

**PREDICTIVE VALIDITY OF THE IUPUI WEB-BASED PLACEMENT TEST SCORES
FOR COURSE PLACEMENT AT IUPUI: 1998-1999**

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Executive Summary

This annual report addresses a variety of issues regarding the undergraduate placement tests that are mandated for all entering students at IUPUI. Several changes to the placement testing process were implemented by the academic departments recently, cutoff score modifications to the computerized adaptive math placement test and an experimental procedure for the computerized assessment of writing samples to be used with the high school testing activities (Shermis, Mzumara, Harrington, & Olson, 1998). Based on last year's data, revised placement graphs have been incorporated that indicate the probability of success for a student who achieves a given placement test score (Noble & Sawyer, 1997). We hope that these interpretational aids will provide some additional help to counselors and other academic advisors looking to use the placement tests as one source of information in guiding the student to an appropriate course.

The evaluation of the computerized adaptive math test involved samples drawn from fall of 1998 and spring of 1999. A computerized adaptive test is one that conforms to the ability level of the examinee. Several studies have shown this type of test to be just as reliable as the older non-adaptive test, even though it averages to be 30-50% shorter. Our own exit surveys continue to suggest that students like the adaptive tests because they are neither too difficult nor too easy. Moreover, the current computerized adaptive math test, which consists of an item bank of 168 items, addresses security concerns in that each student essentially takes a different form of the test. The placement validity coefficients for this test, calculated on the relationship between the placement test results and a score on a common final, averaged $r = .49$, which makes it a very useful predictor and a significant improvement over the last several years. At present, however, the Department of Mathematical Sciences, working with the

Testing Center, are engaged in looking at alternative ways to improving the predictive validity of the test, particularly for higher-level courses. Most recently, efforts have been focused on reviewing two of the most popular commercial and nationally-normed placement tests (namely COMPASS and Accuplacer) for possible adoption of either one of the math placement test to address the problem of "under-placement" of students in higher-level math courses.

The Indiana-Purdue Computerized Reading Test is modeled after the Nelson-Denny Reading Test, a nationally recognized assessment that is used for placement purposes. This test has been evaluated on a number of psychometric dimensions and has been demonstrated to have good reliability and validity (Shermis, Wolting, & Lombard, 1996). The advantage of the computerized test is that it can be easily scored and interpreted. Because only those who score low on the test are required to take a reading course higher scorers are "exempt" from a reading requirement, the sample drawn from Fall 1998 is homogeneous and tends to underestimate the predictive validity coefficient. In spite of this statistical anomaly, the predictive validity coefficient, based on the placement test and score on the Nelson-Denny Form H), averaged about $r = .25$ and is considered to be useful. Placement graphs for reading are included in this report.

The English written assessment is a writing sample of approximately 500 words generated in response to a prompt. The test not only asks the examinee to compose an impromptu essay, but also to reflect on their impromptu essay and writing process. The essay is evaluated by one or, in some cases, two raters from the English Department, and a placement recommendation is made. While the rating scale used by the department has sufficient variance for a good validity assessment, the fact that the outcome measure is based on grades tends to underestimate the true relationship between the two variables. The placement validity

coefficients for a sample drawn from Fall of 1998 averaged in the mid-teens, but this finding is still useful for placement purposes. The department is investigating alternative measures that might be used as predictor variables. For instance, the department is evaluating the possibility of using portfolios as an alternative for one writing sample. Meanwhile, the Testing Center has continued to administer the Web-based English placement exam (which involves typing rather than writing of responses) as a way to accommodate students' preferences and writing habits (Harrington, Shermis, & Rollins, 1997).

Shermis and Mzumara (1996) obtained an SDC grant to implement the IUPUI placement tests at designated local area high schools, IUPUI distance learning locations, and Ivy Tech State College. The main technological development has been the implementation of the tests over the World Wide Web (Shermis, Mzumara, Lillig, & Brown, 1997; Shermis, Mzumara, Olson, & Harrington, 1998). Currently, the Web-based placement testing project has been expanded to include about nine area high schools. One outgrowth of this program has been a large-scale assessment of Project Essay Grade (PEG) - an automated grading system for written work (Page & Peterson, 1996). The assessment, which included samples drawn from both college and high school populations, resulted in agreement coefficients that were as good as those obtained by human raters alone. Remarkably, scores on the written work can be obtained in a matter of seconds. Interested readers can try out this new technology at the PEG site: <http://134.68.49.185/pegdemo/>.

Also, it is interesting to note that preliminary results of the correlation analysis between PEG (holistic) scores and English W131 course grades (for IUPUI students) are statistically significant ($r = .14$, $n = 378$, $p < .01$), indicating a moderate improvement in validity coefficients over those for the conventional English placement test scores. Partly due to the relatively small sample size with available PEG scores, we obtained

mixed results for correlations between PEG scores and course grades in W001 and W140, respectively.

Introduction

As part of ongoing efforts to monitor and improve the IUPUI placement tests, the present study was designed to assess the validity of placement test scores in making course placement decisions at Indiana University Purdue University Indianapolis (IUPUI) for the fall and spring semesters of the 1998/99 academic year. Placing new students into appropriate first year courses has become an increasingly challenging task for colleges and universities. Sawyer (1996) indicates that the percentage of postsecondary institutions with some form of placement and developmental instruction has steadily increased in the past decade and is now about 90%.

In placement decisions, the concern of the institution is to create learning environments in which all students will learn. Hills, Hirsch, and Subhiyah (1990) define placement as a process by which students are assigned to courses commensurate with their past achievements in order to facilitate expeditious further learning. "The underlying idea is that students differ. They may differ in their level of preparation, in their adeptness at learning, in their interests, in their ability to organize for themselves, and so on. As a result, for efficient instruction, one arranges for different approaches for the different students or groups of students. Ideally, a student is placed in the learning situation which is best for him" (Hills, Hirsch, & Subhiyah, 1990, p.5). Accordingly, IUPUI has implemented a mandatory placement testing program for all undergraduate students in order to facilitate the academic success of students at the University.

The IUPUI placement tests were developed for the purpose of course placement (i.e., matching students with instruction appropriate to their academic preparation) in English (writing), mathematics, and reading. Thus, like most other higher education institutions (NCES, October 1996), IUPUI provides developmental courses in reading, writing, and mathematics.

Generally speaking, developmental courses are provided to those college students lacking in academic skills necessary to perform college-level work at the level required by the institution (NCES, October 1996). Although what constitutes developmental courses varies from institution to institution, often developmental courses do not carry credit toward satisfying degree requirements.

In general, the rationale for placement testing is threefold: First, students who enroll in appropriate university courses should have a more positive experience than those who enroll in courses that are either too difficult or too easy. They should be more satisfied with their university experience, and thus more likely to be retained. Second, because students are more likely to be retained in classes that are appropriate to their ability level, departmental administrators can more carefully plan how best to allocate faculty resources to respective class sections. Finally, the placement tests might serve as a basis for assessing the contributions of the University to the development of general educational skills. If placement tests perform the three vital functions well, then University funds spent on these assessments are wisely expended. A brief description of the major IUPUI placement tests follows.

Mathematics Placement Exam. The mathematics placement examination was designed to assess students' college-level mathematics readiness skills upon admission into IUPUI. The mathematics exam used in the present study was a computerized adaptive test which consists of 168 objective items that assess skills ranging from pre-algebra to introductory calculus. The total placement score on the mathematics test ranged from 6 (lowest score) to 40 (highest possible score), and represents a student's ability level in mathematics. For course placement purposes, students who scored 6 on the test were advised to take Mathematics M010 (Pre-Algebra), a developmental mathematics course. Students who scored between 7 and 13 on the

mathematics placement test were advised to take Mathematics 001 (Introduction to Algebra). Students who scored between 14 and 20 on the mathematics test received a placement recommendation of Mathematics 111 (Algebra). Students with scores between 21 and 40 were advised into a variety of mathematics course offerings, depending on their academic major. Based on this assessment, therefore, placement is made into an appropriate mathematics class. (The aforementioned cutoff scores became effective on October 1, 1998.) Mathematics placement test scores are valid for one year from the test date.

Reading Placement Exam. The computerized reading placement exam used in the present study is an objective reading assessment consisting of five parts: reading rate, comprehension, and three different types of vocabulary tests (Word Attack, Words in Context, and Words in Isolation). The purpose of this test was to assess students' vocabulary and reading comprehension skills upon entry into IUPUI. Based on this test, a student's eligibility for university reading requirements or the need for reading improvement was determined. The total reading score ranged from 0 to 170, and indicates a weighted raw score composite. Students who scored between 0 and 52 were asked to contact the Office of Admissions for counseling and placement. Students who scored between 53 and 68 were advised to enroll in Education X150, and a score of 68 to 79 resulted in a placement recommendation for Education X152. Students who obtained a score equal to or greater than 80 were exempt from further requirements in reading skill development. Thus, students who read at college level were exempt from taking the developmental reading classes. Reading placement test scores are valid for one year from the test date.

English Placement Exam. The English placement exam is a one-hour exam that asks students to write an essay that explains and supports their opinion on a current social issue. The test provides a brief explanation

of the issue or the context in which the issue is posed. Students are also asked to evaluate their answer and explain what changes they might make, had they the time to do so. When readers assess the English placement tests, they look for presence or absence of organization, support, development, and the student's position on the issue presented. Students who need extra help focusing their essays around a major theme, or students who need extra help understanding the relationship between assertion and support, are placed into an appropriate developmental course.

The purpose of the English placement exam is to assess students' ability to write an essay that explains and supports one's viewpoint or opinion on a given issue. Examinees have a choice of two questions, each of which allows the students to use their personal experiences and/or observations in writing the essay. It is important that the test conveys not only the examinee's viewpoint on the selected topic, but also the reasons for taking a particular position. The test, however, does not require any specialized knowledge or research, only an ability to discuss an individual's opinion and reasons. Within the one hour time allotted to the English placement test, students are expected to (a) think seriously about the topic selected, (b) state an opinion clearly, (c) present examples or details that support an opinion, and (d) organize the essay clearly. The English test score is valid for two years from the test date. Students are required to register for the respective courses into which they are placed [i.e., W001 - Fundamentals of English; W131 - Elementary Composition; or W140 - an honors version of W131].

Major Changes Made in 1998

During the past academic year, we focused on making incremental quality improvements in the interface of the IUPUI Web-based placement tests, revision of the cutoff scores for the mathematics placement test,

and expansion of the High School placement testing program. The changes were based on the recommendations outlined in the previous placement validity reports (cf. Mzumara, Shermis, & Fogel, 1998; Mzumara, Shermis, Dossinger, & Olson, 1997; Mzumara, Shermis, & Wimer, 1996). Otherwise, we have maintained the same research design or methodology for assessing the predictive validity of the placement test scores (as reported in the aforementioned placement validity reports). It is noteworthy that the Testing Center (in conjunction with the Mathematics Department) engaged in a series of deliberations and/or pilot studies aimed at addressing concerns regarding the possible "under-placement" of students in higher-level mathematics courses at IUPUI (i.e., courses above Math 111). Part of the deliberations resulted in the revision and implementation of the mathematics cutoff scores that took effect on October 1, 1998. And continued efforts are being made to closely match the mathematics placement test with the math department's curriculum so as to improve course placement at IUPUI, particularly in upper level mathematics courses. Most recently, the mathematics faculty has reviewed two of the most popular and nationally-normed placement tests (namely, The College Board's Accuplacer and ACT's COMPASS) in an effort to find a suitable math placement test to address the current concerns about student "under-placement" in higher-level math courses at IUPUI. A decision is yet to be made about the adoption of either one of these tests to replace the existing computerized adaptive math test. (Note that new procedural changes pertaining to the placement tests will be reported in the Testing Center's annual report, which will be available on-line at the Testing Center's Web site: <http://assessment.iupui.edu/report/report.html>).

Three years ago, with funding from IU's Strategic Directions Charter, the Testing Center began administering placement tests over the World Wide Web to local area high schools. The purpose of the testing program was to

help secondary students, beginning in the 10th grade, determine whether or not they were on a "trajectory" for taking college-level courses when they arrived at the university. This information can often serve as a "wake-up" call for students who may not be seriously considering the rigors of post-secondary work. Moreover, the feedback is geared to provide students counsel and advice as to the kinds of opportunities that might be available in their district to get them back on the college-level trajectory. For example, feedback to a second semester high school junior might suggest that the wiser choice would be to enroll in an English course with a substantial writing component rather than in a course that doesn't require much writing. Other opportunities might include the availability of adult education programs or extra-curricular experiences. The high school placement testing program currently serves nine area high schools in Marion County.

Method

Sample

The target population comprised all students who took either an English, mathematics, or reading placement test from January, 1998, through August, 1998, **and** enrolled in an English writing, mathematics or reading course during the Fall 1998 semester at the IUPUI campus. (Note that math data from spring 1999 were also obtained for the purpose of looking at the impact of the recently revised cutoff scores. For the present study, students with incomplete and/or missing course grades were excluded from data analysis.)

Procedure for Obtaining the Data

Students' raw data were obtained through a FOCUS query (and/or from students' academic records provided by the respective course coordinators)

from the Fall 1998 cohort of students who took the placement tests and subsequently enrolled in a mathematics, reading or English course during Fall 1998 or Spring 1999 semester. Because the IUPUI placement tests are seen as advisory¹ rather than prescriptive, in some cases a student enrolled in a course that was not recommended by the placement test score. Consequently, for the purpose of statistical analyses, students were divided into two categories, namely, "compliant" and "non-compliant." The compliant group comprised students who took the recommended courses based on the placement test scores. The non-compliant group consisted of students who chose (sometimes in consultation with their advisors) not to take the recommended course. The current extract resulted in a pool of 615 students for mathematics (based on the available data for spring 1999), 450 students for reading², and 1556 students for the English (written) essay. With respect to compliance, there were 518 students who took the mathematics placement exam (based on the revised cutoff scores, MA305) during the fall semester of 1998, and then enrolled in a recommended mathematics M010, Math 001, Math 111 or a higher class during the spring semester of 1999. Likewise, 417 students took the computerized reading test and then enrolled appropriately in either Education X150 or Education X152. (Note that the sample for reading excluded students who took the *Nelson-Denny Reading Test Form G*.) With respect to English, there were 1511 students who took the English placement exam and then enrolled in one of the following recommended courses of interest: W001, W131, or W140 in fall of 1998. Overall, the total compliance rates (based on the available data) were 84% for mathematics, 93% for reading, and 97% for English, which are about 2%-3% higher than those reported last year (with exception of the compliance rate for reading which was 94%).

¹The English Department views the placement test results as prescriptive rather than advisory, although it does offer an appeal process for students who wish to challenge their placements.

Research Design and Data Analysis

Like the last two year's placement validity reports, the present study employed some aspects of decision theory models (Sawyer, 1996; Noble & Sawyer, 1997) and logistic regression techniques (Hosmer & Lemeshow; 1989; Norusis/SPSS Inc., 1992) to provide validity evidence for course placement criteria. In addition, simple correlation and regression analyses were used to demonstrate the relationship between predictor scores and outcome variables. It is noteworthy that most college placement exams have correlations that run between .20 to .40 (cf. Hills, Hirsch, & Subhiyah, 1990).

The predictor variables consisted of students' placement exam scores on mathematics, reading, and English, respectively. The outcome measures were the corresponding exam scores and/or course grades in the respective content areas. The rationale for the validation/research design was as follows. To the extent that the usefulness of a placement test depends on the existence of statistical relationships, such evidence is clearly essential to validation. Thus, by measuring the strength of this statistical relationship, we obtained evidence on the validity of the placement test scores for making course placement recommendations. (Note that the present study employed the logistic regression model in validating the IUPUI course placement tests.)

The primary criterion measure for mathematics comprised final examination scores and/or grades based on a common final exam. The secondary outcome variable for mathematics consisted of the course grade obtained by the student at the end of the fall and spring semesters of the 1998/99 academic year. The mathematics grades ranged from "A+" to "F".

²Students whose total reading score was equal to or less than 52 or 80 and above on the computerized reading test, were excluded from the present study.

For purposes of correlation analyses, the letter grades were converted to a numeric scale ranging from 4.33 for an "A+" to 0.33 for an "F".

For the correlation procedure, the primary outcome variable for reading consisted of the total reading score received by a student on *Form H* of the *Nelson-Denny Reading Test* (RD004). For the logistic regression analyses, however, the criterion measures were based on the course grades and not the post-test (RD004) reading scores. The predictor variable for reading comprised students' placement test scores based on the IUPUI computerized reading test (RD100). For reading courses, letter grades ranging from "A+" to "F" were obtained. For purposes of conducting correlation analyses, however, the letter grades were converted to numeric scores ranging from 4.33 for "A+" to 0.33 for "F". (Note that instructors do not give a grade of "D" in the EDUC X150 or X152 courses, thereby restricting the range of the secondary outcome measures. Furthermore, students who withdrew from either Education X150 or X152 course were excluded from the correlation analyses.)

The outcome variable for English was the course grade obtained at the end of the fall semester. English grades ranged from "A+" to "F". For purposes of calculating correlation coefficients, the letter grades were converted to a numeric scale ranging from 4.33 for "A+" to 0.33 for "F". Students who withdrew from courses of interest were excluded only from the correlation analyses.

The present study was aimed at providing two major types of validity information. First, probabilities of success were estimated from logistic regression and frequency distributions of scores on the placement measures to determine the effectiveness of the course placement criteria. Probability graphs were then developed to provide graphical illustrations of the relationship between placement test scores and predicted first-year college performance in English, mathematics, and reading, respectively.

Second, simple correlation analyses were conducted to obtain coefficients among all the variables studied (i.e., predictor and outcome measures). The intercorrelations (validity coefficients) between the predictors and each outcome measure indicated how the predictors were working, but did not provide a means of making specific predictions for individuals. This was accomplished with the prediction equations, which were essentially the product of logistic regression analyses. In essence, the prediction equations used one variable (i.e., the respective placement test scores) to predict an outcome. This information, however, did not indicate how effective the predictions were. Thus, estimates of measurement error in prediction (i.e., standard errors of estimate) were computed. The results of fitting logistic regression models to the respective data are reported in subsequent tables (see Tables B.1 - B.7 in Appendix B).

Probability of Success

The statistical relationship between students' outcomes (i.e., a course grade of, say, "C" or higher) and their placement test scores was estimated using logistic regression. (Details regarding logistic regression are presented in Appendix A.) The relationship was estimated from the data of students who actually took a placement test and subsequently enrolled and completed the respective course(s) during Fall 1997 semester. For each placement test score, a corresponding probability of success was estimated. The outcome variable used a 0/1 (unsuccessful/successful) criterion measure. (Note that for logistic regression purposes, "FX" grades and withdrawals ("Ws") were considered as unsuccessful outcomes, without necessarily converting them to "F" grades). For purposes of this study, the criterion variable was generally defined as a grade of "C" or higher (2.0 or higher). However, probabilities of

success were also estimated for grades of "B" or higher and "A-" or higher, respectively.

Results

The basic course placement procedure applied at IUPUI is mostly dependent upon students' academic achievement, as measured by the placement tests in English, mathematics, and reading, respectively. The manner in which placement decisions are made has been described in the Introduction section. Thus, it is imperative that the effectiveness of the existing placement procedures be known. To provide some information, the probability of success estimated what would happen if a specific cutoff on a particular criterion measure was applied to a particular reference group. (In the context of course placement, the reference group may be thought to as the student pool that took placement tests.) Note that using correlations as the basis of comparing potential placement measures can be misleading, as the "compliant" group of students may differ substantially from the reference group. Also, the restriction of range problem in the outcome measures lowers the utility of correlation coefficients in validating placement criteria. Alternative methods for validating course placement criteria were warranted as correlation evidence *per se* has severe limitations (see Mzumara, Shermis, & Wimer, 1996; Noble & Sawyer, 1997).

Table 1 provides a summary of the descriptive statistics for the compliant and non-compliant groups based on the respective placement test scores. The results of logistic regression analyses including graphs showing the probability of success for the respective groups by course are provided subsequently as Tables B.1 to B.7 in Appendix B. Based on the tables and graphs, a summary of the results per course is presented in turn.

Mathematics

The following is a summary of the descriptive statistics based on compliant and non-compliant groups for mathematics (see Table 1)³. The compliant group for mathematics M010 ($\underline{n} = 32$) had a mean placement test score of 6.00 with no standard deviation as, currently, there is no range in placement test scores for M010. Similarly, all ($\underline{n} = 4$) students in the non-compliant group for Mathematics M010 obtained a placement score of 6.00. The compliant group for Mathematics 001 ($\underline{n} = 439$) obtained a mean mathematics placement test score of 8.03, with a standard deviation of 1.45. The corresponding non-compliant group for Mathematics 001 ($\underline{n} = 75$) had a mean placement test score of 10.11 and a standard deviation of 2.00. For Mathematics 111, the number of compliant students was 47, with a mean placement score of 15.72 and a standard deviation of 1.93. In contrast, there were 18 non-compliant students in Mathematics 111 course with a mean placement score of 16.17 and a standard deviation of 2.09.

Table 1

Descriptive Statistics for the Compliant and Non-Compliant Groups
Based on the Placement Exam Scores (PES) for Fall 1998

SUBJECT	COURSE	GROUP	PES MEAN	PES SD	N
Mathematics 4	M010	Compliant	6.00	.00	32

³ The current math data are for students who tested between October 1 and December 31, 1998 (and then enrolled in math courses during spring 1999 semester), and exclude students who took the older version of the math placement test (MA300).

⁴ The results for Mathematics are based on the revised cutoff scores (MA305) implemented on October 1, 1998. Specifically, the math data are for students who tested between October 1 and December 31, 1998 (and then enrolled in math courses during spring 1999

		Non-compliant	6.00	.00	4
	001	Compliant	8.03	1.45	439
		Non-compliant	10.11	2.00	75
	111	Compliant	15.72	1.93	47
		Non-compliant	16.17	2.09	18
Reading	X150	Compliant	60.73	4.41	209
		Non-compliant	60.89	4.76	19
	X152	Compliant	73.63	3.15	208
		Non-compliant	74.86	3.13	14
English	W001	Compliant	9.46	.91	373
		Non-compliant	9.00	2.11	10
	W131	Compliant	14.13	1.11	1099
		Non-compliant	14.36	1.08	25
	W140	Compliant	20.95	1.10	39
		Non-compliant	20.60	1.08	10

semester), and exclude students who took the older version of the math placement test (MA300).

Figures 1 and 2 present probability estimates based on specific cutoffs on the outcome measures when applied to particular mathematics compliant groups. (Tables B.1 and B.2 in Appendix B show the results of logistic regression analyses for mathematics data.) For instance, as Figure 1 shows, a student with a mathematics placement test score of 10 is associated with an estimated probability of a B or higher grade of about .48. The corresponding C or higher cutoff score is 9 (probability of success is about .54). (Note, however, when a grade of A or higher is employed, scores between 7 and 13 are associated with estimated probabilities of success of less than .25.). Overall, Figure 1 shows that the estimated probability of success increases as placement test scores increase. In other words, the higher the placement score, the greater the probability of success in mathematics.

It is worthwhile to mention that the advantages of using a logistic regression approach, rather than traditional correlation methods, are that we can observe curvilinear relationships and the approach does not require strong distributional assumptions. "When the outcome measure is considered as a dichotomy (pass/fail), rather than as a continuous variable, the focus is placed on addressing the appropriate question, that being whether a student will be successful or unsuccessful, and less so whether a student will receive an A average vs. a B average" (Noble & Sawyer, 1997, p. 3). Thus, the logistic regression approach helps to reduce the problem of restriction of range in course grades.

The placement validity coefficients for the computerized adaptive mathematics test, calculated on the relationship between the placement test scores and scores on a common final mathematics exam, averaged .49 (Math 001: $r_{xy} = .41$, $n = 246$, $p < .001$; Math 111: $r_{xy} = .56$, $n = 33$, $p < .001$). It is possible that the validity coefficient for Math 111 is artificially inflated due to the relatively small sample size ($n = 33$); hence, caution

must be taken when interpreting the observed validity coefficients. Nonetheless, the present average validity coefficient continues to reflect

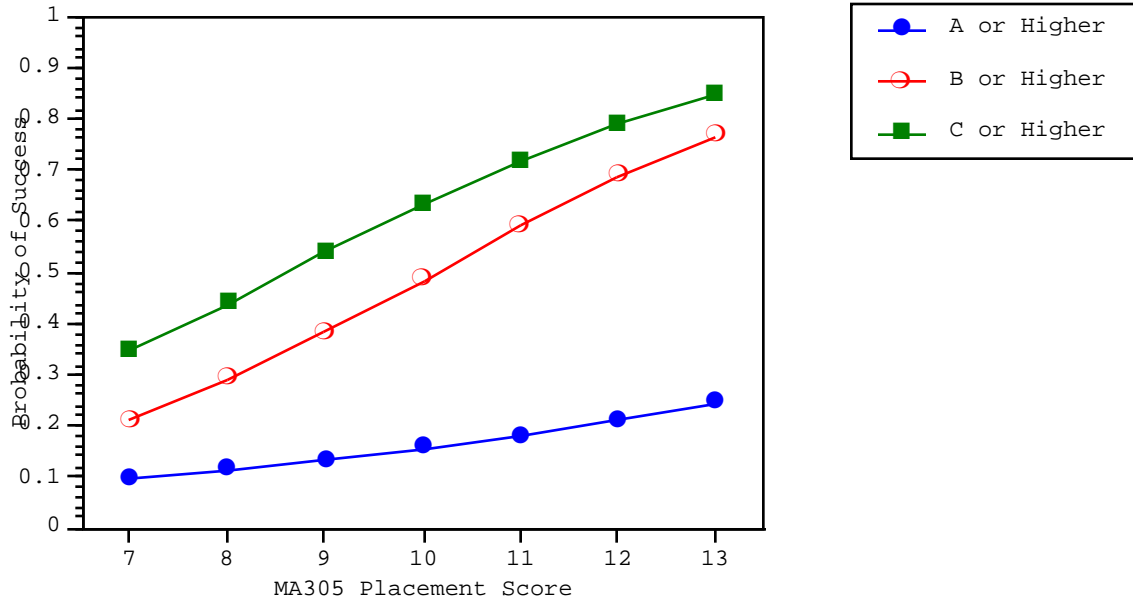


Figure 1. Estimated Probability of Success in Mathematics 001
A or Higher, B or Higher, and C or Higher

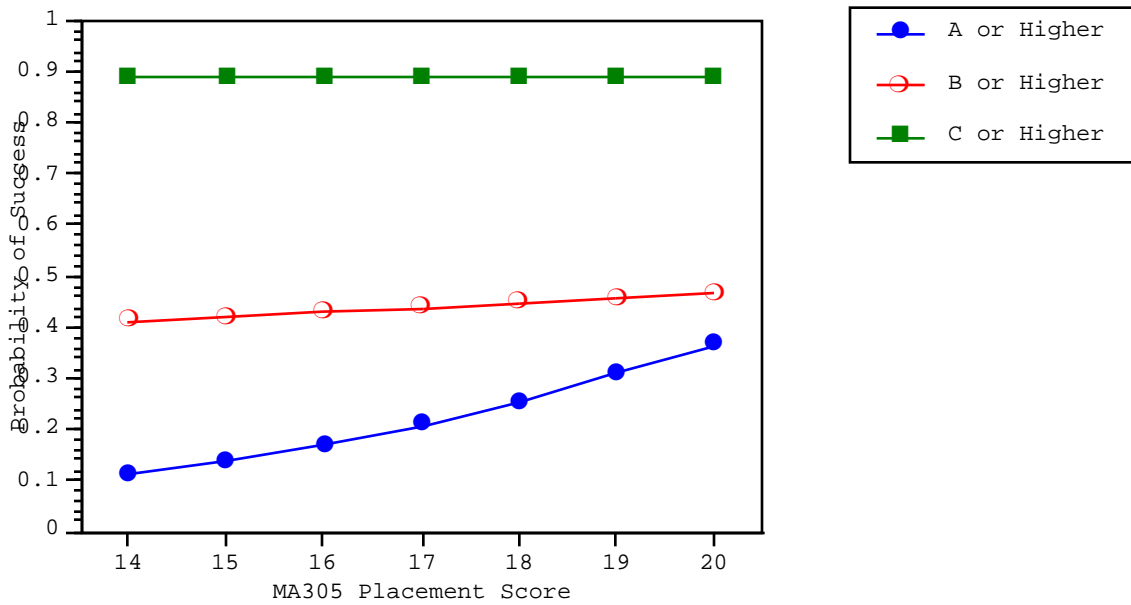


Figure 2. Estimated Probability of Success in Mathematics 111
A or Higher, B or Higher, and C or Higher

a very useful predictor and a significant improvement over last year's correlation of .38. Using math course grades as outcome measures, the correlation coefficient for compliant students was approximately .23 for Math 001 ($n = 331$, $p < .001$) and negligible for Math 111. A slight drop in the validity coefficient for course grades was expected because of the adverse effect of range restriction.

It is interesting to note, however, that the validity coefficients based on the "old" cutoff scores (MA300) and math outcome data (common final) for fall 1998 semester are not statistically different from those obtained using the revised cutoff scores and spring 1999 data. For instance, the correlation coefficient between MA300 and scores on the common final for math 001 compliant group is .41 ($n = 1293$, $p < .001$), which is identical to the finding reported above for MA305 and Math 001. Using MA300 placement scores and fall 1998 math data, the validity coefficient for Math 111 is .20 ($n = 296$, $p < .001$), and the finding based on the spring 1999 data seems to be artificially inflated (Math 111: $r_{xy} = .56$, $n = 33$, $p < .001$).

Reading

Descriptive statistics for reading courses are shown in Table 1. Tables B.3 and B.4 (see Appendix B) show the results of fitting a logistic regression model to data for the reading X150 and X152 compliant groups, respectively. The estimated probabilities of success in reading courses X150 and X152 are presented in Figures 3 and 4, respectively. As Figure 3 shows, a reading placement score of 53 is associated with a probability of a B or higher grade of approximately .59. The probability estimates for a grade of C or higher for the EDUC X150 course range between .86 and .91. Figure 4 indicates that a reading placement score of 68 is associated with a probability of a B or higher grade of about .52. The estimated

probabilities of success in EDUC X152 course with a grade of C or higher indicate a very narrow range from .86 to .87 across-the-board.

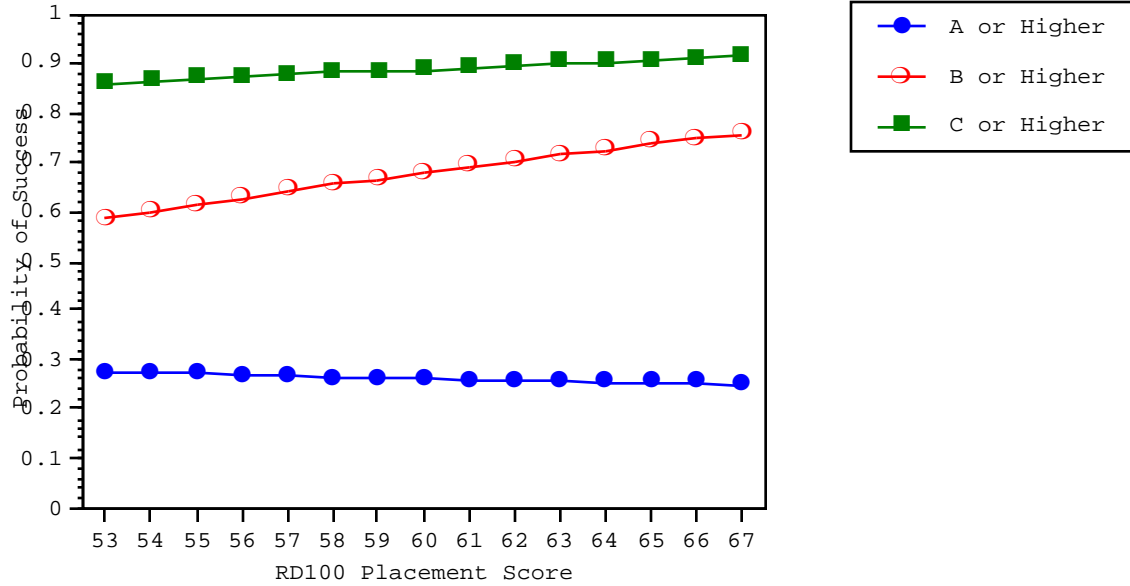


Figure 3. Estimated Probability of Success in EDUC X150
A or Higher, B or Higher, and C or Higher

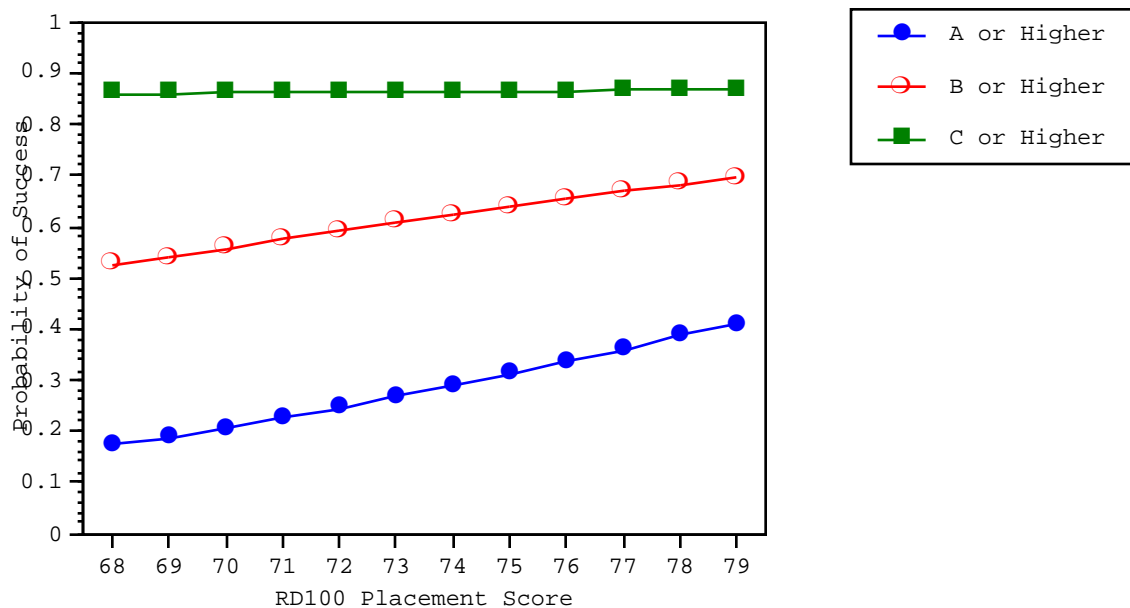


Figure 4. Estimated Probability of Success in EDUC X152

A or Higher, B or Higher, and C or Higher

With respect to correlation analysis, the average correlation coefficient between the reading placement test scores and scores on the *Nelson-Denny Reading Test Form H* was about .20 for the reading compliant groups. Specifically, for the EDUC X150 course, the validity coefficient between the computerized reading placement scores and the *Nelson-Denny Reading Test Form H* (post-test) scores is .20 ($n = 200$, $p < .05$). The present validity coefficient is similar to the findings reported in last year's report, and it could be considered useful for course placement purposes. Similarly, the validity coefficient for the EDUC X152 compliant group is .21 ($n = 205$, $p < .05$).

English

The descriptive statistics for English are summarized in Table 1. The compliant students for W001 writing course ($n = 373$) obtained a mean English placement test score of 9.46 and a standard deviation of .91. The compliant group for W131 course comprised 1099 students who had a mean English placement score of 14.13 with a standard deviation of 1.11. For the W140 compliant group ($n = 39$), the mean placement test score was 20.94 with a standard deviation of 1.10. In most cases, there were too few non-compliant students for writing courses to warrant separate statistical analyses. These results are similar to those reported for last year.

Tables B.5 - B.7 (in Appendix B) provide the results for logistic regression analyses for respective writing courses. The accompanying graphs with estimates of probability of success in writing courses are shown as Figures 5 - 7. As Figure 5 shows, an English placement score of 10 is associated with a probability of a B or higher grade of about .56. The estimated probabilities for obtaining C or higher course grades in W001

are about .99 across-the-board. Overall, as seen in Figures 5 - 6, the estimated probability of success in writing increases as placement scores

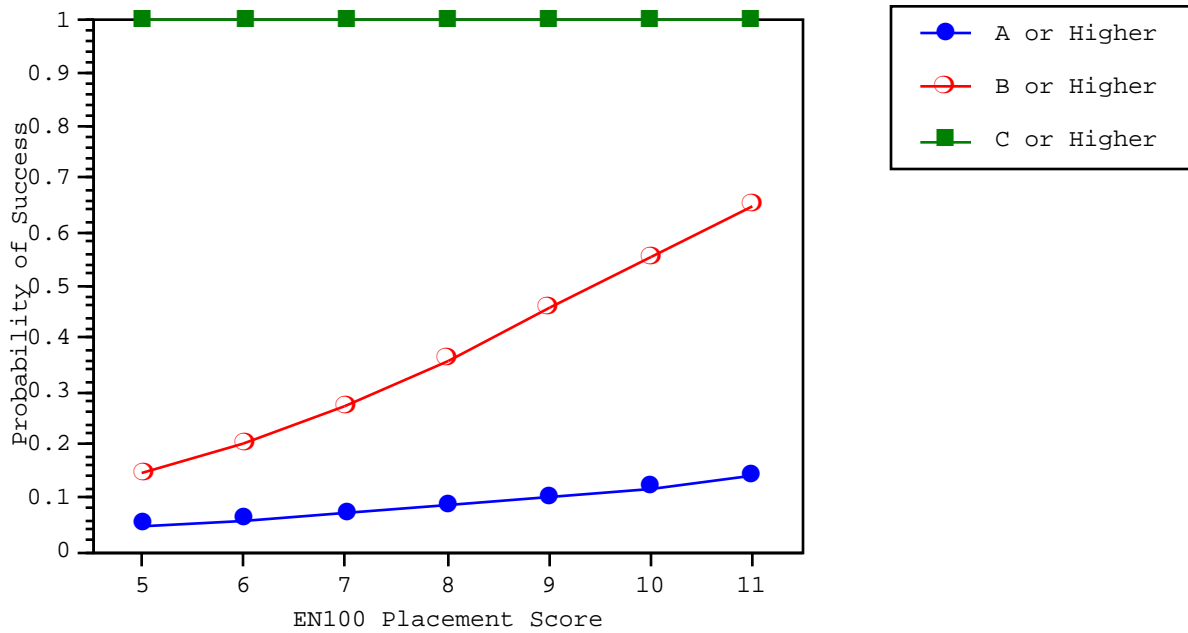


Figure 5. Estimated Probability of Success in English W001
A or Higher, B or Higher, and C or Higher

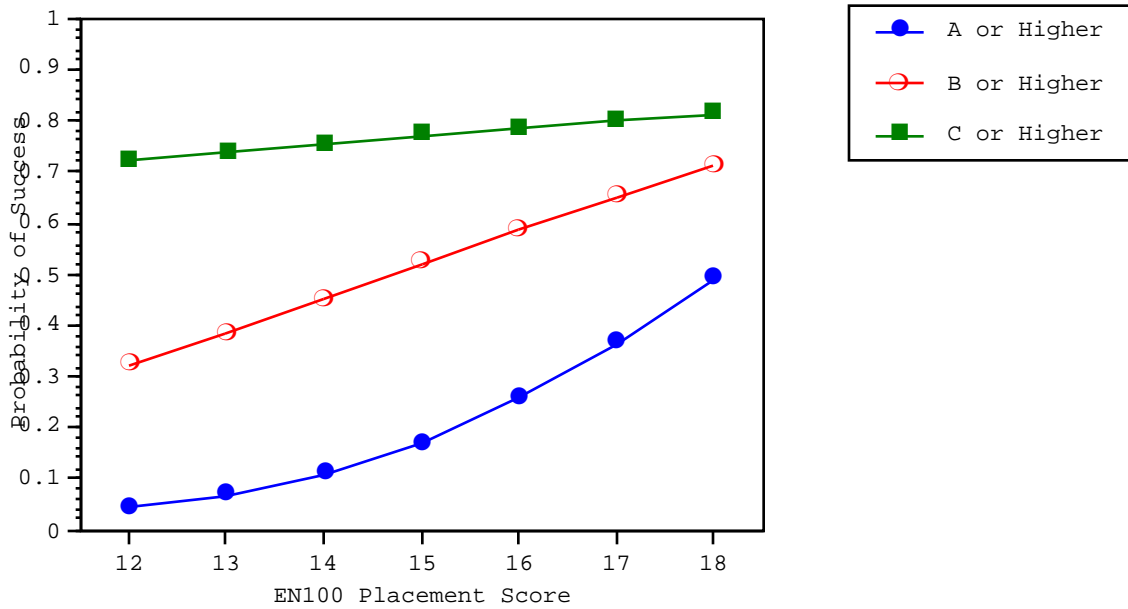


Figure 6. Estimated Probability of Success in English W131
A or Higher, B or Higher, and C or Higher

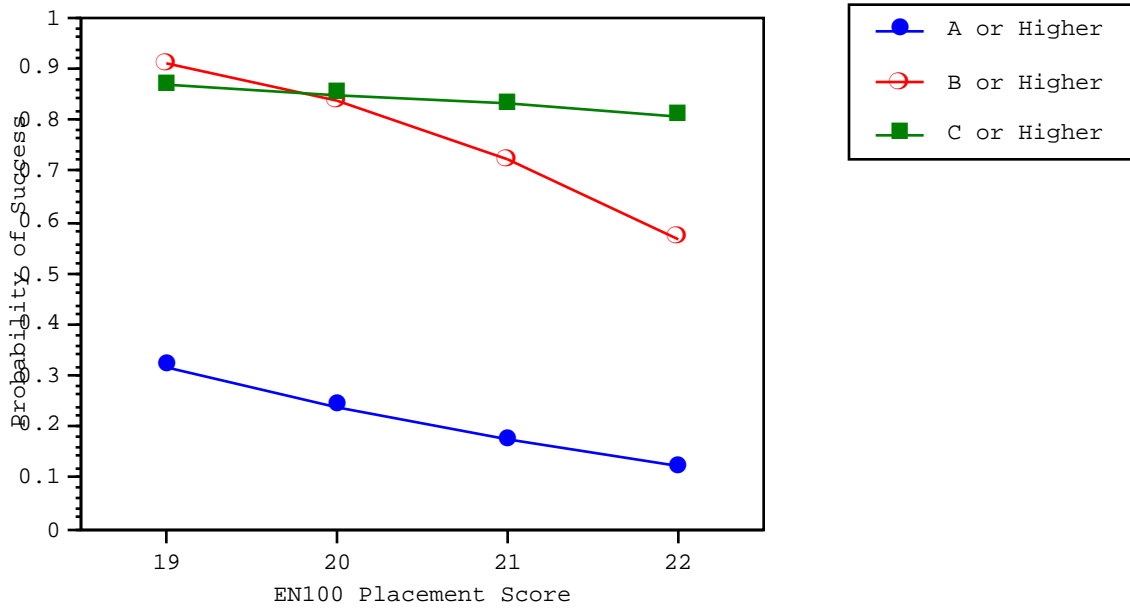


Figure 7. Estimated Probability of Success in English W140
A or Higher, B or Higher, and C or Higher

increase. Note (in Figure 7) that the negative results and/or lack of statistical significance of the estimated logistic regression coefficients and the corresponding Wald (W) statistics for English W140 data could most likely be due to sampling error, as English W140 (an honors writing course) had a very small sample size for the compliant group (n = 39).

For exploratory purposes, a correlation analysis was conducted between PEG scores and English course grades for IUPUI students. Like last year's results, the overall results are quite promising. In particular, it is noteworthy that a statistically significant correlation coefficient was obtained between PEG (holistic) scores and Spring 1999 final course grades in W131 ($r_{xy} = .14$, n = 378, p < .01), which indicates a moderate improvement in validity coefficients over those for the conventional English placement test scores. Perhaps continuing work in this area will

yield significant findings that would be useful in making incremental improvements in the IUPUI placement testing program.

Results of Gender and Ethnic Analyses

As in the previous placement validity reports, the Student *t*-test for independent samples was used to explore gender-related differences in academic achievement of freshmen students at IUPUI. The results of the present study indicated some statistically significant gender differences in achievement as reflected in performance on the respective placement tests and/or outcome measures. Specifically, statistically significant differences were obtained for the adaptive mathematics placement test scores for 1998 fall semester [$M(\text{males}) = 11.22$, $M(\text{females}) = 9.99$; $t(3118) = 8.27$, $p < .001$] with males scoring higher. However, no gender-related differences were observed for the final course grades in mathematics [$M(\text{males}) = 2.36$, $M(\text{females}) = 2.43$]; $t(2767) = -1.52$, *ns*]. Similarly, no statistically significant differences were obtained for gender analysis based on the common final exam in mathematics [$M(\text{males}) = 25.22$, $M(\text{females}) = 24.79$]; $t(2040) = 1.31$, *ns*]. With respect to performance on the English placement test, female students performed significantly better than [$M(\text{males}) = 12.93$, $M(\text{females}) = 13.13$; $t(3066) = -2.09$, $p < .05$]. Similarly, a statistically significant gender-related difference was obtained for the English course grades [$M(\text{males}) = 2.12$, $M(\text{females}) = 2.34$; $t(1946) = -3.37$, $p < .001$], with female students performing significantly better than male students. In accordance with last year's observation, there was a statistically significant gender difference in reading placement test scores [$M(\text{males}) = 93.96$, $M(\text{females}) = 88.23$; $t(3015) = 7.52$, $p < .001$], and on the reading post-test (*N-D Reading Test Form H*) scores [$M(\text{males}) = 100.10$, $M(\text{females}) = 95.73$; $t(283) = 2.30$, $p < .05$]. Furthermore, statistically significant gender differences were

observed for the EDUC X150 course [$M(\text{males}) = 1.73$, $M(\text{females}) = 2.27$; $t(330) = -3.22$, $p < .001$], but not for EDUC X152 [$M(\text{males}) = 2.37$, $M(\text{females}) = 2.38$; $t(425) = -.03$, *ns*]. Perhaps the statistically significant result for EDUC X150 can be attributed to the disparate sample sizes for the gender groups.

The aforementioned results indicate a need to conduct a thorough investigation on gender-related differences in academic performance, as reflected in placement test scores and/or course grades at IUPUI. The issue on gender research is, therefore, left for further study.

The analyses based on the ethnicity of students did not yield statistically significant results, when sampling error due to disproportionate sample sizes was taken into account. This finding is similar to that obtained in previous validity studies at IUPUI. However, given the exploratory nature of the present investigations on gender and ethnic related differences, it seems worthwhile to investigate further the link between ethnicity and academic achievement at IUPUI.

Discussion and Conclusion

The primary purpose of the present study was to investigate the validity of the IUPUI placement exam scores for course placement in mathematics, reading, and English. In comparison with the last two years' findings, the overall validity coefficients for mathematics were higher, and the same for reading and English. The logistic regression approach, however, offered a more appropriate means of determining the effectiveness of the placement criteria. Therefore, graphs indicating estimates of probabilities of success were constructed for each placement test score. We hope that the new probability graphs will provide some additional help to counselors and other academic advisors seeking to use the placement

tests as one source of information in guiding the student to an appropriate course.

Of course, the logistic regression techniques have limitations too, such as the influence of range restriction in extreme cases. For instance, if very few or no students are unsuccessful (e.g., below a grade of B) or, for course placement, the course is either very easy or very hard, it is difficult to estimate probabilities of success (Noble & Sawyer, 1997). Similarly, estimated probabilities of success are also influenced by sample size. Generally speaking, the sample sizes required to estimate the logistic regression weights are larger than those needed for linear regression. Thus, we can expect relatively large sampling error whenever small sample sizes (say, $n < 100$) are employed in logistic regression analyses (see Noble & Sawyer, 1997).

Some of the general factors for explaining the results of placement validity studies are outlined in the 1996 annual placement validity report (cf. Mzumara, Shermis, & Wimer, 1996). As noted earlier, a modest increase in the validity coefficients is observed when the *Nelson-Denny Reading Test Form H* scores are employed as a primary criterion. A similar situation was observed this year. Probably due to the influence of score range restriction and small sample size on validity coefficients, the correlations obtained for English were relatively low and in some cases not statistically significant, particularly for the English W140 course.

Notwithstanding the methodological limitations of placement validity studies, several recommendations are outlined in the next section.

Recommendations

Based on the findings of this study and our prior experience, the following suggestions should be helpful in making incremental/quality

improvement in course placement and test construction. Recommendations are presented separately for each content domain under investigation.

Mathematics

To improve the validity coefficients for mathematics, the IUPUI Testing Center and Department of Mathematical Sciences should continue to seek ways to improve the content (particularly the item bank) of the adaptive math placement test. To date, development has been focused in the following areas: (1) improvement of item bank characteristics via item revision, (2) fine-tuning of the cutoff scores on the basis of empirical evidence, and (3) improvement in reporting of placement test results to include screening information (cf. Mzumara, Shermis, & Wimer, 1998). Furthermore, development and implementation of testlets or minitests seems to be a plausible way to improve course placement plus content and predictive validity of the computerized adaptive mathematics placement test.

Most recently, the Department of Mathematical Sciences has evaluated Accuplacer and COMPASS as an alternative to the locally-developed web-based computerized adaptive math test. The latter assessment, though it has shown good predictive validity over the years, has come under criticism for allegedly underplacing students at the upper end of the ability spectrum. Both systems that were evaluated incorporate nationally-normed computerized adaptive math tests. They both support substantially larger item banks than the current assessment, can route students to diagnostic test (if warranted), and are both supported by large national testing corporations. Although Accuplacer or COMPASS are used primarily in community colleges, the domains of testing do not extend to calculus, but it is possible to extrapolate the cutoff scores to include placement for introductory-level calculus courses. Note that no specific evidence was available for either

test's predictive validity, but it is possible that Accuplacer or COMPASS could match or exceed the predictive validity of the current adaptive math placement test (low 40's). This last point is an empirical issue and will require at least a semester to evaluate.

Reading

The use of the Indiana-Purdue Computerized Reading Placement Test, as a replacement for the *Nelson-Denny Reading Test (Form E)*, has continued to yield relatively favorable findings (Shermis, Wolting, & Lombard, 1996). This test has been evaluated on several psychometric dimensions, and has been demonstrated to have good reliability and validity (Shermis, Wolting, & Banta, 1996). As stated in the previous placement validity reports, we encourage all efforts to convert to a computerized adaptive reading test, either locally-developed or through adoption of a commercial placement test.

English

With respect to English, we recommend and/or encourage the English Department faculty to seek or adopt alternative methods of assessment (e.g., portfolios), in conjunction with traditional forms of assessment, to obtain a wider range of scores. Perhaps expanding the current score range for the current English placement test would help to minimize the influence of score range restriction. (Details regarding possible reasons for the score range restriction are discussed in the Department of English placement test reports and the IUPUI Institutional Portfolio available at the following web site:

<http://imir.iupui.edu/iupuifolio/sliccommWrStartPlace.htm>.)

Some thought might also be given to using a graded writing assignment as an outcome measure instead of relying solely on course grades, since these sometimes include non-ability factors in their composition.

General Remarks

It might be worthwhile for future placement validity studies to include an analysis of the nature and content of the outcome measures. It is likely that any one year's examination is different in its content coverage of the curriculum, standards or difficulty. Such year-to-year differences in skills tested may account for a considerable amount of any change in performance on the examinations. A content validity analysis would provide some useful and/or supplementary information that would help explain some of the observed inconsistency in the relationships between predictor and outcome scores.

It is noteworthy that placement tests are designed to be used in conjunction with counselors' recommendations, and provide one source of information about the student's current ability level. Decisions regarding course placement ought to include a student's previous academic record and not be made on the basis of placement test scores alone. Because the IUPUI placement recommendations (at least for reading and mathematics) are advisory, the placement tests are designed for use in conjunction with counselors' advice to students. Thus, the use of multiple predictors for course placement is desirable (see Sawyer, 1996). Rather than use placement test scores alone, additional predictors may include one or more of the following variables: high school (HS) overall grade point average (GPA), HS subject GPA, HS (percentile) rank, and HS courses completed. It seems likely that the more information counselors have about a student, the better the chance of their making an appropriate placement decision. (Note that data collection and management for research purposes will be

facilitated with an improved Indiana University Test Reporting System (IUTS), which is currently in beta testing.)

After several years of placement testing in English, mathematics and reading, the respective stakeholders should be fairly convinced that the IUPUI placement testing program provides an efficient, practical, and workable method of placing students in appropriate courses which give them the best chance for academic success. The IUPUI placement tests, however, are a guide, based on the past performances of other similar students, of potential success in specific sets of courses in English, mathematics, and reading. Although the placement tests cannot measure motivation or other affective variables in academic learning, they are quite useful in providing our students with a healthier and more valid learning experience in the respective courses. Placement testing, therefore, offers the University a practical way to accommodate the more diverse academic needs and talents of the entering students.

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APPENDIX A

Logistic Regression and Probability of Success

Ordinarily, logistic regression estimates the relationship between a dichotomous outcome (i.e., a university course grade of "C" or higher) and one or more predictors (Hosmer & Lemeshow, 1989). In most respects, logistic regression employs same general principles as linear regression, but fits a non-linear model with a predicted outcome bounded by 0 and 1. The advantages and utility of logistic regression approach, compared to traditional correlation methods, in validating placement criteria are discussed elsewhere in the literature (e.g., see Noble & Sawyer, 1997; Sawyer, 1996; and Hosmer & Lemeshow, 1989).

Logistic regression produced a student's estimated probability of success, using the following formula:

$$P[\text{success} | K = x] = e^{(a+b*x)} / [1 + e^{(a+b*x)}]$$

where a and b are regression coefficients estimated on the data,
 x is the score the placement test,
 K is the cutoff score on the placement test, and
 e is the base of the natural logarithms, approximately 2.718
(Hosmer & Lemeshow, 1989; Noble & Sawyer, 1997).

APPENDIX B

Table B.1

Logistic Regression Statistics for Mathematics 001 Data ($n = 439$)

(A or higher, B or Higher, and C or Higher)

Variable	Estimated Coefficient	Standard Error	Wald Statistic	df	p
A or Higher					
Math Placement Score	.184	.089	4.271	1	.039
Constant	-3.532	.757	21.783	1	.001
-2 Log-likelihood = 311.480 Goodness of Fit = 435.360 Model $\chi^2 = 3.924^*$					
B or Higher					
Math Placement Score	.421	.074	32.599	1	.001
Constant	-4.275	.613	48.576	1	.001
-2 Log-likelihood = 501.021 Goodness of Fit = 435.943 Model $\chi^2 = 35.825^{***}$					
C or Higher					
Math Placement Score	.391	.077	26.002	1	.001
Constant	-3.368	.618	29.716	1	.001
-2 Log-likelihood = 572.190 Goodness of Fit = 444.827 Model $\chi^2 = 30.455^{***}$					

* $p < .05$; ** $p < .01$; *** $p < .001$

Table B.2

Logistic Regression Statistics for Mathematics 111 Data ($n = 47$)
 (A or higher, B or Higher, and C or Higher)

Variable	Estimated Coefficient	Standard Error	Wald Statistic	df	p
A or Higher					
Math Placement Score	.261	.184	2.009	1	.156
Constant	-5.774	3.038	3.612	1	.057
-2 Log-likelihood = 40.940 Goodness of Fit = 45.935 Model $\chi^2 = 1.945$					
B or Higher					
Math Placement Score	.036	.154	.056	1	.813
Constant	-.873	2.440	.128	1	.721
-2 Log-likelihood = 64.054 Goodness of Fit = 47.002 Model $\chi^2 = .056$					
C or Higher					
Math Placement Score	-.082	.160	.265	1	.607
Constant	2.056	2.552	.649	1	.420
-2 Log-likelihood = 58.604 Goodness of Fit = 47.032 Model $\chi^2 = .261$					

* $p < .05$; ** $p < .01$; *** $p < .001$

Table B.3

Logistic Regression Statistics for Educ X150 Data ($n = 209$)
 (A or higher, B or Higher, and C or Higher)

Variable	Estimated Coefficient	Standard Error	Wald Statistic	df	p
A or Higher					
Reading Placement Score	-.009	.037	.056	1	.812
Constant	-.515	2.240	.053	1	.818
-2 Log-likelihood = 229.166 Goodness of Fit = 200.009 Model $\chi^2 = .056$					
B or Higher					
Reading Placement Score	.056	.035	2.585	1	.108
Constant	-2.629	2.117	1.542	1	.214
-2 Log-likelihood = 246.612 Goodness of Fit = 199.759 Model $\chi^2 = 2.605$					
C or Higher					
Reading Placement Score	.039	.051	.586	1	.444
Constant	-.287	3.099	.009	1	.926
-2 Log-likelihood = 138.021 Goodness of Fit = 199.898 Model $\chi^2 = .585$					

* $p < .05$; ** $p < .01$; *** $p < .001$

Table B.4

Logistic Regression Statistics for Educ X152 Data ($n = 208$)
(A or higher, B or Higher, and C or Higher)

Variable	Estimated Coefficient	Standard Error	Wald Statistic	df	p
A or Higher					
Reading Placement Score	.109	.051	4.639	1	.031
Constant	-8.894	3.762	5.702	1	.017
-2 Log-likelihood = 233.605 Goodness of Fit = 200.233 Model $\chi^2 = 4.767^*$					
B or Higher					
Reading Placement Score	.068	.046	2.136	1	.144
Constant	-4.520	3.421	1.745	1	.186
-2 Log-likelihood = 262.504 Goodness of Fit = 199.041 Model $\chi^2 = 2.162$					
C or Higher					
Reading Placement Score	.006	.065	.009	1	.925
Constant	1.397	4.806	.084	1	.771
-2 Log-likelihood = 158.013 Goodness of Fit = 198.995 Model $\chi^2 = .009$					

* $p < .05$; ** $p < .01$; *** $p < .001$

Table B.5

Logistic Regression Statistics for the English W001 Data ($n = 373$)
(A or higher, B or Higher, and C or Higher)

Variable	Estimated Coefficient	Standard Error	Wald Statistic	df	p
A or Higher					
English Placement Score	.198	.201	.976	1	.323
Constant	-3.965	1.931	4.215	1	.040
-2 Log-likelihood = 237.356 Goodness of Fit = 340.203 Model $\chi^2 = 1.009$					
B or Higher					
English Placement Score	.400	.125	10.157	1	.001
Constant	-3.779	1.193	10.019	1	.001
-2 Log-likelihood = 462.168 Goodness of Fit = 341.214 Model $\chi^2 = 10.556^{***}$					
C or Higher					
English Placement Score	-.039	.148	.066	1	.797
Constant	1.661	1.409	1.389	1	.239
-2 Log-likelihood = 354.101 Goodness of Fit = 341.018 Model $\chi^2 = .066$					

* $p < .05$; ** $p < .01$; *** $p < .001$

Table B.6

Logistic Regression Statistics for the English W131 Data ($n = 1099$)
 (A or higher, B or Higher, and C or Higher)

Variable	Estimated Coefficient	Standard Error	Wald Statistic	df	p
A or Higher					
English Placement Score	.509	.094	29.172	1	.001
Constant	-9.207	1.374	44.872	1	.001
-2 Log-likelihood = 707.227 Goodness of Fit = 968.549 Model $\chi^2 = 31.588^{***}$					
B or Higher					
English Placement Score	.275	.060	20.860	1	.001
Constant	-4.046	.854	22.426	1	.001
-2 Log-likelihood = 1303.48 Goodness of Fit = 960.473 Model $\chi^2 = 21.342^{***}$					
C or Higher					
English Placement Score	.084	.068	1.511	1	.219
Constant	-.056	.967	.003	1	.954
-2 Log-likelihood = 1064.784 Goodness of Fit = 960.013 Model $\chi^2 = 1.515$					

* $p < .05$; ** $p < .01$; *** $p < .001$

Table B.7

Logistic Regression Statistics for the English W140 Data ($n = 39$)
 (A- or higher, B or Higher, and C or Higher)

Variable	Estimated Coefficient	Standard Error	Wald Statistic	df	p
A or Higher					
English Placement Score	-.405	.509	.634	1	.426
Constant	6.933	10.636	.425	1	.515
-2 Log-likelihood = 26.038 Goodness of Fit = 28.824 Model $\chi^2 = .624$					
B or Higher					
English Placement Score	-.674	.522	1.667	1	.197
Constant	15.106	11.149	1.836	1	.175
-2 Log-likelihood = 33.980 Goodness of Fit = 31.703 Model $\chi^2 = 1.943$					
C or Higher					
English Placement Score	-.142	.552	.066	1	.798
Constant	4.563	11.709	.152	1	.697
-2 Log-likelihood = 26.595 Goodness of Fit = 29.144 Model $\chi^2 = .068$					

* $p < .05$; ** $p < .01$; *** $p < .001$