	.76	.04	.27	.50	16 (2)	6	24
	4	3.0	5.0	7.0	.57	.64	.86	.01	.28	.72	12 (1)	1	14
	5				.68	.75	.92	.05	.40	.76	0 (3)	18	21
	6				.69	.76	.92	.08	.42	.75	1 (1)	20	22
	7				.69	.74	.89	.05	.40	.77	1 (1)	8	10
	8				.67	.70	.75	.08	.30	.47	4 (1)	4	9
C or higher	1	12.0	18.0	25.0	.64	.74	.90	.00	.06	.55			
	2	0.5	2.2	3.6	.61	.74	.89	.00	.03	.50	12 (7)	7	26
	3	1.7	2.6	3.7	.64	.73	.89	.00	.02	.50	14 (5)	7	26
	4	1.0	3.0	6.0	.61	.67	.88	.00	.03	.45	12 (1)	0	13
	5				.66	.76	.91	.01	.10	.63	0 (1)	20	21
	6				.67	.76	.91	.00	.12	.63	1 (3)	18	22
	7				.67	.70	.90	.00	.09	.56	0 (1)	7	8
	8				.65	.69	.90	.00	.05	.20	2 (3)	5	10

Note. 1. The values in parenthesis refer to the number of courses having the same ΔAR.
2. AR = accuracy rate and ΔAR = delta accuracy rate.

Table 8

Comparison of Models Across Institutions for Analytic Trigonometry

Success criterion	Model	Optimum cutoff score			Maximum AR			Maximum ΔAR			Number of courses where ΔAR was greater for		Total number of courses compared
		Min	Med	Max	Min	Med	Max	Min	Med	Max	Model 1	Models 2-8	
B or higher	1	19.0	21.5	24.0	.66	.69	.74	.11	.24	.42			
	2	2.0	3.1	3.5	.66	.71	.75	.07	.15	.46	1 (1)	2	4
	3	2.1	3.2	3.4	.65	.69	.74	.04	.14	.38	3 (1)	0	4
	4	3.0	4.0	5.0	.57	.59	.61	.01	.11	.21	2 (0)	0	2
	5				.70	.77	.82	.17	.38	.54	0 (0)	4	4
	6				.69	.75	.82	.16	.37	.50	0 (0)	4	4
C or higher	1	15.0	17.0	19.0	.64	.76	.81	.00	.06	.19			
	2	1.5	2.0	2.8	.70	.80	.81	.01	.02	.19	1 (1)	2	4
	3	1.7	2.4	2.8	.67	.80	.81	.00	.01	.11	1 (3)	0	4
	5				.72	.80	.81	.03	.17	.37	0	4	4
	6				.69	.79	.81	.02	.13	.36	0	4	4

Note. 1. The values in parenthesis refer to the number of courses having the same ΔAR.
2. AR = accuracy rate and ΔAR = delta accuracy rate.

Table 9

Comparison of Models Across Institutions for College Algebra

Success criterion	Model	Optimum cutoff score			Maximum AR			Maximum ΔAR			Number of courses where ΔAR was greater for		Total number of courses compared
		Min	Med	Max	Min	Med	Max	Min	Med	Max	Model 1	Models 2-8	
B or higher	1	20.0	23.0	29.0	.61	.70	.88	.07	.35	.76			
	2	2.7	3.3	4.0	.62	.68	.73	.07	.27	.46	5 (2)	1	8
	3	3.0	3.3	3.5	.65	.68	.75	.08	.26	.50	5 (0)	3	8
	4	4.0	5.0	7.0	.60	.65	.86	.03	.28	.72	6 (0)	0	6
	5				.72	.74	.88	.08	.40	.76	0 (1)	6	7
	6				.73	.76	.84	.08	.42	.67	1 (0)	6	7
	7				.71	.74	.89	.24	.42	.77	0 (0)	5	5
	8				.69	.71	.73	.23	.37	.40	2 (1)	2	5
C or higher	1	12.0	16.0	24.0	.65	.71	.90	.00	.03	.51			
	2	1.3	1.6	3.6	.65	.72	.89	.00	.03	.50	4 (4)	1	9
	3	1.9	2.3	3.7	.66	.72	.89	.00	.02	.50	4 (2)	3	9
	4	1.0	2.5	6.0	.62	.69	.88	.00	.02	.45	5 (1)	0	6
	5				.69	.76	.91	.01	.10	.57	0 (0)	7	7
	6				.70	.74	.91	.00	.01	.42	1 (1)	5	7
	7				.68	.70	.79	.04	.12	.56	0 (0)	5	5
	8				.67	.70	.73	.05	.07	.11	1 (1)	2	4

Note. 1. The values in parenthesis refer to the number of courses having the same ΔAR.
2. AR = accuracy rate and ΔAR = delta accuracy rate.

Table 10

Comparison of Models Across Institutions for Calculus and Geometry

Success criterion	Model	Optimum cutoff score			Maximum AR			Maximum ΔAR			Number of courses where ΔAR was greater for		Total number of courses compared
		Min	Med	Max	Min	Med	Max	Min	Med	Max	Model 1	Models 2-8	
B or higher	1	26.0	26.5	29.0	.72	.80	.88	.39	.55	.71			
	2	3.3	3.6	3.8	.64	.71	.76	.24	.35	.45	4 (0)	0	4
	3	3.3	3.6	3.7	.63	.71	.72	.21	.34	.40	4 (0)	0	4
	5				.74	.83	.92	.43	.59	.75	0 (0)	2	2
	6				.73	.80	.92	.41	.54	.75	0 (0)	3	3
C or higher	1	19.0	21.0	25.0	.61	.75	.81	.05	.15	.55			
	2	1.9	2.4	3.3	.72	.74	.77	.01	.05	.30	3 (0)	1	4
	3	2.2	2.6	3.3	.71	.74	.79	.00	.03	.23	4 (0)	0	4
	5				.70	.80	.89	.01	.37	.63	0 (0)	2	2
	6				.69	.75	.89	.08	.19	.63	0 (0)	3	3

Note. 1. The values in parenthesis refer to the number of courses having the same ΔAR.
2. AR = accuracy rate and ΔAR = delta accuracy rate.

Table 11

Comparison of Models Across Institutions for All Remedial-Level English Courses

Success criterion	Model	Optimum cutoff score			Maximum AR			Maximum ΔAR			Number of courses where ΔAR was greater for		Total number of courses compared
		Min	Med	Max	Min	Med	Max	Min	Med	Max	Model 1	Models 2-8	
B or higher	1	13.0	14.5	23.0	.59	.75	.88	.00	.03	.44			
	2	1.8	2.4	4.0	.58	.66	.74	.01	.07	.47	0 (1)	3	4
	3	2.1	2.3	3.8	.58	.66	.74	.00	.10	.47	0 (0)	4	4
	5				.74	.75	.81	.03	.16	.25	1 (0)	2	3
	6				.74	.77	.80	.04	.10	.16	1 (0)	2	3
C or higher	1	8.0	11.0	11.0	.87	.90	.91	.00	.00	.00			
	2	0.0	1.0	1.0	.74	.84	.90	.00	.00	.00	0 (4)	0	4
	3	1.0	1.3	1.4	.74	.83	.89	.00	.00	.01	0 (2)	1	3
	5				.89	.91	.93	.00	.00	.01	0 (2)	1	3
	6				.89	.91	.92	.00	.00	.00	0 (2)	0	2

Note. 1. The values in parenthesis refer to the number of courses having the same ΔAR.
2. AR = accuracy rate and ΔAR = delta accuracy rate.

Table 12

Comparison of Models Across Institutions for All Standard-Level English Courses

Success criterion	Model	Optimum cutoff score			Maximum AR			Maximum ΔAR			Number of courses where ΔAR was greater for		Total number of courses compared
		Min	Med	Max	Min	Med	Max	Min	Med	Max	Model 1	Models 2-8	
B or higher	1	10.0	18.5	30.0	.61	.74	.88	.00	.07	.76			
	2	1.3	2.5	4.0	.62	.76	.90	.00	.01	.35	6 (4)	1	11
	3	1.7	2.5	3.3	.64	.77	.91	.00	.02	.36	5 (3)	3	11
	5				.65	.78	.88	.00	.10	.76	1 (3)	5	9
	6				.65	.78	.89	.00	.10	.77	1 (2)	6	9
C or higher	1	10.0	15.0	18.0	.67	.78	.88	.00	.01	.09			
	2	1.3	1.5	2.2	.67	.78	.92	.00	.01	.03	3 (0)	1	4
	3	1.8	1.9	2.3	.67	.77	.91	.00	.01	.04	2 (2)	0	4
	5				.68	.76	.78	.00	.05	.09	0 (2)	1	3
	6				.69	.76	.78	.00	.06	.13	0 (1)	2	3

Note. 1. The values in parenthesis refer to the number of courses having the same ΔAR.
2. AR = accuracy rate and ΔAR = delta accuracy rate.