EMPIRICAL AND CLINICAL MODELS FOR STUDENT PLACEMENT IN THE COMMUNITY COLLEGE MATHEMATICS CURRICULUM

By

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For Barbara, Charles, and Travis

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The problem of this study was to assess the appropriateness of currently used placement tests in predicting student success in mathematics courses and to identify additional factors which would lead to appropriate placement of students into community college mathematics courses. Placement test scores from the American College Testing Program (ACT) and the Scholastic Aptitude Test (SAT) were correlated with grades in entry-level mathematics courses for 605 first-time college students who had graduated from high school the previous school year. Successful "high-risk" students, identified as those with test scores below the cut-off points, were interviewed in order to identify factors considered important to their successful completion of college-level math courses. These and other factors reported in the literature were utilized in a clinical evaluation model which was reviewed by a panel of experts, composed of community college instructors, counselors, administrators, and university professors, for content and feasibility.

Correlations of test scores and grades in mathematics courses were found to be low. Almost half of the correlations were negative and only two of the positive correlations were greater than .50. Three main factors emerged from the interviews as important. High school preparation in mathematics, quality of student effort, and clinical evaluation techniques were considered important by the students interviewed. The panel of experts agreed that the concept of clinical evaluation had merit. However, the panel disagreed over the assumption that a hierarchy of subjects and levels in math could be effectively used as a screening device in the model.

The study lends support to criticisms of the use of standardized tests as a sole means of evaluation for mathematics placement. Other factors which could be of use such as factors in a placement model were identified, but not analyzed statistically. Recommendations for further research of the validity of these factors in placement models were made.

CHAPTER I

INTRODUCTION

The concept of the "open door" as an admissions policy has been viewed as fundamental to the realization of the mission and purpose of the community college. Thornton (1966) noted that, historically, the community college had attempted to provide educational opportunity to the average student. In describing the open door philosophy of community colleges, Thornton described any high school graduate, or any person who seemed capable of profiting by the instruction offered, as being eligible for admission. Cross (1971), however, maintained that without proper consideration of the diversity of students that enter colleges, the open door can turn into a "revolving door," wherein students exit the college unfulfilled.

Florida's community colleges require a high school diploma or its equivalent for admission. However, many students possessing high school diplomas are not properly prepared for college level work. For example, Florida's high school graduation requirements currently include a minimum of three credits in mathematics; however, no credit in high school algebra is required. Because of this, many entering students need a significant amount of additional preparation in math to master college level courses. As a result, college preparatory courses have been included in the curriculum of Florida's community colleges.

Consequently, appropriate placement of students into these college preparatory courses becomes imperative. Roueche (1980) commented that in order to give hope to students having learning deficiencies who enroll, colleges were going to have to divorce themselves from the "students have a right to fail" mind set, and design instructional programs accordingly. Florida law requires colleges to administer placement tests to all entering degree-seeking students in order to assign them to courses commensurate with their abilities. Because of the open door policy, entrance testing in community colleges has been used as a means of placement rather than a means of selection.

Four specific tests have been approved for placement purposes in Florida's community colleges. The Florida legislature has mandated in Rule 6A-10.315, FAC, that scores on one or more of the four approved tests be used to place students in college preparatory communication and computation courses, beginning the 1985 fall term. The four tests are the American College Testing Program (ACT), Scholastic Aptitude Test (SAT), Multiple Assessment Programs and Services (MAPS), and Assessment Skills for Successful Entry and Transfer (ASSET). The cut-off score for ACT has been set at 13, for SAT at 400, for MAPS at 206, and at 12 for ASSET. Students who score within one standard deviation of the cut-off scores may be exempted from or included in college preparatory instruction on the basis of supplemental testing or assessment documented by the institution. Identification of factors in addition to standardized test scores that would provide information concerning students' probability of success is therefore needed.

Students who score below the state-mandated cut-off scores on the tests and are thus required to enroll in college preparatory courses legitimately might ask how effective the tests and cut-off scores are in predicting success in college level courses. Enrollment in college preparatory courses will most likely increase the amount of time and money spent for a college education and may lead to frustration and lowered self-esteem. However, allowing students to enroll in courses for which they are not properly prepared often diminishes the probability of successfully passing the course. Since the goal of effective placement is to assign students to courses in which they have a reasonable probability of success, it is imperative to obtain information as to what factors contribute to such success.

The necessity for some means of placement is widely recognized. While some may support a "right-to-fail" concept that would allow students to register for courses at any level, current practice supports the use of placement methods to assure their right to succeed. This has been accomplished not by restricting entry to community colleges, but by identifying students' needs and then providing the resources necessary to meet those specific needs.

The means of accomplishing effective placement, however, have been elusive. Use of standardized testing has become pervasive in admissions, placement, and curriculum decisions. A review of the related literature revealed mixed results and only limited success, when using standardized tests as predictors of academic success. Other factors appear to be of equal or greater importance than test scores when predicting academic success. Standardized tests persist, however, as the most widely used type of evaluation for placement.

Hills (1971) stated "for some reason, though, there seems to be a halo about test scores for placement that causes some faculty members to believe that no other kind of data deserve consideration" (p. 707).

Evans (1975) cited the following statement by Winston Churchill which helps explain some of the arguments for not using test scores as a sole means of evaluation:

> Examinations were a great trial to me. The subjects which were dearest to the examiners were almost invariably those I fancied least. . . . I should have liked to be asked what I knew. They always tried to ask what I did not know. When I would willingly have displayed my knowledge, they sought to expose my ignorance. This sort of treatment had only one result: I did not do well in examinations. (p. 270)

By virtually any other evaluative standard, Winston Churchill would be considered successful. Yet, by his own admission, his performance on examinations was poor. How many students entering the community college system in this state and in this nation would similarly do poorly on examinations but nevertheless have capabilities and qualities that could lead to successful completion of college-level courses?

McClelland (1973) and others have questioned the use of standardized tests as a sole means of evaluation. Depending on certain factors such as the type of test (aptitude or achievement) and method of scoring (norm-referenced or criterion-referenced), interpretation of test scores has been subject to question. Testing experts disagree on the amount of emphasis that should be placed on test scores. A continuing controversy rests on the implicit assumption that standardized tests do indeed measure what they purport to measure (Haney, 1980). Until it can be demonstrated with certainty

that test scores provide information sufficiently accurate to justify the decision under consideration, the controversy is likely to remain.

Clearly, there is no definitive answer to the question of how much emphasis to place on test scores for various decisions. Bersoff (1973) aptly noted that the validity of a measuring device must be evaluated in terms of the purpose for which it is intended. The goal of assessment has been seen as the acquisition of relevant information that will contribute to decisions about desired changes in behavior. With regard to placement, then, other factors of evaluating student competence would add to our understanding of assessment techniques and help in making important educational decisions.

The task facing educators is one of improving processes of evaluating students. A desirable combination would, ideally, incorporate the impartial, objective nature of tests with other, more holistic, means. Alternative methods of assessment are seen by this writer as useful for complementing and cross-validating standardized tests. While objective tests can be of use in identifying which students do not possess certain competencies, they add little (if any) insight into specific deficiencies causing the low test results. A more comprehensive model for placement, taking factors into consideration other than test scores, is called for.

The strongest arguments in favor of using standardized tests for placement purposes appear to be convenience and a lack of standardization of grades or other measures. Many criteria other than tests have been explored as predictors; however, problems with quantification, objectivity, and standardization limit their usage. Student opinion, teacher opinion, and clinical evaluation, among

others, have seemed to have promise for placement, only to be rejected for various reasons.

Experts in mathematics have long known that use of standardized tests as a sole means of evaluation is inadequate. The National Council of Teachers of Mathematics (NCTM) Handbook on Evaluation in Math (1961) concluded that many possible combinations of evaluative techniques should be used. Studies comparing mathematics tests and subsequent grades have demonstrated only moderate to limited predictibility. However, a search of the literature revealed no definitive methods that have been widely used to supplant the use of standardized tests, which persist as one of the best single methods of evaluation in mathematics. Some combination of previous grades in math and test scores appears to be the best method of prediction (Larson & Scontrino, 1976).

Test scores are commonly intended for use as part of a placement program. Since test scores reflect past opportunities to learn, the scores should not be used as the sole criterion in a placement decision. Test scores provide a means of comparing students to a common standard and represent a valuable criterion in placement decisions. These decisions should be reviewed periodically, however, and should be adjusted if classroom performance indicates students have not been placed correctly (Florida MAPS: Technical Manual, 1984).

Placement is most systematic when based on the results of a validity study. Hills (1971) has stated that utility should be of primary consideration when deciding on placement methods and procedures. If the standardized tests approved for the placement process are appropriate, research would demonstrate the validity of

the tests for placement purposes. If not, perhaps other, more utilitarian practices could be explored in order to minimize the expense and maximize the effectiveness of placement procedures.

Research in the area of learning has indicated that the probability of success is an important factor in subsequent learning. Students who experience success are likely to demonstrate continued success (Ferster & Perrott, 1968). The converse of this "success breeds success" premise has also been demonstrated. Individuals who are thwarted in initial attempts at accomplishing certain tasks have developed the phenomenon referred to as "learned helplessness" (Levine, 1977). Thus, students not having a reasonable chance of success should be discouraged (or even prevented) from enrolling in courses and programs for which the probability of failure is high.

For these reasons, community college administrators recognize the necessity of assessment following admission in order to place students in courses where they have a good chance to succeed. Students having deficiencies have recently been required to take necessary developmental work before proceeding to programs where the lack of skill could cause failure (McCabe, as cited in Schinoff, 1982). The success of this combination of assessment, placement, and instruction has been documented (McCabe & Skidmore, 1983). The structured approach resulted in increased completion rates and improved student performance.

Since current practice is to think of assessment as a means of sorting and screening students and is seen as a key to learning (Justiz, 1985), effective placement techniques are needed. As a result of objections to the use of standardized test scores for the

sole means of placement, the identification of factors that could be used in addition to test scores is one of the purposes of this study. Learning theorists conclude that individuals process information differently (Cross, 1976; Ferguson, 1980; Roueche, 1980; Dunn, Dunn, & Price, 1981). Admonitions to instructors to vary their teaching techniques abound (Cross, 1976; Dunn & Dunn, 1979; Cohen & Brawer, 1982; Easton, Barshis, & Ginsberg, 1983-1984). Why, then, should educators be locked into a one-dimensional method of assessment? If teaching strategies should be flexible, it seems self-evident that evaluation strategies should be equally free of stifling methodologies that lock educators into a single type of evaluation for placement. A study that analyzes the effectiveness of mathematics placement tests used in Florida's community colleges and attempts to identify other potential factors for use in placement strategies would be useful.

The Problem

The necessity of appropriate placement in order to enhance student success in community college mathematics courses has been recognized. The factors that are currently used for placement are certain state-mandated test scores which have been questioned when used as the sole means of evaluation. The problem of this study was to analyze the appropriateness of currently used placement tests in predicting student success in mathematics courses and to identify additional factors which would lead to appropriate placement of students into community college mathematics courses.

Specifically, the following questions were addressed:

1. What is the relationship between selected placement test scores and success in initial mathematics courses?

2. To what factors did high-risk students attribute their successful completion of college-level mathematics courses?

3. What factors identified by the results of question number two and in the literature may be used for components of a clinical evaluation model which could augment the use of standardized test scores for placement in mathematics courses?

Methodology

In order to investigate the appropriateness of the presently used placement strategy, performance on the tests and actual performance in the classroom were analyzed. Thus, to answer question number one, test scores on the math portion of the ACT and SAT were correlated with grades in entry-level mathematics courses from a community college. The sample consisted of data from 605 students who had enrolled at Santa Fe Community College in Gainesville, Florida. All of the students were high school graduates from the 1983-84 school year and were entering the college for the first time. The students had entrance test scores on record (ACT or SAT were the only test scores available) and had completed their first college math course during either the summer or the fall term, 1984.

The scores and grades were correlated using the Pearson product-moment correlation (Pearson's r). This technique enabled a comparison of student test score to student grade in order to examine the strength of the relationship between the variables. This was done for each of eight math courses, for each of the two tests for a total of

16 comparisons. A correlation with grades from all eight courses was also computed.

In order to answer question number two, students were identified who may have been considered "high-risk" because of low test scores, but who had successfully completed a college-level math course on their initial attempt. Specifically, students who scored 15 or below on ACT or 430 or below on SAT and made C or better in a college mathematics course other than MAT 1000 (Introductory Math Skills) or MAT 1002 (Basic Mathematical Skills) were interviewed. Twenty students were interviewed by telephone to determine the factors to which they attributed their success in college-level math courses.

Question number three was answered by construction of a clinical evaluation model which was examined by a panel of community college math faculty members, counselors, administrators, and university professors. The panel responded to questions concerning content, feasibility, and utility of the model and made recommendations concerning its use.

Assumptions

In selecting the sample of test scores, courses, and grades it was assumed that the students and instructors in the particular college which generated the data were representative of students and instructors in community colleges throughout the state.

It was also assumed that the members of the panel of experts who evaluated the model were representative of math instructors and administrators in community colleges throughout the state.

Limitations

Of the four tests that have been approved for placement purposes in Florida's higher educational system, only ACT and SAT were considered in this study. Furthermore, only the mathematics section of the tests and mathematics courses were analyzed. Therefore, only mathematics placement was studied.

The data for courses and grades earned were limited to summer and fall semesters, 1984 only. Students who did not have a test score on record, did not take a math course in those terms, or did not complete their course (grade of "W" or "I") were not included in the sample.

The sample was also limited to high school graduates from the 1983-84 school year. Since community college populations are composed of large percentages of students who are not recent high school graduates, limiting the sample to recent graduates eliminated other elements of the community college population. However, this did serve as a control for age of students.

This study was also limited to initial math courses only. No data were collected on subsequent math courses to determine student performance in the overall mathematics curriculum.

Justification for the Study

The community college student has been viewed as somewhat different from the traditional college or university student (Koos, 1970). Primarily designed to alleviate financial, geographic, and motivational barriers, the community college was established for

students that may have been hindered from attending college because of these barriers (Wattenbarger, 1971).

As community colleges developed and grew in numbers across this nation, this uniquely American educational institution began to attract new and different types of students. Non-traditional students--those with lower entrance scores, from different socio-economic backgrounds, part-time, older, having a variety of goals and interests--made up larger and larger percentages of the community college student population (Cross, 1976). The concept of the open door was seen as fundamental to the mission and purpose of the community college. Open access, allowing virtually any student to enroll having a high school diploma or its equivalent, was largely responsible for altering the course of American higher education (Medsker & Tillery, 1971).

This emerging wave of students brought challenges and problems never before encountered. Accountability and standards of excellence became issues of high priority. Quality became a key word in higher education. Many felt that the large number of new, non-traditional students had somehow limited the quality of higher education in the United States (Thornton, 1966). Recently, certain trends have indicated a gradual closing of the open door (Henderson, 1982).

Because of the concerns for excellence and quality, additional means of evaluation have become necessary. Florida's mandatory student placement procedure, and the College Level Academic Skills Test (CLAST), provide a current example. Merely having an open door policy, then, has not been sufficient in accomplishing the stated goals of the community college. For various reasons, students not

able to complete course requirements (and more recently, standardized test requirements) turn the open door into a revolving door (Cross, 1976). For these reasons, effective placement procedures are extremely important.

Open access with a "right-to-fail" philosophy is not justifiable given the mission and goals of the community college, which include development of students' abilities to the fullest. Rather than allowing students to enroll in college-level courses for which they are not prepared, appropriate placement would ensure enrollment into courses compatible with their abilities. Students would then have a reasonable probability of success in the course. Placement and remediation, then, should be viewed as affirmation of the mission and goals of the community college.

Research to provide information concerning the appropriateness of current placement tests would enable decision makers to evaluate the usefulness of the tests. Identification of factors in addition to standardized tests that could be used in placement strategies would, it is hoped lead to their implementation in placement models. Further research on these subsequent models could validate the effectiveness of the additional factors. Therefore, the results of this study could be used in a comprehensive evaluation of the placement process. Ultimately, the students in Florida's community colleges should benefit from improved placement procedures.

Organization of the Research Report

The report consists of four additional chapters following this introduction. Chapter II contains a review of the related literature.

Chapter III is a description of the methods and procedures, including selection of the sample, data collected, and description of the statistical analysis. Chapter IV presents the results of the research. Finally, Chapter V contains the summary, conclusions, recommendations, and implications of the study.

CHAPTER II

REVIEW OF RELATED LITERATURE

Community College Students and Rationale for Placement

The population of students attending this nation's community colleges is markedly different from the population of students attending four-year institutions. The population of community college students includes students from a wide range of ability, age, and other factors (Koos, 1970). Roueche (1980) referred to this population as diverse. He noted that more and more students with serious learning deficiencies had enrolled in community colleges and were expected to continue to do so.

Cross (1976) reported that the historical trends in college access from aristocratic to meritorious to egalitarian had brought increasing numbers of low-ability students into programs of post-secondary education. Calling these low-ability students "new-students," Cross operationally defined them as those scoring in the lowest third among national samples of young people on traditional tests of academic ability.

Thornton (1966) noted that, historically, the community college had attempted to provide educational opportunity for the average student. The "open door" philosophy was described by Thornton as allowing any high school graduate, or any person who seemed capable of profiting by the instruction offered as being eligible for admission.

In a statement summarizing entrance requirements, Thornton stated that the responsibility for choice--success or failure--should rest with the student, not with a standardized test nor with the decision of an admissions counselor. Entrance testing in community colleges has not been seen as a selection process as is common in four year institutions, but rather as a means of placement.

This concept of an "open door" as an admissions policy has been seen as fundamental to the realization of the mission and purpose of the community college. Cross (1971), however, maintained that without proper consideration of this diverse population of students, the open door can turn into a "revolving door," wherein students exit the college unfulfilled. She commented that community colleges encouraged diversity, yet seemed unable to move away from the unproductive preoccupation with wanting all to learn the same thing at the same rate.

Roueche (1980) commented that in order to give hope to students who enroll having learning deficiencies, colleges were going to have to divorce themselves from the "students have a right to fail" mind-set, and design instructional programs accordingly. Placement into proper courses was seen as essential to success in completion of programs.

Wiener (1985) reported that between 60 and 70 % of all community college students must take remedial courses. The drop-out rate among such students was reported at over half. Students who have successfully completed remedial courses, however, demonstrated a much greater probability of completing their college programs. Wiener

called for mandatory placement testing and subsequent assignment into remedial programs when necessary.

Linthicum (1980) studied the procedures and instruments used to place students in developmental programs at a community college. The evaluation system was designed to identify levels of skills and subsequently guide students into the appropriate program. Grades, nationally normed tests, and certain institutionally developed tests were used to assess levels of skills. Linthicum also looked at measures of the affective domain as reported by means of an Affective Measurement checklist and a Self-Assessment checklist.

In evaluating the general success of the program, Linthicum found that student choice was not an effective method of placement and that a mandatory placement program was essential for student success. However, placement based solely on test scores was not effective. Qualitative factors such as motivation and self-concept were suggested as important factors in the learning process. Linthicum emphasized the necessity of flexibility in placement. She reported that reading tests were better predictors of academic success than were math tests and even recommended that math courses not be taken during the first term by low ability students.

A study by Cordrey (1984) examined the effectiveness of a "skills prerequisite program" used at a community college. The program included mandatory placement testing and a curriculum of prescribed remedial courses as a result of placement. The study examined placement patterns, drop out rates, effects of remediation on subsequent grade point average (GPA), and academic persistence. Results of the study indicated that withdrawal from courses was

reduced as a result of the placement program. An institutionally developed test was used for placement in math. The study also showed that remediation did have a positive effect on future success in academic courses. Other writers have questioned the effectiveness of remediation.

Haase and Caffrey (1983) reported information concerning the assessment and placement process that had recently been instituted at a community college. The Stanford Test of Academic Skills (TASK) was used in addition to institutionally developed diagnostic assessment techniques. An increase in retention of students as a result of the placement program was reported. They concluded by commenting on the necessity of continuously monitoring placement procedures and changing assessment techniques when necessary. It was recommended that methods beyond mere testing were needed and that flexibility was imperative.

Reap (1979) reviewed the American College Testing (ACT) Assessment Program in terms of its use at a community college. The purpose of the evaluation was to determine how effective ACT was in helping the college reach its educational goals. Specifically the study sought to answer two questions: (1) Did ACT provide an accurate description of the entering freshmen? (2) Did ACT operate as an effective predictor of student success? Reap concluded that the first question could be answered in the affirmative, but the latter question in the negative.

The review in Buros (as cited in Reap, 1979) reported that the predictive validity of ACT was as satisfactory as the state of the measurement art then permitted. Since ACT was used as a placement instrument, Reap's study examined its effectiveness at that

institution. The correlation of math grades with ACT scores was reported as .19. Reap further reported that when high school grade averages were included, the effectiveness of prediction was increased, and suggested that possibly high school transcripts should be considered for predictive purposes. While it did appear that the effectiveness of ACT in predicting grades increased as scores increased, Reap concluded that the ACT did not appear to be successful as an effective predictor of student success.

Clark (1980) explored six factors in attempts at determining which variables were significantly related to student success in four different math courses. These were

Placement test scores
High school GPA
Prior college units taken
Prior college GPA
High school math grades
Prior college math grades

Grades in high school and college math courses were found to be significantly related to success (defined as grade "C" or better) using the Chi-square technique at the .05 level of confidence.

Allen (1981) in describing instructional techniques in a Fundamental Algebra course at a community college emphasized the necessity of proper placement. "A 40 question 'Co-op Test'" was administered to all entering students at the college. Initially, students had the option of taking their desired course in mathematics; however, the college agreed that waivers of the suggested placement were counter-productive. Students were placed into the Fundamentals of Algebra course on the basis of test scores, with no waivers. This decision was based on a prior study by Allen which found that when a student was given the appropriate placement test and placed into the

recommended course according to math department guidelines there was a positive correlation between placement scores and grades in initial math courses. Allen recommended correct placement as the first step for success in the initial math course.

Palow (1979) advocated that assessment and placement were an "integral part of a comprehensive program of instruction in mathematics" (p. 1). Citing the SAT scores from the previous year which indicated that the freshman class was the "least academically prepared" group in the history of the examination, Palow emphasized the necessity of a system of assessment and placement to "match and funnel" students into a compatible system of instruction.

The assessment and placement system described by Palow consisted of combining the results of two paper and pencil inventories. The first inventory was a multiple choice mathematics test geared to the course which the students had indicated they wanted to pursue. The second inventory was the Canfield-Lafferty Learning Styles Inventory, designed to determine an individual's preferred way of learning. Through a set of decision rules programmed into a computer the student was assigned to one of four modes in individualized instruction. Results of the placement program were not available; however, the rationale for the necessity of placement was consistent with other writers' recommendations. It was also significant in that it represented one of the only programs that included students' preferred learning style as a factor in placement.

Wood (1980) noted that the assumption that algebra should be the first course in mathematics for an entering college student was unwarranted. Since open-door colleges have been faced with

ever-larger numbers of entering freshmen who have studied very little or no mathematics, Wood made a strong case for effective placement programs in mathematics at the community college level.

Wood suggested three probable causes for failures among entering freshmen: (1) students that had not completed two years of high school algebra; (2) students that had completed two years of high school algebra, but had been out of school for three or more years; and (3) students that had completed two years of high school algebra, but with minimal grades of low "C" or "D."

A testing program recommended by Wood included two placement testing instruments--ACT and institutionally developed mathematics tests composed by the faculty. Six different entry-level courses ranging from a math review course (practical arithmetic) through the first course in calculus were offered.

Wood's recommendations for an appropriate placement program in math were summarized as follows:

1. A majority of junior college freshmen have deficiencies in mathematics that range from partial to total.

2. Records show that these deficiencies do not necessarily imply a lack of ability. They frequently spring from insufficient high school training and/or a time lapse between high school and college.

3. For students of normal or above-normal ability, these deficiencies can be effectively removed by a review course of one or two semesters. Our experience leads us to believe that the two-semester plan is the better one for any college with an open-door policy.

4. Presidents and academic deans of colleges need to be aware that short of returning to high school, students with serious mathematical deficiencies have no way to improve without such a review course or courses. This is especially true of mathematics because of its cumulative nature.

5. Placement tests for entering freshmen as well as advanced-standing examinations (in college algebra and trigonometry) for well-prepared students provide an efficient way to achieve accurate student placement.

6. The results of our investigation support the philosophy that any junior college that maintains an open-door policy to all high school graduates accepts responsibility for providing students with courses in which they have a reasonable chance to succeed. (Wood, 1980, p. 64)

Hierarchical Nature of Mathematics

Wilson (1971) discussed and illustrated testing for evaluation purposes in secondary school mathematics. In the process of this discussion, a framework or model of the secondary school mathematics curriculum was constructed. Based on a taxonomy of educational objectives developed by Bloom (1956), the model described the mathematics curriculum in terms of content and behaviors. The content consisted of number systems, algebra, and geometry while the behaviors included the cognitive and affective domains.

Mathematics content was described as being progressive or sequential in nature. For instance, the concepts involved in number systems were arranged in order from simple to complex. Many of the concepts that were described required proficiency in prior content. Number systems preceded algebra and geometry. However, it was emphasized that much of the content was incorporated throughout the curriculum rather than in a specific course. In describing the sequential aspects of the mathematics curriculum, Wilson said that although there was a sequential nature to the mathematics curriculum, a given topic may be presented at increasing levels of sophistication.

While some topics logically precede others, the dividing line between content areas was described as unimportant.

The levels of behavior were described as being both hierarchical and ordered. The levels were subdivided into the cognitive and the affective domain. The cognitive domain included computation, comprehension, application, and analysis. The affective domain included interests and attitudes, and appreciation.

Computation items were designed to require recall of basic facts and terminology. Emphasis was upon knowing and performing operations and not upon deciding which operations were appropriate. Comprehension related to recall of concepts and generalizations. The emphasis was upon demonstrating understanding of concepts and their relationships, not upon using concepts to produce a solution. Application items required recall of relevant knowledge, selection of appropriate operations, and performance of the operations. Analysis items required a nonroutine application of concepts such as the detection of relationships, the finding of patterns, and the organization and use of concepts and operations in a nonpracticed context.

Wilson commented on the hierarchical and ordered nature of the levels of behavior:

> It is ordered in the sense that analysis is more cognitively complex than application, which is in turn more cognitively complex than comprehension, and the computation level includes those items which are the least cognitively complex. It is hierarchical in that, for example, an item at the application level may require both comprehension level skills (selection of appropriate operations) and computation level skills (performance of an operation). (p. 649)

The affective domain was not described as hierarchical. It was emphasized, however, that the affective domain must not be discounted when considering instruction and evaluation of mathematics.

Effectiveness of Standardized Tests as Placement Instruments

While several sources in the literature demonstrated the necessity for placement in community colleges, the means of achieving effective placement have been somewhat elusive. As cited, most methods of placement involve the use of a standardized testing instrument, either as a sole means of placement or used in conjunction with other criteria. One of the purposes of placement is the prediction of success in the course or courses into which the students are placed. Standardized tests have demonstrated only limited predictive value. Apparently other factors are involved which have been difficult to detect.

McClelland (1973) questioned the use of standardized tests, as predictors of academic success and also as predictors of "success in life" as defined by certain accomplishments such as job status, earnings, satisfactions, etc. McClelland noted that researchers have had difficulty in demonstrating that grades in school are related to any other behaviors of importance--other than doing well on aptitude tests. Making a case that standardized tests and grades only correlate highly with one another, McClelland urged that a wider array of talents should be assessed for college entrance. While the argument applies mainly to the use of tests as selection instruments,

their value as placement instruments has also been subject to question.

Haney (1980) examined the use of standardized tests in a broad context and related considerable controversy over their use. Sharp disagreement was reported among testing experts on issues of test bias and validity. Haney maintained that while a wide variety of inferences may be drawn from any test score, one acid test of what inferences were drawn was how the scores were used by social institutions.

Haney commented on the differences between aptitude tests which were reported as being used for screening or selection purposes and minimum competency tests. The competency testing movement generally represented a government or institutional effort to regulate and improve schooling. Haney cited Jensen who commented that the only justification for competency testing for placement purposes was evidence that the alternative treatments were more beneficial to the individuals assigned to them than would be the case if everyone got the same treatment. Jensen concluded that minimum competency testing would not contribute to the solution of the problem of test bias and validity since it appeared to be an unnecessary stigmatizing practice with no redeeming benefits to individual pupils or to society.

Jensen apparently felt that alternative treatments, i.e., remediation, or low level classes, were not effective. This view is consistent with information reported by Hills (1971), who cited research that indicated evaluation of remedial courses was not effective. Popham (1975), however, felt that competence testing for placement was useful because it allowed isolation and remediation of

instructional deficiencies. Apparently, Popham assumed that remediation was possible and effective.

A distinction has been made in the literature on testing between two types of tests--norm referenced and criterion referenced. Fundamentally, the difference is based on comparison of performance to other individuals (norm referenced) or comparison to certain predetermined standards (criterion referenced).

Glaser (1963) and Popham and Husek (1969) were the first to introduce and popularize the field of criterion-referenced tests (CRT) which promised to be a significant breakthrough in education. The CRTs were seen as a means of maximizing the potential of each student. Cross (1976) discussed individualized, competency-based or mastery learning and pointed out similar advantages of CRTs.

Hambleton, Swaminathan, Algina, and Coulson (1978) noted that the introduction of CRTs was intended to meet the testing and measurement requirements in objectives-based instructional programs. Problems arose regarding a precise, acceptable definition of criterion-referenced test, the central issue being the use of the word "criterion." "Criterion" is best defined for these purposes as a domain of behaviors, not a performance standard, minimum proficiency or cut-off score. Popham (1975) provided the best workable definition of CRT: "A criterion referenced test is used to ascertain an individual's status (referred to as a domain score) with respect to a well-defined behavior domain" (p. 2).

Controversy existed regarding terminology for tests of this sort, with the terms criterion-referenced, domain-referenced, and objectives

referenced being the three discussed most. Popham advocated the term "criteria-referenced" because of considerable public support and the ill-advisedness of beginning a new campaign for "domain-referenced" tests, even though the latter term is probably most descriptive.

According to McClelland (1973) competency-based testing should

1. be criterion referenced (not norm referenced)
2. be designed to reflect changes in what the individual has learned (not measure "native intelligence")
3. provide public and explicit information on how to improve on the characteristic(s) tested (not keep answers secreted away from the public)
4. assess competencies involved in clusters of life outcomes (not test esoteric qualities that are of little use in the real world)
   a. communication skills
   b. patience
   c. moderate goal setting
   d. ego development
5. involve operant as well as respondent behavior (not require only pre-determined responses that may be unfairly limited, i.e., all true-false or multiple choice)
6. sample operant thought processes to get maximum generalizability to various action outcomes (so that students can see the relevance of the skill, its application, and ramifications in life situations)

The rapid acceptance of criterion-referenced testing in general was not without problems, however. An urgent need for establishment

of standards, both for the development of and for demonstrating validity of CRTs was noted by Evans (1975).

Novick and Lewis (1974) dealt with these problems as well as a problem concerning the length of CRTs for a specified objective, commenting that

> The minimum acceptable length depends on the manner in which test information is used to make decisions about individual students, the level of functioning required for defining mastery of an objective, the relative losses incurred in making false positive and false negative decisions, the background information available on the student and on the instruction process, and the premium on testing time within the instructional process. (p. 139)

Novick and Lewis adopted guidelines which effectively said that test lengths of 12 items or fewer for a specified objective were very desirable. Lengths above this and up to 20 were tolerable. Tests that were longer than this for a single objective were described as discomforting. Tables of test lengths, taking the above mentioned factors into account, were published. They concluded that "mastery must be confirmed by a test that permits demonstration of non-mastery" (1974, p. 158).

Special categories of CRTs were identified by Keesling (1974), in particular, the specific type of mastery learning in which order of presentation was crucial. Objectives that were subject to a priority ordering based upon task analysis or theories of instruction were distinguished from objectives that required no ordering of presentation or transfer of training. Keesling concluded that the validity of the proposed structure of relationships among objectives was very important. This hierarchy is not always detectable, however. Hambleton et al. (1978) commented that when it is possible for a set

of learning objectives to be arranged into a learning hierarchy, the strategy of branch-testing would seem to offer considerable potential for decreasing the amount of testing while improving its quality.

The problems associated with criterion-referenced tests, particularly such issues as test score validity, determination of cut-off scores, and complicated legal actions by the courts have not been totally resolved. However, Hambleton et al. (1978) reported that sufficient theory and practical guidelines were available for construction of at least adequate CRTs and criteria-referenced testing programs.

Numerous studies have examined specific standardized tests, most notably the SAT and the ACT and their correlation with grades. The results have been inconclusive. Schade (1977) reported a study carried out at a community college to determine the predictive validity of various parts of two standardized tests toward academic achievement as measured by the first semester GPA. The tests used in the study were the ACT and the Missouri College Placement Test (MCPT). Each of the ACT segments showed a significant correlation with first semester GPA. The ACT mathematics segment had the lowest correlation, $r^2 = .125$. Schade described the predictive power of the tests as "poor to moderate" and indicated that the values of the correlation coefficients were comparable to results that had been reported from a variety of institutions. None of the MCPT segments showed a significant correlation.

Schade theorized as to why his study and several others which he cited failed to demonstrate high correlations between grades and test scores. One possibility mentioned was a change in student motivation,

either positive or negative. College-level work could possibly stimulate previously low achievers with lower test scores into better performance or could stifle earlier motivation. A second possibility noted was that the tests could be suspect. A low score was actually impossible to interpret, possibly indicating insufficient native capacity or inadequate training in the skills and abilities tested. Test bias may have also been a factor. Thirdly, grades and a lack of standardization of grading systems could have contributed to the poor correlation.

Nolan (1976) also conducted a correlational study using ACT sub-test scores and grades earned in corresponding subject areas to determine the predictive value of ACT. The correlation analysis yielded coefficientis of such low magnitude as to make him conclude that there was no significant relationship between ACT scores and academic performance. The r^2 for mathematics grades and the ACT math sub-test was reported at .07. Nolan stated that "it appears that high school grades alone are the best predictors considering the negligible amount of variance accounted for by ACT scores" (p. 4).

Larson and Scontrino (1976) examined the validity of high school grade point average and of the verbal and mathematical portions of the SAT as predictors of college performance over an eight year period. They reported multiple-correlation coefficients that were "consistently high." Interestingly, the mean proportion of variance accounted for in the eight-combined samples by using all three predictor variables in combination was only 4.7% greater than the mean proportion of variance accounted for by using the high school GPA as a single predictor.

Fincher (1974) examined SAT scores in a state university system over a 13 year period. He noted that the value of SAT scores is their use in conjunction with high school grades. The SAT scores alone (the zero-order) correlated with college performance was not considered a sufficient indicator. However, used in addition to the high school record, SAT was judged to improve predictive efficiency.

Fincher's comment regarding the mathematics portion of SAT was noteworthy. He commented that the mathematics scale contributed with less consistency than the verbal section of the test and would not appear to be highly useful in one-half of the situations where it was applied.

Other findings of interest by Fincher were confirmation of previous findings that females were more predictable in academic performance than males (when comparing SAT scores, high school grades, and college grades) and the loss of information from combining SAT math and verbal scores. Each portion of the test taken separately was a better predictor than the combined score. These results were consistent with previous findings and Fincher recommended continued use of SAT as a selection instrument.

Price and Kim (1976) compared high school grades and entrance test scores with performance in college. The ACT scores were used as the standardized test scores. College GPA was mostly determined (75%) by both high school grades and ACT scores. However, Price and Kim concluded that it appeared reasonable to believe that ACT scores were more significant and important in predicting a person's ability to perform in college than were high school grades because the beta

coefficients of four specific fields of the ACT program were relatively larger than those of high school grades.

Alternative Means of Assessment for Placement

Grades

Grades have traditionally been a basic means of evaluating, recording, and reporting students' progress. Several sources in the literature have expressed concern with using grades for objective measurement purposes since grades are often determined subjectively. Haase and Caffrey (1983) stated that grades were not good measures of performance because of grade inflation and lack of standardization.

Schade (1977) commented similarly about the lack of standardization of grades:

> Among the many teachers, areas of study, and institutions, there are a plethora of grading standards. A student who achieves at a certain level in one class should be expected to achieve at approximately the same level in other classes. Yet this does not always happen. If students were to take the same course from different teachers, whether at the same or at a different institution, they would not necessarily make the same grades. Different academic areas will tend to have different standards. Some disciplines are notoriously stringent and demanding while others are the opposite. Compounding this difficulty is the fact that lower ability students will tend to gravitate towards those areas that are less taxing. (p. 19)

Goldman and Slaughter (1976) questioned the use of the grade point average (GPA) as a validation criterion. Most studies attempting to validate standardized tests compare test scores to GPA. However, because grades appear to be more explainable by unmeasured traits than by test scores or previous grades, their use as a

validation criterion becomes suspect. Goldman and Slaughter further maintained that composite GPA was a poorer predictor than single class grades. Since composite GPA is made up of decidedly nonequivalent components it is less reliable and hence less predictable than grades from a single class.

Longstreet (1975) questioned the use of grades as fair and objective measures of performance, maintaining that grades are used for convenience in administration and for tradition. Longstreet noted the important difference between grading based upon knowledge of subject matter and grading based on comparative scores. Longstreet called for alternatives to traditional grading such as mastery learning, contract grading, self-assigned grading and conferences with students, commenting that "criteria truly significant to the development of an intellectually independent and creative individual cannot be reduced to . . . a few letters or percentage points, however convenient these may be bureaucratically" (p. 246).

McClelland (1973) questioned the validity of grades as predictors, asserting that while grades and test scores correlate highly with one another, neither can accurately predict future measures of success in life. He noted that researchers have had difficulty demonstrating that grades in school are related to any other behaviors of importance other than doing well on aptitude tests. He stated that while grade <u>level</u> attained seemed related to future measures of success in life, performance within grade was related only slightly. Results of several studies indicate that superior on-the-job performance is related in no way to better grades in college.

Clinical Evaluation

Though grades have been the subject of criticism, their use is widespread, practically universal. As previously noted, standardized test scores have also been subject to criticism for many of the same reasons as grades. Alternative means of assessment have been reported in the literature. However, there seems to be no agreement on what, if any, measures should be used as alternatives. Grades and standardized tests persist as the most common means of measurement. Clinical and holistic methods of evaluation have been suggested as alternatives. The concept of clinical evaluation, an analytical assessment of competencies and deficiencies, and the prescription of treatment based on direct communication and observation by a practicing professional, was referred to by several writers.

Holistic evaluation, based on the theory that reality is made up of unified wholes that are different from the simple sum of their parts, has also been proposed as a viable addition to measurement and evaluation methods dominated by traditional grades and standardized tests. Oral exams, performance tests, situational tests, observations, and checklists were suggested as complements and alternatives (Roueche, 1980). A holistic approach emphasizes the importance of the whole and the interdependence of its parts (Ferguson, 1980).

Clinical and holistic evaluation have been referenced numerous times pertaining to mathematics; however, the specific terms have not been used. Many writers who proposed alternatives to standardized testing made reference to clinical and holistic approaches to evaluation.

Wilson (1971) concluded that standardized testing alone was not sufficient for proper evaluation in mathematics:

> Mathematics learning is a many-component task. It should be measured or evaluated over a broad range of criteria. The evaluation of mathematics learning in terms of a single measure leads in incomplete or even erroneous information. . . . The use of standardized tests in the evaluation of classroom learning is of limited value. They are inappropriate for formative evaluation. For summative evaluation, standardized tests tend to concentrate on one level of behavior (and hence limit the range of outcomes to be considered) or combine scores, levels of behavior or content (and hence limit the information that may be available on the test). (p. 264)

Sueltz (1961) in the National Council of Teachers of Mathematics (NCTM) Handbook on Evaluation on Math commented that to determine the level of sophistication of a student's work and the depth of understanding of a major topic requires a much more refined procedure than mere standardized testing. The writers of the Handbook further conclude that evaluation of the thinking and procedures employed by students usually is better done by careful observation and interview than by objective testing.

Various writers have called for holistic and clinical approaches to evaluation as alternatives to standardized tests and traditional grading. Quinto and McKenna (1977), in an NEA published monograph, suggested several alternatives to standardized testing as means of evaluation. The alternatives included contract grading, conferences with students, and checklists based on observations. Kopfstein (1980) commented on community college reading and study skills programs, proposing certain methods of evaluation that would be considered clinical, although the term is not specifically used. Student interviews were one of the primary methods suggested. O'Reilly,

Vogler, and Asche (1980) suggested several options that could be used as alternatives to standardized tests, all of which would be considered clinical or part of a holistic evaluation, although again the terms are not used. Ginsburg (1975) recommended evaluating student progress through "direct oral communication." Interviews and conversations with students were essential to this type of evaluation.

In fields other than education, especially the medical field, writers have called for additional methods of assessment. Clinical observation procedures have been proposed. Kuliecke, Lloyd, and Mathis (1982) identified problems in evaluation of medical students and emphasized the necessity of process evaluation and not mere product evaluation. Factors were cited that were responsible for poor performance on medical examinations by medical students. Lack of complexity in data analysis procedures, quality of training, mental set at time of examination, experience with taking exams, effort put into training, and barriers to assimilating training (especially foreign language barriers) were cited. Kuliecke et al. called for models of evaluation that could take these factors into account.

Shugars, May, and Vann (1981) discussed evaluation of dental students. They maintained that cumulative data from several faculty members should be used as a basis for grades. In addition, means for assessing professionality in students was stressed. A clinical judgment examination, wherein faculty members carefully observed students, was integral to the dental evaluation model.

Halpin, Halpin, and Schaer (1981) compared objective measures of writing to holistically scored essays. The holistic method of scoring was based upon a generalized impression or global quality of the

essay. Halpin et al. found that 26% of the variance in the essay scores was explained by the objective measures. Clemson (1978) reported a somewhat higher correlation, 49% for r^2, in a similarly conducted study. Objective measures were not sufficient in explaining the total range of variation in holistically scored samples. The holistic method of evaluation appeared to be at least as useful as objective measures in assessing competence.

Attitude and the Affective Domain

Corcoran and Gibb (1961) discussed attitude appraisal in the learning of mathematics, noting that suitable instruments were not widely available. Attitude towards math involves both cognitive and non-cognitive aspects. They noted that a student's attitude toward mathematics is a composite of intellectual appreciation of the subject and emotional reactions to it. Corcoran and Gibb examined attitude according to direction (attraction or repulsion) and intensity (strong or weak). Other important aspects of attitude toward mathematics were noted as consistency, salience, reaction to difficulty, interest, and value.

Various methods of assessing attitudes toward math were reported, basically separated into self-reports wherein students reported their own attitudes, and observer reports, based on interviews with the students. Thurstone scaling methods, Likert scales, Guttman-type scales, and Hoyt-MacEachern scales were used in self-reporting attitude appraisal. The Minnesota National Laboratory instrument was suggested for observer reporting. Fouche (1961) summarized Corcoran and Gibb's chapter by stating that ignoring attitude evaluations

completely would be almost to treat students as mere learning machines, devoid of feelings and emotions, and such higher, complex behavior as creativity and discovery. Fouche indirectly referred to holistic evaluation in math:

> A little thought will show that what is generally meant by "testing" is really uniform testing of a number of students. The conscientious, skillful, perceptive mathematics teacher is constantly making evaluations of a student's verbal answers, of his blackboard work, of his facial expressions and other non-verbal behavior, but tests are required nonetheless in order to have uniform and easily comparable information about the behavior of all students in the same situation. (p. 172)

Learning Style

Since no two students have the same learning style, Roueche (1980) maintained that no single methodology of evaluation would fit all students. Some students are "right-hemisphere preferenced"; that is, they excel at holistic and spatial functions. Traditional methods of instruction and evaluation, designed around left-hemisphere strengths (verbal and analytic) of the middle class, will not reach them according to Roueche.

Within the last decade research having far-reaching implications for evaluation and placement has been done regarding learning styles. Dunn, Dunn, and Price (1977) stated that <u>how</u> a student learns is perhaps the most important factor in his academic achievement. Dunn and Dunn (1979) developed a "Learning Style Inventory" (LSI) based on research data that yielded 18 categories which suggest that learners are affected by the following elements:

1. immediate environment (sound, temperature, light, and design),
2. emotionality (motivation, responsibility, persistence, and structure),
3. sociological needs (self, pairs, peers, teams, adult, and/or varied), and
4. physical needs (perceptual strengths and/or weaknesses, time of day, intake of foods and fluids, and mobility).

Dunn and Dunn (1979) reported that teachers were able to recognize some learning style elements with considerable accuracy. Certain other elements were admittedly more difficult to assess. They further commented that people "learn in ways that differ dramatically, but certain students achieve only through selected methods--methods that frequently fail to produce academic results for others" (p. 238). The Productivity Environmental Preference Scale (PEPS), an adult version of the LSI, has also been developed by Dunn and Dunn. The PEPS would be suitable for use in community college curriculum, instruction, and evaluation.

Farr (1971) confirmed in a study of learning styles that individuals could accurately predict the modality in which they could demonstrate superior learning performance. The data revealed that "it is advantageous to learn and be tested in the same modality and that such an advantage is reduced when learning and testing are both conducted in an individual's non-preferred modality" (p. 242). The most desirable conditions existed when learning and testing were both in the student's preferred modality.

Domino (1970) reported that students who had been exposed to a teaching style consonant with the ways they believed they learned scored higher on tests, fact knowledge, attitude, and efficiency of work than those who had been taught in a manner dissonant with their orientation. Hunt (1981) asserted that learning style described students in terms of those educational conditions under which they are most likely to learn. To say that a student differs in learning style means that certain educational approaches are more effective than others, said Hunt. This differed somewhat from Dunn and Dunn in that Hunt viewed learning style as a malleable trait.

Hunt (1981) further stressed the reciprocal relation between psychological theory and educational practice, concluding that reciprocity is a central feature in matching of styles. Taking such a reciprocal view of matching, Hunt declared, more reasonably accounts for the continuously changing nature of the teaching/learning transaction.

Davidman (1981) was critical of some of the assertions made regarding learning styles. In particular, the validity of the LSI was questioned. Davidman argued that, although the LSI provided interesting information, it should not be taken as a clear and irrefutable indication of a student's pattern of learning. He concluded by stating his belief that brief, teacher-made instruments would initiate a more useful diagnostic process.

Dunn, Dunn, and Price (1981) countered Davidman's criticism by maintaining that the LSI offered a reliable and practical alternative to "soft evaluation." They stated that "in conjunction with teachers'

insights and experiences, it could provide the foundation for building learning environments designed to meet the needs of individuals" (p. 646).

Palow (1979), as previously cited, listed learning-style preference as a major consideration for placement of students. However, no other sources were found that used learning style preference as a placement strategy.

Summary

Placement has been a continuing problem for community colleges in particular, because of the great diversity that characterizes their clientele. Since entering students vary greatly in academic skills, some means of assigning students to courses commensurate with their skills has been considered imperative. Standardized tests have been the most commonly used means of assessment for student placement. High school grades have also been used, with slightly better success than tests. Alternative means of assessment, including clinical and holistic evaluation, assessment of the affective domain, and learning-style preference have been proposed. Because of the difficulty in reliably measuring these alternatives, the use of traditional grades and standardized tests persist as the most widely used placement techniques.

Numerous studies have considered the relationship of standardized tests and grades. Most of these, however, examine the predictive validity of the tests for use as selection instruments. Since mandatory testing for placement is relatively recent in community colleges, information regarding the effectiveness of certain commonly

used tests as placement instruments was limited. Only a small amount of information was found in the literature regarding appropriate placement strategies in community colleges. Most of the studies had a similar rationale and underscored the necessity for placement. However, it appears that an effective, agreed-upon system of placement has not been reported.

CHAPTER III

METHODS AND PROCEDURES

Research Design and Selection of Variables

In order to determine the relationship between placement tests and student performance in mathematics, and thus address the first question of this study, several decisions were required in order to design a suitable research model. As previously noted, four tests have been approved by the Florida legislature for placement purposes in higher education. While information on all four tests would have been desirable, data on two of the tests, MAPS and ASSET, were not available from the college used in this study. Both ACT and SAT have long been used as admissions tests and data were available. The MAPS and ASSET tests are relatively new and data concerning these two tests, when available, should be used in subsequent studies.

High school grades have been commonly reported in the literature as effective predictors of college grades. Several writers recommended using high school grades in conjunction with placement tests for the most effective prediction of college grades. Prior grades typically have proven to be the best predictors of subsequent grades. Therefore, the possibility of including high school grades as a second independent variable was considered. However, since previous research has been adequate in demonstrating the usefulness of high school grades, they were not used as a second independent variable.

Since test scores were the only state-mandated measures for math placement at the time of this study, standardized test scores were used as the sole independent variable.

Several alternatives were available for selection as measures of student performance to use as the dependent variable. Various measures of performance and combinations thereof have been reported in the literature in the assessment of student performance. Student opinion, teacher opinion, clinical evaluation methods, other standardized tests, grade point average, student retention, and other factors have been used to measure relative success. Convincing arguments have been made for the use of measures other than grades in evaluating student performance. Grades have been criticized as lacking objectivity and standardization. These same criticisms apply, however, to the previously mentioned alternative means of assessment. Grades have continued to be accepted as the most commonly used measure of student performance. Therefore, grades in math courses were chosen as the measure of student performance for this study.

Relationships between test score and grade would be most meaningful when considered for each course individually. Grades in different mathematics courses would obviously have different meanings since math courses are sequentially arranged in the curriculum. For instance, a grade of "A" in a college preparatory course would have a much different meaning than a grade of "A" in calculus, since calculus is near the end of the sequential mathematics curriculum, whereas college preparatory math is a simpler course.

For these reasons, ACT and SAT scores and grades were correlated for each of the eight selected math courses. A composite correlation of test score and grades was also performed for each test.

Factors found in the literature and thought to be of potential use in the placement process were studied by interviewing students who had enrolled in college mathematics courses and were successful, i.e., achieved grades of C or better in courses other than MAT 1000 (Introductory Math Skills) or MAT 1002 (Basic Mathematical Skills) but had test scores below or slightly above the cut-off scores.

Sample Selection and Data Collection

Given the variables which were to be used in the study--placement test scores and grades--a source of data containing these variables was located. Data from all students that had enrolled for the first time in the summer or fall semester of 1984 who had entrance test scores on record as well as a math course and grade were obtained through the Management Information Services division of Santa Fe Community College, one of the 28 community colleges in Florida's higher educational system. The college is located in Gainesville, in north-central Florida, and draws students mainly from its local district, as well as from throughout the state and from other states and nations.

The demographics of the selected cases obtained from the college were found to be similar to the statewide population of community college students. Table 3.1 shows the similarity.

The breakdowns by race and sex for recent statewide high school graduates was quite similar as well. Statewide data represent students in the 15-19 age group, while data from the college in the study represent 1984 high school graduates (Table 3.2).

Table 3.1

Demographics of First-Time Community College Students

Santa Fe Community College			Students Statewide		
Sex	Male	44%	Sex	Male	41.3%
	Female	56%		Female	58.7%
Race	Black	11%	Race	Black	10.8%
	White	79%		White	77.3%
	Other	10%		Other	11.8%

Table 3.2

Demographics of Recent High School Graduates Entering the Community College System

Santa Fe Community College			Age 15-19 Students Statewide		
Sex	Male	43.4%	Sex	Male	43.7%
	Female	56.5%		Female	56.3%
Race	Black	13.6%	Race	Black	11.4%
	White	79.3%		White	72.4%
	Other	7.0%		Other	16.0%

The data for students actually used in the sample, i.e., those who had a test score and passed a course, were also similar. Table 3.3 depicts this.

Table 3.3

Demographics of Sample of 1984 High School Graduates

		Number	%
Sex	Male	280	46.2
	Female	325	53.8
	Total	605	100.0
Race	Black	67	11.0
	White	484	80.0
	Other	54	9.0
	Total	605	100.0

The data were collected from a computer print-out from the college which contained information on all of the entering students for the 1984-85 academic year (including both summer and fall semesters) who had graduated from high school the previous academic year, 1983-84. Only data from those students who had a test score on record and had enrolled in and completed a math course were collected. A total of 605 complete sets of data were used in the study.

Description of Data

Tests

The two placement tests used in this study were the ACT and SAT examinations. As noted previously, these tests were designed for predictive purposes and have been commonly used as selection

instruments. However, these tests were widely used for placement purposes in most of the community colleges in Florida at the time of this study.

Kline (1972), in Buros' Seventh Mental Measurement Yearbook, explained that the ACT Mathematics Placement Examination was developed to assist colleges in placing entering students in the mathematics classes most appropriate for their ability and preparation. The test contains four categories: intermediate algebra, college algebra, trigonometry, and "special topics." Kline suggested that the test may be most useful for predicting success in highest level freshman mathematics, analytic geometry, and calculus. The reliability, KR-21, was reported at .81 for the total score.

Dubois (1972) and Wallace (1972) also reported in the Buros yearbook. The purpose of SAT was described as an aid in assessing students' competence for satisfactory achievement in college. The SAT was designed to be effective over the full range of abilities of students. The test had been found to have "reasonably good" validities for predicting college achievement. Internal consistency reliability was reported at .90 for SAT-mathematics. Alternate-form coefficients of correlation were reported at .88. It was also noted that multiple correlation studies with high-school grades yielded better predictive results for college grades than SAT alone.

Scores on the ACT in this study range from 1 to 32. The mean score on ACT was 14.262, median score was 14.5, and the mode was 10. One standard deviation was 6.288. The mean SAT score was 433.029, with standard deviation of 92.529. Median score was 429.333 and the mode was 450. Of the 605 student scores used in the study, 421 were

ACT scores and 184 of the scores were SAT. Scores on the SAT ranged from 210 to 710.

Courses

Eight math courses were chosen for use in this study, ranging in content from fundamental skills in arithmetic to the first course in calculus. These courses were by far the ones selected most often. A small percentage of students chose other courses, such as business math or the second course in calculus, but were not included in the study. Twenty-three (23) students were enrolled in MAT 1000, Introductory Math Skills. This course was designed for students who needed to develop basic computational skills and improve accuracy with basic arithmetic facts. Included in the course was a math lab, where students worked individually to improve skills.

One hundred ninety-eight (198) students enrolled in MAT 1002, Basic Mathematical Skills, which included the arithmetic of whole numbers, fractions, decimals, and percents. This course also had a lab component where students worked individually to develop and improve skills.

One hundred ten (110) students enrolled in MAT 1024, Elementary Algebra. This course represents the first of three algebra courses offered by the college and included the study of algebraic notation and terminology and the addition, subtraction, multiplication, and division of general algebraic expressions, among other topics.

One hundred fifty-one (151) students enrolled in MAC 1102, Intermediate Algebra. This course was the second in the algebra

series and included the study of complex rational expressions, exponents, roots, radicals, and other algebraic topics.

One hundred twenty-one (121) students enrolled in MAC 1104, College Algebra, the third course in the algebra series. This course included the study of relations, functions and conic sections, theory of equations, systems of equations, exponential and logarithmic functions, and other related topics.

The sixth course of the eight courses used in this study was MGF 1113, Principles of Mathematics. Only 13 students enrolled in this course which presented an overview of the various branches of mathematics and their development. Sets, logic, introduction to algebra, statistics, probability, and geometry were among the topics covered.

Trigonometry, MAC 1114, was the choice of 22 students. This course covered the study of the six trigonometric functions, their interrelationships, and their application to both right and oblique triangles.

Finally, 29 students enrolled in MAC 2311, Calculus I with Analytic Geometry. This course was the first course offered in the calculus series and included the study of limits, the derivative and its geometric interpretation, continuity, integration of algebraic and trigonometric functions, and applications of integration to area.

Grades

Students who received grades of "W" (withdrawal) or "I" (incomplete) were not included in the study. Sixty-two (62) students, approximately 9%, had grades of "W" or "I" and were omitted.

Data Analysis

Test scores, course, and grade were entered and analyzed using the Statistical Program for the Social Sciences (SPSS) package. Initially, the data were separated by test score, ACT or SAT, yielding two groups. Since no student had scores on both the ACT and SAT, no direct comparison of tests was made. The relationship of test score to grade was determined separately for each test.

The data were then categorized by course. The eight courses were analyzed for each test, yielding 16 tables and graphs (summarized in Chapter IV). The Pearson-product moment correlation (Perason's r) was computed for each course, correlating test score with grade. Finally, composite correlations were done for each test across all courses, comparing test score to grade.

Student Interviews

The literature suggested that other factors should be used in addition to test scores when evaluating students for placement or other purposes. However, identifying, defining, quantifying, and using these other factors has been rather difficult and, as yet, no strategies have been implemented on a statewide basis that make use of any factors other than test scores.

In an attempt to identify additional factors that may be of use in placement of students, interviews were conducted. Students who scored below or slightly above the state-mandated cut-off scores (effective August, 1985) were identified. Those students who successfully completed a college-level mathematics course ("C" or

better) were asked what factors they considered important to their success. The purpose of these interviews was not to draw any conclusions or generate any statistical evidence on other factors for placement. Rather, the identification of potential factors for use in a placement model was the intent of the interviews.

The cut-off scores on ACT and SAT (math) have been mandated as 13 and 400, respectively. Students who scored below the cut-off or slightly above were interviewed. Specifically, students whose score on ACT was 15 or less, or 440 or less on SAT, were interviewed, but only if they achieved a "C" or better in a college-level math course (MAT 1024 or above).

Travers (1969) discussed the effects of an interviewer on the results. As much uniformity as possible was recommended in order to maintain consistency in the conditions under which the information was collected. Interviews were suggested that were not too highly structured, allowing the interviewee to respond freely but still in accord with the subject at hand. The same introductory and concluding remarks were recommended. Therefore, each interview began with an introduction of the caller, a brief explanation of the purpose of the interview, and a question as to whether the student would be willing to participate. Following the interview, the interviewer thanked the student for cooperating. The interview process was very similar, then, for each student contacted.

Difficulties in quantification of results of interviews were also reported by Travers. However, the purpose of the interviews in this study was not to generate empirical data, but rather to identify potential factors for use in placement strategies. Therefore,

quantification of responses was not part of the interview process, except to report in a general way what the students said.

An interview guide is located in the appendix of this report. The guide represents a framework from which the interviewer (this writer) conducted the interviews. Twenty students were interviewed, all by telephone. Results of the interviews are reported in Chapter IV.

Development of the Clinical Model

As a result of the literature search in developing a rationale for this study, several alternatives to standardized testing emerged. Using the term "clinical evaluation," the writer attempted to combine several of these aspects into a model which could be used to evaluate student competence in mathematics. The intended use of the model was to provide additional information beyond test scores, that could be useful in decisions regarding placement, remediation, and curriculum.

The model was grounded in theoretical concepts that seemingly would be of value when applied to practical problems in community colleges, such as placement, design of college-preparatory courses, and evaluation of student competence. In an attempt to validate the effectiveness of the model, a "panel of experts" was consulted and asked to respond to the model with respect to content and feasibility.

The panel consisted of knowledgeable persons in the field of community college mathematics. Specifically, eight persons were contacted. Two of the individuals were university professors familiar with the problems of mathematics placement in the community colleges. One of the panel members was a community college administrator,

likewise familiar with mathematics and related problems. One was a counselor at a community college who was experienced in problems of mathematics evaluation and placement. Four of the panel members were mathematics instructors at community colleges, one of whom was the department head.

The panel members were in agreement with the concept of such a model. All of the members supported the idea that information in addition to test scores would be useful. At various stages of the development of the model various panel members made suggestions to enhance the development of the model. The model was revised several times and eventually a final version was submitted to the panel for their comments, criticism, and suggestions as to the feasibility and content of the model. A description of the model and a summary of the panel's reaction to the model are included in Chapter IV.

CHAPTER IV

RESULTS

Results are presented in this chapter in response to the three questions outlined in Chapter I. Results of the data analysis to determine the relationship between placement test scores and success in initial math courses (Question one) are presented in Table 4.1. This table summarizes the correlations of ACT and SAT scores and grades earned in the eight entry level mathematics courses described in Chapter III. The correlations are presented separately for ACT and SAT. The Pearson product-moment correlation (r) is given for each course. The final two rows represent the correlation for a composite of grades across all courses, for ACT and for SAT.

A further analysis of the comparison of test scores and grades is provided in Tables 4.2 and 4.3. The correlations reported in Table 4.1 which were significant at the .95 level are included in these tables. Test scores are grouped into four categories which are indicated in a horizontal arrangement. Grades are listed vertically from A down through F. A cross-tabular effect is thus presented, showing the number (n) and percentage of students who earned a specific grade (A through F) and whose test score was in a certain category. Table 4.2 presents ACT scores and grades, cross-tabulated for the three courses which had significant r levels, and the composite of all ACT scores and grades. Table 4.3 presents the same information for SAT scores.

Table 4.1

Correlation of Test Score and Grade for ACT and SAT for Entry Level Mathematics Courses

	STATISTICS		
Course	Test	n	r
Introductory Math	ACT	20	-.01
	SAT	3	-.50
Basic Math	ACT	160	.31*
	SAT	27	-.04
Elementary Algebra	ACT	71	.04
	SAT	32	.19
Intermediate Albegra	ACT	77	-.07
	SAT	54	.22*
College Algebra	ACT	62	.21*
	SAT	42	.47*
Principles of Mathematics	ACT	7	-.42
	SAT	5	-.24
Trigonometry	ACT	11	.78*
	SAT	10	.69*
Calculus	ACT	13	.25
	SAT	12	-.16
Composite	ACT	423	.16
Composite	SAT	188	.12

Note: Composite score included 4 scores on SAT and 2 scores on ACT which were subsequently dropped because the courses were not used in the study.

*Significant at the 95% level.

Table 4.2

Cross-Tabulation of ACT Scores and Grades

		ACT Scores							
		0-7		8-15		16-23		24-32	
Course	Grades	N	%	N	%	N	%	N	%
Basic Math	A	6	4%	29	18%	0	0%	0	0%
	B	15	9%	26	16%	0	0%	0	0%
	C	9	6%	19	12%	2	1%	0	0%
	D	0	0%	7	4%	1	0%	0	0%
	F	27	17%	19	12%	0	0%	0	0%
College Algebra	A	0	0%	2	3%	5	8%	8	13%
	B	0	0%	2	3%	10	16%	5	8%
	C	0	0%	1	2%	10	16%	0	0%
	D	0	0%	2	3%	2	3%	1	2%
	F	0	0%	1	2%	11	18%	2	3%
Trigonometry	A	0	0%	0	0%	2	18%	3	27%
	B	0	0%	0	0%	1	9%	0	0%
	C	0	0%	0	0%	3	27%	0	0%
	D	0	0%	1	9%	1	9%	0	0%
	F	0	0%	0	0%	0	0%	0	0%
Composite	A	8	2%	42	10%	20	5%	18	4%
	B	19	5%	37	9%	29	7%	5	1%
	C	14	3%	34	8%	37	9%	3	1%
	D	1	0%	19	5%	17	4%	2	1%
	F	36	9%	33	8%	40	10%	3	1%

Table 4.3

Cross-Tabulation of SAT Scores and Grades

		SAT Scores							
		210-330		340-450		460-570		580-710	
Course	Grades	N	%	N	%	N	%	N	%
Intermediate Algebra	A	0	0%	2	4%	2	4%	1	2%
	B	0	0%	7	13%	7	13%	1	2%
	C	0	0%	15	26%	1	2%	1	2%
	D	1	2%	5	9%	1	2%	0	0%
	F	1	2%	6	11%	2	4%	1	2%
College Algebra	A	0	0%	2	5%	5	12%	4	10%
	B	0	0%	3	6%	3	6%	1	2%
	C	0	0%	5	12%	2	5%	0	0%
	D	0	0%	5	12%	2	5%	0	0%
	F	0	0%	5	12%	5	12%	0	0%
Trigonometry	A	0	0%	0	0%	2	20%	2	20%
	B	0	0%	0	0%	1	10%	0	0%
	C	0	0%	3	30%	0	0%	0	0%
	D	0	0%	1	10%	1	10%	0	0%
	F	0	0%	0	0%	0	0%	0	0%
Composite	A	9	5%	10	5%	12	6%	7	4%
	B	9	5%	18	10%	17	9%	5	3%
	C	1	0%	30	16%	7	4%	3	2%
	D	2	1%	18	10%	4	2%	0	0%
	F	6	3%	20	11%	9	5%	2	1%

Discussion of Results to Question One

Question one, which addressed the relationship between placement test scores and performance in initial college mathematics courses, was answered by correlating test scores and grades. As indicated in Table 4.1, the Pearson product-moment coefficient of correlation (r) was computed for each course, comparing test score to grade. The r statistic is a numerical descriptive measure of the correlation between two variables which measures the strength of the linear relationship between them (McClave, 1982).

The implicit assumption in such a comparison of test scores to grades would be that if a positive linear relationship existed between test score and grades, that relationship would be apparent from the r statistic. Correlations of a highly positive nature would indicate such a relationship. However, the results of this study indicate quite low correlations, with many of them actually negative.

Only two of the positive correlations were at the .50 magnitude or higher. Grades in MAC 1114, Trigonometry, were correlated with ACT scores at .78 and with SAT scores at .69. Other moderately positive correlations were .47 for grades in MAC 1004, College Algebra, and SAT scores, .31 for grades in MAT 1002, Basic Mathematical Skills, and ACT scores and .25 for grades in MAC 2311, Calculus, and ACT scores. The most striking aspect of the correlations appears to be the seven negative values of r, and the modest to low nature of the correlations in general. High positive correlations would have indicated large

proportions of low test scores corresponding to low grades and high test scores corresponding to high grades. Low to moderate correlations are seen as indicating weak relationships, with high test scores sometimes associated with high grades, but also occurring with low grades. Thus, the results from the correlations performed in response to question one indicate that there is only a moderate to weak relationship between test scores and grades. Standardized test scores appear to be of only minimal value in predicting success in initial mathematics courses. Apparently, other factors must be used in appropriate placement.

Results With Respect to Question Two

Question two was an attempt to determine additional factors which could be of use in placement strategies. The question asked what factors "high-risk" students attributed to their successful completion of college mathematics courses. As previously described, students that may have been expected to do poorly in college-level courses, or be excluded altogether, because of low test scores were interviewed. These students had successfully completed a college-level course (MAT 1024 or above) in their first attempt. The interviews focused on why they felt they were able to perform as well as they did.

The students were all willing to talk about their experiences in the math courses. Using the interview guide (in Appendix A) as a framework, the students' responses were tabulated. Results appear in Table 4.4.

Table 4.4

Factors Considered Important by Students for Successful Completion of College-Level Math Courses

Instructor	High School Math Background	Tutor	Effort/Time	Math Lab
80%	100%	20%	90%	40%

Since there was no uniform manner of responding, each student's responses were unique. There were, however, many similarities in the comments the students made. The percentages given in Table 4.4 are based on generalizations made by the interviewer in order to place responses into one of the categories on the checklist. When clarification was necessary, the interviewer asked a direct question in order to determine the student's intended meaning.

Discussion of Results With Respect to Question Two

The intent of the survey of "high-risk" students was to identify possible factors that could be of use in the placement process. By speaking directly with students, the interviewer was able to get a more personal feeling for which factors were apparently important. The literature had identified many of the factors mentioned by the students. The results of the interviews verified many of the factors mentioned in the literature such as motivation/effort, high school performance (grades), and "clinical evaluation" in the form of direct

personal assistance by the instructor, a tutor and/or use of the math lab. Two factors not mentioned by the students that were found in the literature were attitude toward math (affective domain) and learning-style preference.

It would appear from the results of the interviews that three main factors emerged as important. High school performance or background in math, motivation and effort, and "clinical evaluation" during the course were all mentioned prominently in the interviews. It seems very likely that these factors, given adequate means of defining and quantifying them, could be of great value in the placing of students.

Every one of the students interviewed indicated that they had completed high school mathematics courses beyond the first course in algebra. Two of the students had taken calculus, 11 had taken trigonometry/analytic geometry, 5 had taken the second course in algebra, and 2 had taken geometry. This was unexpected since they each were below the present cut-off score for placement in college level courses.

A second important factor as identified by the interviews and in the literature related to student effort. In general the students' responses concerning effort and time spent preparing for the course were related to high school background. For instance, the two students who had taken calculus reported minimal time and effort studying. Other students considered their time and effort to have been extremely important. As reported, 40% made use of the math lab.

Quality of student effort is seen as an important factor in student achievement. Pace (1980) maintained that pronouncements should not be made concerning college impact without taking quality of

effort into consideration. Not only must the offerings of the institution be considered but what the students do with those offerings as well. The special value of measuring quality of effort was demonstrated to be the most influential single variable in accounting for students' attainment in the study by Pace.

The third factor suggested in the interviews and having considerable support in the literature was "clinical evaluation." Direct personal assistance by the instructor or a tutor and use of the math lab pertain to this type of assessment. Methods of identifying students' deficiencies and prescribing remedial work were seen as another important factor which should be used in the placement and instructional process.

Results With Respect to Question Three

The third question of this study pertains to the construction of a clinical evaluation model which makes use of factors identified in the literature and in the student interviews described in Question two. Such a model was constructed as a result of this study and was evaluated by the panel of experts described in Chapter III.

A description of the model is presented herein. The panel's reactions to the model and the discussion thereof follows.

Description of the Clinical Evaluation Model

Clinical evaluation is defined as an analytical assessment of deficiencies and the prescribing of treatment based on direct observation by a practicing professional. Clinical evaluation allows

for a holistic approach to evaluation that is not possible using standardized testing alone. Use of the model should enable the evaluator and the student to understand more fully the nature of the deficiency in a given area than would be possible using standardized testing alone.

The model presumed a hierarchy of levels of skills in mathematics, wherein certain skills cannot be mastered without previous mastery of more fundamental skills. Use of the model depended greatly on the professional capabilities of the evaluator--ideally a community college mathematics instructor. The professional judgment and skill of the evaluator were seen as extremely important.

The model was divided into subject areas--Arithmetic, Algebra, Geometry, Statistics--and levels--Algorithms, Concepts, Generalizations, and Problem Solving. Figure 4.1 is a flowchart of the clinical evaluation process. Individual flowcharts for each subject area are presented as Figures 4.2 through 4.5. Each level on the model presumed mastery of certain prerequisite levels. These levels are shown in relation to one another as they would occur in the evaluation process. Arithmetic was seen as a prerequisite subject for all other subjects on the model (see Appendix B).

Using the Model

The clinical evaluation would begin with Algebra. The flowchart (Fig. 4.1) represents the sequences that would follow. If the student demonstrates mastery of the required skills in Algebra, it is theorized that the student could also perform the required skills in Arithmetic and thus the evaluation would proceed to Geometry and then

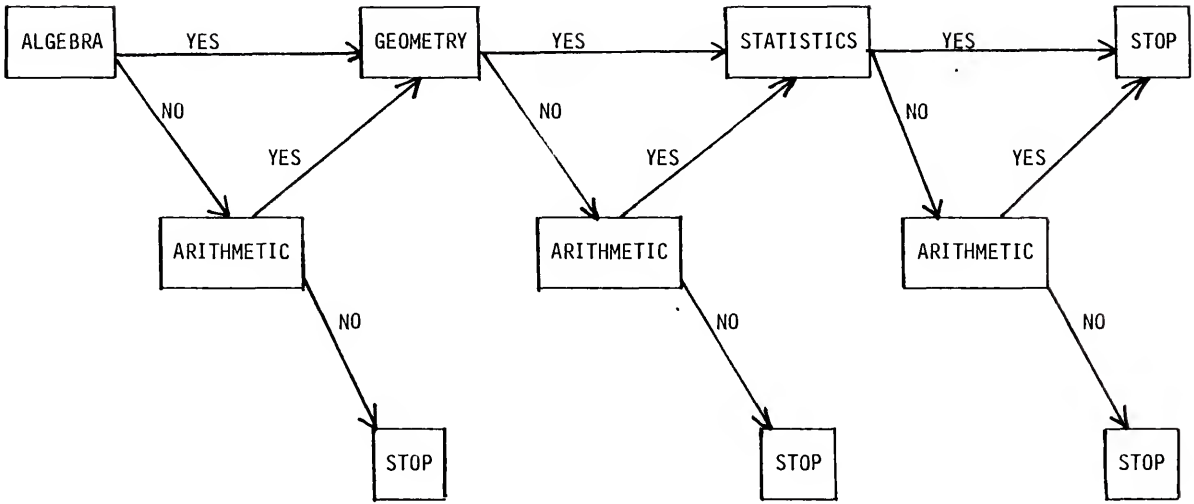

Figure 4.1. Flowchart for Clinical Evaluation

to Statistics. If the evaluator determines that the student has not demonstrated at least 70% mastery of the skills in Algebra, the evaluation must then also include Arithmetic. If Algebra and Arithmetic were evaluated at less than 70% competence, the evaluation would terminate.

Figures 4.2 through 4.5 represent the sequences of the clinical evaluation for each subject area. The sequencing provides for rapid progress through the flowchart, specifically if the student demonstrates competence of higher levels, by presuming mastery of the lowest levels (Algorithms). If, however, the student did not demonstrate mastery of the higher levels (concepts, or generalizations and problem solving) the Algorithm level must also be evaluated. Mastery is defined at 70% or greater for each subject area.

By following the sequence indicated by the flowcharts, the evaluator would consult a checklist to determine what specific skills comprise that particular subject and level. The evaluator would then formulate a problem pertaining to the first skill or select a sample problem from a data bank. The student would attempt to solve the problem, listing or explaining the steps taken and the result. The evaluator must then determine whether the student's result is correct. If so, the evaluator would proceed to the next enumerated skill for that subject/level. If not, the evaluator would formulate another problem, ask a related line of questions or anything further that may help determine whether or not the student could perform the designated skill. Since clinical evaluation calls for direct oral communication between the student and evaluator, the evaluator would initiate dialogue by asking appropriate, related questions. If, in the

evaluator's judgment, the student could not perform that skill, the evaluator would note the skill and continue to the next skill. When all the skills had been evaluated, the flow chart would be consulted to determine the next step in the evaluation process (see Appendix C).

Algebra. The evaluation for Algebra would begin with the Concepts level. If the student demonstrated mastery at the 70% level or above, the evaluation would proceed to the Generalization and Problem Solving questions. If not, the evaluation would proceed to the Algorithm level. If that level is evaluated at less than 70%, the evaluation of Algebra would terminate and proceed to Arithmetic. Similarly, if the evaluation of Generalizations and Problem Solving were evaluated at less than 70%, the evaluation would proceed to Algorithms. In order to proceed to Geometry, the student would demonstrate proficiency in 70% of the skills. If not, the evaluation would proceed to Arithmetic.

Arithmetic. If Arithmetic was evaluated, the starting point would be Concepts. Mastery would be demonstrated by performance at 70% or above. If the evaluator determined that the student had not demonstrated mastery at the concepts level, the evaluation would proceed to Algorithms. If Algorithm skills in Arithmetic were determined as deficient, the evaluation would terminate. If, however, the student demonstrated mastery of Arithmetic Algorithms, the evaluation would proceed to Generalizations and Problem Solving. If the student demonstrated mastery at 70% or above the evaluation would proceed to Geometry. If not (and thus the overall performance in Arithmetic is less than 70%) the clinical evaluation would terminate.

Geometry. The evaluation of Geometry would begin with the Concepts level. The student would demonstrate mastery of at least 70% or the evaluation would proceed to Algorithms. The student would demonstrate mastery of Algorithm skills or the Geometry component would terminate. If the student did demonstrate mastery of Concepts the evaluation would proceed to Generalizations and Problem Solving. The demonstration of mastery would be at least 70% or the Algorithm level would be evaluated as well. Overall mastery of over 70% should be demonstrated for Geometry.

Statistics. The evaluation of students' competence in Statistics would begin with the Concepts level. If mastery was demonstrated at 70% the evaluation would proceed to Generalizations and Problem Solving. If not, Algorithms would be evaluated. All of the Statistics algorithms should be demonstrated successfully or the Statistics component would terminate. The Generalizations and Problem Solving skills should be demonstrated at least 70% or the Algorithms level would be evaluated as well. Overall mastery of Statistics would be demonstrated at 70%.

Following the clinical evaluation, appropriate remedial work for each deficient category should be prescribed. Math labs in the community colleges would be equipped with remediation techniques such as programmed instruction units (perhaps computerized), workbooks, cassette tapes, flash cards, etc., that address the enumerated skills.

The model, therefore, would be used to allow the evaluator and the student to identify deficiencies and plan learning activities which could strengthen those deficiencies. The model could be used as

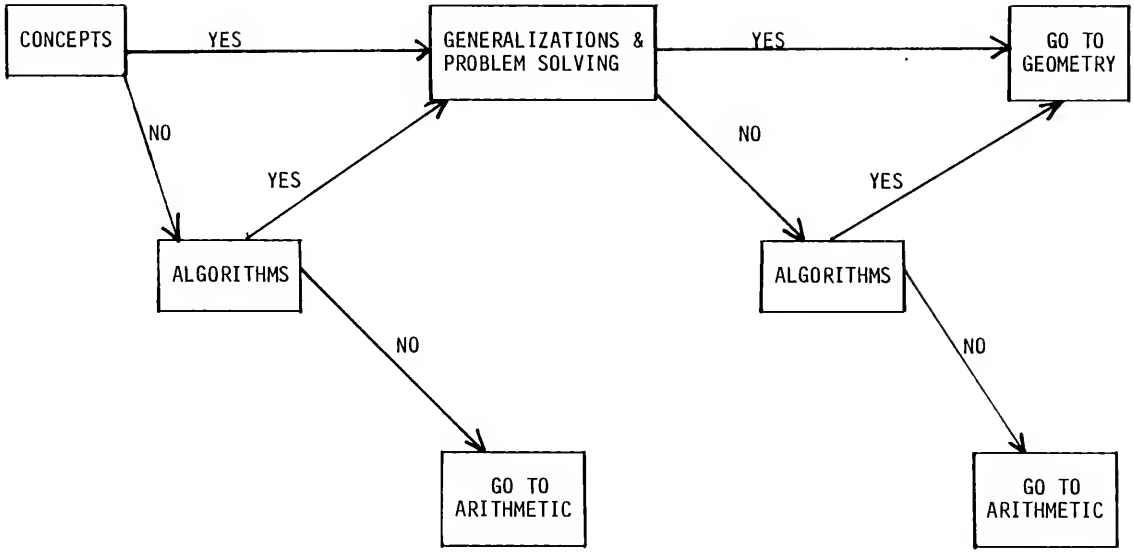

Figure 4.2. Algebra Flowchart

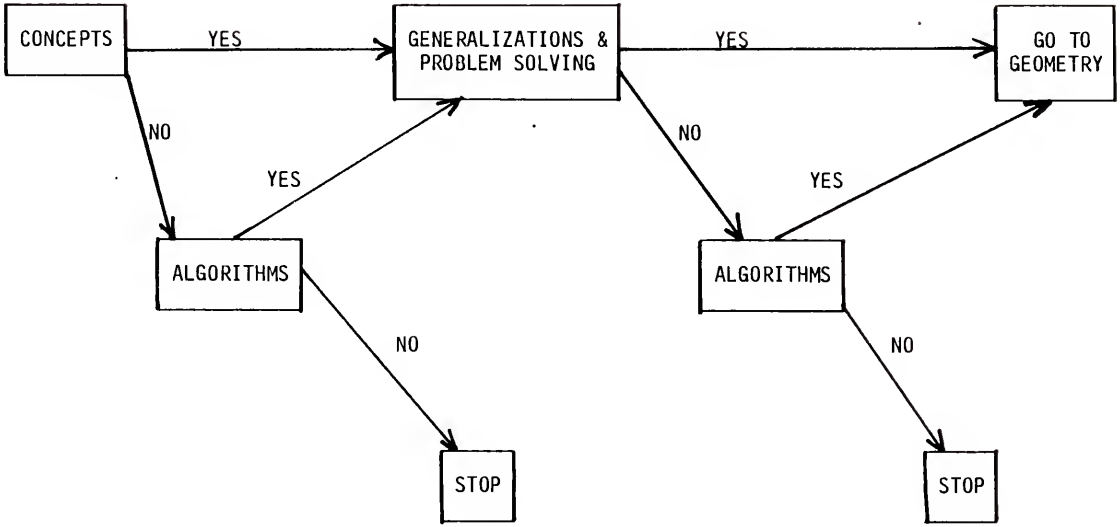

Figure 4.3. Arithmetic Flowchart

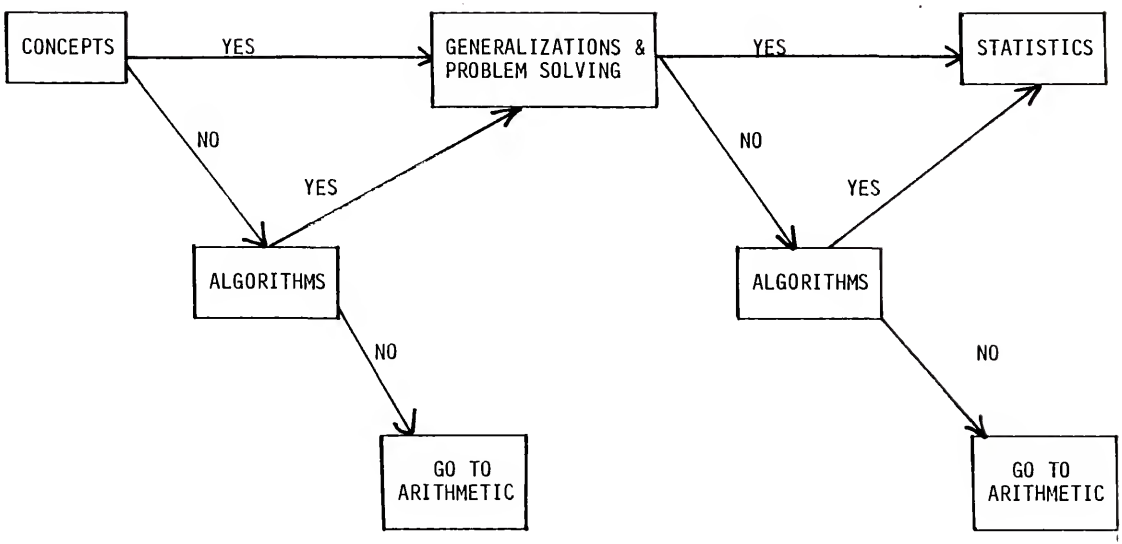

Figure 4.4. Geometry Flowchart

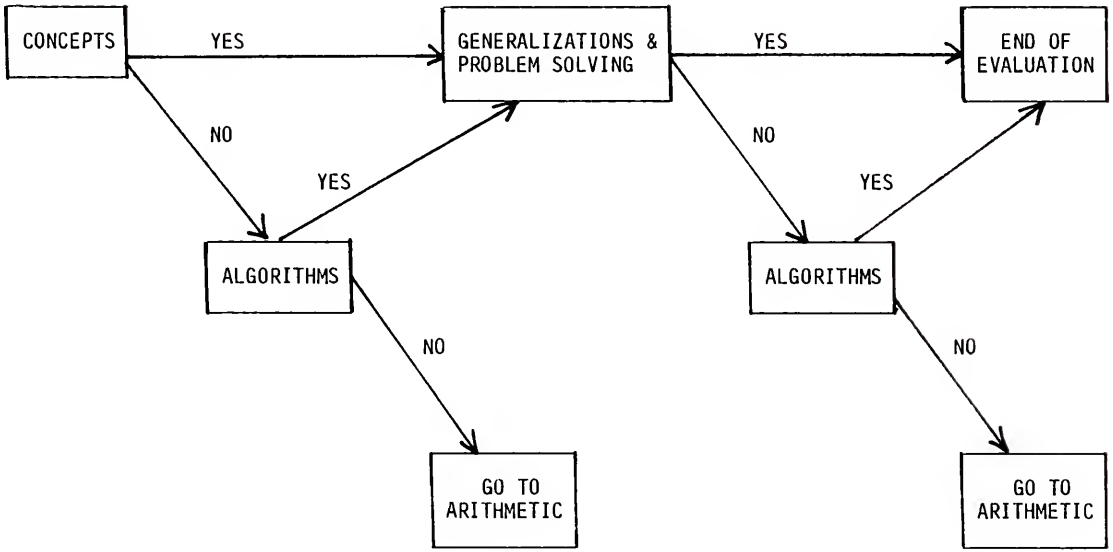

Figure 4.5. Statistics Flowchart

a component of a well planned placement and instructional process in mathematics. As noted previously, expert professional personnel would be required in addition to a well-equipped "math lab" for the entire developmental process to succeed. The extent to which these resources and personnel are available determine the effectiveness and feasibility of implementing a model such as this.

Discussion of Results to Question Three

The eight member panel which was consulted for their expert opinion concerning the model was in agreement on certain aspects but disagreed on others. Each member of the panel agreed that such a model, if possible to construct, would be of great use in placement and curriculum decisions. The panel split four to four over the theoretical assumptions on which the model was based.

The model was based on the assumption that since mathematics was of a hierarchical nature, the hierarchy could be used to evaluate mathematical competencies. Wilson (1971) based an instructional model on the hierarchical nature of mathematics. However, even though math curriculum is structured according to such a hierarchy, four of the panel members believed students do not reliably recall skills according to that hierarchy. For this reason, the four panel members doubted that the hierarchical nature of math could be used in the evaluation model. Interestingly and probably significantly, the four panel members to express such doubt were all community college mathematics instructors who were familiar with the abilities and skills of students. The counselor, administrator, and the two university professors accepted the assumption that mathematical hierarchy could be so used.

Finally, all of the panel members expressed concern over the feasibility of implementing the model. Those who assumed that the hierarchy could screen students were more optimistic. The assumption was that fewer skills would actually be evaluated since many of the skills would have been presumed mastered if students demonstrated proficiency of the "higher" skills. Those who rejected the hierarchical concept contended that nearly all skills would need to be evaluated individually, thus greatly increasing the length of a "clinical evaluation." The large amounts of time, resources, and personnel necessary to implement a nonhierarchical model in the colleges rendered it unfeasible in the opinion of the panel.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND IMPLICATIONS

Summary

Placement for community college students in math has been recognized as imperative. Effective, widely accepted placement techniques have not been reported in the literature. This study has analyzed the relationship between tests used for placement purposes and subsequent grades in mathematics courses. In order to identify and verify other factors which could be used in the placement process, interviews were conducted with students who had successfully completed their initial college level course, but had been identified as "high-risk" as a result of low test scores. Three main factors emerged from the interviews as important. High school preparation in mathematics, quality of student effort, and clinical evaluation techniques were considered important by the students in leading to their successful completion of college-level courses.

A clinical evaluation model was developed which was based on concepts found in the literature and confirmed by students in the interviews. A panel of experts reacted to the model. The model was seen as lacking validity by four of eight experts and problems with feasibility of implementing a variation of the model were expressed.

Conclusions

The correlations for ACT and SAT scores and grades in initial mathematics courses were found to be generally low. It is concluded that the relationship between test scores and grades was weak for the data under consideration in this study. The results of this study lend support to criticism of using standardized test scores as a sole means of evaluation in the placement process.

Other factors that could be used in placement strategies were sought. Based on a review of related literature and interviews with "high-risk" students, factors necessary for successful completion of college-level courses were identified. High school math background, student effort, and availability of clinical evaluation techniques were the three most promising for use.

A clinical evaluation model based on theoretical concepts from the literature was constructed. A panel of experts concluded that an acceptable variation of the model would not be useful given constraints of time, resources, and personnel.

Recommendations

Heretofore, no standardized test or other single means of evaluation has emerged as an effective placement instrument. Mandatory placement is a relatively recent practice in Florida's community colleges and suitable methods of accomplishing it are still being sought. Research designed to study possible methods of placement is needed. A combination of two or more factors would seem to offer the most promise for effective placement, particularly in light of the lack of a single reliable instrument.

The following variables seem to be worthy of further study:

1. high school math grades
2. other standardized tests
3. student effort/motivation
4. clinical evaluation methods
5. learning-style preference
6. affective domain/attitude toward math

Problems have been identified for each of the possible variables listed above. However, since no acceptable, widely used placement techniques are available, their investigation would appear to be warranted.

Grades have been criticized as a variable for use in research studies because of lack of standardization. This characteristic does not seem likely to change. Even though there are problems using grades, other studies have shown them to be useful in predicting academic success. Particularly in mathematics, where high school courses are sequentially arranged, would consideration of grades be appropriate because information on the level of mathematics in students' backgrounds should be beneficial.

Standardized tests other than ACT and SAT may prove to be better placement instruments. Certainly MAPS and ASSET should be studied to determine their effectiveness as placement instruments. Other tests, particularly competency-based, content exams should be considered as possible placement instruments.

Quality of student effort has been identified as an important factor. Outcomes have been predicted quite well using quality of student effort as a variable. Further investigation in this area should prove valuable.

Clinical evaluation techniques, in theory, seem to offer great promise for appropriate placement. The analytical assessment of competencies and deficiencies based on direct observation by a competent observer would have advantages that standardized tests could not provide. Specifically, the identification of exact areas of deficiency in math would be possible. Considering the hierarchical nature of mathematics, knowledge of certain deficiencies would be most useful in the placement process.

Unfortunately, such a model for clinical evaluation in mathematics would not be accepted by many practitioners. Specifically, the model developed in this study was not acceptable based on opinions of knowledgeable persons in the field. Various problems were identified in the construction of such a model. Much of the evaluation would greatly depend on the observer, and it would be very difficult to maintain consistency from one observer to another. Problems also were identified with quantification of the results of the observations. Difficulty in defining a true hierarchy in math skills was also discovered.

Nevertheless, if some or all of these problems could be minimized, clinical evaluation of math skills would appear to have possibilities for placement of students. More research in the area is needed.

As previously noted, learning-style preference has been considered in only a small number of the studies reported in the literature. This area also holds potential for placement and should be researched more fully.

The affective domain and the student's attitude toward math have been difficult to study. Emphasis has too often been placed on the cognitive domain. The affective domain represents a vital component of how students learn, yet has often been neglected in instruction and learning paradigms. Possibly because of the lack of reliable instruments to measure it, the attitudes and emotions are not assessed and considered in placement strategies.

Implications

One rather obvious implication of this study is to confirm the opposition of several writers to the use of standardized tests as the sole means of evaluation. Indeed, the composers of standardized tests caution against their use as the sole criterion in a placement decision. Even so, the recently mandated cut-off scores require the use of standardized test scores, although provisions were made for the use of additional means of evaluation for placement. Therefore, this study clearly implies the need for other factors which can be used for appropriate placement.

The concept of clinical evaluation based on the hierarchical nature of mathematics formed the theoretical basis for the construction of the clinical evaluation model. The hierarchical nature of mathematics has long been recognized and utilized in curriculum design. The sequential nature of mathematics courses in general follows a logical progression. However, the assumption that this hierarchy would be useful for evaluation purposes has not been demonstrated by this study. Even though mathematics must be presented in the proper sequence for the purpose of sound instruction, students

do not reliably recall skills in the order presented. Therefore, an evaluation model which is based on strict application of the hierarchy would lack validity. It is an oversimplification to presume that because a student demonstrates proficiency in certain areas of the mathematics curriculum that student could also perform at lower levels. Similarly, it cannot be assumed that proficiency in higher levels of the cognitive domain (applications, for example) necessarily imply proficiency in lower levels such as algorithms.

The implication, then, is that for purposes of summative evaluation, the assumed use of the hierarchy is insufficient. This implies that for a valid summative evaluation each skill at each level should be evaluated separately. There is evidence that a clinical means of evaluation would be more accurate than using standardized tests, but in either case mastery of lower levels cannot be presumed because of demonstration of proficiency at higher levels.

This is not to say that the hierarchy cannot be used in the placement process. If it can be demonstrated that skills presumed to be prerequisite are indeed such, a test or clinical evaluation to determine mastery of these prerequisite skills would be most useful for placing students into the proper course. The narrower the range of skills, the more detectable the prerequisites would be. For these reasons, use of the hierarchical nature of math would be helpful in formative evaluation such as for placement. For example, if a series of questions that have been demonstrated to be necessary prerequisites for, say, an algebra course were available, evaluation of students' mastery of those skills could be used to determine readiness for the course. This evaluation could be a standardized test or a clinical

evaluation, although again the clinical evaluation is recommended given adequate resources and personnel.

In conclusion, then, use of the hierarchy for assumption of proficiency of lower skills because of proficiency in higher skills has not been demonstrated to be valid. Therefore use of the mathematical hierarchy for summative evaluation (such as CLAST) is not recommended. However, using the hierarchical and sequential nature of mathematics shows promise for use in formative evaluation such as placement.

APPENDIX A

INTERVIEW GUIDE

1. Identification of caller.

2. Would you be willing to answer a few questions regarding the math course you took in the fall (or summer) of 1984?

3. You've been identified as doing well in the course (name course specifically). The questions relate to why you feel you were able to successfully complete the course. What reasons would you give for your success?

4. What other factors would you consider important?

5. Any others? What about _____? (refer to checklist)

6. About how many hours per week did you study for this course?

7. Any other reasons that you can think of?

8. Thank you for your help.

Checklist

Reasons or factors given by students for successful completion.

INSTRUCTOR

HIGH SCHOOL PREPARATION

TUTOR

WEEKLY HOURS OF STUDY

MATH LAB

OTHER

APPENDIX B

SUBJECT BY LEVEL MATRIX

LEVELS

		ALGORITHMS	CONCEPTS	GENERALIZATIONS	PROBLEM-SOLVING
SUBJECTS	ARITHMETIC				
	ALGEBRA				
	GEOMETRY				
	STATISTICS				

APPENDIX C

SUGGESTED STEPS FOR CLINICAL EVALUATION

1. The evaluator presents a problem pertaining to the skill that is to be evaluated. The students should solve the problem, listing the steps taken and the answer. The evaluator examines each step as well as the final answer.

2. The evaluator presents a solution and answer to a problem that pertains to the skill; however, the solution steps and answer contain an error. The student is to identify the error or errors and make corrections.

3. The student is asked to formulate a problem/question that requires use of the skill under consideration, then list the solution steps and the answer.

Some or all of these recommended steps may be used to initiate discussion and thus provide information concerning the student's understanding and competence. Other techniques may be used, such as a related line of questioning, particularly if the evaluator senses the need for such. Creativity on the part of the evaluator would be beneficial.

It is here that the holistic approach to evaluation is necessary as well as use of the hierarchical nature of mathematics.

REFERENCES

Allen, L.R. (1981). Fundamental algebra: Increasing mastery and retention in college. [Position paper] Community College of Allegheny County, PA. (ERIC Document Reproduction Service No. ED 202 560)

Bersoff, D.N. (1973). Silk purses into sow's ears: The decline of psychological testing and a suggestion for its redemption. American Psychologist, 28, 892-898.

Bloom, B.S. (Ed.). (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook 1. Cognitive domain. New York: McKay.

Clark, R.M. (1980). Summary analysis of students and grades: Mathematics A, elementary algebra; mathematics B, plane geometry; mathematics C, trigonometry; mathematics D, intermediate algebra. Reedley, CA: Kings River Community College. (ERIC Document Reproduction Service No. ED 215 744)

Clemson, E. (1978). A study of the basic skills assessment: Direct and indirect measures of writing ability. Princeton, NJ: Educational Testing Service. (ERIC Document Reproduction Service No. ED 204 409)

Cohen, A.M., & Brawer, F.B. (1982). The technology of instruction. Community and Junior College Journal, 53(1), 34-37.

Corcoran, M., & Gibb, E.G. (1961). Appraising attitudes in the learning of mathematics. In The National Council of Teachers of Mathematics, Evaluation in mathematics (pp. 105-122). Washington, DC: NCTM.

Cordrey, L.J. (1984). Evaluation of the skills prerequisite system at Fullerton College (a two year follow-up). Fullerton, CA: Fullerton College. (ERIC Document Reproduction Service No. ED 244 663)

Cross, K.P. (1971). Beyond the open door. San Francisco: Jossey-Bass.

Cross, K.P. (1976). Accent on learning. San Francisco: Jossey-Bass.

Davidman, L. (1981). Learning style: The myth, the panacea, the wisdom. Phi Delta Kappan, 62, 641-645.

Domino, G. (1970). Interactive effects of achievement orientation and teaching styles on academic achievement. Act Research Report 39, pp. 1-9.

Dubois, P.H. (1972). [Review of Scholastic Aptitude Test] in Buros, O.K. (Ed.), The seventh mental measurements yearbook. Highland Park, NJ: The Gryphon Press.

Dunn, K.J., & Dunn, R.S. (1979). Learning styles/teaching styles: Should they . . . can they . . . be matched? Educational Leadership, 36, 238-244.

Dunn, K.J., Dunn, R.S., & Price, G.E. (1977). Diagnosing learning styles: A prescription for avoiding malpractice suits. Phi Delta Kappan, 58, 418-420.

Dunn, K.J., Dunn, R.S., & Price, G.E. (1981). Learning styles: Research vs. opinion. Phi Delta Kappan, 62, 645-646.

Easton, J.Q., Barshis, D., & Ginsberg, R. (1983-1984). Chicago colleges identify effective teachers, students. Community and Junior College Journal, 54(4), 27-31.

Evans, D.N. (1975). Standards are needed for crt's. Educational Leadership, 32, 268-270.

Farr, B.J. (1971). Individual differences in learning: Predicting one's more effective learning modality. Dissertation Abstracts International, 1332A.

Ferguson, M. (1980). The aquarian conspiracy. Los Angeles: J.P. Tarcher.

Ferster, C.B., & Perrott, M.C. (1968). Behavior principles. New York: Meredith.

Fincher, C. (1974). Is the SAT worth its salt? An evaluation of the use of the Scholastic Aptitude Test in the university system of Georgia over a thirteen-year period. Review of Educational Research, 44, 293-305.

Florida MAPS: Technical manual. (1984). Princeton, NJ: Educational Testing Service.

Fouche, R.S. (1961). Overview and practical interpretations. In The National Council of Teachers of Mathematics, Evaluation in mathematics (pp. 167-180). Washington, DC: NCTM,

Ginsburg, H. (1975, April). Talking with children: An alternative to testing. Educational Technology, 15(4), 41.

Glaser, R. (1963). Instructional technology and the measurement of learning outcomes. American Psychologist, 18, 519-521.

Goldman, R.D., & Slaughter, R.E. (1976). Why college grade point average is difficult to predict. Journal of Educational Psychology, 68, 9-14.

Haase, M., & Caffrey, P. (1983). Assessment procedures, Fall, 1982 & Spring, 1983 (Semi-annual research report, part I). Sacramento, CA: Sacramento City College. (ERIC Document Reproduction Service No. ED 231 494)

Halpin, G., Halpin, G., & Schaer, B.B. (1981, March). Research on writing: A search for objective measures related to holistically scored essays. Paper presented at the annual meeting of the Eastern Educational Research Association, Philadelphia, PA. (ERIC Document Reproduction Service No. ED 208 042)

Hambleton, R.K., Swaminathan, H., Algina, J., & Coulson, D.B. (1978). Criterion-referenced testing and measurement: A review of technical issues and developments. Review of Educational Research, 48, 1-47.

Haney, W. (1980). Trouble over testing. Educational Leadership, 37, 640-650.

Henderson, L.N., Jr. (1983). Application of the theory on incrementalism to statutory changes in the open door philosophy of Florida's community colleges, 1957 to 1981 (Doctoral dissertation, University of Florida, Gainesville, 1982). Dissertation Abstracts International, 42, 4309A.

Hills, J.R. (1971). Use of measurement in selection and placement. In R.L. Thorndike (Ed.), Educational measurement (pp. 680-732). Washington, DC: American Council on Education.

Hunt, D.E. (1981). Learning style and the interdependence of practice and theory. Phi Delta Kappan, 62, 647.

Justiz, M.J. (1985). Involvement in learning: The three keys. Community and Junior College Journal, 55(7), 23-28.

Keesling, J.W. (1974). Empirical validation of criterion-references measures. In C.W. Harris, M.C. Alkin, & W.S. Popham (Eds.), Problems in criterion-referenced measurement. Los Angeles: Center for the Study of Evaluation, University of California.

Kline, W.E. (1972). [Review of American College Testing Program] in Buros, O.K. (Ed.), The seventh mental measurements yearbook. Highland Park, NJ: The Gryphon Press.

Koos, L.V. (1970). The community college student. Gainesville: University of Florida Press.

Kopfstein, R.W. (1980, March). Study skills evaluation: Why does who do what and how? Paper presented at the Annual Conference of the Western College Reading Association, San Francisco. (ERIC Document Reproduction Service No. ED 187 406)

Kuliecke, M.J., Lloyd, J.S., & Mathis, B.C. (1982, March). The competence and performance of foreign medical graduates: Research and implications. Paper presented at the annual meeting of the American Educational Research Association, New York.

Larson, J.R., & Scontrino, M.P. (1976). The consistency of high school grade point average and the verbal and mathematical portions of the Scholastic Aptitude Test of the CEEB, as predictors of college performance: An eight year study. Educational and Psychological Measurement, 36, 439-443.

Levine, A. (1977). Understanding psychology (2nd Ed.). New York: Random House.

Linthicum, D.S. (1980). Dundalk community college developmental education research project. Baltimore, MD: Dundalk Community College. (ERIC Document Reproductive Service No. 206 332)

Longstreet, W.S. (1975). The grading syndrome. Educational Leadership, 32, 243-246.

McCabe, R.H., & Skidmore, S.B. (1983). Miami-Dade: Results justify reforms. Community and Junior College Journal, 54(1), 26-29.

McClave, J.T., & Dietrich, F.H., II. (1982). Statistics (2nd Ed.). San Francisco: Dellen.

McClelland, D.C. (1973). Testing for competence rather than for intelligence. American Psychologist, 28, 1-14.

Medsker, L.L., & Tillery, D. (1971). Breaking the access barriers. New York: McGraw-Hill.

Nolan, E.J. (1976). The relationship between ACT sub-test scores and grades earned: A correlational study. Southern West Virginia Community College. (ERIC Document Reproduction Service No. ED 131 902)

Novick, M.R., & Lewis, C. (1974). Prescribing test length for criterion-referenced measurement. In C.W. Harris, M.C. Alkin, & W.S. Popham (Eds.), Problems in criterion-referenced measurement. Los Angeles: Center for the Study of Evaluation, University of California.

O'Reilly, P., Vogler, D.E., & Asche, F.M. (1980). Evluating performances: Implementing competency based education in community colleges. Virginia Polytechnic Institute and State University, Blacksburg, VA. (ERIC Document Reproduction Service No. ED 195 302)

Pace, C.R. (1980). Measuring the quality of student effort. Current Issues in Higher Education, 2, 39-46.

Palow, W.P. (1979, April). Technology in teaching mathematics: A computer managed, multimedia mathematics learning center. Paper presented at the Annual Meeting of the National Council of Teachers of Mathematics, Boston. (ERIC Document Reproduction Service No. ED 184 609)

Popham, W.J. (1975). Educational evaluation. Englewood Cliffs, NJ: Prentice-Hall.

Popham, W.J., & Husek, T.R. (1969). Implications of criterion-referenced measurement. Journal of Educational Measurement, 6, 1-9.

Price, F.W., & Kim, S.H. (1976). The association of college performance with high school grades and college entrance test scores. Educational and Psychological Measurement, 36, 965-970.

Quinto, F., & McKenna, B. (1977). Alternatives to standardized testing. Washington, DC: National Education Association, Division of Instruction and Professional Development. (ERIC Document Reproduction Service No. ED 190 591)

Reap, M.C. (1979, February). A community college user's approach to American College Testing data. Paper presented at the Southwest Educational Research Association, Houston, TX. (ERIC Document Reproduction Service No. ED 207 615)

Roueche, J.E. (1980). Holistic literacy in college teaching. New York: Media Systems.

Schade, H.C. (1977). The ability of the ACT and MCPT to predict the college grade point average (Institutional Research Report 3-77). Neosho, MO: Crowder College. (ERIC Document Reproduction Service No. ED 188 683)

Schinoff, R.B. (1982). No nonsense at Miami-Dade. Community and Junior College Journal, 53(3), 34-44.

Shugars, D.A., May, K.N., & Vann, W.F. (1981). Comprehensive evaluation in a preclinical restorative dentistry technique course. Journal of Dental Education, 45, 801-803.

Sueltz, B.A. (1961). The role of evaluation in the classroom. In The National Council of Teachers of Mathematics, Evaluation in mathematics (pp. 7-20). Washington, DC: NCTM.

Thornton, J.W., Jr. (1966). The community junior college (2nd Ed.). New York: John Wiley & Sons.

Travers, R.M.W. (1969). An introduction to educational research (3rd Ed.). New York: Macmillan.

Wallace, W.L. (1972). [Review of Scholastic Aptitude Test] in Buros, O.K. (Ed.), The seventh mental measurements yearbook. Highland Park, NJ: The Gryphon Press.

Wattenbarger, J.L. (1971). The expanding roles of the junior and community colleges. In W.K. Ogilvie & M.R. Raines (Eds.), Perspectives on the community junior college (pp. 52-56). New York: Meredith.

Wiener, S.P. (1985). Through the cracks: Learning basic skills. Community and Junior College Journal, 55, 52-54.

Wilson, J.W. (1971). Evaluation of learning in secondary school mathematics. In B.S. Bloom, J.T. Hastings, & G.F. Madaus (Eds.), Handbook on formative and summative evaluation of student learning (pp. 646-695). New York: McGraw-Hill.

Wood, J.P. (1980). Mathematics placement testing. New Directions for Community College, 31, 59-64.

BIOGRAPHICAL SKETCH

Robert Norman McLeod was born August 5, 1950, in Jacksonville, Florida. The first of four children of H.F. and the late Norma B. McLeod, he moved with his family to Miami where he completed elementary and secondary education in the public schools of Dade county.

He attended the University of Florida from 1968 through 1972, receiving the B.A. with honors, majoring in psychology. After returning to Dade county he taught psychology, mathematics, and reading there for six years, during which time he earned the Master's and Ed.S. degrees from Nova University.

In 1980 he was married to Jackie Barbara Polly. They moved to Ocala in 1981 as work began on the Ph.D. Two sons, Charles Robert and Travis Gordon, were born in 1982 and 1984, respectively. He has taught mathematics in the Marion county school system since August, 1981.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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