EVALUATION OF THE MATHEMATICS PLACEMENT PROCEDURE AT KANSAS STATE UNIVERSITY

By

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CHAPTER ONE

INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

Placing college freshmen into an appropriate mathematics course is a problem universities face every term. Each university has a variety of entry-level courses, each course with its own definition of prerequisite mathematical knowledge. Since each university's mathematics courses place emphasis on prerequisite knowledge differently, each university is responsible for its own problem resolution. At Kansas State University a method for placing first semester freshmen enrolling in mathematics was developed. The main objective was to decrease the number of students failing or withdrawing from the initial mathematics course. The purpose of this report is to investigate the performance of placement tests and observed grades of first semester freshmen (Fall 1986) as predictors of success in Intermediate Algebra (Math 010), College Algebra (Math 100), and Calculus I (Math 220)[1], as these are the mathematics courses the majority of first semester freshmen enrolled in.

In June and July of 1986, 1,853 new fall freshmen preenrolled in entry-level mathematics at Kansas State University. Some of these students may have enrolled in two entry-level courses; for example, College Algebra and Trigo-

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[1] Later in this report MATH100 and MATH220 are used as variable names. To avoid confusion, the course names Intermediate Algebra, College Algebra, and Calculus I have been used rather than the corresponding Mathematics Department course numbers.

nometry. On August 1, 1986, enrollment was closed until the week preceding the start of classes in late August. It was these 1,853 students that were monitored through the fall semester. Most of the incoming students had taken either the American College Test (ACT). The ACT scores were used to place students. Enrollees fit into one of the following four categories:

1. Record of ACT scores with an ACT Composite score of 16 or more and self-reported high school grades.

2. Record of ACT scores with an ACT Composite score of 16 or more and no record of high school grades available.

3. Record of ACT scores with an ACT Composite of 15 or less.[2]

4. No record of ACT scores, although students may have SAT and/or high school grades reported.

For those students in Category 1, two scores, MATH100 and MATH220, were calculated for each student, using the following regression equations supplied by ACT for Kansas State University,

$$(1)\quad \text{MATH100a} = -0.426 + 0.031 \cdot \text{ACT\_E} + 0.116 \cdot \text{ACT\_M} - 0.019 \cdot \text{ACT\_SS} + 0.003 \cdot \text{ACT\_NS},$$

$$(2)\quad \text{MATH100b} = -0.106 + 0.231 \cdot \text{HS\_E} + 0.299 \cdot \text{HS\_M} + 0.217 \cdot \text{HS\_SS} + 0.041 \cdot \text{HS\_NS},$$

and

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[2] Earlier evidence has shown that students with ACT Composite scores of 15 or below should be further tested in reading and mathematics and placed in the Learning Skills program. This division of ACT scores was maintained during this placement procedure.

(3) MATH100 = (MATH100a + MATH100b) / 2.[3]

Similarly for MATH220,

(4) MATH220a = -1.286 + 0.026 · ACT_E + 0.119 · ACT_M - 0.021 · ACT_SS + 0.008 · ACT_NS,

(5) MATH220b = -1.212 + 0.439 · HS_E + 0.037 . HS_M + 0.128 · HS_SS + 0.384 · HS_NS,

and

(6) MATH220 = (MATH220a + MATH220b) / 2.

Once these scores were obtained, students were recommended as follows:

(7)
$0 \leq$ MATH100 ≤ 1.499 Math Review[4]
$1.500 \leq$ MATH100 ≤ 2.299 Intermediate Algebra
$2.300 \leq$ MATH100 and MATH220 ≤ 2.299 College Algebra
$2.300 \leq$ MATH100 and $2.300 \leq$ MATH220 Calculus I

(Note: MATH100 is a score, not a course. Similarly for MATH220. Refer to footnote 1 again if necessary.)

With success in a course being defined as a final grade of C or above, the probability of success (success percentage) in either College Algebra or Calculus I can be found in

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[3] ACT_E = ACT English score; ACT_M = ACT Mathematics score; ACT_SS = ACT Social Science sore; ACT_NS = ACT Natural Science score. All high school grades were put on a 4.0 scale where A = 4, B = 3, C = 2, D = 1, and F = 0. Then HS_E = High School English grade and so on for mathematics, social science and natural science.

[4] Math Review is a course designed to assist students that have a deficiency in mathematics. This course is offered by itself or in conjunction with Learning Skills. The Department of Education: Curriculum and Instruction offers the Study Skills Lab.

the appropriate TH Index tables contained in the ACT Standard Research Service Report in the Appendix. The TH index for each table means that ACT scores and high school grades were used to calculate MATH100 and MATH220 for Category 1 students.

The regression equations employed here were provided by ACT's Standard Research Service (SRS) in which Kansas State University participates. SRS provides information such as this to all participating universities. The report found in the Appendix was a part of this service as well. The information provided by SRS is unique to the participating universities; that is, SRS processes information to Kansas State University for its designated courses based on Kansas State University students' courses, final grades, ACT scores, and high school grades. Through this service universities are able to design research plans for course placement and make predictions for success in specific courses. Notice prediction equations include all four curriculum areas ACT tests, not just the Mathematics Usage Test. The greater the number of variables in a regression equation, the more precise becomes the prediction.

For those students in Category 2, that is, their high school grades were missing from their ACT profile, MATH100 was calculated using Equation (1) only, and MATH220 was calculated using Equation (4) only. The same interpretation of scores, (7), was used. (ACT recommends averaging

ACT_SCORES and HS_SCORES whenever possible for optimum results. Otherwise, MATH100 = MATH100a (1) and MATH220 = MATH220a (4).) Success probabilities can be found in the T-Index tables in the Appendix. The T-Index indicates the MATH100 and MATH220 were obtained using only the ACT test scores.

To students in Category 3, ACT Composite of 15 or less, the Mathematical Association of America's Mathematics Placement Exam Form A/4A (1981) was administered. The Mathematics Placement Exam was deemed valid and representative of the prerequisite material for Intermediate Algebra, College Algebra, and Calculus I. The exam has thirty-two questions. Students who took this exam were strongly urged not to guess, as they could be inappropriately placed. Placement based on these scores was made as follows:

(8)
0 - 6	Math Review
7 - 17	Intermediate Algebra
18 - 25	College Algebra
26 - 32	Calculus I

Students without ACT scores, though they may have taken the SAT, comprised Category 4. These students had to take the thirty-two question exam. Placement was made as in (8). The Mathematics Placement Exam was adopted as the required test to be taken by Learning Skills students, thereby replacing the formerly administered mathematics test.

Statement of the Problem

In the past, students had not been advised in this manner. In the Fall of 1985, students in the three monitored courses took the same placement exam and their final grades were correlated with their scores. In 1985, it was suggested to students that they change to an appropriate level course if their placement exam indicated so. In 1986, the exam was applied as a placement tool during enrollment, rather than after classes had begun. The scores recommended to enroll in a course were slightly higher than those recommended in Fall 1985.

A better success percentage is expected for each of the courses. In 1985, College Algebra experienced only 46% success and Calculus I only 62% success. Raising the requirements for enrollment a smaller percentage of letter grades D and F, W = withdrawal and I = incomplete (unsuccessful percentage) was expected. Advisement was not always followed, however. How did those students who followed advisement do versus those who were in a course of greater difficulty (over placed) and those who were in a course of lesser difficulty (under placed)? Correlations between final grades and predictors will again be examined. What are the effects of the placement procedure on the correlations? Specific to Category 3 students, was it necessary to retest those students who had ACT Composite scores of 15 or less? In relation to this, does the Placement Exam place

people differently than the ACT recommendation? Finally, overall how did this newly applied placement system perform, and what modifications, if any, should be made? To assist in answering these questions, the following null hypotheses will be tested for Intermediate Algebra, College Algebra, and Calculus I:

1. There is no correlation between the final grade and the predictor variables ACT Mathematics score, Mathematics Placement Exam score MATH100 and MATH220.

2. There is no difference between correlation coefficients for Fall 1985 and correlation coefficients for Fall 1986.

3. There is no difference between the ACT predicted final GPA for a group and the actual final GPA attained in the course.

4. There is no difference between final GPA achieved in a course by students whose ACT Composite score was 15 or less and the final GPA achieved by students whose ACT Composite score was 16 or more.

CHAPTER TWO

HISTORICAL REVIEW

Because of the increasing interest in the performance of freshmen in mathematics, research at various universities has been done to determine the best final grade predictors. Research has been done on predictor variables such as: ACT scores, SAT scores, Math Placement Exams, high school GPA, high school science GPA, sex of student, number of years since high school (age of student), and so on. With the more heterogenous college enrollments, the more a reliable means of placement is needed at universities. Since Kansas State University's advisement procedure utilizes high school grades, ACT scores, and Mathematics Placement Exam scores, supporting reports in these areas have been cited.

High School Grades as Predictors of Mathematics Achievement

As a result of the research done by its research departments, ACT has reported that the self-reported high school grades are among the most reliable predictors of college performance. Kansas State University collects individuals' high school grades from the ACT Assessment College Reports sent to the university. The accuracy of these student self-reported grades is about 98% correct according to ACT. Any error that occurs here is usually a discrepancy within only one grade.

Steve Ahrens reported that the high school mathematics background of students at West Virginia University was indicative of the success experienced by mathematics

students. The prediction equations utilizing the high school background proved to be very effective at separating the various mathematics capabilities of the students. Advisor recommendations, which were also collected, had to be eliminated from his study.[5] In a study done at Lake Superior State College it was found that advisors tend to place their students in higher levels of mathematics, thus reducing the students' chances to perform successfully in the course.[6]

At the University of Mississippi, predictor variables for the final grade given in a College Algebra course were examined. In a study of 188 freshmen enrolled in this course, a Pearson product-moment correlation coefficient of 0.607 was calculated for high school GPA with the final grade in College Algebra. This was significant at the 0.05 level.[7]

Restricting the population examined to those who majored in mathematics, a similar strong relationship was observed between the GPA in college mathematics courses and high school GPA at three universities in Mississippi. These

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[5] "Analysis and Classification of Entering Freshman Mathematics Students Using Multiple Discriminate Analysis," RIE, December 1981.

[6] Mary Adams Bone, A Comparison of Three Methods of Mathematics Placement for College Freshmen (Ph.D. Dissertation, Michigan State University, 1981).

[7] Isaac Jerald Dykes, Prediction of Success in College Algebra at Copiah-Lincoln Junior College (Ph.D. Dissertation, The University of Mississippi, 1980).

results were obtained by examining the backgrounds of 197 students who completed a bachelor's degree in mathematics. Overall, high school GPA was the single best predictor of success in mathematics in this study, where ACT scores, number of semester of math in high school, and percentile rank in high school class were also investigated.[8] Another subpopulation of engineering students at Purdue University Calumet exhibited a strong relationship between final grades in an entry-level math course and high school GPA.[9]

ACT Scores as Predictors of Mathematics Achievement

As ACT scores provide a measure of a student's scholastic aptitude before entering college, it seems obvious that a relationship between the ACT scores and final grades in college (not necessarily mathematics solely) would be examined.

Another result of Dykes' study supported the utilization of the ACT scores as placement tools. In this study the ACT mathematics scores and the ACT composite scores correlated with the final grades given in a College Algebra course. The Pearson product-moment correlation coefficients

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[8] Lucy Hamblin Burnside, Prediction of Success in Mathematics as a Major Field of Study at the Public Universities in Mississippi (Ph.D. Dissertation, The University of Mississippi, 1972).

[9] Jeffrey Dean Case, Predicting Student Performance in Entry Level Electrical Engineering Technology and Mathematics Courses Using Precollege Data (Ph.D. Dissertation, University of Illinois at Urbana-Champaign, 1983).

were both significant at the 0.05 level. They were as follows: for the ACT mathematics score, r = 0.535, and for the ACT Composite score, r = 0.486.[10]

Similar success for Calculus I scores were found in a study at the University of Southern Mississippi. Both the ACT mathematics and ACT Composite scores were significantly related (p = 0.0002) to grades given in Calculus I.[11]

Mathematics Placement Exam as a Predictor of Mathematics Achievement

In some instances the placement of students by the scores on the ACT was inappropriate. (Various other universities may have used SAT scores.) In an effort to reduce this error, some universities have implemented a placement exam to determine mathematical ability, and have done so with some success. In each case a placement exam was chosen or designed to fit the needs of that institution.

By implementing a placement exam at Kings River Community College it was determined that students in Math Analysis I had less than a 50% chance of success if they scored

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[10] Dykes, Prediction of Success in College Algebra at Copiah-Lincoln Junior College, 1980.

[11] Raymond Williams, A Study of Differences in Achievement in Precalculus Courses By Junior College Transfer and Non-Transfer Students at the University of Southern Mississippi (Ph.D. Dissertation, University of Southern Mississippi, 1980).

less than the 94th percentile on the Math Placement Exam.[12] Mathematics D (equivalent of College Algebra) students had less than a 50% chance of success if they scored below the 56th percentile on the Math Placement Exam.[13]

At Richland College the Mathematical Association of America Placement Test BA/1 was administered to students who enrolled in College Algebra. A significant correlation ($p = 0.05$) was found between placement exam scores and course grades. The same level of significance was obtained for the placement exam scores and the scores on a standardized final exam. It was also noted that students with two years of high school algebra had better success in College Algebra than those without.[14]

At Brigham Young University, a mathematics placement exam did reduce the failure rate in an entry-level algebra course.[15] At Iowa State University, a placement exam was a

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[12] Robert M. Clark, "Math Courses Survey: Math 5A-Math Analysis I," RIE, May 1982.

[13] Robert M. Clark, "Summary Analysis of Students and Grades: Mathematics A, Elementary Algebra; Mathematics B, Plane Geometry; Mathematics C, Trigonometry; and Mathematics D, Intermediate Algebra Fall 1980," RIE, September 1982.

[14] Georgia Lee Sims, Predictions of Success in College Algebra at Richland College in Dallas, Texas (Ph.D. Dissertation, The Florida State University, 1979).

[15] Martha Ann Larkin, The Effects of a Placement Test to Counsel Students in Precalculus Mathematics Registration (Ph.D. Dissertation, Brigham Young University, 1983).

better predictor of success in a course than the final grade in the prerequisite course.[16]

At the University of Akron, students in College Algebra were administered a mathematics placement exam. For the prediction model, the placement exam score, high school GPA, and ACT mathematics score were used and accounted for 44% of the variance in the final College Algebra grade. In fact, it was strongly recommended that all freshmen take the placement exam as it was the most applicable.[17]

There are certainly many universities that have conducted tests such as these mentioned and with some degree of success. Only a few have been mentioned here. The success of others in this area gives incentive to the program at Kansas State University.

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[16] Willard Parker, "The Placement Exam at Iowa State University," paper presented to the Kansas State University faculty, 1985.

[17] Faith Illeen Helmick, Evaluation of the Placement Test For First-Year Mathematics at the University of Akron (Ph.D. Dissertation, The University of Akron, 1983).

CHAPTER THREE

STUDY DESIGN

Objectives

As stated earlier, this study is evaluating the performance of first semester freshmen in entry-level mathematics. From university enrollment data ACT scores, placement exam scores, beginning course, ending course, final grade, MATH100, MATH220, and College Algebra were obtained for each freshman student enrolled in mathematics. Correlations between ACT Mathematics scores and final grades and between placement exam scores and final grades will be done and compared to 1985 data. Correlations of MATH100, MATH220, and placement exam scores with final grades will also be done. Results of the tests of the null hypotheses stated in Chapter One will be utilized. Defining success in a course as a final grade of A, B, or C, and an unsuccessful completion of a course as one with final grades D, F, I, or W, success percentages for each course will be determined. A comparison of MATH100 and MATH220 with the final grade will be done. Again, the hypotheses stated in Chapter One will be tested and will help validate the accuracy of the predictors.

Courses

The courses monitored in this study are Intermediate Algebra, College Algebra, and Calculus I. The other entry-level courses not monitored in this study are Math: Its Form and Impact, Trigonometry, Precalculus, Elementary Applied

Math, General Calculus and Linear Algebra, and Technical Calculus I. (Eleven freshmen were able to enroll in Calculus II and four were able to enroll in Calculus III because of credit by examination in Calculus I or Calculus II and/or having had beginning calculus in high school.)

Analyzing the Data

The necessary statistics were calculated using Statistical Analysis System (SAS) available at Kansas State University.

Variables

The variables are given and described in the following table.

Variable	Description
COURSE	Course the student initially enrolled in.
F_COURSE	Course student was enrolled in at semester's end.
F_GRADE	Final letter grade given in F_COURSE.
N_GRADE	Final letter grades converted to a 4.0 scale, A = 4, B = 3, C = 2, D = 1, F = 0.
SCORE	Mathematics Placement Exam score.
ACT_COMP	ACT Composite score (0 - 35).
ACT_MATH	ACT Mathematics score (0 - 36).
MATH100	Predicted final grade in College Algebra on a 4.0 scale.

MATH220	Predicted final grade in Calculus I on a 4.0 scale.
RECOMND	Course student was recommended to take. Math Review, Intermediate Algebra, College Algebra, and Calculus I are the only four courses recommended. Students who did not take the placement exam received no recommendation.

CHAPTER FOUR

SUCCESS PERCENTAGES

Success being defined as the category of grades A, B, and C, and an unsuccessful completion of a course being defined as the category of grades D, F, W (Withdrawal), and I (Incomplete), percentages of each have been determined. Percentages arrived at show that Fall 1986 was much more successful than Fall 1985. Those students who followed advisement also appeared to do better than those who were over placed.

What follows are four tables. Each table contains information for each value the variable RECOMND takes on. Only these four courses: Math Review, Intermediate Algebra, College Algebra, and Calculus I are monitored for initial enrollment (COURSE) and final completion (F_COURSE). In each table, the rows are the courses initially enrolled in, and the columns are the final course for which a grade was given. Each F_COURSE is divided into two columns, S = successful and U = unsuccessful. When a student received a blank final grade, it was most likely because the student withdrew from the course before a grade of W was assigned; that is, the student withdrew from the course prior to the twenty-fifth day of classes, after which a grade of W is given. In a very few cases, a blank was the result of a clerical recording error no more probably for a blank that for any other grade. If a student received a blank, there is a separate column for that frequency. A column marked

"C" contains the frequency that students changed from one of the four monitored courses to a non-monitored course. An example to illustrate this: A student initially enrolled in Calculus I and changed to Trigonometry. This student would appear in the Calculus I row and the C column of the table for this student's specific recommendation.

Table 4-1
Performance of Students Whose
Recommendation Was Math Review

	F_COURSE									
	Math Review		Inter. Algebra		College Algebra		Calculus I			
COURSE	S	U	S	U	S	U	S	U	Blank	C
Math Review	97	25	4						24	
Inter. Algebra	1		17	12					7	
College Algebra			1	1	3	1			4	
Calculus I										
Totals	98	25	22	13	3	1	0	0	35	0

For those students who completed Math Review as recommended, the success percentage was 98/123 x 100% = 79.7%. Those students who were recommended to Math Review and instead completed Intermediate Algebra had a success per-

centage of 22/35 x 100% = 62.9%. Adequate comparisons of these two courses cannot be done under any recommendation, as the final grade given in Math Review was not necessarily dependent on a student's math skills. Recall that Math Review is a part of Learning Skills where other factors were considered as a part of the final grade.

Table 4-2
Performance of Students Whose
Recommendation Was Intermediate Algebra

	F_COURSE									
	Math Review		Inter. Algebra		College Algebra		Calculus I			
COURSE	S	U	S	U	S	U	S	U	Blank	C
Math Review	5	3							2	
Inter. Algebra	1	1	128	83	7	3			23	7
College Algebra			5	2	83	33	1		11	12
Calculus I							2	2	1	2
Totals	6	4	133	85	90	36	3	2	47	21

For those students who completed Intermediate Algebra as recommended, the success percentage was 133/218 x 100% = 61.0%. For those students who were thought to be over placed by enrolling in College Algebra the success percent-

age was 90/126 x 100% = 71.4%. This percentage being so much greater implies at least three things: 1) Advisors were adequately interpreting other information to assess students' ability; 2) The College Algebra cut-off placement score and MATH100 values could be lowered somewhat, and a high success percentage would still result for College Algebra; and 3) College Algebra students may have more motivation to succeed than Intermediate Algebra students do.

The low success percentage for Intermediate Algebra could be enhanced by raising the standards for enrollment in the course. Raising the Intermediate Algebra cut-off placement score and MATH100 values would appropriately place those students needing the more fundamental math skills in Math Review.

Of significant showing was the College of Arts and Sciences. For those correctly placed students in that college, S = 12 (out of 128) and U = 29 (out of 85) for a college success percentage of only 12/41 x 100% = 29.3%, considerably less than the freshmen success percentage. In addition 17 students (17/58 x 100% = 29.3% of initial enrollees) dropped the class before the twenty-fifth day of class; that is, Blank = 17.

Table 4-3
Performance of Students Whose
Recommendation Was College Algebra

	F_COURSE									
	Math Review		Inter. Algebra		College Algebra		Calculus I			
COURSE	S	U	S	U	S	U	S	U	Blank	C
Math Review										
Inter. Algebra			5	2	2					
College Algebra		1	8		232	39	2		21	2
Calculus I					5	1	74	21	15	4
Totals	0	1	13	2	239	40	76	21	36	6

For those students recommended to take College Algebra and followed advisement, the success percentage was 239/279 x 100% = 85.7%. For those students who did not follow advisement the number of students was only substantial for those who were "over placed" in Calculus I. For these students, the success percentage was 76/97 x 100% = 78.4%. This high success percentage would indicate that the Calculus I cut-off placement score and MATH220 values could be somewhat lower, and a high success percentage would still result for Calculus I. Even though the number who received

a grade in Intermediate Algebra was not large, notice that the success ratio was quite good.

The most prominent subgroup in the area of over placement was the College of Engineering students with S = 61 (out of 76), U = 19 (out of 21) and Blank = 10 (out of 15) for a slightly smaller success percentage of 61/80 x 100% = 76.3%. This high success percentage indicated that advisors within the College of Engineering made appropriate placement decisions utilizing some other information regarding their students' mathematical prowess.

Table 4-4
Performance of Students Whose
Recommendation Was Calculus I

	F_COURSE									
	Math Review		Inter. Algebra		College Algebra		Calculus I			
COURSE	S	U	S	U	S	U	S	U	Blank	C
Math Review	1	1							1	
Inter. Algebra			4	2					3	
College Algebra				1	39	3	4	2	7	2
Calculus I					4		121	19	10	4
Totals	1	1	4	3	43	4	125	21	21	6

For those students who completed Calculus I as advised, the success percentage was 125/146 x 100% = 85.6%. For those students who were under placed, it can be quite easily seen that they were successful. Those who took College Algebra were of substantial enough number to calculate the success percentage of 43/47 x 100% = 91.5% so those who had a recognized algebra deficiency did complete College Algebra very successfully.

Table 4-5
Overall Student Performance
Regardless of Recommendation

	F_COURSE									
	Math Review		Inter. Algebra		College Algebra		Calculus I			
COURSE	S	U	S	U	S	U	S	U	Blank	C
Math Review	112	31	5						32	
Inter. Algebra	5	1	231	120	9	3			52	
College Algebra		1	16	3	405	94	3	2	60	6
Calculus I					15	1	223	49	32	11
Totals	117	33	252	123	419	98	226	51	176	17

Regardless of the course recommendation the freshmen success percentages obtained were:

Math Review	%S = 117/150 x 100% = 78.0%
Intermediate Algebra	%S = 252/375 x 100% = 67.2%
College Algebra	%S = 419/517 x 100% = 81.0%
Calculus I	%S = 226/277 x 100% = 81.6%

The Kansas State University Mathematics Department reported a population (all classes of students) success percentage for College Algebra in Fall 1985 of 46%. At 81%, the large freshmen subgroup was substantially greater for Fall 1986. The population success percentage for College Algebra Fall 1986 was 66.7%. A similar result was observed for Calculus I. For Fall 1985 the population success percentage was 62.0%. The Fall 1986 population success percentage was 70.2%, with the freshmen subgroup at 81.6%

Now, compare the overall percentages obtained from Table 4-5 to the data immediately following Tables 4-1, 4-2, 4-3, and 4-4. First from Table 4-1, the success percentage obtained was 79.7% versus the overall success percentage of 78.0%. These two would be expected to be nearly the same since Math Review has no prerequisite. That is, a student really could not be over placed in Math Review to deflate the overall success percentage.

For Intermediate Algebra, compare 61.0% (freshmen) to 67.2% (overall). Though there is not much difference, the slight increase may possibly be due to the inclusion of non-

freshmen. The older student taking Intermediate Algebra is a better student; that is, the older student is more mature and usually has better study habits than a freshman would. Traditionally, freshmen in this course are weaker students.

The College Algebra recommended students had a success percentage of 85.7% versus the overall freshmen success percentage of 81.0%. The former was naturally expected to be somewhat higher because the over placed students were obviously not included in the computation.

For Calculus I, reasoning similar to that for College Algebra would explain the difference between recommended Calculus I students success percentage of 85.6% versus the overall freshmen success percentage of 81.6%.

Major observations made from this portion of the study were that suggested requirements for Intermediate Algebra be raised in order to increase the success percentage of students recommended for Intermediate Algebra. For both College Algebra and Calculus I evidence from over placed students in each of the courses indicates that the requirements for each course could be lowered somewhat without doing too much harm to the success percentages.

Probably the most important results were how much better the Fall 1986 College Algebra and Calculus I success percentages were than those for Fall 1985. College Algebra changed from 46% to 66.7% with 1986 freshmen at 81%, and Calculus I changed from 62% to 70.2% with 1986 freshmen at

81.6%. For these two courses not only was a placement program in use, but the Mathematics Department employed paper graders for homework in these two classes. In the past, daily homework was not graded by instructors due to the vast number of students enrolled. Having graders may improve the success percentage somewhat; to what extent is unknown. That either one or both of these factors were entirely responsible for these increases is doubtful; though they each do have their merit. Other more likely factors that would influence the success percentages are the difficulty levels and fairness of testing and evaluation procedures and quality of instruction.

CHAPTER FIVE

CORRELATION ANALYSIS

To analyze the effect of the placement program on final grades, Pearson product-moment correlation coefficients were calculated for N_GRADE with each of the following predictor variables: ACT_MATH, SCORE, MATH100 (MATH100 correlated with N_GRADE only when F_COURSE was College Algebra), MATH220 (MATH220 correlated with N_GRADE only when F_COURSE was Calculus I). These correlations were done for each of the three courses. Correlation coefficients were done for each course in Fall 1986 and compared to the correlation coefficients obtained for the Fall 1985 courses.

Results are presented in tabular form. Each cell of the table includes data pertinent to the following hypothesis test:

H_0: There is no correlation between the variables ($\rho = 0$).

The probability of a Type 1 error, α, was set equal to 0.05 in making decisions regarding the rejection of H_0: $\rho = 0$. Each cell of the table contains the following information:

- r = Pearson product-moment correlation coefficient
- r^2 = Proportion of variance in N_GRADE attributable to the predictor variable
- p = Level of significance
- n = Number of students
- d = Decision

Table 5-1
Correlations of N_GRADE for Intermediate Algebra, College Algebra, and Calculus I With ACT_MATH, SCORE, MATH100, and MATH220 For 1985[a] and 1986

	Intermediate Algebra		College Algebra		Calculus I	
	1985	1986	1985	1986	1985	1986
ACT_MATH	0.163 0.0266 0.0150 221 *	0.21104 0.04454 0.0007 254 *	0.468 0.219 0.0001 614 *	0.29475 0.08688 0.0001 430 *	0.3704 0.1372 0.0001 331 *	0.27098 0.0734 0.0001 231 *
SCORE	0.285 0.08123 0.0001 233 *	0.32831 0.10779 0.0001 147 *	0.497 0.247 0.0001 489 *	0.30112 0.09067 0.0255 55 *	0.5034 0.2534 0.0001 328 *	0.28785 0.08286 0.4526 9 **
MATH100	+	+	+	0.34135 0.1165 0.0001 430 *	+	+
MATH220	+	+	+	+	+	0.22885 0.05237 0.0005 231 *

[a] Source of 1985 data: Sakirah Zakaria, A Comparison Between Mathematics or Certain Classes of Students at Kansas State University, Masters Thesis, Kansas State University, 1986.

* Conclusion: Reject H_0. There is a correlation between these two variables.

** Conclusion: Insufficient sample size for a valid test.

+ Information is unavailable or irrelevant to this course.

One important fact to point out in the preceding table was that r^2 was also reported. This was done because the values of r were not necessarily "that large" in order to be significant at the 0.05 level when dealing with larger values of n. Of stronger meaning would be r^2, as r^2 is the proportion of variance in N_GRADE explained by the variance in the particular predictor variable.

For all correlations available and relevant, save one, there was a significance. For the insignificant correlation between SCORE and N_GRADE for Calculus I, there were only nine students to determine the correlation coefficient. This number was really too small to consider this particular test valid. For all other 1985 data versus 1986 data tests were run to determine whether or not the 1986 correlation coefficients were significantly different than the 1985 correlation coefficients; that is,

H_0: There is no difference in correlation coefficients from 1985 to 1986.

Again for the hypothesis testing, $\alpha = 0.05$. Each hypothesis is symbolized below as H_0: $\rho = \rho_0$, where ρ_0 is the correlation coefficient found in 1985 and are the same as those in Table 5-1.

Intermediate Algebra

ACT_MATH	SCORE
$H_0 : \rho = 0.163$	$H_0 : \rho = 0.285$
$r = 0.21104$	$r = 0.32831$
$n = 254$	$n = 147$
$z = 0.776$	$z = 0.566$
$p = 0.4412$	$p = 0.56$

College Algebra

ACT_MATH	SCORE
$H_0 : \rho = 0.468$	$H_0 : \rho = 0.497$
$r = 0.29475$	$r = 0.30112$
$n = 430$	$n = 55$
$z = -4.19$	$z = -1.695$
$p \leq 0.0001$	$p = 0.091$

Calculus I

ACT_MATH	SCORE
$H_0 : \rho = 0.3704$	
$r = 0.27098$	Inadequate
$n = 231$	sample size
$z = -1.68$	$n = 9$
$p = 0.093$	

Only one correlation (ACT_MATH versus N_GRADE for College Algebra) was significantly different at the 0.05 level.

Table 5-2
Variability Measures for 1985 and 1986

	Intermediate Algebra		College Algebra		Calculus I	
	1985	1986	1985	1986	1985	1986
ACT_MATH						
Min	1	1	1	1	8	14
Max	28	25	35	36	36	36
Mean	13.841	14.390	19.763	22.299	26.491	27.482
Std Dev	5.616	5.297	5.747	4.280	4.280	3.433
ρ	0.16342	0.21104	0.46766	0.29475	0.37049	0.27098
SCORE						
Min	0	0	0	2	8	
Max	25	20	30	28	32	Inadequate
Mean	7.923	9.705	16.059	16.617	25.230	sample
Std Dev	4.365	3.470	5.660	5.106	4.675	size
ρ	0.28473	0.32831	0.49666	0.30112	0.50338	

From the above table a decrease in variability of predictors from 1985 to 1986 can be observed. This decrease in variability partially explains the decrease in the correlation coefficients for College Algebra and Calculus I. (Also, it should be noted that the minimum and maximum values given were for those who initially enrolled. These ranges would inevitably decrease by the end of the semester. Standard deviations of the predictors were also computed from initial enrollment rather than the final enrollment.) In Chapter Four the success percentages for College Algebra and Calculus I were up substantially. The success percentage would indicate that the distribution for N_GRADE is somewhat skewed, and by design the distributions for ACT_MATH and SCORE for 1986 were skewed more so than in 1985. This skewness attributed to the deflation of the correlation coefficients for College Algebra also.

Now, Intermediate Algebra, which had only a 67.2% success percentage, had an increase in correlation coefficients (though not significantly different). The average value of SCORE (9.705) being so low and the recommendation in Chapter Four to raise the values of SCORE and MATH100 required for placement in Intermediate Algebra would similarly reduce the correlation coefficients for Intermediate Algebra. These lower values of SCORE and ACT_MATH with the low N_GRADES were increasing the value of r.

Overall, the key items to focus on were the correlations between ACT_MATH and N_GRADE and SCORE with N_GRADE were significant at the 0.05 level. By using the placement procedure, each course obtained a more homogeneous and better prepared student enrollment. By reducing the variability in predictors the correlation coefficients were also reduced from 1985 values, but not significantly.

CHAPTER SIX

THE NECESSITY OF ACT RECOMMENDATION AND THE PLACEMENT EXAM

In Chapter One the guidelines for placement were outlined. Some students were placed by MATH100 and/or MATH 220, and others were placed by SCORE. Obviously those students who had not taken the ACT needed to take the Math Placement Exam and were placed according to SCORE. But students who had ACT_COMP $\leq$ 15 were also administered the Math Placement Exam. There were even a few students who had ACT_COMP$\geq$ 16 and completed the placement exam. Why the duplication of placement procedures for some students? In this chapter, for the above two subgroups and the entire enrollments for each course will be examined. By the end of this chapter the rationale for this procedure will be clarified.

Recall from Chapter One that students with ACT_COMP $\leq$ 15 and students without ACT scores were tested as a part of the Learning Skills program. (Students without ACT scores were typically poorer students.) It has been the experience of the university that these students require additional testing, in reading as well as mathematics. To verify this claim, there were 442 students with ACT scores administered the placement exam and of these, 327 (74.0%) were recommended to take Math Review according to ACT. But SCORE recommended only 161 out of 442 (36.4%) for Math Review. The more detailed distribution appears in the following table:

Table 6-1
Comparison of Placement By SCORE
Versus Placement By MATH100 and MATH220

	ACT Recommendation				
RECOMND	Calculus I	College Algebra	Intermediate Algebra	Math Review	Total
Calculus I	1	1	0	12	14
College Algebra	4	3	13	37	57
Inter. Algebra	11	3	55	141	210
Math Review	2	1	21	137	161
Total	18	8	89	327	442

Those numbers along the diagonal (\) of the table are those whose SCORE and ACT recommendation based on MATH100 and/or MATH220 were in agreement. Thus, 196 of the 442 (44.3%) would have been correctly placed based on ACT. The lower left-hand triangle total is the number of students placed higher by ACT than by SCORE (42 out of 442 or 9.5%). The right upper triangle of the table contains the numbers of students whose ACT recommendation was lower than that determined by SCORE (204 out of 442 or 46.2%).

In some instances (few to be sure), students with ACT_COMP $\geq$ 16 computed the placement exam. The students' MATH100 and/or MATH220 over placed the students. During

advisement, it was made evident to advisors that the students lacked prerequisite knowledge for the ACT recommended course. Thus, these students were administered the placement exam. It was also possible that a student may have guessed on the ACT and obtained a higher score than if he/she did not guess. Students who took the Math Placement Exam were strongly cautioned against guessing.

Another reason for further testing students with ACT_COMP $\leq$ 15 has been determined by the university. There are a few students who perform badly on the ACT due to test anxiety or other personal or extenuating circumstances. By administering the Math Placement Exam, more accurate advising was done for these individuals.

What follows are tables containing average ACT scores, placement scores, MATH100 and MATH220 values, and N_GRADES for each of the three monitored courses. Each course is divided into ACT_COMP determined subpopulations. The entire range of ACT scores is also included. These tables depict the differences between placement procedures. In the tables, values for ACT_COMP, ACT_MATH, and SCORE are given, though no hypothesis testing utilizing them are done. These are included to provide additional insight into the particular subpopulation or population dealt with. Also, recall that all students having a value for SCORE were placed by it regardless of the ACT recommendation.

Table 6-2
Average Values For
Intermediate Algebra Predictors and N_GRADE

	ACT_COMP ≤ 15		ACT_COMP ≥ 16		ACT_COMP All	
	n	Mean Std Dev	n	Mean Std Dev	n	Mean Std Dev
ACT_COMP	101	13.2475 1.7743	181	20.0773 2.5570	282	17.6312 4.0087
ACT_MATH	101	9.8812 4.2598	181	16.9061 3.9940	282	14.3900 5.2972
SCORE	152	9.6645 3.4563	14	10.1429 3.7181	166	9.7048 3.4698
MATH100	101	1.6157 0.6592	181	2.0422 0.6564	282	1.8895 0.6875
N_GRADE	176	2.3580 1.4232	166	2.5904 1.4316	342	2.4708 1.4299

For Intermediate Algebra no test can be run on MATH100 compared to N_GRADE because that is the predicted GPA in College Algebra for this particular group of students. Using the prediction tables in the Appendix and the above MATH100 values, the percentage of students earning a C or better in College Algebra was between 33% and 34% for ACT_COMP ≤ 15, 50% for ACT_COMP ≥ 16, and 46% overall. (Figures obtained by using both TH Index and T Index Tables found in the Appendix.) As these predicted percentages are low, it is not difficult to see why these students were recommended to Intermediate Algebra. Notice that both sub-

populations finished Intermediate Algebra with better than a C average.

The following hypothesis is tested with = 0.05.

H_0: There is no difference between the predicted final GPA's for students with ACT_COMP $\leq$ 15 and students with ACT_COMP $\geq$ 16 ($_{15}$ - $_{16}$ = 0; $_{15}$ = mean MATH100 for ACT_COMP $\leq$ 15 and $_{16}$ = mean MATH100 for ACT_COMP $\geq$ 16).

The obtained result is $z = -5.22$ where $p \leq 0.0001$. Thus, the predicted College Algebra grades for the two subpopulations are significantly different; that is, H_0 is rejected. Similarly,

H_0: There is no difference between final GPA's of the two groups ACT_COMP $\leq$ 15 and ACT_COMP $\geq$ 16 ($_{15}$ - $_{16}$ = 0, where $_{15}$ and $_{16}$ are the mean values of N_GRADE for ACT_COMP $\leq$ 15 and ACT_COMP $\geq$ 16 respectively).

Testing this hypothesis with = 0.05 yields, $z = -1.50$ and $p = 0.12$. So, H_0 cannot be rejected. Thus, the conclusion is that the final Intermediate Algebra grades were not significantly different even though the predicted College Algebra grades were. From this it can be concluded that the appropriate group is being targeted for administration of the Math Placement Exam. The ACT appears to under place lower ability students.

Now, for College Algebra the predicted success percentages, using the tables in the Appendix again, were 46% for ACT_COMP $\leq$ 15, 70-71% for ACT_COMP $\geq$ 16, and 70-71% overall. Recall that the actual success percentage in Chapter Four was 81%. In general, it would appear that MATH100

underestimated the students' overall performance. But, considering the ACT regression equations were determined based on a weaker group of students, it seems logical that MATH100 would be lower.

Table 6-3
Average Values For College
Algebra Predictors and N_GRADE

	ACT_COMP ≤ 15		ACT_COMP ≥ 16		ACT_COMP All	
	n	Mean Std Dev	n	Mean Std Dev	n	Mean Std Dev
ACT_COMP	26	14.0769 1.2304	425	22.6752 3.0956	451	22.1796 3.6247
ACT_MATH	26	14.1923 4.8910	425	22.7952 3.7085	451	22.2993 4.2798
SCORE	51	16.667 5.3653	9	16.3333 3.5000	60	16.6167 5.1060
MATH100	26	1.8563 0.5829	425	2.5408 0.4329	451	2.5013 0.4701
N_GRADE	116	2.3448 0.7857	406	2.6207 1.1107	522	2.5594 1.1175

For each subpopulation and the overall population the following hypothesis was tested:

H_0: There is no difference between the predicted final GPA and actual GPA attained in College Algebra (H_0: $n - m = 0$, where n = mean N_GRADE and m = mean MATH100).

with $\alpha = 0.05$.

ACT_COMP ≤ 15	ACT_COMP ≥ 16	ACT_COMP All
z = 3.60	z = 1.35	z = 1.08
p = 0.0004	p = 0.177	p = 0.2802

The result of the above data would be to reject H_0 for ACT_COMP $\leq$ 15 only. That is, MATH100 provided a close enough approximation for N_GRADE for the overall range of ACT scores and for students whose ACT_COMP $\geq$ 16. When ACT_COMP $\leq$ 15, however, MATH100 is significantly different than N_GRADE. Placing almost half (51 out of 116) of the students in ACT_COMP $\leq$ 15 by SCORE appeared to be more appropriate than placing them using MATH100.

Finally, for College Algebra, the N_GRADE's for ACT_COMP $\leq$ 15 and ACT_COMP $\geq$ 16 were compared.

> H_0: There is no difference in the final grades earned by those whose ACT_COMP $\leq$ 15 and by those whose ACT_COMP $\geq$ 16 ($\mu_{15} - \mu_{16} = 0$, where μ_{15} and μ_{16} are the mean N_GRADES for the two groups).

This test was run with $\alpha = 0.05$. With $z = -3.02$ and $p = 0.0026$, the conclusion was to reject H_0, and state that there was a difference in the final grades achieved by the two subpopulations. A substantial number of students in ACT_COMP $\leq$ 15 managed to bypass the placement system and enroll in College Algebra. The difference in N_GRADE's could be attributed partially to this. Also, it is to be expected that low ability students will not perform as well.

The mean N_GRADES for all the groups were greater than 2.3, the MATH100 cut-off value used to predict 62-63% success in College Algebra. Though there was a detectable difference between ACT_COMP $\leq$ 15 and ACT_COMP $\geq$ 16, the net effect was that the preset success percentage was surpassed.

In fact, according to the prediction charts 2.5594 would have predicted approximately 73-75% success. The actual value was 81.0%. Thus, in College Algebra the preset standards were attained quite well.

It appeared that MATH100 served as an accurate overall predictor and under this placement system a higher than anticipated success percentage was achieved. In Chapter Four the recommendation was that placement cut-off values for College Algebra could be lowered slightly and a high success percentage would still result. The results of this chapter affirm that recommendation.

Table 6-4
Average Values For
Calculus I Predictors and N_GRADE

	ACT_COMP $\leq$ 15		ACT_COMP $\geq$ 16		ACT_COMP All	
	n	Mean Std Dev	n	Mean Std Dev	n	Mean Std Dev
ACT_COMP	4	13.2500 0.5000	241	26.2448 3.0059	245	26.0327 3.4079
ACT_MATH	4	20.7500 4.7871	241	27.5934 3.3054	245	27.4816 3.4327
SCORE	8	25.6250 5.0973	2	26.5000 7.778	10	25.8000 5.2026
MATH100	4	1.9800 0.3666	241	2.3805 0.4296	245	2.3740 0.4311
N_GRADE	40	2.3750 1.1916	227	2.5242 1.0488	267	2.5019 1.0704

For Calculus I, the number of students with ACT_COMP $\leq$ 15 and a value for SCORE or MATH220 is really too small in comparison to ACT_COMP $\geq$ 16 to run a valid test comparing either MATH220 or N_GRADE. It would, however, be appropriate to test the following hypothesis at $\alpha = 0.05$:

H_0: There is no difference between the predicted final GPA and actual final GPA in Calculus I ($\mu_m - \mu_n = 0$, where μ_m = mean MATH220 and μ_n = mean N_GRADE).

For this test $z = 1.80$ and $p = 0.0718$. Thus, the evidence here indicates that there is no difference between the mean final grade and the predicted mean final grade. Thus, MATH220 appears to be a reasonably accurate predictor.

In summary, MATH100 and MATH220 are reasonable predictors of N_GRADE for ACT_COMP $\geq$ 16. For College Algebra and Intermediate Algebra, MATH100 appeared to underestimate the ability of students with ACT_COMP $\leq$ 15. Being placed by SCORE rather than MATH100 was the appropriate measure. Those students who managed to "slip through the cracks" and avoid the placement procedure may lower the N_GRADE of particular groups, because, as said earlier, without placement guidelines advisors tend to over place their students.

CHAPTER SEVEN

CONCLUSION

Findings

At the onset of this report the main purpose of this report was to evaluate the placement procedure with which freshmen were placed in entry-level mathematics courses. To assess the effectiveness of the procedure, success percentages were figured and compared to the success percentages from the previous year, correlations between final grades and predictors were calculated, and predicted final grades in College Algebra and Calculus I were tested for accuracy. The most prominent findings are recounted here. Recall from Chapter One the null hypotheses that were to be tested within this report that support the following results.

First, and probably the most notable result, was the freshmen success percentages experienced in Fall 1986. The freshmen success percentages were 78.0% for Math Review, 67.2% for Intermediate Algebra, 81.0% for College Algebra, and 81.6% for Calculus I. From data available from Fall 1985, the overall success percentage for College Algebra was 46% and for Calculus I 62.0%. The overall success percentages for College Algebra and Calculus I for Fall 1986 were 66.7% and 70.2%, respectfully. The large freshmen subpopulation in each course had a dramatic effect on the overall success percentages.

Second was the correlation analysis. The expectation here was that the correlation coefficients would increase

across the board from 1985 to 1986. In fact, only one correlation coefficient in 1986 differed significantly from 1985. What was actually experienced was a change in range of scores and score variabilities that reduced the correlation coefficients. By placing a more homogeneous group into a course, the range of the predictors is cut as well as the variability. It should be noted though, that in spite of this lack of variability, the correlation coefficients were still significant when the number of students involved was adequate.

Third, the predicted final grades, MATH100 and MATH220, proved to be accurate for the overall range of ACT scores and for students whose ACT_COMP $\geq$ 16. Both, however, underestimated students with ACT_COMP $\leq$ 15. These were the students who were administered the Mathematics Placement Exam. SCORE proved to be a better placement tool for these students. From the data, it was observed that the appropriate group of students is being targeted for further testing.

Recommendations

Recommendations to improve the placement system are few at present. To improve the success percentage of Intermediate Algebra, the lower limits of SCORE and MATH100 should be raised to 8 or 9 and 1.699 respectively. This would place more students lacking in mathematical fundamentals in Math Review. The lower limits for SCORE and

MATH100 should be lowered to 15 or 16 and 2.199 respectively for College Algebra and SCORE and MATH220 lowered to 25 or 26 and 2.199 respectively for Calculus I, and a high success percentage would still result. In the cases of the latter two, students who took these classes who were thought to be over placed actually performed quite well. Although, with newly generated regression equations from ACT each year, this situation may "cure" itself.

By observing the success of this program, hopefully advisors will utilize the information better when counseling enrollees. Steps should be taken to minimize the number of students who are not placed at all. These students often times do not fair as well as those under advisement.

Overall the placement system was quite successful. Those individuals involved in testing and advising are to be commended.

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APPENDIX

The following information is a portion of the ACT Standard Research Service Report received by Kansas State University.

KANSAS STATE UNIV COLLEGE CODE 1428 SUB-GROUP - 1 SUMMARY A

TABLE LI - 2.1 COMPUTATIONAL TABLE FOR PREDICTING COLLEGE ALGEBRA

STEP 1. TO PREDICT G.P.A. FROM ACT SCORES, ADD THE APPROPRIATE DIGITS FROM FIGURE 1 TO THE ACT CONSTANT (-4), THEN MARK OFF ONE DECIMAL POSITION.

STEP 2. TO PREDICT G.P.A. FROM HIGH SCHOOL GRADES ADD THE APPROPRIATE DIGITS FROM FIGURE 2 TO THE HIGH SCHOOL CONSTANT (-1), THEN MARK OFF ONE DECIMAL POSITION.

STEP 3. TO OBTAIN THE OPTIMUM ACT INDEX, AVERAGE THE TWO PREDICTIONS.

FIGURE 2

H.S. GRADES	(GRADE) X (REGR. COEF.) ENG.	MATH.	SOC.S.	N.SCI.
A = 4	9	12	9	2
B = 3	7	9	7	1
C = 2	5	6	4	1
D = 1	2	3	2	0

REGRESSION COEFFICIENTS

	B0	B1	B2	B3	B4
ACT SCORES	-0.426	0.031	0.116	-0.019	0.003
H.S. GRADES	-0.106	0.231	0.299	0.217	0.041

FIGURE 1

ACT SCORE	(SCORE) X (REGR. COEF.) ENG.	MATH.	SOC.S.	N.SCI.
36	11	42	-7	1
35	11	40	-7	1
34	10	39	-6	1
33	10	38	-6	1
32	10	37	-6	1
31	10	36	-6	1
30	9	35	-6	1
29	9	34	-6	1
28	9	32	-5	1
27	8	31	-5	1
26	8	30	-5	1
25	8	29	-5	1
24	7	28	-5	1
23	7	27	-4	1
22	7	25	-4	1
21	6	24	-4	1
20	6	23	-4	1
19	6	22	-4	1
18	6	21	-3	1
17	5	20	-3	1
16	5	19	-3	1
15	5	17	-3	1
14	4	16	-3	0
13	4	15	-2	0
12	4	14	-2	0
11	3	13	-2	0
10	3	12	-2	0
9	3	10	-2	0
8	2	9	-2	0
7	2	8	-1	0
6	2	7	-1	0
5	2	6	-1	0

KANSAS STATE UNIV COLLEGE CODE 1428 SUB-GROUP - 1 SUMMARY A

TABLE LI - 2.2 COMPUTATIONAL TABLE FOR PREDICTING CALCULUS A

STEP 1. TO PREDICT G.P.A. FROM ACT SCORES, ADD THE APPROPRIATE DIGITS FROM FIGURE 1 TO THE ACT CONSTANT (-13), THEN MARK OFF ONE DECIMAL POSITION.

STEP 2. TO PREDICT G.P.A. FROM HIGH SCHOOL GRADES ADD THE APPROPRIATE DIGITS FROM FIGURE 2 TO THE HIGH SCHOOL CONSTANT (-12), THEN MARK OFF ONE DECIMAL POSITION.

STEP 3. TO OBTAIN THE OPTIMUM ACT INDEX, AVERAGE THE TWO PREDICTIONS.

FIGURE 2

H.S. GRADES	(GRADE) X (REGR. COEF.) ENG.	MATH.	SOC.S.	N.SCI.
A = 4	18	1	5	15
B = 3	13	1	4	12
C = 2	9	1	3	8
D = 1	4	0	1	4

REGRESSION COEFFICIENTS

	B0	B1	B2	B3	B4
ACT SCORES	-1.286	0.026	0.119	-0.021	0.008
H.S. GRADES	-1.212	0.439	0.037	0.128	0.384

FIGURE 1

ACT SCORE	(SCORE) X (REGR. COEF.) ENG.	MATH.	SOC.S.	N.SCI.
36	9	43	-8	3
35	9	42	-7	3
34	9	40	-7	3
33	9	39	-7	3
32	8	38	-7	2
31	8	37	-7	2
30	8	36	-6	2
29	7	34	-6	2
28	7	33	-6	2
27	7	32	-6	2
26	7	31	-5	2
25	6	30	-5	2
24	6	28	-5	2
23	6	27	-5	2
22	6	26	-5	2
21	5	25	-4	2
20	5	24	-4	2
19	5	23	-4	1
18	5	21	-4	1
17	4	20	-4	1
16	4	19	-3	1
15	4	18	-3	1
14	4	17	-3	1
13	3	15	-3	1
12	3	14	-3	1
11	3	13	-2	1
10	3	12	-2	1
9	2	11	-2	1
8	2	9	-2	1
7	2	8	-1	1
6	2	7	-1	0
5	1	6	-1	0

KANSAS STATE UNIV COLLEGE CODE 1428 SUB-GROUP - 1 SUMMARY A

TABLE LI - 3.1 G.P.A. EXPECTANCIES IN COLLEGE COLLEGE ALGEBRA

BASED ON TH INDEX, PERCENT EXPECTED TO EARN -					BASED ON T INDEX, PERCENT EXPECTED TO EARN -				
PREDICTED G.P.A.	LESS THAN 1.0 (D)	LESS THAN 2.0 (C)	2.0 (C) OR HIGHER	3.0 (B) OR HIGHER	LESS THAN 1.0 (D)	LESS THAN 2.0 (C)	2.0 (C) OR HIGHER	3.0 (B) OR HIGHER	PREDICTED G.P.A.
3.6	0	4	96	75	0	5	95	73	3.6
3.5	0	5	95	71	0	6	94	70	3.5
3.4	0	6	94	67	1	7	93	66	3.4
3.3	1	7	93	63	1	9	91	62	3.3
3.2	1	9	91	59	1	11	89	58	3.2
3.1	1	11	89	54	1	13	87	54	3.1
3.0	1	13	87	50	2	15	85	50	3.0
2.9	2	16	84	46	2	17	83	46	2.9
2.8	2	19	81	41	3	20	80	42	2.8
2.7	3	22	78	37	4	23	77	38	2.7
2.6	4	25	75	33	5	27	73	34	2.6
2.5	5	29	71	29	6	30	70	30	2.5
2.4	6	33	67	25	7	34	66	27	2.4
2.3	7	37	63	22	9	38	62	23	2.3
2.2	9	41	59	19	11	42	58	20	2.2
2.1	11	46	54	16	13	46	54	17	2.1
2.0	13	50	50	13	15	50	50	15	2.0
1.9	16	54	46	11	17	54	46	13	1.9
1.8	19	59	41	9	20	58	42	11	1.8
1.7	22	63	37	7	23	62	38	9	1.7
1.6	25	67	33	6	27	66	34	7	1.6
1.5	29	71	29	5	30	70	30	6	1.5
1.4	33	75	25	4	34	73	27	5	1.4
1.3	37	78	22	3	38	77	23	4	1.3
1.2	41	81	19	2	42	80	20	3	1.2
1.1	46	84	16	2	46	83	17	2	1.1
1.0	50	87	13	1	50	85	15	2	1.0

KANSAS STATE UNIV COLLEGE CODE 1428 SUB-GROUP - 1 SUMMARY A

TABLE LI - 3.2 G.P.A. EXPECTANCIES IN COLLEGE CALCULUS A

BASED ON TH INDEX, PERCENT EXPECTED TO EARN -					BASED ON T INDEX, PERCENT EXPECTED TO EARN -				
PREDICTED G.P.A.	LESS THAN 1.0 (D)	LESS THAN 2.0 (C)	2.0 (C) OR HIGHER	3.0 (B) OR HIGHER	LESS THAN 1.0 (D)	LESS THAN 2.0 (C)	2.0 (C) OR HIGHER	3.0 (B) OR HIGHER	PREDICTED G.P.A.
3.6	1	6	94	72	1	7	93	71	3.6
3.5	1	8	92	68	1	9	91	67	3.5
3.4	1	9	91	65	1	10	90	64	3.4
3.3	1	11	89	61	2	12	88	61	3.3
3.2	2	13	87	58	2	14	86	57	3.2
3.1	2	15	85	54	3	16	84	54	3.1
3.0	3	17	83	50	3	18	82	50	3.0
2.9	3	20	80	46	4	21	79	46	2.9
2.8	4	22	78	42	5	23	77	43	2.8
2.7	5	25	75	39	6	26	74	39	2.7
2.6	6	28	72	35	7	29	71	36	2.6
2.5	8	32	68	32	9	33	67	33	2.5
2.4	9	25	65	28	10	36	64	29	2.4
2.3	11	29	61	25	12	39	61	26	2.3
2.2	13	42	58	22	14	43	57	23	2.2
2.1	15	46	54	20	16	46	54	21	2.1
2.0	17	50	50	17	18	50	50	18	2.0
1.9	20	54	46	15	21	54	46	16	1.9
1.8	22	58	42	13	23	57	43	14	1.8
1.7	25	61	39	11	26	61	39	12	1.7
1.6	28	65	35	9	29	64	36	10	1.6
1.5	32	68	32	8	33	67	33	9	1.5
1.4	25	72	28	6	36	71	29	7	1.4
1.3	29	75	25	5	39	74	26	6	1.3
1.2	42	78	22	4	43	77	23	5	1.2
1.1	46	80	20	3	46	79	21	4	1.1
1.0	50	83	17	3	50	82	18	3	1.0

EVALUATION OF THE MATHEMATICS PLACEMENT PROCEDURE AT KANSAS STATE UNIVERSITY

By

Carla Lynn Geier

B.S., Friends University, 1985

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Mathematics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

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During freshmen enrollment for fall 1986, freshmen were placed into entry-level mathematics courses based on either predictor variables utilizing their ACT scores or the scores achieved on the Mathematics Placement Exam (For A/4A). Students without ACT scores were administered the placement exam. Those students with an ACT Composite score of 15 or below were also administered the exam. Unless some circumstance warranted it, students with an ACT Composite score of 16 or more did not complete the exam. If they did complete the exam, the placement score was used to make recommendations. The ACT predictor variables were arrived at using regression equations supplied to Kansas State University by ACT's Standard Research Service. The recommendations made were Math Review, Intermediate Algebra, College Algebra, and Calculus I. For students who did not complete the placement exam, there was no recommendation made.

Success in a course was defined as the final grades of A, B, or C in a course. For each of the above four courses the success percentages were calculated. The success percentages were: Math Review - 78.0%, Intermediate Algebra-67.2%, College Algebra - 81.0%, and Calculus I - 81.6%. For the latter two there were substantial increases over the fall 1985 enrollment.

Pearson product-moment correlation coefficients were figured for final grades (using a 4.0 scale) with each of the following: ACT Mathematics score, placement exam score, MATH100, and MATH220. The latter two are the predictor

variables generated by the ACT regression equations. They are the predicted GPA's for College Algebra and Calculus I respectively. All correlation coefficients were significant at the 0.05 level. There were slight differences in the correlation coefficients from 1985 to 1986, though the differences were not significant. These changes in the correlation coefficients were brought on by the reduced variability in each of the course populations. The placement program reduced the variability in each of these populations, hence affecting the correlation coefficients.

The third result of this study supports the need to retest those students with an ACT Composite score of 15 or less. The recommendation given by ACT for these students tended to underestimate the ability of students. For example, the predicted College Algebra GPA for these students, as figured by the ACT predictors, differs substantially from the final GPA of this group. Thus, the right group was being selected to complete the placement exam.

Recommendations to improve this program were to raise the requirements for enrollment in Intermediate Algebra, and lower those for College Algebra and Calculus I. As evidenced by the success percentages, the implementation of the placement program has improved the student performance in the entry-level mathematics courses. Only slight refining was recommended to be done to the program.