COMPUTERIZED PLACEMENT TESTS AS A PREDICTOR OF SUCCESS IN COLLEGE LEVEL MATHEMATICS COURSES AT SURRY COMMUNITY COLLEGE

A Thesis

By

RICHARD WISTAR WOOLDREDGE

Submitted to the Graduate School

Appalachian State University

in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

June 1997

Major Department: Psychology

William Leonard Eury
Appalachian Collection

COMPUTERIZED PLACEMENT TESTS AS A PREDICTOR OF SUCCESS IN COLLEGE LEVEL MATHEMATICS COURSES AT SURRY COMMUNITY COLLEGE

A Thesis

by

Richard Wistar Wooldredge

APPROVED BY:

Paul A Fox

Paul A. Fox
Chairperson, Thesis Committee

Verne R. Bacharach

Verne R. Bacharach
Member, Thesis Committee

Stanley R. Aeschleman
Member, Thesis Committee

James D. Long

James D. Long
Chairperson, Department of Psychology

EDHuntley

E. D. Huntley
Associate Dean, Graduate Studies and Research

ABSTRACT

COMPUTERIZED PLACEMENT TESTS AS A PREDICTOR OF SUCCESS IN COLLEGE LEVEL MATHEMATICS COURSES AT SURRY COMMUNITY COLLEGE. (June, 1997)

Richard Wistar Wooldredge, B.S., Gardner-Webb College

M.A., Appalachian State University

Thesis Chairperson: Paul A. Fox

Admissions personnel at Surry Community College have used students' scores on the mathematics section of the Computerized Placement Test to make placement recommendations since February of 1993. Although the Educational Testing Service has conducted its own correlational research on the predictive validity of the Computerized Placement Test, the present study was conducted to determine the extent to which the mathematics section of the Computerized Placement Test predicted grades in entry level mathematics courses at Surry Community College and to determine appropriate cut-off scores.

Data were gathered from 402 Surry Community College students who had taken at least one mathematics section of the Computerized Placement Test and had completed a course in either introductory algebra, intermediate algebra, or college algebra and trigonometry at the college.

A bi-variate regression analysis was performed using the course grades and the Computerized Placement Test scores. Results indicated that the elementary algebra section of the Computerized Placement Test was the best predictor of grades for both introductory and intermediate algebra courses and that the college level mathematics section of the Computerized Placement Test was the best predictor of grades in college algebra and trigonometry courses. As a result of these analyses, cut-off scores were selected that would allow for the prediction of a grade of "C" or better 70% of the time.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Paul Fox, and my committee members, Dr. Vernon Bacharach and Dr. Stan Aeschleman for the time they have invested during the completion of this thesis. I would also like to express my appreciation to Anne Bishop and Robert Nicklow for their friendship and guidance during the years that I needed it the most. Finally, I would like to thank Jody Hartle for the encouragement and support she has given me to complete this thesis.

DEDICATION

This thesis is dedicated to my mother, Zenaide Jenkins Ward, and in memory of my grandmother, Grace McMillian Jenkins.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Concern over the degree to which college students are prepared for college-level work is not a new phenomenon. Higher education in this country has historically been a means of upward mobility for emigrants and the poor. Space has typically been reserved for the sometimes unqualified, but politically connected students. Availability of students, and thus admission standards, have fluctuated over time (Maxwell, 1979). As a result, even the most prestigious colleges and universities have had student populations that varied in the degree to which individuals were prepared for college-level course work (Maxwell, 1979). Things are no different today. Current estimates place the number of entering college students that are academically underprepared at approximately 50% (Gabriel, 1989; Mitter & Bers, 1994).

Prior to the twentieth century, secondary school and early college success were used to determine whether a student was prepared for college (Maxwell, 1979). With the establishment of the College Entrance Examination Board (CEEB) in 1900, colleges and universities began to identify underprepared students on the basis of scores obtained on college entrance exams (Rounds & Anderson, 1985). Because admissions tests were created to be used in the initial admissions process, a separate category of instruments was later developed to identify those areas in which a student lacked the knowledge necessary to succeed in specific college-level classes. These tests came to be known as placement tests. Most colleges and universities now use these tests (sometimes in combination with high school grade point averages and/or college entrance exam scores) as part of their academic placement procedures (College Entrance Examination Board [CEEB] and Educational Testing Service [ETS], 1993; Maxwell, 1979; Morante, 1989).

Although there was a move away from mandatory testing and remedial placement during the 1960s and 1970s, most colleges and universities have reestablished such testing and placement procedures (Rounds & Anderson, 1985). The emphasis on mandatory testing and placement is due, in part, to recent studies that have indicated that such programs are effective. Rounds and Anderson (1985) stated that "an increasing number of studies show significant gains in retention and GPA data for those students who were tested and placed in courses meeting their skill needs" (p.11).

An effective testing and placement program is more essential at community colleges than it is at four-year colleges and universities. Unlike most four-year institutions, community colleges typically have a broader mission and an open door policy which allows anyone to register for classes regardless of academic accomplishment

(Rounds & Anderson, 1985). In addition, "community college students are often more diverse in terms of age, background, employment status, preparation, and educational objective than their four-year college or university counterparts" (Seybert, 1994, p.24). These factors contribute to the increased variability of academic achievement of the students found at community colleges.

At Surry Community College (SCC), where this study took place, there has been a move away from the current voluntary testing and placement program toward a mandatory program. This change is due, in part, to the low number of students at SCC who have taken the placement test (60%) and/or conformed to counseling recommendations. Moreover, the North Carolina Department of Community Colleges is requiring that all community colleges in the system move toward a mandatory testing and placement system (Church, 1994; J. M. Brame, personal communication, May 17, 1996).

The test currently used to make placement recommendations at SCC is the Computerized Placement Test (CPT) that was developed jointly by the CEEB and Educational Testing Service (ETS) (J. M. Brame, personal communication, May 17, 1996; CEEB and ETS, 1993). Since all incoming SCC students are now required to take the CPT, there has been increasing concern over how valid the CPT is for use at SCC and over the appropriateness of the current cut-off scores.

Although the CEEB and ETS have conducted their own study on the relationship between CPT scores and college grades, SCC has a student population that differs from those that attended the colleges and universities that were part of the CEEB/ETS study. In the study conducted by the CEEB and ETS, students from four-year colleges and universities were included (37.9% of the total sample). As cited before, community colleges typically have a student population that differs significantly in academic achievement, goals, and background from those students found at four-year institutions. In addition, the demographics of sex and race differ in the CEEB/ETS study and the population found at SCC. SCC has a student population that is 62.2% female and 95.0% white. The student population used in the CEEB/ETS study was 49.7% female and 61.4% white (CEEB and ETS, 1993; SCC, 1995).

One other area that was of concern when considering the validity of the CPT for use at SCC is that SCC mathematics course content may differ from those mathematics courses used in the CEEB/ETS study. In the one instance in which the title of the SCC course is the same as a course in the CEEB/ETS study (intermediate algebra), there is no evidence that the content of the courses are equivalent.

In addressing these issues, Maxwell (1979) pointed out that "it is important that the [placement] instruments have local norms and validity for the purposes for which they are to be used" since institutions often differ in the type and/or content of their courses and in their student make-up (p. 45). Failure to establish these local norms and validity will often result in inappropriate cut-off scores and either an under or over assignment of students to remedial courses (Maxwell, 1979).

As a result of the concerns over the CPT, the Mathematics Division at SCC adopted as one of its goals for the 1995-1996 school year a study of the mathematics section of the CPT. This study was conducted to address two related questions. The first concern is the validity of the CPT's arithmetic, elementary algebra, and college-level math scores as predictors of grades in college-level math courses. The second area of interest is the validity of the current cut-off scores for these CPT sections. In the past, cut-off scores were obtained through the guess work of instructors in the math department (D. D. Atkins, personal communication, September 9, 1995).

Previous CPT Research

CPTs are adaptive tests in that they automatically adjust to the skill level of the individual as the test progresses. This adjustment helps overcome some of the limitations of conventional pencil and paper tests which are the same for all test-takers and typically have only a small number of questions that discriminate between test-takers at either the upper or lower end of the skill range. This adaptive function also shortens the average testing time and helps to keep the student interested and challenged, thus increasing the validity of the results (Smittle, 1990). Since CPTs were designed to be used by post secondary institutions to place students in appropriate classes, the test must have predictive validity to function effectively in that capacity (CEEB and ETS, 1993; Smittle, 1990).

To measure predictive validity, test scores were correlated with grades in seven mathematics courses at 50 colleges and universities. In the CEEB/ETS study, correlation coefficients ranged from a high of .49 to a low of .19. (see Table 1 for correlational data) (CEEB and ETS, 1993).

It should be noted that since students were placed in different levels of courses based in part on their scores on the CPT and on the results of other tests, the makers of the CPT believe "that the correlations underestimate the true value of CPTs as a placement measure" (CEEB and ETS, 1993, p. 53).

Statement of the Problem

There are two areas of concern in this study. First, to determine which, if any, of the mathematics sections of the CPT (arithmetic, elementary algebra, or college-level mathematics) are valid predictors of the grades students receive in introductory algebra, intermediate algebra, or college algebra and trigonometry at SCC. The second concern

Table 1

Correlation of Computerized Placement Tests with College Grades

CPT	College Course	*r*
Arithmetic	General Math	.38
	Arithmetic	.31
	Elementary Algebra	.33
	Intermediate Algebra	.38
Elementary Algebra	Elementary Algebra	.19
	Intermediate Algebra	.33
	College Algebra	.26
	Precalculus	.38
	Calculus	.31
College Level Mathematics	Elementary Algebra	.34
	Intermediate Algebra	.34
	College Algebra	.32
	Precalculus	.33
	Calculus	.49

Note: Significance (*p*) levels were not published.

was to determine whether any of the CPT mathematics tests are valid predictors of performance in these introductory, college-level mathematics courses, and where the cut-off scores should be set to make appropriate placement decisions at SCC.

METHOD

Participants

Participants were selected for the study on the basis of three criteria. First, students were included in the data base only if they had completed at least one math section of the CPT. Second, students were chosen for the study only if they had completed an introductory algebra, intermediate algebra, or college algebra and trigonometry class that had been taught by one of the SCC mathematics instructors. Finally, the grades achieved in these courses were included in the data base only if the student had not completed a remedial mathematics course prior to obtaining the grades. This was done because any instruction received after taking the CPT and before taking the college-level math course would be a confounding variable. A total of 402 students met the above criteria and were included in the study.

Materials and Procedure

Beginning in February 1993, when CPT testing was first placed in service at SCC, students who applied to the college were advised to take the CPT. Out of these entering students, approximately 60% reported to the Learning Lab during the hours scheduled for placement testing. Once in the Learning Lab, each student took the CPT on one of the personal computers programmed for this task, and the students' scores were entered into the main computer system for the college (J. M. Brame, personal communication, September 16, 1995).

When taking the mathematics sections of the CPT, questions were presented one at a time in the form of either a multiple choice question or in a free response format in which the answer was typed in. Once the student selected and confirmed a response, the answer could not be changed. The number of questions, the question format, and the subject matter varied depending on the test section taken. In the arithmetic section of the CPT, there were a total of 16 multiple choice questions to be answered in three categories: operations with fractions and whole numbers, applications and problem solving, and operations with decimals and percents. The elementary algebra section of the CPT contained 12 multiple choice questions in three areas: operations with algebraic expressions; operations with integers and rational numbers; and equation solving, inequalities, and word problems. The last CPT mathematics section, college-level mathematics, was comprised of 20 multiple choice and free response questions pertaining to five categories: algebraic operations, coordinate geometry, functions and trigonometry, applications and other algebraic topics, and solutions of equations and inequalities. (CEEB and ETS, 1993).

Data Collection and Analysis

After acquiring written permission from SCC's Dean of Student Services, the data for this study were obtained from academic records with the assistance of the Director of Planning and Institutional Research and the Director of Administrative Computer Services. During the data collection phase, personnel at SCC were advised that data from individuals would be assigned identification numbers, and that the participants' names would not be used or published in any way.

After assigning grades numerical values (A = 4, B = 3, C = 2, D = 1, and W or F = 0), Minitab software was used to complete bi-variate regression analyses on grades and the math CPT scores. A significance level (p value) was set at .05 prior to conducting the analysis.

As in the original studies conducted by the CEEB and ETS, it was decided that only single CPT scores would be used as predictor variables. This was done for two reasons. First, the use of a combination of CPT scores as predictor variables would require the computation of a confidence interval table that had all of the possible combinations of the two or three scores that a student could get on each CPT section. Personnel at SCC felt that this would produce a table that was too complex for use in the admissions process. Secondly, since the CPT provides scores on only those sections that the test taker had the competence to attain, the use of a single CPT score as a predictor variable increases the likelihood that a student will have obtained a score on the CPT section being used for making placement decisions.

Finally, cut-off scores were determined for introductory algebra, intermediate algebra, and college algebra and trigonometry. To establish cut-off scores, a table of confidence intervals for predicted values for each of the three math courses was constructed. A confidence interval of 70% was selected because it was the highest confidence interval that provided a usable (reasonably narrow) grade prediction range.

RESULTS

After completing the bi-variate regression analyses, the number of cases (*n*), the regression coefficient (*R*), and the significance level (*p*) were used as the criteria to make decisions on which CPT section was the best predictor of grades in each of the three math courses (see Table 2 for correlational data).

Since single CPT scores were used as predictor variables, elementary algebra was the best predictor variable for both introductory algebra (R = .34) and intermediate algebra (R = .32). For college algebra and trigonometry, the college math section of the CPT was the best predictor of grades (R = .53).

After computing two-tailed confidence intervals, cut-off scores were selected that predicted a course grade that would be, at worst, a low "C" 70% of the time. For introductory algebra, an elementary algebra cut-off score of 25 or better was recommended; for intermediate algebra, an elementary algebra cut-off score of 55 or better was recommended; and for college algebra and trigonometry, a college level math cut-off score of 30 or better was recommended (see Table 3 for the 70% confidence intervals).

Table 2

Correlation of Computerized Placement Tests with Math Grades

Test	Mathematics Course	R	p
Arithmetic	Introductory Algebra	.15	N.S.
	Intermediate Algebra	.10	N.S.
	College Algebra & Trigonometry	.15	N.S.
Elementary Algebra	Introductory Algebra	.34	*
	Intermediate Algebra	.32	*
	College Algebra & Trigonometry	.00	N.S.
College Level Mathematics	Introductory Algebra	.09	N.S.
	Intermediate Algebra	.11	N.S.
	College Algebra & Trigonometry	.53	*

*$p \leq .05$ N.S. = Nonsignificant

Table 3

70% Confidence Intervals for Recommended Predictor Variables

Introductory Algebra (MAT 090)

*EA Score	70% CI	*EA Score	70% CI
20	1.371 - 1.842	60	2.561 - 3.164
***25	1.556 - 1.970	65	2.667 - 3.362
30	1.733 - 2.108	70	2.791 - 3.561
35	1.898 - 2.257	75	2.904 - 3.763
40	2.049 - 2.419	80	3.015 - 3.965
45	2.188 - 2.594	85	3.126 - 4.000
50	2.318 - 2.778	90	3.237 - 4.000
55	2.442 - 2.969	95	3.347 - 4.000
		100	3.456 - 4.000

Intermediate Algebra (MAT 091)

*EA Score	70% CI	*EA Score	70% CI
20	0.340 - 0.996	60	1.778 - 2.115
25	0.542 - 1.114	65	1.909 - 2.315
30	0.742 - 1.235	70	2.034 - 2.511
35	0.940 - 1.359	75	2.155 - 2.711
40	1.131 - 1.488	80	2.273 - 2.913
45	1.313 - 1.627	85	2.390 - 3.117
50	1.483 - 1.778	90	2.506 - 3.322
***55	1.637 - 1.945	95	2.622 - 3.528
		100	2.736 - 3.734

College Algebra and Trigonometry

**CM Score	70% CI	**CM Score	70% CI
10	0.518 - 0.941	45	2.398 - 2.655
15	0.805 - 1.168	50	2.632 - 2.935
20	1.089 - 1.397	55	2.861 - 3.218
25	1.369 - 1.631	60	3.088 - 3.505
***30	1.642 - 1.871	65	3.314 - 3.793
35	1.905 - 2.121	70	3.538 - 4.000
40	2.156 - 2.283	75	3.761 - 4.000
		80	3.984 - 4.000

* Elementary Algebra (CPT)
** College Level Mathematics (CPT)
*** Cut-off Scores

DISCUSSION

This study was conducted to determine if the mathematics sections of the CPT are valid predictors of students' grades in the three entry-level mathematics courses offered at SCC. It was questioned whether the initial study completed by the makers of the CPT was valid for SCC. Therefore, the CEEB/ETS data were not used as a means of accepting or rejecting the use of the CPT as a placement tool at the college.

There were three reasons for questioning the validity of the CEEB/ETS study. The first was the contention that the student population at SCC differed from the one used in the original study. Secondly, only one course (intermediate algebra) was of the same course title as those in CEEB/ETS study. Finally, in the case of intermediate algebra, there is no evidence that the courses used in the original study covered the same material as those taught at SCC.

Support for the hypothesis that the initial CEEB/ETS study was not valid as a means for determining the effectiveness of the CPT as a placement tool at SCC can be seen in the results of this study. In the CEEB/ETS study, the arithmetic, elementary algebra, and college level mathematics sections of the CPT were reported to be valid predictors of success in intermediate algebra courses ($\underline{R}$ =

.38, $\underline{R}$ = .33, and $\underline{R}$ = .34, respectively). In the SCC study, only the elementary algebra section of the CPT was shown to be a valid predictor of grades in intermediate algebra classes ($\underline{R}$ = .32).

Having obtained predictive statistics specific to SCC, the question returns to that of the validity of the mathematics sections of the CPT as predictors of course grades in the three introductory mathematics courses. Although this study yielded only moderate correlations between the CPT and the mathematics courses, administrators at SCC have decided to continue to use the CPT as a placement tool.

The reason cited for the continued use of the CPT is that SCC personnel believe that the CPT is actually a better predictor of grades than is indicated by this study. Since 50% of the students complied with the recommendation to enter remedial courses prior to taking mathematics courses, the lower-end CPT scores are underrepresented in these classes. As a result, the variability of CPT scores is decreased and variables such as motivation and other personal variables have a greater influence on grade outcomes.

The second part of this study was completed in compliance to requests by admissions personnel at SCC. Since the original cut-off scores were based purely on intuition and guess work, there was a push to determine empirically justifiable cut-off scores that could be used in making placement decisions. During this phase, personnel in the Mathematics Department of SCC believed that the use of two-tailed confidence intervals was the best means of determining cut-off scores. After the completion of this study, it was recommended to the mathematics department that future studies on this topic use a one-tailed confidence interval to determine CPT cut-off scores. By using a one tailed test, the CPT cut-off score should decrease and, as a result, be a more accurate predictor of course success since all confidence intervals for grades would include grade ranges up to a 4.0.

In addition to the recommendation of using a one-tailed test, it was also recommended that the CPT continue to be administered so that all students complete as much of the test as they are capable of completing and that they start at the beginning of the test (the arithmetic section). Until June of 1994, students at SCC were allowed to access and stop at different levels of the CPT. As a result, CPT data was lost that otherwise would have been available for analysis. Because of this confound, personnel in the Mathematics Division have decided to replicate this study in the 1996/97 school year using data collected since June of 1994.

One final recommendation was made as a result of this study. Since there is evidence that post-secondary schools may vary in the degree to which their student and course variables are the same as those found in the CEEB/ETS study, each college and university should conduct its own study to determine the validity of the use of the CPT at their specific institution.

REFERENCES

Church C. C. (1994). [Remediation and Testing Task Force's Final Report on recommended tests and proficiency levels to be used in selecting and placing students in developmental courses]. Unpublished raw data.

Gabriel, D. (1989). Assessing assessment. Review of Research in Developmental Education, 6(5), 1-5.

Maxwell M. (1979). Improving student learning skills. San Francisco: Jossey-Bass.

Mitter, M. L., & Bers, T. H. (1994, Winter). Assessment and transfer: Unexplained complexities. New Directions for Community Colleges, 88 (22), 31-36.

Morante, E. A. (1989). Selecting tests and placing students. Journal of Developmental Education, 13(2), 2-6.

Rounds, J. C., & Anderson, D. (1985). Placement in remedial college classes: Required vs. recommended. Community College Review, 13(1), 20-27.

Seybert, J. A. (1994). Assessment from a national perspective: Where are we, really? New Directions for Community Colleges, 88 (22), 23-30.

Smittle, P. (1990). Assessment's next wave: The computerized placement tests. The College Board Review, 156, 22-27.

Surry Community College. (1993). Surry Community College Catalog 1993-94. Dobson, NC: Author.

Surry Community College. (1995). Surry Community College: Institutional Effectiveness Plan 1995-1996. Dobson, NC: Author.

The College Entrance Examination Board and Educational Testing Service. (1993). Accuplacer computerized placement tests technical data supplement. Princeton, NJ: Author.

VITA

Richard Wistar Wooldredge was born in Newton, Massachusetts, on June 10, 1955. He attended primary and secondary schools in Washington, D. C. and Maryland, and graduated from John F. Kennedy High School in June 1973. His work experiences include six years as an Operations Specialist in the U. S. Navy, nine years as a police officer in Washington, D. C. and Winston-Salem, North Carolina, and five years as a psychology instructor at Surry Community College in Dobson, North Carolina.

The author has received an Associate of Science degree in Criminal Justice from Surry Community College, and a Bachelor of Science degree in Criminal Justice from Gardner-Webb College, and graduated from Appalachian State University with a Master of Arts degree in General-Theoretical Psychology.

At the present, the author can be found either on Jody Hartle's farm in Roaring River, North Carolina, or on his Harley, traveling the blue highways of North America.