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# Identification of the At-Risk Mathematics Student Within the Community College Environment

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# Identification of the at-risk mathematics student within the community-college environment

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School of Education

# IDENTIFICATION OF THE AT-RISK MATHEMATICS STUDENT WITHIN THE COMMUNITY-COLLEGE ENVIRONMENT

A Dissertation

Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

Gerry Lee Cox

August 1993

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ABSTRACT

IDENTIFICATION OF THE AT-RISK MATHEMATICS STUDENT WITHIN THE COMMUNITY-COLLEGE ENVIRONMENT

by

Gerry Lee Cox

Chair: Paul Brantley

ABSTRACT OF GRADUATE STUDENT RESEARCH

Dissertation

Andrews University

School of Education

Title: IDENTIFICATION OF THE AT-RISK MATHEMATICS STUDENT WITHIN THE COMMUNITY-COLLEGE ENVIRONMENT

Name of researcher: Gerry L. Cox

Name and degree of faculty chair: Paul Brantley, Ph.D.

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Problem

This study sought to develop a tool to identify the nonsuccessful, at-risk community-college student for correct placement, monitoring, and retention. A comparison in academic achievement of at-risk, remediated students with nonremedial students in a first college-level mathematics class (Intermediate Algebra 101) was also studied.

Method

The ex post facto study sought to determine to what extent the successful and nonsuccessful at-risk

mathematics students (n = 358) differ on ASSET test scores, criterion referenced pretest scores, mathematics attitude scores, attendance profile, race, gender, and demographic variables. Statistical analyses using descriptive procedures, ANOVA, MANOVA, Chi-square, and discriminant analysis were used with an alpha = .05.

The achievement of the at-risk students (n=40) with non-at-risk students (n=48) in a first college-level mathematics class (Intermediate Algebra 101) was studied.

## Results

The variables found in fractions, whole numbers, ASSET (Numerical Skills), age, and gender were significant in the prediction of successful or nonsuccessful achievement in the Basic Mathematics class with a 65.35% correct classification rate. Decimals, ratio and proportions, percentages, attitude, race, attendance, and educational goals were nonsignificant for academic prediction.

There was no significant difference in achievement between the remediated at-risk students and the nonremedial students in the Intermediate Algebra (101) course.

## Conclusions

Older students generally outperformed their younger counterparts. These students had better attendance, and thus used their time for academic achievement. Females in both the younger and older age groups tended to academically outperform their male counterparts.

This study suggests that knowledge of a community-college student's demographic information, the ASSET test, and a criterion referenced test can, to a limited extent, aid in predicting whether an at-risk student will or will not finish the first remedial mathematics course.

Results from grade analysis in the Intermediate Algebra course suggest that the mathematics laboratory has removed the mathematics deficiencies and these students are academically comparable with the nonremedial students in this course. In fact, the remediated at-risk students had a higher grade average in this course and a higher cumulative GPA than their nonremedial counterparts, although they were not statistically significantly different at alpha = .05.

# CHAPTER I

# INTRODUCTION

## Introduction of the Problem

The United States needs citizens who can make enlightened decisions for their own personal good and for the good of the country. As Thomas Jefferson once said, "If a nation expects to be ignorant and free, it expects what never was and never will be" (Brydon, 1983). Jefferson wanted college education within a day's ride of all Virginians and education open to the masses in the State (Wagoner, 1976). Education as envisioned by Jefferson renders society an essential service by helping students understand their moral principles. If a democracy is to succeed, citizens must be educated to think through the moral principles, on one hand, and to make sound decisions on the other hand (Farrell, 1981; Tinto, 1987b).

These ideals are most evident among those who persist in college but are least evident among those failing to enter college (Blanchfield, 1971; Brydon, 1983; Trend & Medsker, 1981). A morally weak populace contributes to the politics of decadence. A nation with educated, enlightened citizens is more likely to be rewarded with a productive economy with less turmoil and revolution than a nation with an illiterate, uninformed citizenry. The pursuit of freedom for the individual and the promise of the "good life" can best be extended with educational opportunities. "But today, there seems to be an ever widening gap between society's increasing need for literate citizens and the decreasing number of citizens with these needed skills" (Cross, 1981, p. 46).

Excellence in education is inevitably linked to larger issues of human-resources development and the economy of a nation. A nation becomes a wasteful society when it fails to maximize the potential of its citizenry. To compete in a global economy, a nation must ensure that its labor force is as well educated, if not better educated, as any in the world. To keep ahead of competitors, the most effective technologies must be employed. Judged by educational attainment and working skills, the U.S. presently lags far behind other developed nations (Thurow, 1987). Both West Germany, with elaborate apprenticeship programs, and Japan, with extensive company training programs, have developed systems for teaching technical skills to people who are not college bound.

Workers in the U.S. must also be highly educated in these technologies. A Nation at Risk (1983) and America 2000 (1991) addressed the nation's educational dilemma. These commissions realized it was time for the U.S. to value its human resources as much, if not more, than its natural resources of oil, gas, coal, and precious metals (McAninch, 1985; Parnell, 1985). School standards needed improving. High-school diplomas were no longer adequate for the new high-skilled job market. New lifelong learning opportunities needed to be created by higher education for a large portion of the U.S. populace. The community college with its commitment to the community is a vital player in this educational process.

## The Community Colleges' Open Door Dilemma

The community college "open door" concept represents an equalitarian philosophy introduced in the 1950s and 1960s for the purpose of making higher education accessible to those who previously had not been considered college material (Thompson, 1985; Vaughan, 1983). The "open door" policy of admissions at most community colleges allows anyone to attend college with minimal academic qualifications. These students may or may not be high-school graduates.

At-risk students in community colleges, therefore, include the functional illiterate as well as students planning to transfer to universities who would fail to qualify for regular freshmen-level admission (Vaughan, 1983). These students must remediate basic skills that should have been mastered prior to entry into the post-secondary system. These students pose a dilemma for higher education.

The community college is reminiscent of the inscription on the Statue of Liberty: "Give me your tired, your poor . . ." Because of their poor educational backgrounds, at-risk community college students add greatly to the college attrition statistics, necessitating the introduction of remedial courses which strain college budgets. Despite increased access for these students, the question remains as to the extent to which such students can profit from a quality college degree. Critics argue that "open admissions" requires large expensive remedial programs. Some suggest that at-risk students should be the responsibility of high-school adult-education classes (Damaree, 1986; Jaschik, 1985; Platt, 1986).

Robert McCabe, the president of Miami Dade Community College, the largest community college in the world, believes "the nation cannot afford to give up on those who have academic skill deficiencies. America needs more, rather than fewer, well-educated individuals" (McCabe & Skidmore, 1982, p. 5). Consequently, much controversy surrounds the concept of the "open door" or "open access" policy at the community-college level (Roueche & Baker, 1987).

For all of its flaws, open admissions allows access to higher education for those segments of society which were traditionally denied that opportunity. The "open door" policy promotes the concept of lifelong learning as a means of improving all educational levels of American society (Hodgkinson, 1986).

Most community colleges are committed to an open-admissions policy. Remediation, therefore, has become an important consequence of this commitment. Unfortunately, many at-risk students are unwilling to volunteer for remedial courses. Yet it is essential that these students be identified as soon as possible, that they be assigned to remedial classes, and that their progress be monitored to enhance the likelihood of success in their studies.

## Purpose of the Study

Consequently, the focus of this study was to develop and test a statistical model for predicting mathematics achievement of the at-risk community-college student. Such a model will provide the theoretic base for identifying the unsuccessful at-risk students, thus giving counselors and teachers the ability to monitor, track, and supervise these students. It was essential that this design conform to real-life conditions at the community college rather than a hypothetical environment. Information to be used will be available to any teacher in the classroom, so that the model may be implemented with fidelity in the community college. The methodology utilized in this study is designed to have applications for community colleges and other institutions of higher learning with problems similar to those of the community college.

## Importance of the Study

The community college is a vehicle of upward mobility for those who traditionally have been denied the opportunity for advanced education. The "open door" admissions represents the very essence of American democracy in creating and maintaining educational opportunity for all. Even those students with inferior high-school academic records have another chance to succeed.

Identification, placement, and monitoring of these at-risk students is the key to their academic success. Many more students presumably will succeed if placed in courses they are, at the time of entry, prepared to take. Through appropriate identification, placement, and monitoring, these students may realize their degree aspirations. In addition, course standards may be readily guaranteed and raised (Johnson, 1984). Teachers, faced with more articulate students than before, will teach at levels challenging to the students, but beyond the understanding of the underprepared student. No longer must teachers spend large amounts of time explaining material or concepts that should have been learned in prior classes. Class time will be used more efficiently and appropriately to ensure quality and excellence in student learning. Thus, the college's effectiveness and esteem will be enhanced, while creating a labor pool for industry in the community.

Institutional responses to low-achieving students in terms of the development and maturity of retention programs are extremely important. Consequently, students who need remediation and who fail to enroll in appropriate programs have little chance of succeeding in college. The "open door" need not become a "revolving door" where students enroll and drop out. Failure to appropriately identify and monitor the mathematically "at-risk" student represents a significant loss of human potential. The best evidence of a nation's future is the educational provision it makes for all its citizens (Rouche, Baker, & Rouche, 1984).

## Questions

The purpose of this study was to determine to what extent basic mathematics performance on the part of at-risk community-college students can be predicted from norm and criterion referenced assessment results coupled with demographic information. This research project endeavored to answer the following questions dealing with the remedial student:

1. What are the grade distributions of the students in remedial basic mathematics classes?

2. Is there a difference in mathematics attitude

between the successful and nonsuccessful remedial students as measured by the Aiken-Dreger Mathematics Attitude Test?

3. Are there subtests within the criterion referenced instrument which predict successful and nonsuccessful completion rates in the basic mathematics course?

4. Is regularity of attendance in the classroom until completion significantly different for grades A to W?

5. To what extent do the characteristics of the criterion referenced test, the mathematics attitude, the norm referenced test, age, sex, race, and educational goals differentiate between successful and nonsuccessful remedial mathematics students?

6. Is there a difference in achievement in the next college-level mathematics class, intermediate algebra, between students who had taken the mathematics laboratory and those who were not required to take the remedial mathematics laboratory course?

## Research Hypotheses

The above questions led to the following research or working hypotheses:

1. The distribution of grades for the Basic Mathematics class is not normally distributed.

2. A significant difference exists between the means of the successful and nonsuccessful remedial students in mathematics attitude as measured by the Aiken-Dreger

Mathematics Attitude Test.

3. The subtests in the criterion referenced test are significantly related to the student's grade and can be used to predict successful or nonsuccessful completion.

4. A relationship exists between the regularity of attendance in the classroom until completion and the grade the student receives.

5. There is a significant difference between the two group centroids of successful and nonsuccessful remedial students with respect to the variables: the criterion referenced test, the mathematics attitude, the norm referenced test, age, sex, race, and educational goals.

6. There is a significant grade difference in achievement in the subsequent college-level mathematics course (Intermediate Algebra) between the students who took the mathematics laboratory and the traditional students who were not required to take a remedial mathematics laboratory course.

## Dependent Variable

For the purpose of this study the Basic Mathematics course completion is defined as the dependent variable. This is a quantifiable variable related to the academic proficiency (grade) of the student in the Basic Mathematics course. Grade proficiency is widely understood and accepted in any academic institution. Successful and nonsuccessful completion are operationally defined in the definition section.

## Independent Variables

The key criterion for selecting independent variables is that they must be easily measured and readily available. This information can be derived from data normally available on all entering college students, thereby, making it economically practical and efficient for the college to use.

Variables used for prediction in this study were: student's age, sex, race, educational goals, class attendance, mathematics attitude score, ASSET (Assessment of Skills for Successful Entry and Transfer) scores in mathematics, criterion referenced mathematics scores that assessed ability in the usage of: whole numbers, fractions, decimals, ratios and proportions, and percentages. High-school GPAs were not used because many students at the community college do not have a high-school transcript in their files.

## Definitions

ASSET (Assessment of Skills for Successful Entry and Transfer): The norm referenced test given to all entering students.

Attendance: The proportion of class attendance until completion.

At-risk student: Student who must redo or reiterate basic skills which should have been mastered prior to entry into the post-secondary system (used synonymously with the term remedial student or under-prepared student).

Completion, Nonsuccessful: Grades of D, F, or W (withdraw).

Completion, Successful: A grade of C or higher.

Criterion referenced test: A non-standardized achievement test of whole numbers, fractions, decimals, ratios and proportions, and percentages.

Mathematics attitude test: A test that expresses action, feeling, mood, or disposition towards mathematics as measured in this study by the Aiken-Dreger Mathematics Attitude Test.

Minorities: Persons of African American, Native American, Alaskan Native, Asian, Pacific Islander, or Hispanic descent.

Remedial mathematics: An instructional program or activity prerequisite to college-level mathematics; in this study basic mathematics which consists of whole numbers, fractions, decimals, ratios and proportions, and percentages.

Remedial student: see at-risk student or under-prepared student.

Under-prepared student: see At-risk student or Remedial student.

# CHAPTER II

# REVIEW OF THE LITERATURE

## Introduction

Each year an increasing number of at-risk students continue to enroll at the community college level of higher education. Identification of these students is the key to their academic success.

This chapter will focus on who are the at-risk students and strategies used by the community college to identify and educate them. Also explored are predictive models and variable characteristics relating to the identification of the academic success of these students.

## The At-Risk Community-College Student

At-risk community-college students are less prepared for college than are their counterparts--the traditional, nonremedial student. These students tend to have one or more of the following characteristics (Austin, 1982, p. 138; Lazdowski, 1985; Tinto, 1987b; Zwerling, 1980):

1. Lack of academic skills--achieve lower scores on SAT, ASSET, and ACT tests and exhibit inadequate prerequisites for successful college study

2. Poor attitude--do not demonstrate effort and motivation; fail to see learning as a lifetime experience

3. Lack of counseling--have never spoken to a career counselor, lack direction, and have parents who have never been to college

4. Lack of college survival skills--have poor elementary and secondary schooling; have difficulty taking notes, outlining, listening, taking tests, using the library; have poor memory and concentration skills

5. Low aspirations--have a fear of failure because of negative self-image and a lack of self-confidence

6. Cognitive style--are more interested in non-academics and are unable to use their own learning styles to their best advantage

7. Limited vision--do not realize the need for mathematics skills to be used later; have tunnel vision and are unable to perceive long-range outcomes

8. Lack of maturity--lack educational objectives which causes these students to have a high course repeat rate and a high attrition rate

9. Low income--are eligible for financial aid; lack child care and family support; parents have incomes below the $15,000 level.

At-risk community-college students are the non-traditional college students who typically took a minimum of college preparation courses in high school. They performed below average in high school and do not anticipate going to college (Tinto, 1987a). Many nontraditional students are older students returning to school for various reasons. Some attempt to upgrade existing job skills, complete certificate or apprenticeship programs, and others pursue associate degrees. These students either failed to retain or never learned the needed prerequisite skills for college.

Young high-school graduates are not the only beneficiaries of remedial programs. Other persons likely to benefit include the older citizens, employed or unemployed, needing short-term training or upgrading of skills, foreign students needing help with basic communications skills, and the retired who may be taking courses for their own personal interest (Cross, 1981; Demaree, 1986; Platt, 1986).

In his presentation to a conference on higher education, Daniel Patrick Moynihan (1964) quoted statistics from the U.S. Office of Education which indicated that 50% of the U.S. population at that time had the capacity to complete a community/junior college curriculum. It is estimated that humans use as little as 5% of their brain capacities (Otto, 1969), but mental abilities may be increased by training (Brydon, 1983; Sheehan, 1989). Our ability to think, like other abilities, needs regular practice to maintain its strength (Amabile, 1983; Beyer, 1988; Costa & Lowery, 1989; Gray, 1991; Long & Long, 1987; Perkins, 1985). This may imply that there is questionable logic in having inflexible selective admissions policies, when such a small portion of human potential is used. A much larger proportion of the populace can benefit by education beyond high school. Students should be encouraged to successfully expand their academic horizons by being allowed to try (Cohen & Frawer, 1981; Moynihan, 1964). However, something must be done to enhance their chances of success. The psychology of failure is devastating and must not be allowed to compromise the students' potential. Perhaps these students will need more time than the traditional students to complete a "two-year" degree or program. Getting through college quickly may not be as important as completing college with good academic achievement (McAninch, 1985; Parnell, 1985; U.S. National Commission on Excellence in Education, 1983; Vaughan, 1983).

Dale Parnell (1985), president of the Association of Community Colleges, estimates that about 23 million individuals in the United States cannot read, write, or compute at a functional level. Many of these are the at-risk students who turn to the community college for help. Community colleges, then, must find out what can be done to assist these students who cannot succeed without remediation.

The financial aspects of creating new courses and hiring additional teachers has caused many community-colleges to question whether the costs are worth the trouble. The University of California system spends $35 million and the California community-college system spends $60 million on remedial programs (Mickler, 1989). Louisiana, Oklahoma, and Tennessee are spending between $16-32 million on remediation (Lively, 1993). In most cases, attrition in each college is responsible for annual revenue losses of six or seven digits (Jones, 1986; Lively, 1993). Community colleges, especially, are beginning to realize that if revenues are to be increased, attrition must be decreased (Lively, 1993). Yet, the price of remedial college programs is small compared to that of maintaining a society laden with the uneducated, the unemployable, and the discontented.

## Origins of the Community College

American public education and the community-college system were developed in accordance with the American democratic ideal that every person should be allowed to develop to his or her fullest potential (Heslep, 1960; Johnson, Collins, Dupius, & Johansen, 1988; Platt, 1986). The State of Massachusetts established common schools in 1837; these schools were the beginning of public education in America. In 1862 the Morrill Land Grant Act established land-grant colleges to give greater access to higher education (Brick, 1964; Platt, 1986).

The land-grant colleges reached a stratum of students for whom higher private education was not available (Hodgkinson, 1986; Vaughan, 1983). The concept of the "people's college" was born. The ideas of Jefferson and the broadening of the land-grant philosophy were further expanded by William R. Harper and Henry P. Tappan, founders of the community college (Platt, 1986). Tappan, president of the University of Michigan, and Harper, president of the University of Chicago, believed that the first two years of the university belonged in the high schools, where students were still more adolescent than adults (Monroe, 1977).

In the 1890s community colleges were established in Illinois, Michigan, and Colorado, based on Tappan and Harper's philosophy (Brick, 1964). Consequently, the public community college was configured in the image of the public K-12; that is, the community college tends to be low cost, locally controlled, and supported with a curriculum designed to meet the needs of the individual, the community, and the nation.

Soldiers returning from World War II and the development of wartime technology increased the number of skilled jobs and the need for more sophisticated work skills. The new jobs required greater specialization and focused preparation. The G.I. Bill of Rights in 1944 increased the number of college students (Hodgkinson, 1986).

The growth of community colleges was further advanced during the civil rights era of the 1960s. The demand intensified the development of a community-college system across the nation (Knoell, 1981; Parnell, 1985; Rounds & Andersen, 1985). Thus the basic function of the two-year community college was established--providing post-secondary education for all people in the community without regard to race, sex, religion, geographical location, or financial status (Hodgkinson, 1986). Hence, many referred to the community college as the "people's college" because of its open accessibility to all.

## Mathematics Deficiencies of Students

At least half of the entering college freshmen in two-year colleges need remedial mathematics programs (Adelman, 1982; Cohen, 1987; Demaree, 1986; Plisko & Stern, 1985; Roueche, 1984). A 1977 study at El Paso Community College found that 98% of its students needed remedial mathematics programs (Rounds & Anderson, 1985). Results of the 1984 New Jersey Basic Skills Test indicate that 70% of incoming students needed remediation in basic computational skills in mathematics, while 88% needed remediation in elementary algebra (Wepner, 1985). In 1988, although the number of incoming students in need of remediation in basic computational skills decreased slightly to 64%, the number in need of remediation in elementary algebra skills increased to 96%. Test results at Lake Michigan College (LMC, 1991) indicate that 65%-75% of entering freshmen need remedial mathematics courses. Clearly something needs to be done to identify and help these at-risk students or they will become attrition statistics (Hughes & Nelson, 1991).

Nationally, colleges report that it is not uncommon to experience attrition rates ranging from 25% to 65%, with two-year colleges being the most likely to experience the highest and most sustained attrition rates because of the large number of at-risk students (Jones, 1986; Platt, 1986). Such students are definitely not prepared for college programs when they first enter the community college. At-risk students take longer than traditional students to earn an associate degree because they need remedial courses before starting a degree program. Attrition statistics for at-risk students are further compounded by students' uncertainty about a major or career plans (Clagett, 1988; Roueche, 1978; Vaughan, 1983).

### Identification and Intervention Strategies

The desire to ensure the success of at-risk students has motivated community-college teachers and administrators to search for effective ways to maximize retention and successful completion. One solution was the addition of remedial courses to the community-college curriculum. To date, 96% of 2-year colleges have instituted remedial arithmetic courses which cover material normally taught in the primary and secondary school systems. However, remediation in arithmetic has not proven highly successful. Less than half of arithmetic students complete the remedial course on the first attempt (Boyd, 1988; Cohen, 1987; Gash, 1983; Goldston, 1983; Worden, 1984). Consequently, successful identification and intervention programs are urgently needed.

One method being used to identify at-risk students is testing and early placement (Grable, 1988; Hughes & Nelson, 1991; Jones, 1986; Percy & Smith, 1982). Many schools use general-assessment testing such as the Scholastic Aptitude Test (SAT), American College Test (ACT), Assessment of Skills for Successful Entry and Transfer (ASSET) test, or institutionally prepared tests as primary tools for mandatory placement (Rounds & Andersen, 1985). Currently, the ASSET test is the most frequently used test in the community college for placement into mathematics classes (Grable, 1988). Cut-off scores vary from institution to institution (Bernknopf, 1980; Blair, 1991; Michigan State Board of Education, 1990b; Percy & Smith, 1982).

Some researchers, such as McDonald (1989), believe that the design of placement cut-off scores should provide, whenever possible, a three-level system for decision categories (Morante, Faskow, & Menditto, 1984). In such systems, the highest-cut score level indicates students proficient in the skill area being tested: students who are clearly ready for higher level courses.

The second level presents a decision zone in which students are allowed to choose the higher or lower level course work with assistance from an academic advisor. The lowest-cut score level designates students who lack proficiency in this skill area. Scoring at this level means that a student has little chance of success unless placed in the lower level course which addresses the skill deficiency indicated by the test. Other researchers simply believe in a simple two-level test.

Whichever level system is used, it is unrealistic to believe that merely advising students to take the courses in which they have done poorly in the past will be sufficient (Enright, 1988). In a 1988 study as many as 40%-50% of all students assigned, advised, or counseled into remedial courses never completed them (Adam & Lindoo, 1989; Mickler, 1989).

To increase the completion rate a number of approaches have been devised:

1. A more relaxed classroom atmosphere and a 30:1 or smaller student-teacher ratio (Grable, 1988; Worden, 1984)

2. Mathematics laboratory instruction with innovative teaching techniques such as individualized, self-paced, mastery, and programed learning (Cox, 1990; Roueche, 1984; Slavin & Karweit, 1985)

3. Mandatory counseling and placement, flexible completion strategies, monitoring of student progress, peer tutorial services, and developmental services using

the techniques of personalized instruction in a laboratory setting (With personalized instruction, students have a one-to-one relationship with the evaluator as questions are being asked and answered or when tests are being corrected. This face-to-face relationship gives the teacher or student tutor more flexibility in giving the student assistance, increasing self-confidence, and increasing retention [Johnson, 1981; Koch, 1992; Maxwell, 1991; Slavin & Karweit, 1985]. Nevertheless, problems do occur in the system with the student procrastinating or not being able to progress to the mastery level. However, for many students, individual differences may be in the rate of learning, not in the individual capabilities, and with appropriate teaching methods and techniques many students can learn as much as the average traditional college student [Roueche, 1981; Zwerling, 1980].)

4. Individualized instruction using audio-tutorial, audio-video, and computerized instruction (Capps, 1984; Rounds & Andersen, 1985).

Programed learning and personalized instruction have made it possible to incorporate the mastery learning model of Bloom and Skinner when teaching remedial students (Rich, 1985). In mastery learning each student must reach a proficiency level of 80% before continuing to the next section (Capps, 1984; Cox, 1990; Joyce & Weil, 1986: Munn, 1988). This means that near perfection is required in each section before a student can progress. A student does not go to the next section until the present material has been thoroughly mastered.

Research on mastery learning indicates that it can be a very powerful force in improving student achievement, particularly among low achievers (Kennedy, 1988). Mastery learning can bring about achievement gains from 1.28 to 2 standard deviations. This means that mastery learning can raise the low achiever from the 10th or 15th percentile to the 50th percentile or above (Ornstein & Levin, 1984). Enormous gains in academic achievement are being registered when mastery learning is implemented effectively, when attention is paid to students' entry skills, and when principles of effective instruction are used (Jones & Spady, 1985; Kincaid, 1991; Zwerling, 1980).

Slower, capable students may benefit by taking an extra semester to complete the work (Roueche, 1981). This partially takes some of the pressure off students by allowing them to work at their own pace. Self-paced instructions allow more time for slower students to work in their subjects and finish the task. Allowing maximum time for specific learning strategies, support services with periodic feed back, and corrective procedures can be used to bring the majority of the slow, capable students up to the standards of the college (Rich, 1985; Vaughan, 1983). At some colleges the faster student may finish more than one remedial mathematics course in a given semester (Cox, 1990).

At Tarrant County Junior College (Capps, 1984; Worden, 1984) students who took remedial courses did as well as, and had a better completion rate in the first college-level mathematics class than, the nonremedial students going directly into that course. This replicates the findings of a study in 1977 by J. Sparks and C. Davis at Dalton Junior College. Overall GPA, in the first college-level mathematics class, indicates that the remedial student completer performs as well or better than the nonremedial student and the following semester's retention is comparable to that of the nonremedial student (McCornak, 1985). This was also validated by Wynn and Fletcher (1987) and Lovell and Fletcher (1989) at the Tennessee Technological University.

Lovell and Fletcher and Wynn and Fletcher found that at-risk students enrolled in a first college-level mathematics class had a grade point of 2.32 and a GPA that semester of 2.31 whereas the regular students in the class had a grade of 2.51 and a GPA of 2.43. These grade average and GPA differences were found to be statistically insignificant at the .05 level using Analysis of Variance. This indicates that the scholastic abilities of the remedial student are being raised academically to the level of the nonremedial student (Gash, 1983; Rounds & Andersen, 1985).

The strength of the GPA is strongly related to attrition. Attrition seems to vary inversely with GPA.

Remediation positively influences retention, but attrition is likely for students with poor academic performance during the first semester (Tambe, 1984). This indicates that accurate predictions of persistence and withdrawal for the individual open-admissions students cannot be made at the time of matriculation. Instead, outcomes can be extrapolated after the second semester, after grades are given and GPAs computed. Friedlander (1981) and Rounds and Andersen (1985) state that the at-risk students who complete the prescribed remedial courses have significantly higher college grade point averages and complete 30% more credits than the at-risk students who avoided or only partly completed the developmental program. In addition 32% more graduated. Remediation seems to be effective if at-risk students take the courses.

Summary

The learning problems associated with the at-risk student will not go away. Increasingly more at-risk students will continue to enroll in the community colleges. The task ahead is to design programs that facilitate student development in deficient areas. Some community colleges are achieving results using: (1) mandatory entry testing and mandatory placement; (2) various teaching methods (programed learning, personalized instruction, and individualized self-paced mastery learning); and (3) smaller student teacher ratio. Remediation is bringing the at-risk students to the academic level of the nonremedial students, thereby, increasing GPA, retention, and program completion.

## Predictive Statistical Models

A Utica College study (Blanchfield, 1971) used discriminant analysis to identify potential successful and nonsuccessful students. Blanchfield (1971) and Clagett (1988) stated that discriminant analysis is ideally suited for this research study since it places the dependent variable in a group (category) rather than a relative position and eliminates the problem of independent variables being too closely bunched for regression techniques. Four variables were found significant: (1) social consciousness scores, (2) percentage of college costs financed by grants, (3) first semester GPA, and (4) high-school rank.

The successful students had a greater understanding and concern for social issues, had a higher number of financial grants, had a higher GPA which helped build confidence, and belonged to the upper rank in their high-school class.

Ahrens (1980) in a study at West Virginia University used discriminant analysis on 6,000 student records to properly place students in beginning algebra, college algebra, trigonometry, precalculus mathematics, or calculus. Variables used in the study included: (1) department mathematics examination, (2) high-school background in mathematics, and (3) ACT scores. Two discriminant functions were derived and accounted for 88.5% of the power. Success or nonsuccess for beginning algebra students was given by the following equation: D = .5620*(High School Mathematics Background) + .2038*(ACT Math Score) + .3129 (ACT Composite) + .7342*(Department Exam Score in Mathematics).

Webb (1988), in a longitudinal study of 31,363 students at three Los Angeles community-college campuses, used step-wise regression to classify students into three classes: (1) students who did not complete the first semester, (2) students who completed first semester but did not return for the next semester, (3) students who completed first semester and returned for the next semester.

Variables which significantly contributed to the model's development were: (1) Taking Vocational Programs (0 = no, 1 = yes), (2) ASSET Numerical Skills Test, (3) ASSET Reading Skills Test, (4) Day-time student (0 = no, 1 = yes), (5) Educational goals (1 = classes only, 2 = certificate or degree), (6) Race (0 = minority, 1 = nonminority), (7) Graduate = 1, Nongraduate = 0, (8) Degree or Certificate Plans (0 = no, 1 = yes), (9) English Primary Language (0 = no, 1 = yes), (10) Certainty of

Major (1 = not sure, 2 = fairly sure, 3 = very sure).

Webb concluded that eight variables increased a student's chance of finishing the freshman year and earning a good GPA for the first semester: (1) being in a vocational program, (2) being primarily a day student, (3) having an educational goal of at least a 1/2-year certificate, (4) being a high-school or GED graduate, (5) planning to obtain a degree or certificate, (6) having high ASSET subtest scores, (7) being certain of an academic major, (8) and/or having English as the primary language. Conversely, being a minority decreased one's chances of finishing the year and earning a good GPA for the semester.

Christine Brooks-Leonard, in a 1991 study using 796 students at a Indiana Vocational Technical College in South Bend, Indiana, found significant demographic characteristics related to student retention. These variables were: (1) Educational Objectives (degree-certificate or course only), (2) Full-time/part-time status, (3) Employment Status (no job, part-time job, full-time job), (4) Age, and (5) First Term GPA. Gender and race were found to be nonsignificant variables. Tests used were Chi-square, Anova, and standardized residuals to determine significance of variables in retention. GPA was found to be a major contributor to retention of students. Students with GPA mean scores of 3.00 or higher were likely to return, but students with GPA mean scores of

2.00 or less were not likely to return the next term.

## Variables

### Age and Gender

Over the past 20 years there has been a large body of literature on the differences between the ability of men and women to perform at various mathematical levels (Branum, 1990; Fennema, 1977; Haertel, Walberg, Junker, & Pascarella, 1981). In mathematics, females perform better at computational tasks and males perform better at higher cognitive tasks, but the differences are quite small (Haertel, et al., 1981). Sex differences in mathematics performances are small and perhaps diminishing over time through the high-school years. The sex variable accounts for no more than 5% of the variance in achievement when other factors are held constant. Men, nevertheless, are much more likely to enter a profession using mathematics after leaving school (Boli, Allen, & Payne, 1985). The Michigan State Board of Education's study (1990b) of community colleges found that 61% of the at-risk students were 17-21 years of age, 20% were 22-29 years old, and 19% were 30 years or older. This study also stated that 60% of those needing mathematics remediation were women (5,907 female and 3,962 male). Women in the remedial mathematics classes outnumbered the men by approximately 2:1. Some reasons for differences seem to be that men use mathematics more in the workplace than women do and do not need a remedial course. Many women may be older, divorced students just entering the work environment and are not proficient in this subject area (Cox, 1987; DeVoll, 1989; Sleeter & Grant, 1986).

Goldston (1982), from Brookdale Community College in New Jersey, reported that men who take the basic mathematics course have a poorer completion rate (41%) than women (54%). The attrition rate for these remedial mathematics classes was very high, often around 50% or higher (Adelman, 1982; Cohen, 1987; Roueche, 1984). Returning women over the age of 23 have the highest completion rate at 70%, which is noticeably higher than the average 50% (Goldston, 1982). At-risk females have a higher completion rate and GPA than at-risk males (Roberts, 1986); but age does not appear to be a crucial factor in determining nonsuccess (Pantages & Creedon, 1978) except for women over the age of 23.

Cox (1990) in a 1987-1988 study found that the percentage of women in the remedial mathematics class was approximately 57% to 66%, which is similar to the State of Michigan's findings. Nevertheless, contrary to Roberts' study, Cox found no statistically significant difference between the grades for men and women.

The relationship between gender and successful remediation appears to be inconclusive in the research literature. However, women tend to drop out of school for nonscholastic reasons and are less likely to re-enroll later. Women who enroll are more likely to finish the 4-year degree (Pantages & Creedon, 1978).

### Traditional Measures for Predicting Success in College

High-school grades, rank, and scholastic aptitude measures appear to be effective in predicting college achievement, but less effective in measuring college persistence (Pantages & Creedon, 1978; Tinto, 1988). When the at-risk students are separated from the regular students, high-school GPA plus SAT scores in verbal skills and mathematics skills account for only 13%-25% of the variance in predicting first-year GPA (Gee, 1988; Leroy, Hogrebe, Dwinell, & Newman, 1984). This becomes a moot point at community colleges with the "open door" admissions policy where records on the student may be non-existent. To circumvent this problem, most schools are pretesting entering students with the ACT, SAT, or ASSET tests and using these scores to help place students (Blair, 1991; Johnson, 1984; McDonald, 1989; Percy & Smith, 1982).

### ASSET

The ASSET test is a norm referenced test with national norms specifically developed for the community college. The sub-scale test for numerical skills contains items on addition, subtraction, multiplication, and division, ranging from simple to complex. This test, though broadly defined and indicating how well students compare in achievement, tells little about the particular strengths and weaknesses of individual student performance. However, it does yield scores indicating the student's general achievement in the area of numerical computations and is a useful tool in identifying entering students with weak skills needing remediation (Grable, 1988).

An AMATYC (American Mathematics Association of Two-Year Colleges) survey in April 1990 found that the ASSET test is the most frequently used test by 2-year colleges, in the U.S. and Canada, for placement into arithmetic or beginning algebra courses. More than 60% of the respondents reported that they intended to use the ASSET test the next year. Two-thirds reported that testing was mandatory; 49% of these indicated mandatory placement. Considerable ambiguity surrounds the question of cut-off scores for this test (Blair, 1991; Johnson, 1984; Percy & Smith, 1982).

Combining information on gender with scores from the reading and numerical sections of the ASSET test accounted for only 9% of the variance in the predictive GPA of developmental students (Roberts, 1986). This was less than the 19% reported in an earlier study reported by

Pascarella, Smart, and Ethnington (1986). The regression equation that Roberts calculated was: GPA = 1.28 +.035 ASSET Reading +.035 ASSET Numerical -.3 Sex. Sex was recorded as male = 1 and female = 0. If ASSET reading and numerical skills are equal for both sexes, then females will have higher GPAs than males.

Broward Community College found that 32% of those needing remediation in mathematics, but not taking the courses, passed their first college-level mathematics class, whereas 46% of those needing remediation and taking the program passed the first college-level mathematics class. The school had established a cut-off score of 12 on the ASSET test from a total score of 32 (Gabe, 1989). This low ASSET score is only 37.5% of the total, which may account for the poor results. Other institutions are using a cut-off score of 17 or higher which makes a great difference in the achievement of the remedial student (Gabe, 1989).

Kirkwood Community College found the numerical skills portion of the ASSET sub-test as the best indicator of potential dropouts in the programs of business technologies, data processing, health technologies, and industrial technologies. In two groups studied, the persisters had mean scores of 20.88 and 21.04, whereas the dropouts had mean scores of 17.20 and 18.54 which were significantly different at the .05 level. The total test scores accounted for approximately 18% of the variance in GPA (Nielsen & Chambers, 1989).

The Michigan State Board of Education's Study (1990b) found that there is a wide range for cut-off scores for the old and new ASSET test. The cut-off scores for the state community colleges are given in Table 1.

Table 1

ASSET Test Cut-off Scores for Community Colleges in the State of Michigan

| n[a] | Old ASSET TEST | n[a] | NEW ASSET TEST |
|---|---|---|---|
| 1 | 12 | 1 | 32 |
| 1 | 14 | 1 | 36 |
| 3 | 17 | 1 | 37 |
| 3 | 18 | 2 | 39 |
| 1 | 19 | 1 | 40 |
| 2 | 20 | 1 | 41 |
| | | 2 | 42 |
| | | 1 | 43 |
| | | 1 | 44 |

[a] n = number of colleges at that cut-off score.

The ASSET technical manual (1986) provides information for establishing local cut-off scores for the ASSET test. Each college must administer the test to students who have completed or nearly completed the course in which the test is considered relevant. The cut-off scores may be the average score on the test earned by the students earning a C in the course. A sample of 100 students or more is recommended to ensure that these local norms are reasonably stable. Cut-off scores can be continuously monitored and adjusted on the basis of empirical data.

Attitude

An attitude score expresses action, feeling, mood, or disposition towards mathematics and has been found to relate to mathematics achievement (Benbow & Stanley, 1982; Norma & Rendon, 1990). For this study the Aiken and Dreger Mathematics Attitude Test was used (Aiken, 1976).

Neale (1969) suggests that the correlation between attitude and achievement is in the range $r = .23$ to $.34$. Table 2 illustrates the attitudes that were found.

Table 2

Mathematics Attitudes Found in Mathematics Classes

| Low Scores | High Scores |
| --- | --- |
| Math as a process | |
| Fixed, formal system of rigid, unchanging rules | Changing; allows different views; requires understanding |
| Difficulty of learning | |
| Only for elite | Can be learned by anyone |
| Place in society | |
| Luxury only | Essential to nation |

Note. From "The Role of Attitude in Learning Mathematics" F. L. Neale, 1969, Arithmetic Teacher, 16, p. 631.

In a 1975 study, Trachtman found that by using attitude scores in measuring the performance of remedial students the amount of explained variance could be increased by a factor of two (from 20% to 40%). Trachtman also suggested the desirability of strengthening the student's sense of personal fate, decreasing tendencies toward dogmatism, and blind dependence upon authority. These improvements would increase attitude and grades.

A study of 937 students at Brookdale Community College found that as attitude scores rose past a certain point, passing rates increased drastically in remedial mathematics courses (Goldston, 1982). Reports on a study of 513 developmental mathematics students in eight Illinois community colleges revealed that attitude toward mathematics was a determinant of success or failure in remedial mathematics courses (Elderveld, 1983). The attitude survey could be a useful tool for assessing need for study skills, level of anxiety and/or confidence for learning mathematics, degree to which mathematics is perceived to be useful and relevant, and the level of motivation to succeed (Neale, 1969). The evidence suggests that it is worthwhile to find ways to increase students' positive attitudes towards mathematics (Goldston, 1983).

A 1970 study (Aiken) found that scores on mathematics attitudes differ by gender. The fact that men scored higher than women on mathematics attitude tests was interpreted as being reinforced by the cultural environment that "mathematics is a man's world" (Aiken, 1976). However, the sex variable accounts for no more than 5% of the variance of attitude when other factors are held constant (Boli et al., 1985).

R. B. Cattell and H. J. Butcher attacked the problem of attitude in a comprehensive way in The Prediction of Achievement and Creativity (1968). They used factor analytic techniques to relate mental abilities, personality traits, and motivational factors to measure school achievement. Cattell and Butcher found that ability, personality, and attitude each accounted for 25% of the variance in achievement. Two factors with the strongest correlation with achievement were submissiveness (+.50) and superego (+.44). Curiosity had a negative relationship with achievement (-.20) (p. 215). Students learn because they want to be obedient and do their duty.

## Criterion Referenced Tests

The criterion referenced test measures the student's absolute level of performance in a precisely defined content area. The content area is more narrowly defined than in a norm referenced achievement test. The advantage of this test is that it is tailored to the specific content area with which the testing institution is concerned (Borg & Gall, 1983), which in many cases consists of whole numbers, fractions, decimals, ratios and proportions, and percentages. This allows the institution to identify the strengths and weaknesses of the student in the content area, thus giving the institution the ability to create a program designed to help the student in his/her weak areas. It also provides a back-up test in case the student is competent in the given area but failed to demonstrate this on the norm referenced test which is generally given first.

In many community colleges the criterion referenced test is used in a pretest-posttest design to determine student grades or progress through the remedial program (Cox, 1987, 1990; Michigan State Board of Education, 1990b).

These tests are designed by individual colleges with little consideration for reliability or validity (Taylor, 1978). Blair (1991) stated in his report that little is known about these tests or cut-off scores.

## Race

There is an increasing diversity in the growth of racial and ethnic minorities in the nation. Hodgkinson's All One System (1985) stated "by around the year 2000, America will be a nation in which one in every three persons will be nonwhite" (Hodgkinson, 1985, p. 7). "Culture can influence different ways of thinking [and] processing information" (Knott, 1991, p. 15).

At this time minorities are more affected by poverty than White Americans. Thirty-three percent of certain ethnic groups of minorities are leaving high school with D and F averages (Platt, 1986; Plisko & Stern, 1985). Minorities need to learn to use basic skills to help them understand and change their life circumstances. They are the ones most likely to suffer from the shift to more technical jobs and automation in the coming century. Diplomas and degrees help sort people into existing jobs and can change a person's circumstance by giving the person the opportunity of a better occupation (Sleeter & Grant, 1986).

Developmental programs at Miami Dade, the nation's largest community college, have increased retention from 32% to 47% for minorities with no declines in enrollment levels, giving minorities the opportunity for upward mobility (Mickler & Chapel, 1989). K. Patricia Cross (1981) states that less than one fourth of the students enrolled in remedial courses were from ethnic minorities. Similar results in a Michigan State Board of Education study (1990b) found that 21% of the population (10,820) enrolled in Michigan's community college remedial classes were minorities. However, the race of the remedial student appears to have little or no effect on the college GPA (Roberts, 1986).

## Need for More Research

More than 40% of the 2-year colleges' mathematics courses are remedial (Chang, 1983). Remedial courses are the fastest growing area of the college curriculum, but little is known about the effectiveness of the different programs (Cross, 1974; McCornak, 1985). Post-program measurements are significantly higher than pre-program measurements. However, little is known about the effectiveness of the subsequent courses (Jones, 1986; Pascarella, et al., 1986; Roueche, 1984; Tinto, 1987b; Webb, 1988).

In early October of 1991, I talked to Susane Roueche, the editor of *Innovation Abstracts*, at the University of Texas at Austin. She is the wife of John Roueche, the author of numerous articles on the remedial student at the community-college level. Mrs. Roueche could give me the name of only one individual who might be of assistance in locating researchers in the forefront of remedial mathematics research--Robert Hackworth.

Robert Hackworth, at H&H Publishing Company in Clearwater, Florida, and several other teachers from St. Petersburg Junior College wrote Focus on a New Idea for College Algebra. Hackworth (personal communication, October 1991) said, "There was little or no formal research on the subject of the remedial mathematics student, and that the field was wide open." He reiterated his impression that the traditional lecture technique was not effective with these students.

In an October of 1991 phone conversation, Jack Cohen, the publisher of The American Mathematics Association of Two Year Colleges Review, stated that there was little in the way of research on remedial mathematics at the community-college level. He did give the name of Jack Rotman, an instructor at Lansing Community College in Lansing, Michigan. Rotman has been doing research in the form of literature reviews in elementary algebra. He confirmed (personal communication, November 1991) that "This is a very sparse field in which little research has been done. Everything is open at the community college level in this area."

## Summary

Very little research has been done on the at-risk mathematics community-college student; in fact, research on remedial programs in the open-door community college is practically non-existent (DeVoll, 1989). Empirically based studies of the remedial mathematics student are rare. Schools apparently use trial and error techniques in setting up programs because of insufficient research and funding.

Increasingly more students with serious learning deficiencies are enrolling in community colleges. A need exists for further research to develop useful tools and techniques to identify the nonsuccessful remedial student for correct placement and monitoring. Unless research studies are conducted and adequate intervention strategies are developed, the catastrophe of human potential through community-college attrition will continue, thus restricting the economic, career, and social mobility of untold thousands. The democratic ideal of an enlightened citizenry hangs in the balance.

CHAPTER III

# METHODOLOGY

## Type of Research

The ex post facto study sought to determine to what extent successful and nonsuccessful at-risk mathematics students differ on norm and criterion referenced pretest scores, attitudinal measures, attendance profile, and demographic variables. The research design used statistical analysis to explore relationships between successful and nonsuccessful at-risk remedial mathematics students in the Basic Mathematics laboratory setting and to evaluate the achievement of these at-risk students in the first college-level mathematics class.

## The Setting

### Population

The population for this study consisted of 358 students, the total number enrolled in the fall 1991 and winter 1992 Basic Mathematics 090 classes at Lake Michigan College, a community college in Southwestern Michigan. These remedial developmental classes were designed for at-risk students who enter college without appropriate mathematics skills. This group represented about 75% of the entering students at Lake Michigan College.

One hundred eleven students from the 1992 winter semester Intermediate Algebra 101 classes were used to study the success of the mathematics laboratory student in the first college-level mathematics class.

Lake Michigan College

Founded in 1946, Lake Michigan College (LMC) is located approximately 70 miles northeast of Chicago, in Benton Harbor, a southwestern Michigan community of approximately 13,000 persons.

LMC is a comprehensive community college serving Berrien County, Covert Township (in Van Buren County), and adjacent areas. The area contains both rural agriculture and urban industry. It is in the immediate area of the world's largest fruit market and 170 industrial firms. Several of the leading industrial firms in recent years have closed, reflecting a chronically depressed economic environment with high unemployment. There were 6,600 people looking for work in the county during 1991.

The college has an enrollment of approximately 4,000 students in more than 100 programs. Students may choose from over 300 courses in 22 academic disciplines. The college also offers hundreds of courses in 35 occupational-vocational fields.

The educational philosophy of the college is:

1. To provide for the educational aspirations, needs, and expectations of the student and the community

2. To provide for the vocational needs and the desires of the individual and the community

3. To provide for the cultural interests and the recreational needs of the individual, and thus contribute to the development of effective citizens

4. To provide an assurance of quality for programs and in people

5. To provide an environment of global awareness, intercultural sensitivity, and international communication for individual students and the community.

To fulfill this philosophy, LMC has an open admissions policy. Financial aid is given to students who demonstrate need, which represents nearly a third of the student population. Full-time students (those taking 12 credit hours or more) must be high-school graduates, or have completed a General Educational Development (GED) test, or have successfully completed at least 25 semester hours of college work. Part-time students (those taking less than 12 credit hours) have no entrance restrictions.

At LMC 1,900 students fail to return each year. Some of these transfer to other colleges, some finish 2-year programs, and others terminate their education. More than half of these 1,900 students (52.6%) have grade point averages below 2.0.

## The Basic Mathematics Program at LMC

Since the fall of 1989, all students entering LMC are required to take the ASSET placement series of tests prior to registration. Placement tests have shown that approximately 11% of entering students need developmental writing courses, 17% need developmental reading, and 75% need developmental mathematics before they are ready for higher-level college courses. A Skills Enhancement Center was established to assist students who need to develop or brush up on those skills which are critical for college success. Students' reading, writing, and mathematics skills are screened. When low skill levels are found, students are placed in remedial classes in the College's Skills Enhancement Center.

## The Basic Mathematics Course (090)

At the time of the study the text Basic College Mathematics: A Text/Workbook, 3rd edition, by Miller, Salzman, and Lial was used in Basic Mathematics 090, a self-paced, fundamental mathematics skills class. Students have the option of using audio or video tutorial; most students use video tutorial. Computer-assisted instruction is available for those needing additional review in numerical concepts, such as addition, subtraction, multiplication, and division. Students are taught concepts in whole numbers, fractions, decimals, ratios and proportions, percentages, and one short section of elementary geometry or algebra (see Appendix C, Course Outline).

Since the course is self-paced, many students finish early; they are relearning skills not retained. A few students take more than one semester to finish. Cox (1990), in a 1988 study at LMC, found five students repeating from the previous fall of 1987's Basic Mathematics class. This material was never learned and more time had to be spent on the task of learning.

Students in this classroom are seated in modular booths with headphones. The headsets serve a dual purpose (1) to minimize distractions and hold student attention, and (2) to minimize comprehension problems associated with poor reading skills. The book is read to the students by means of audio-tapes or videotapes and examples are explained. Many of these students have reading deficiencies which the audio tapes help overcome.

The mathematics laboratory has one or two teachers every hour, a paraprofessional, and student assistants. Generally these classes have no more than 30 students. If more than 30 students are enrolled in the class, then two teachers are assigned to the course.

The teacher explains material not comprehended, grades the students' tests, and explains missed problems in a one-on-one tutorial-instructional mode. A personalized instruction system is employed, using the mastery learning approach similar to that of Benjamin Bloom (Joyce & Weil, 1986).

The laboratory's paraprofessional faculty coordinates, trains, and supervises support staff of the Mathematics Center, is responsible for records, oversees security and maintenance of equipment, and assists students and faculty.

Student assistants augment the instructional staff through one-to-one instruction, grading, operating equipment, mentoring, and performing assigned clerical duties.

## Instrumentation

### ASSET Test

Beginning in the Fall of 1989, all students entering LMC were required to take the ASSET placement series tests of basic skills prior to registration. The ASSET program is an American College Testing Program developed specifically to serve students entering 2-year colleges. The basic skills level of ASSET tests language, reading, and numerical skills. The score from the Numerical Skills section was reported as a variable in this research project.

This research was interested primarily in the students' scores in the Numerical Skills section. The Numerical Skills section contains 32 multiple-choice questions with five options and is designed to test basic skills in whole numbers, decimals, fractions, and simple word-problem applications (shown in Table 3). Eighteen minutes is allowed for the test.

Table 3

Description of the ASSET Test Which Gives the Proportion of Each Section Covered

| Operations with | No. of items | Proportion of the test |
|---|---|---|
| Whole numbers | 5 | 16% |
| Decimal numbers | 8 | 25% |
| Fractions | 6 | 19% |
| Word Problems | 13 | 40% |

*Note*. From *ASSET Technical Manual*, p. 4.

Students with scores of 0-18 on the older ASSET test or 23-41 on the new ASSET test were assigned to the basic mathematics course. The new ASSET test has 32 questions, but for the purpose of ACT's scale score equating starts at 23 with a maximum score of 55.

Reliability as used here is an estimate of the internal consistency of the test scores. The reliability coefficient for the Numerical Skills test is .88 with a standard error of measurement of 2.23. ASSET uses the Kuder-Richardson formula (KR-20) for its estimate of internal consistency. Test classification consistency with a cut-off score of 18 and 41, respectively, for the old and new ASSET test on the Numerical Skills test is over 84% (over 84% of the examinees were estimated as having been classified consistently) (ASSET, 1986). The test yields interval data.

Criterion Referenced Test

On the first day of the basic mathematics class, a criterion referenced test directly keyed to the instructional goals and objectives in the mathematics 090 course (Appendix A) was administered to each entering student. Multiple forms of this test and sub-unit tests were developed by Dr. Joanna S. Burris (1974). The test assesses whole numbers, fractions, decimals, ratios and proportions, percentages, geometry, and algebra. The test confirmed whether the student did indeed need remediation and identified which sections of the course needed to be remediated. A 75% correct response rate in any unit was considered adequate in that section. If this was accomplished in the first five units (omitting geometry and algebra), the student was put into elementary algebra. If the student did poorly in only two units, a mini-course in arithmetic was assigned along with the algebra course.

Otherwise, to ensure a solid foundation in mathematics, all sections of the basic mathematics course must be taken.

This test has been in use in this course since its beginning in the spring of 1974. The reliability and stability were validated by Taylor (1978) using a randomly selected split sample with a one-way analysis of variance. No significant difference was found between the two groups using alpha = .05. This information is given in Table 4.

Table 4

Reliability and Stability Validation of the Criterion Referenced Test Used at LMC Using a Split Sample (Using an alpha of .05)

| Source | df | SS | MS | F | p< |
|---|---|---|---|---|---|
| Group | 1 | 215.069 | 215.069 | .609 | .443 |
| Error | 80 | 28267.115 | 353.337 | | |

To minimize the measurement error associated with the use of a single assessment tool, LMC's criterion referenced pretest was used to check in which areas the students were weak or whether the course was actually needed.

The scores for all units of the pretest were recorded as interval data. These scores ranged from 0 to 8 for each of the five units.

Mathematics Attitude Test

Mathematics attitude tests have been suggested as doubling the explained variance in regression models with respect to the at-risk students (Trachtman, 1975). Therefore, attitude appeared to be an affective element of achievement, where acts, feelings, or motivations effect grades.

The Aiken-Dreger Revised Mathematics Attitude Test (Appendix B) was administered to many students during the first week of the 1992 winter semester as students filled out other preliminary materials for the course.

The Aiken-Dreger Revised Mathematics Attitude Test was used for several reasons: (1) the scale was validated with first-year college students; (2) the scale achieved a test/retest reliability of $r = .94$ (Shaw & Wright, 1967); and (3) these 20 questions were easily administered with little disruption in the class.

The Aiken-Dreger attitude test has 20 Likert-scale items with five options and includes 10 reversals. The options were: strongly disagree, disagree, undecided, agree, and strongly agree with a point spread of 0 to 4 respectively. The minimum score was 0 points and the maximum score was 80 points. The test yielded an attitudinal score with interval data.

Time Spent on Task

Students in the mathematics laboratory were required to punch a time clock as they entered and left the laboratory. The time clock allowed laboratory personnel and teachers to keep track of the students' attendance and help students feel more responsible for attending mathematics laboratory sessions. Periodic postcards and letters were sent to students with chronic absenteeism and were an effective way for parents or sponsors to be informed of attendance. Since LMC is a commuter school, most students live at home with their parents who are paying their educational expenses.

Students were expected to spend four 55-minute periods in the laboratory per week. A semester was comprised of 60 periods. Attendance was monitored to determine how many, if any, weekly gaps occurred before completion, and if these gaps affected the student's grade. This variable was recorded as the proportion of attendance in the class until completion or formal withdrawal from the course. The process of quantifying attendance yielded ratio data.

Demographic Characteristics

Every student enrolled at LMC completes a registration form which includes demographic information about the student (Appendix D). This form provides information on name, race, gender, age, educational goals, and ASSET scores. Since LMC is an open-door institution, not all students have transcripts in their files; the registration form serves as an important source of data.

Age

Age was taken from the student's birth date on the college registration form. The year of birth was subtracted from the current year, taking the month of birth into consideration. The age was then dichotomized into ordinal data. Students 22 years of age or less were considered college age and were given a value of 1; otherwise the students were given a value of 2 for this variable.

Academic Grades

Grades were taken from the student grade sheets. The grades were A, B, C, D, E, or W. This was quantified as A = 4, B = 3, C = 2, D = 1, and E = W = 0. Since E and W were non-completions, they were both given the value of 0. This was ordinal data.

When these scores were to indicate successful and nonsuccessful completion, the grades were dichotomized into a 2 or 1 respectively. This was done so that analyses could be done differentiating characteristic differences in these two groups of students. This was ordinal data.

Educational Goals

On the application, one of the questions asked is: "What is your primary goal for attending this college?"

The students had two nominal choices to make from a list: (1) university transfer credit, or (2) nontransfer. This was nominal data.

Race

From the student's application, minorities (African American, Native American, Alaskan Native, Asian, Pacific Islander, and Hispanics) were given a value of 1, while White non-Hispanic were given a value of 2. This was nominal data.

Sex

Gender type was available from the registration form, and were reported as nominal data with females and males given a value of 1 and 2 respectively.

Final Grade

When the students finished all the required exercises in the chapter at a proficiency level of 75% or higher, they were ready for the chapter test. Students were encouraged to do the practice chapter test at the end of each chapter prior to taking the graded test from the laboratory. Students need to have a 70% score on this test before proceeding to the next chapter.

If a student scored less than 70% or did not like his/her grade, the test could be repeated three more times. Students taking the test for the second, third, or fourth times received a maximum score of 90%, 80%, or

70% respectively. The students recorded percentage score was the difference of the percentage wrong from the maximum score.

For the student making more than one attempt, the signature of the instructor was required to show that the student had done extra work and seemed to comprehend the concepts.

Seventy percent of the final grade was based on the chapter test scores. The other 30% was based on the grade received on the final exam (taken only once). The grading scale criteria were as follows:

| | |
|---|---|
| 90% - 100% | = A |
| 80% - 89% | = B |
| 70% - 79% | = C |
| 60% - 69% | = D |
| Below 60% | = W (or an E will be given upon written request) |

These scores were quantified into ordinal values of 4, 3, 2, 1, 0, and 0 for the grades A through W respectively.

Successful and nonsuccessful completion was dichotomized into the ordinal values of 2 and 1 respectively.

## Summary

Prior to matriculation, students at LMC were required to take a college-administered norm referenced (ASSET) test. Any student scoring below the cut-off score was then assigned to remedial courses at matriculation. At matriculation the students completed a registration form which contained demographic data which was used in this research report.

During the first two days of the fall and winter semesters students in the remedial mathematics laboratory completed a criterion referenced test, were assigned time clock cards, and reviewed the course syllabi. During the first two periods of the winter semester the Aiken-Dreger Mathematics Attitude Test was administered.

Three hundred and fifty-eight students enrolled in the basic mathematics course and 111 students in the intermediate algebra course were also included in this research study.

Data were collected April and May of 1992. These data were coded on an IBM PC disc to be used later on an Andrews University computer system for statistical analysis, using the statistical package SPSS.

A further description of these variables is given in Table 5.

Table 5

Data Description Chart of the Variables Used

| Independent variables | Data source | Variable indicator | Levels of measure |
|---|---|---|---|
| Age | Registration records | 1 age<= 22<br>2 age>= 23 | Ordinal |
| ASSET Test | Registration records | Scores(1-18) | Interval |
| Attendance | Math lab records | Percentage (0%-100%) | Ratio |
| Attitude Test | Math lab records | Scores(1-80) | Interval |
| Criterion Referenced Test (5-units) | Math lab records | Scores(0-8) on 5 units | Interval |
| Educational Goals | Registration records | 1(transfer)<br>2(nontransfer) | Nominal |
| Race | Registration records | 1(minority)<br>2(nonminority) | Nominal |
| Sex | Registration records | 1(female)<br>2(male) | Nominal |

| Dependent variable | Data source | Variable indicator | Levels of measure |
|---|---|---|---|
| Grades | Math lab records | (4,3,2,1,0) | Ordinal |
| | | and<br>2(successful)<br>1(nonsuccessful) | Ordinal |

Null Hypotheses

It was hoped that the above data would be adequate to test the following null hypotheses:

1. The grades of the Basic Mathematics class are normally distributed.

2. There is no significant difference between the means of the successful and nonsuccessful remedial students in mathematics attitude as measured by the Aiken-Dreger mathematics Attitude Test.

3. There is no significant relationship between performance on the criterion referenced test and success or nonsuccess in the Basic Mathematics course.

4. A significant relationship does not exist between the regularity of attendance in the classroom until completion and the grade the student receives.

5. There is no significant difference between the group centroids of successful and nonsuccessful remedial students with respect to the variables: the criterion referenced test, the mathematics attitude, the norm referenced test, age, sex, race, and educational goals.

6. There is no significant grade difference in achievement in a subsequent college-level mathematics class (Intermediate Algebra) between the remedial students who took the mathematics laboratory and the traditional students who were not required to take a remedial mathematics laboratory course.

## Data Analysis

These hypotheses have been stated with reference to group comparisons using Chi-square, analysis of variance, and multivariate statistics. The grade frequency distribution in Hypothesis 1 was tested by a Chi-square and the Kolmogorov-Smirnov Goodness of Fit Test statistic which described the goodness of fit to the normal curve. Hypotheses 2, 4, and 6 were group comparisons using the t-test and ANOVA; Hypothesis 3 used a Chi-square to see if a relationship exists with respect to the variables. A MANOVA and discriminant analysis were used for Hypothesis 5 to find a linear combination of independent variables to serve as a basis for classifying cases into one of two groups (successful or nonsuccessful students). The effectiveness of the discriminant function was checked from the percentage of cases correctly classified. The Alpha for testing of these null hypotheses was set at .05.

## Human Subjects Review Board (HSRB)

Andrews University requires all research projects involving humans to be submitted to the HSRB. This board ensures that the rights of the subjects involved in the research are protected and the confidentiality of records is maintained.

This research project was submitted to the HSRB and found to be exempt from review. The research proposal had no information that could be traced to any particular subject in the research project.

## External Validity

The researcher acknowledges that this investigation report did use an intact sample. However, a case could be made that the student population at LMC roughly resembles the typical population at community colleges in the State of Michigan and the nation. A report by Dr. Tony Swerbinsky (1987) at LMC demonstrated the similarity of Lake Michigan College's population on ACT test scores to the State as a whole, to the state community colleges, and to the national averages. The ACT score, shown in Table 6, represents the composite scores in English, mathematics, social science, and natural sciences.

Table 6

Comparison of Mean Composite ACT Scores for the Years 1985-1987

| School | Year 1985-86 | Year 1986-87 |
|---|---|---|
| Lake Michigan College | 16.8 | 17.3 |
| Michigan State Community Colleges | 16.8 | 16.7 |
| Michigan State College Mean | 20.6 | 18.9 |
| National College Mean | 18.9 | 19.1 |

In addition, LMC is a typical community college with respect to gender and racial diversity. When compared with the community colleges in the State of Michigan and other community colleges in the nation, LMC is an average college in this group. Table 7 depicts the results of data analysis with respect to gender and racial diversity (Michigan State Board of Education, 1990b; Two-Year Colleges, 1991).

Table 7

Comparison of LMC with Other Community Colleges in the State and Nation by Gender and Minority Distribution

| Categories | LMC | Michigan State Average | National Average |
|---|---|---|---|
| Female | 57% | 56% | 55%-60% |
| Male | 43% | 44% | 40%-45% |
| Minority | 15% | 17% | 16% |

The remedial mathematics program at LMC had a range of 57%-66% females in these classes (Cox, 1990). A State study showed the average population was composed of 60% female. As related to gender, LMC's remedial mathematics program is similar to the State's population.

The fact that LMC seems to be a typical community college in the nation, supports the external validity of this research report. The information found at Lake

Michigan College can therefore be tentatively generalized across the nation.

## Summary

Much more research with the at-risk students remains to be done in strengthening the scientific basis of remedial education and retention. Rather than creating a hypothetical environment, a design which conforms to existing classroom conditions is needed, if the design is to be used in the classroom. The "open door" must not be turned into a "revolving door" where students do not succeed.

The variables age, sex, race, mathematics attitude test, a norm referenced and criterion referenced test, and educational goals are hypothesized as predictors of successful and nonsuccessful remedial groups. Once these groups are identified, the nonsuccessful student can be more effectively placed, monitored, and remediated to help ensure successful completion.

# CHAPTER IV

# PRESENTATION AND ANALYSIS OF THE FINDINGS

## Introduction

This chapter is divided into five sections: the first two sections discuss the sample and variable dichotomization; the third section delineates problems that occurred in data collection, the fourth section evaluates the null hypotheses, and the fifth section analyzes the data.

This study centered around: (1) the development of a statistical model for predicting mathematics achievement for at-risk community-college students and (2) determining the achievement of this group in the first college-level mathematics class. Such a model provides the theoretical basis for identifying the nonsuccessful at-risk students, thus giving counselors and teachers the ability to appropriately place, monitor, and supervise these students.

Data were analyzed using the SPSS statistical package which provided the descriptive and inferential statistics (ANOVA, Chi-square, Discriminant Analysis, Kolmogorov-Smirnov Goodness of Fit, and MANOVA) to evaluate the null hypotheses.

## Sample

Data were gathered from the entire population of the winter semester Intermediate Algebra 101 students (n=111) and the entire population of fall and winter semesters Basic Mathematics 090 students (n = 358) at Lake Michigan College.

## Dichotomization of Variables

### Grade

Hypotheses 2, 3, and 5 are concerned with the successful and nonsuccessful student. To properly deal with these two groups of students, the variable was dichotomized. Students with grades of A, B, and C were classified as the successful students, because of grade transferability. Students with grades of D, F, and W were classified as nonsuccessful, since these grades cannot be transferred to other colleges for credit.

### Race

The vast majority of the students in the research project were African-American or White. The Basic Mathematics class did contain two non-African-American minority students. Consequently, the decision was made to code race as White or non-White.

### Age

Most traditional students attend college immediately after leaving high school at 18 years of age. With 4 years of higher education these students would be approximately 22 years old. So students past the age of 22 may be classified as part of a nontraditional student group. Therefore, students 22 years old or younger were classified as a traditional group, whereas students older than 22 years were classified as nontraditional.

### Educational Goals

Students generally attend the community college in preparation for the 4-year degree or a 1-to-2-year terminal educational program. The educational goals of these students were dichotomized into the two classifications, transfer or nontransfer.

Table 8 contains the number of students in each of these dichotomized groups and each group's relationship to successful and nonsuccessful completion with percentages in each group.

## Problems in Data Collection

### Basic Mathematics

During the data collection from the student records, it was found that 96 of the 358 Basic Mathematics students did not have complete ASSET scores in reading, writing, or mathematics. Thirty-four of these 96 students did have the mathematics section of the ASSET test. Many of those without scores are the older students who were enrolled

Table 8

Information on Dichotomized Basic Mathematics (090) Laboratory Groups

Numbers and Percentages of Dichotomized Groups of Success, Sex, Race, Age, and Educational Goals

| Group | n | % of Population |
|---|---|---|
| Successful | 182 | (50.8) |
| Nonsuccessful | 176 | (49.2) |
| Male | 95 | (26.5) |
| Female | 263 | (73.5) |
| White | 246 | (68.7) |
| NonWhite | 112 | (31.3) |
| Traditional age | 167 | (46.6) |
| Nontraditional age | 191 | (53.4) |
| Transfer student | 90 | (25.1) |
| Nontransfer student | 268 | (74.9) |

Dichotomized Groups as They Relate to Successful and Nonsuccessful Completion With Row Percentages

| Groups | Success | Nonsuccess |
|---|---|---|
| Male | 42(44.2%) | 53(55.8%) |
| Female | 140(53.2%) | 123(46.8%) |
| White | 142(57.7%) | 104(42.3%) |
| NonWhite | 40(35.7%) | 72(64.3%) |
| Traditional age | 73(43.7%) | 94(56.3%) |
| Nontraditional age | 109(57.1%) | 82(42.9%) |
| Transfer student | 44(48.9%) | 46(51.1%) |
| Nontransfer student | 138(51.5%) | 130(48.5%) |

prior to the ASSET test requirement, whereas others appear to have avoided the requirement of this test with a matriculation code waiver.

During the first week of the winter semester the Aiken-Dreger Mathematics Attitude Test was given to the Basic Mathematics classes (n = 186). However, only 118 students took the test. The other 68 students were absent at the time of testing or were missed for some other reason. All mathematics laboratory teachers made a diligent effort to have all students take this mathematics attitude test.

### Intermediate Algebra Class

The grades in this class (n = 111) were A, B, C, D, E, and W. The grade of W (n = 23) posed a dilemma. In this case was it a grade? What reason caused the student to withdraw? Most colleges do not give this W a numeric value. For this study only the grades of A, B, C, D, and E (n = 88) were considered; these were students who completed the course.

## Analysis of Null Hypotheses

Hypothesis 1. The grades of the Basic Mathematics class are normally distributed.

This hypothesis could be tested by the Chi-square or Kolmogorov-Smirnov Goodness of Fit Test. For many variables, grades being one of them, the frequency of the distribution is concentrated about the mean of the distribution. As the distance from this mean increases, the frequency of cases decreases. Such distributions are said to be normally distributed or "bell shaped." This is a symmetric distribution in which the mean, median, and mode all coincide. Although these distributions may have different means and variances, the distribution proportion about the mean is always the same. The normal distribution is the most important distribution in statistics and describes the frequency distribution about the mean.

In most large population samples the grades are normally distributed. The question as to whether the grade distribution is normal can be answered using the Chi-square or Kolmogorov-Smirnov test for a one-sample test. These are based on the comparison between the sample cumulative distribution and the hypothesized cumulative distribution.

The significance levels for these tests were less than .000 for a two-tailed probability distribution. The chances of this being a normal distribution are less than 5 in 10,000. The assumption that the grades in the Basic Mathematics class are not normally distributed is highly probable.

From the results of Table 9 these tests were clearly not necessary. However, to increase credence these tests were implemented.

Table 9

The Grade Distribution for the Basic Mathematic 090 Classes for the Fall and Winter Semesters (n = 358)

| | | | | | |
|---|---|---|---|---|---|
| | | | | | W |
| | | | | | W |
| | | | | | W |
| | | | | | W |
| | | | | | W |
| | | | | | W |
| | | | | | W |
| | | | | | W |
| | A | | | | W |
| | A | | | | W |
| | A | B | | | W |
| | A | B | | | W |
| | A | B | | | W |
| | A | B | | | W |
| | A | B | C | | W |
| | A | B | C | | W |
| | A | B | C | D | W |
| GRADES | A's | B's | C's | D's | W's |
| COUNT | 87 | 70 | 25 | 5 | 171 |
| % OF THE POPULATION | 24.3% | 19.6% | 7.0% | 1.4% | 47.8% |

Hypothesis 2. There is no significant difference between the means of the successful and nonsuccessful remedial students in mathematics attitude as measured by the Aiken-Dreger Mathematics Attitude Test.

The t-test for means of two independent samples was used to test this hypothesis.

Favorable student attitudes may strongly influence learning and mathematics achievement, in this case successful completion. If a difference in mathematics attitude exists between the successful and the nonsuccessful student, then perhaps this test alone can be used to differentiate between these two groups.

The F-test for equality of variances is quite sensitive to departures from normality and will help eliminate type I errors. If the F is not statistically significant, the pooled variance estimate should be used. If the F is statistically significant, the separate variance estimate should be used.

One hundred eighteen students in the winter semester's Basic Mathematics class were given the Aiken-Dreger Mathematics Attitude Test. The results are shown in Table 10.

For such a large F probability value the pooled variance estimate is used. The probability level for the test of the difference of means is greater than .05; hence, we cannot reject the null hypothesis. This says that 80.1% of the time a sample difference of at least this size would occur by chance when the two population means are equal. There does not seem to be much reason to believe that the means differ in the population.

Table 10

T-Test to Ascertain the Differences in Mean Scores Between the Successful and Nonsuccessful Students on the Aiken-Dreger Mathematics Attitude Test

| | Number of cases | Mean | Standard Deviation | Standard Error |
|---|---|---|---|---|
| Successful | 65 | 39.3692 | 16.068 | 1.993 |
| Nonsuccessful | 53 | 38.6038 | 16.744 | 2.300 |
| Total | 118 | 39.025 | 16.309 | 1.501 |

| | | Pooled Variance Est. | | | Separate Var. Est. | | |
|---|---|---|---|---|---|---|---|
| F Value | 2-tail Prob. | t Value | D.F. | 2-tail Prob. | t Value | D.F. | 2-tail Prob. |
| 1.09 | .749 | -.25 | 116 | .801 | -.25 | 109.33 | .802 |

There appears to be no difference in mathematics attitude between the successful and nonsuccessful students with means approximately 39.4 and 38.6 respectively, standard deviations of 16.1 and 16.7 respectively. The attitude towards mathematics in these two groups is not significantly related to achievement.

Hypothesis 3. There is no significant relationship between performance on the criterion referenced test and success or nonsuccess in the Basic Mathematics course.

Teachers in the mathematics department wanted to know if successful students did well on certain topics in the criterion referenced tests on which the nonsuccessful did not perform well. If so, could this be used to separate the successful and nonsuccessful students?

There are five criterion referenced tests that all students in the mathematics laboratory must take. These tests cover the topics of: (1) whole numbers, (2) fractions, (3) decimals, (4) ratios and proportions, and (5) percentages. Each test contains eight questions, with a passing grade requiring at least six correct answers.

The test scores were recorded as pass (at least six out of eight questions answered correctly) or fail (less than six questions correctly answered). To evaluate this hypothesis, a series of Chi-squares were used to see if the variables were related. The Chi-square test is used to test the null hypothesis that the two groups are independent (Table 11). The figure in parentheses in each cell is the proportion of the row total in that cell. Two variables are by definition independent if the probability that a case falls into a given cell is simply the product of the marginal probabilities of the two categories defining the cell. A statistic often used to test the hypothesis that the row and column variables are independent is the Pearson Chi-square. If the probability is small enough (less than .05), the hypothesis that the two variables are independent is rejected. The Chi-square test provides little information about the strength of association between variables. A correlation or regression equation may be used to provide the degree of association or the amount of explained variance.

Table 11

Chi-square Relationships of Success and Nonsuccess With Pass/Fail on Each of the Criterion Referenced Tests

Criterion Test

Whole Numbers

| Count (Proportion of Row total in the cell) | Passed | Failed | Row Totals |
|---|---|---|---|
| Successful Students | 109 (.60) | 73 (.40) | 182 (.51) |
| Nonsuccessful Students | 62 (.35) | 114 (.65) | 176 (.49) |
| Column Totals | 171 (.48) | 187 (.52) | 358 |

| Chi-square | D.F. | Significance | Min E.F. | Cells with E.F. < 5 |
|---|---|---|---|---|
| 20.83571 | 1 | .0000** | 84.065 | None |

Fractions

| Count (Proportion of row Total in the cell) | Passed | Failed | Row Totals |
|---|---|---|---|
| Successful Students | 11 (.06) | 171 (.94) | 182 (.51) |
| Nonsuccessful Students | 0 (.00) | 176 (1.00) | 176 (.49) |
| Column Totals | 11 (.03) | 347 (.97) | 358 |

| Chi-square | D.F. | Significance | Min E.F. | Cells with E.F. < 5 |
|---|---|---|---|---|
| 9.03900 | 1 | .0026** | 5.408 | None |

Table 11--continued.

Decimals

| Count (Proportion of Row Total in the cell) | Passed | Failed | Row Totals |
| --- | --- | --- | --- |
| Successful Students | 41 (.23) | 141 (.77) | 182 (.51) |
| Nonsuccess-ful Students | 21 (.12) | 155 (.88) | 176 (.49) |
| Column Totals | 62 (.17) | 296 (.83) | 358 |

| Chi-square | D.F. | Significance | Min E.F. | Cells with E.F. < 5 |
| --- | --- | --- | --- | --- |
| 6.29474 | 1 | .0121* | 30.480 | None |

Ratios and Proportions

| Count (Proportion of Row Total in the cell) | Passed | Failed | Row Totals |
| --- | --- | --- | --- |
| Successful Students | 5 (.03) | 177 (.97) | 182 (.51) |
| Nonsuccess-ful Students | 2 (.01) | 174 (.99) | 176 (.49) |
| Column Totals | 7 (.02) | 351 (.98) | 358 |

| Chi-square | D.F. | Significance | Min E.F. | Cells with E.F. < 5 |
| --- | --- | --- | --- | --- |
| 0.51660 | 1 | .4723 | 30.441 | 2 of 4(50%) |

Percentages

| Count (Proportion of Row Total in the cell) | Passed | Failed | Row Totals |
| --- | --- | --- | --- |
| Successful Students | 5 (.03) | 177 (.97) | 182 (.51) |
| Nonsuccess-ful Students | 2 (.01) | 174 (.99) | 176 (.49) |
| Column Totals | 7 (.02) | 351 (.98) | 358 |

| Chi-square | D.F. | Significance | Min E.F. | Cells with E.F. < 5 |
| --- | --- | --- | --- | --- |
| 0.51660 | 1 | .4723 | 3.441 | 2 of 4(50%) |

* significant at the .05, ** significant at the .01 level

Using the .05 significance level for the Chi-square test, the null hypotheses for the first three criterion referenced tests (Whole Numbers, Fractions, and Decimals) must be rejected, whereas the null hypotheses for the last two test (Ratios and Proportions, and Percentages) are retained.

Grade outcomes (successful or nonsuccessful) are not independent with respect to the test scores in these first three topics of whole numbers, fractions, and decimals. These results support the mathematics laboratory teachers' perception that these two groups have different scores on some criterion referenced tests. In each case, a higher proportion of the successful students than the nonsuccessful students passed the criterion referenced test. Nevertheless, for fractions, only 6% of the successful students passed the test.

Hypothesis 4. Regularity of attendance in the classroom until completion is not significantly different for the grades A to W and, therefore, cannot be used to differentiate student performance in this course.

The at-risk students in the community college seem to have sporadic attendance problems. In the mathematics laboratory environment students proceed at their own pace with some proceeding faster than others. Many will finish early, before the semester is over, whereas others frequently miss classes and are forced to rush at the semester's end to finish. Do students with better attendance until course completion earn better grades than those who have sporadic attendance?

To evaluate this hypothesis, an ANOVA was used to test the student's grade with the ratio of attendance to the expected attendance until completion. Grades are A, B, C, D, and W. This relationship is shown in Table 12.

Table 12

Relationship Between Grade and Ratio of Attendance Until Completion

| Grade | Percentage Attendance | Standard Deviation | Standard Error | Count(%) of Students in the Lab |
|---|---|---|---|---|
| A | 72.6 | 24.045 | 2.578 | 87 (24.3) |
| B | 73.0 | 22.658 | 2.708 | 70 (19.6) |
| C | 72.2 | 24.428 | 4.886 | 25 ( 7.0) |
| D | 73.2 | 19.766 | 8.840 | 5 ( 1.4) |
| W | 43.3 | 25.675 | 1.963 | 171 (47.8) |
| Success | 72.7 | 23.444 | 1.957 | 182 (50.8) |
| Nonsuccess | 44.1 | 25.946 | 1.738 | 176 (49.2) |

ANOVA Test for Significance in Difference in Means of Attendance.

| Source of Variation | Sum of Squares | DF | Mean Square | Significance F-Ratio | F-Prob. |
|---|---|---|---|---|---|
| Between groups | 77355.0496 | 4 | 19338.762 | 32.036 | .000* |
| Within groups | 213092.897 | 353 | 603.663 | | |

*Significant at the .01 level

The level of significance in Table 12 is less than .0005 for the group means. The likelihood of differences in the means happening by chance when the population means are equal is less than 5 in 10,000 samples. Therefore, the null hypothesis must be rejected. It appears unlikely that the different groups have the same percentage attendance.

To pinpoint where differences occur in these groups, the Scheffe and Student-Newman-Keuls multiple comparison tests were used (Table 13). The Scheffe multiple comparison test is a conservative pair-wise comparison of means and requires a larger difference between means for significance than many other methods. Concern that the Scheffe procedure is more rigorous and will lead to fewer significant results led the researcher to use also the Student-Newman-Keuls Test, which yielded similar results. Pairs of means that are significantly different at the .05 level are indicated with an asterisk (*) in the matrix. The asterisk under the column of W's indicates that the means of attendance are different for this group and the rest of the grades (A, B, C, and D). The means of the groups A, B, C, and D are not significantly different from one another.

As shown in Table 12, the percentage attendance for the grades A through D is very close (between 72.2% and 73.2%), whereas the grade of W has a very low average attendance of 43.3%. The table also compares the attendance of the successful (72.7%) and nonsuccessful (44.1%) students. The variance in attendance among grade levels A to D is not enough to predict performance; the only significant difference lies between W and the grades A to D.

Table 13

Scheffe and Student-Newman-Keuls Multiple Comparison Tests on the Significance Between Ratio of Attendance With Respect to the Grades A-W

| Mean | Group | Group W | Group D | Group C | Group B | Group A |
|---|---|---|---|---|---|---|
| 43.2749 | W | | | | | |
| 73.2000 | D | * | | | | |
| 72.1600 | C | * | | | | |
| 72.9714 | B | * | | | | |
| 72.6292 | A | * | | | | |

* Denotes pairs of groups significantly different at the .05 level.

Hypothesis 5. There is no significant difference between the two group centroids of successful and nonsuccessful remedial students with respect to the variables: the criterion referenced test, the mathematics attitude, the norm referenced test, age, sex, race, and educational goals.

Preliminary research using MANOVA indicated that the centroids of the successful and nonsuccessful students are different on the model using the criterion referenced test, the mathematics attitude, the norm referenced test, age, sex, race, and educational goals. Sample centroids are .60590 and -.68164 respectively for the successful and nonsuccessful students on the variables whole numbers, fractions, decimals, ratios and proportions, percentages, mathematics attitude, the norm referenced test, age, sex, race, and educational goals which do differ as shown in Table 14. The significance level was less than .0005 indicating that the likelihood of finding means this different by chance would be less than 5 in 10,000 samples. These variables might be useful in differentiating between the successful and nonsuccessful student in the mathematics laboratory.

Table 14

Multivariate Tests of Significance for Differences in Group Means for Successful and Nonsuccessful Students on the Variables: Criterion Referenced Test, Mathematics Attitude, Norm Referenced Test, Age, Sex, Race, and Educational Goals

| Test Name | Value | Approx. F | Hypoth. DF | Error DF | Sig. of F |
|---|---|---|---|---|---|
| Wilks | .70360 | 3.44675 | 11 | 90 | .000* |

*Significant at the .01 level.

Because the MANOVA indicated a significant difference among the group centroids, it was followed up by discriminant analysis. Discriminant analysis is the statistical procedure that identifies the variables that are important for distinguishing among groups and develops a procedure for predicting group membership for new cases whose group membership is unclear. The discriminant function provides a classification rule that minimizes the probability of misclassification. Discriminant analysis uses stepwise variable selection algorithms that combine the features of forward selection and backward elimination. In the stepwise method the first variable included in the analysis has the largest acceptable value for the selection criterion. After the first variable is entered, the value of the criterion is reevaluated for all variables not in the model, and the variable with the largest acceptable criterion value is entered next. At this point, the variable entered first is reevaluated to determine whether it meets the removal criterion. If it does, it is removed from the model. The next step is to examine the variables not in the equation for entry, followed by examination of the variables in the equation for removal. Variable selection terminates when no more variables meet entry or removal criteria. For this research the smallest Wilks' Lambda was used to select the variables for entry. Finally, the model was tested on the current sample for an index of effectiveness by determining the number of cases classified correctly. The results of the analysis are given in Table 15. The coding for the gender variable was female = 1 and male = 2.

When comparing the two groups, a probability of less than .00005 was found. The probability of this happening by chance is less than 5 in 100,000. Hence the null hypothesis must be rejected, because there is a significant difference between the centroids of the successful and nonsuccessful students.

The stepwise method entered 11 variables and reduced the number of variables to 5. The standardized discriminant coefficients indicate the relative strength contributed by the 5 variables in the model (Table 15). The model had a canonical correlation of .5335 and predicted approximately 28.5% of the variance attributable to differences among the two groups. In predicting group association, 202 of the 309 cases (65.37%) were correctly classified.

The model indicates that students having high scores on fraction, whole number, and ASSET test are likely to be successful. High scores on the gender variable (male) was a negative indicator of success. Older women with high scores on fractions, whole numbers, and the ASSET test were more likely to be successful.

Table 15

Standardized and Unstandardized Canonical Discriminant Function Coefficients Using Wilks' Lambda

| Rank | Variable | Unstandardized Coefficient | Standardized Coefficient |
|---|---|---|---|
| 1. | Fractions | .3412118 | .44566 |
| 2. | ASSET | .0946206 | .36759 |
| 3. | Age | .6799866 | .33797 |
| 4. | Gender | -.7472308 | -.32934 |
| 5. | Whole Numbers | .2202144 | .31258 |
| | (Constant) | -5.530288 | |

Group means (group centroids) for the discriminant functions

| Group | means |
|---|---|
| Successful students | .58883 |
| Nonsuccessful students | -.66244 |

| Wilks' Lambda | Canonical Correlation | Chi-square | D.F. | Significance |
|---|---|---|---|---|
| .7154 | .5335 | 32.490 | 6 | .0000 |

Classification Results

| Groups | No. of Cases | Predicted Group Membership Nonsuccessful | Successful |
|---|---|---|---|
| Nonsuccessful | 154 | 95(61.7%) | 59(38.3%) |
| Successful | 155 | 48(31.0%) | 107(69.0%) |

Note. Correct classifications 65.37%.

Hypothesis 6. There is no significant grade difference in achievement in a subsequent college-level mathematics class (Intermediate Algebra) between the students who took the mathematics laboratory and the traditional students who were not required to take a remedial mathematics laboratory course.

Analysis of variance was used to test this hypothesis that achievement of the mathematics laboratory students and traditional students are the same in the Intermediate Algebra classes.

In analyzing the transcripts of the students in the Intermediate Algebra class, two categories of mathematics laboratory students were found in the class. Some of these students began with Basic Mathematics (n = 20) whereas others started with Elementary Algebra (n = 20). These two groups of students were compared with the traditional students who started in the Intermediate Algebra class (n = 48). The grade distribution for each group for the Intermediate class is given in Table 16.

The group means indicate that the students who started with Elementary Algebra have the highest group average (3.0), whereas those starting in Basic Mathematics have the lowest group average (2.0). The mean grade point for all mathematics laboratory students in this class is 2.5.

Table 16

Grade Distribution With Column Percentages for Intermediate Algebra With Respect to Each Group of Students

| | Course Started With | | | |
|---|---|---|---|---|
| Grade | Basic Math | Elementary Algebra | Intermediate Algebra | Row Total |
| A | 2 (10%) | 11 (55%) | 14 (29.2%) | 27 |
| B | 3 (15%) | 2 (10%) | 11 (22.9%) | 16 |
| C | 11 (55%) | 5 (25%) | 12 (25.0%) | 28 |
| D | 1 (5%) | - -- | 3 (6.2%) | 4 |
| E | 3 (15%) | 2 (10%) | 8 (16.7%) | 13 |

| Group | Mean Scores | n |
|---|---|---|
| Basic Mathematics | 2.0000 | 20 |
| Elementary Algebra | 3.0000 | 20 |
| Intermediate Algebra | 2.4167 | 48 |
| Math Lab Students | 2.5000 | 40 |
| Intermediate Algebra | 2.4167 | 48 |

A-priori comparison test was initially run to see if a significant difference existed in the grade means with respect to these two mathematics laboratory groups. A large difference appeared to exist between the grades of the Elementary Algebra and the Basic Mathematics groups. To check for this difference, contrast coefficients of +1 and -1 were assigned to the Basic Mathematics and Elementary Algebra groups respectively, whereas the coefficient of the Intermediate Algebra group was given a value of 0. Winer (1961) suggested this approach for contrasting two groups. The results of this comparative analysis can be seen in Table 17.

Table 17

Contrast Test Comparison With Respect to Mean Grades of Basic Mathematics Students and Elementary Algebra Students in the Intermediate Algebra Class

| | | Pooled Var. Est. | | | Separate Var. Est. | | |
|---|---|---|---|---|---|---|---|
| F Value | 2-tailed Prob. | t Value | D.F. | 2-tailed Prob. | t Value | D.F. | 2-tailed Prob. |
| 2.8447 | .0637 | 2.367 | 85 | .020 | 2.56 | 40 | .015 |

The results in Table 17 demonstrate that the two groups appear to have significantly different grades. With the nonsignificant F value given in the table, the pooled variance estimate was used. The probability level less than .05 indicated that the Elementary Algebra and Basic Mathematics group grades in this class were significantly different.

When mathematics laboratory students were considered as one group, the mean (2.5) was only .00853 units different from the mean of the traditional Intermediate Algebra students (2.4167). ANOVA showed this difference in the means of these two groups to be nonsignificant.

With regard to the 71 successful completers (grades A, B, or C), 49% (34) were from the mathematics laboratory, whereas 51% (37) started with Intermediate Algebra as a first course. The percentages of successful completion for the traditional and nontraditional students were approximately the same. Although approximately 35% (6) of the 17 nonsuccessful completers (grades D or E) were from the mathematics laboratory, the other 65% (11) started with Intermediate Algebra. But most of these nonsuccessful students, whether traditional or nontraditional, had low ASSET test scores.

From the analysis of variance (ANOVA, Table 18), no significant differences were found between the groups' achievement in the Intermediate Algebra course, when all three groups were considered. The probability was slightly greater than .05--not enough to reject the null hypothesis.

Table 18

ANOVA Comparison of the Differences of the Three Group Means in the Intermediate Algebra Classes

| Source of Variation | Sum of Squares | DF | Mean Square | Significance F Ratio | F Prob. |
|---|---|---|---|---|---|
| Between groups | 10.1515 | 2 | 5.0758 | 2.8447 | .0637 |
| Within groups | 151.6667 | 85 | 1.7843 | | |
| Total | 161.8182 | 87 | | | |

Significance was found between the mean grades of the Basic Mathematics students and the Elementary Algebra students. The only difference that exists is within the two different mathematics laboratory groups. Elementary Algebra students do significantly better than Basic Mathematics students in the Intermediate Algebra classes. This difference can be clearly seen in the mean scores of the Elementary Algebra and the Basic Mathematics students in Table 16.

The null hypothesis is therefore retained. There is no significant grade difference in achievement in a subsequent college-level mathematics class (Intermediate Algebra) between the students who took the mathematics laboratory and the traditional students who were not required to take a remedial mathematics laboratory course. However, there is a significant difference between the achievement of the Elementary Algebra and Basic Mathematics students.

## Summary of Hypotheses

This study examined six null hypotheses for the at-risk mathematics students at Lake Michigan College during the fall 1991 and winter 1992 semesters. The rejection or non-rejection of these hypotheses was based on an alpha of .05. Table 19 summarizes the results of the tested hypotheses.

Table 19

Summary of Whether the Null Hypotheses Were Rejected or Retained With the Probability Level

| Hypothesis | Results | Level of Significance |
|---|---|---|
| 1. The grades of the Basic Mathematics class are normally distributed. | Reject | .000 |
| 2. There is no significant difference between the means of the successful and nonsuccessful remedial student in mathematics attitude, as measured by the Aiken-Dreger Mathematics Attitude Test. | Retain | .801 |
| 3. There is no significant relationship between performance on the criterion referenced test and success or nonsuccess in the Basic Mathematics course. | | |
| a. Whole Numbers | Reject | .0000 |
| b. Fractions | Reject | .0026 |
| c. Decimals | Reject | .0121 |
| d. Ratios & Proportions | Retain | .4723 |
| e. Percentages | Retain | .4723 |
| 4. Regularity of attendance in the classroom until completion is not significantly different for the grades A to W and therefore, cannot be used to differentiate student performance in this course. | Reject | .000 |

Table 19--continued.

| Hypothesis | Results | Level of Significance |
|---|---|---|
| 5. There is no significant difference between the two group centroids of successful and nonsuccessful remedial students with respect to the variables: the criterion referenced test, the mathematics attitude, the norm referenced test, age, sex, race, and educational goals. | Reject | .0000 |
| Reduced to 5 variables | | |
| (Fractions, ASSET, Age, Gender, and Whole Numbers) | | 65.35% Correct classification |
| 6. There is no significant grade difference in achievement in a subsequent college-level math class (Intermediate Algebra) between the student who took the mathematics lab and the traditional students who were not required to take a remedial mathematics lab course. | Retain | .0637 |

## Analysis

This investigation was designed to find a model that would differentiate between the successful and nonsuccessful students completing a remedial basic mathematics class at a community college. Such a model would give counselors and teachers the ability to identify and closely supervise these students.

Also investigated was the achievement of these students who took the remedial courses compared with the nonremedial mathematics students in the first college-level mathematics class.

### Introduction

While a slim majority of students are succeeding (51%) in the basic mathematics laboratory, still 49% are not. This may be reflected in their mathematics attitude. Roueche (1978) found that these students have unrealistic expectations. Roueche states that these students are not seeking skills to help with a future career, but simply self-esteem, which quickly vanishes. These students are out of high school, and after playing or working all summer, they are ready to do what they have always done--go back to school. These are the students who have made poor choices in the past and will continue to make poor judgments (Cox, 1990; McCabe & Skidmore, 1982; Tinto 1987b). The number of hours spent in the mathematics laboratory shows the procrastination of these students in finishing the task at hand. Many were not serious about their curriculum studies and did not apply themselves and study; they attended classes for only a few hours during the semester. This problem is common to many other institutions as well (Roueche & Baker, 1987; Tinto, 1987b). Regardless of the teaching method used, the problems of time spent on task and absenteeism still persist.

## Grades and Attendance

This investigation found that the A and B students, who represented about 44% of the class population, may not need the total semester to finish the course. They attended class about 73% of the time until completion, which was often early in the semester. These students spent much more time working on their course work at home, while the other groups did their work during class time. For most students in the A and B groups, this was review work of concepts that perhaps they had learned earlier but had forgotten. Much of their class time was spent in getting homework graded, taking tests, or asking questions. This group knew the grade they were capable of earning and had an inner drive to succeed and complete the course as soon as possible.

Forty-eight percent of the students in the Basic Mathematics course belonged to the withdrawal grade group, W. Students in this group missed approximately 57% of their classes, and many of them stopped coming after several weeks. Perhaps this material was never learned and trying to learn these concepts was too frustrating and difficult for them. This may be the process referred to in the literature as the "cooling-off" effect. When students find that college is not for them, they drop out and take their appropriate place in the working society. However, with guidance and encouragement, many of these students might be saved from dropping out. The mathematics laboratory teachers and coordinator monitor the progress of all students; those falling behind are called, and letters or postcards are sent encouraging them to attend, and assistance is offered. If these students could achieve success during the first semester or two of college, they might finish a degree program. Some students in the group had D's for their course grade, but had, for GPA reasons, requested in writing the grade of W. These students would later repeat the course for a grade. This might explain the low number of D grades in the Basic Mathematics class.

Students in the C and D groups spent "about" 72% of their time in the mathematics laboratory until completion. This group represents about 8% of the classroom population. These students worked diligently to finish, but this course and its concepts were a struggle. Many took the chapter tests more than once to raise their grades. This takes away precious class and study time.

This group had about 27% class absences. At the semester's end, these students may not have had enough time to take the semester exam, which was 30% of their grade, and thus their grades were significantly affected.

Attitude

The Aiken-Dreger Mathematics Attitude Test was given to students in the mathematics laboratory. This test has a five-option Likert-type scale with 10 reversals on 20 questions. This short test was easily administered in the class with minimal disruptions to the classes. The literature review in chapter 2 indicated this was an important characteristic with respect to achievement.

An earlier study (Cox, 1990) administered the Aiken-Dreger Mathematics Attitude Test to the Basic Mathematics classes at LMC in the winter of 1987 semester. The test results indicated that the students were "not scared" or "strained in mathematics classes" but had a good feeling toward mathematics. It was not a dreaded subject in which they "felt lost in a jungle." However, "the subject was not stimulating nor did they greatly enjoy taking it." Attitude was not as important a variable as the research of Neale (1969) and Trachtman (1975) indicated. In the Basic Mathematics class, attitude was not significantly related to successful or nonsuccessful achievement. The mean attitude scores on the Aiken-Dreger Mathematics Attitude Test were almost identical for both groups of students with mean scores of 39.3692 and 38.6038 respectively for successful and nonsuccessful completion. Years of failure and poor grades in mathematics have caused student apprehension regarding this subject, and perhaps, has given students a low self-esteem in this subject. With a one-to-one relationship with the instructors (both teachers and tutors) in the mathematics laboratory, this attitude will change (Aiken, 1976; Joyce & Weil, 1986). As students attain their goals, attitudes will change and self-esteem will increase and be a major contributor to retention (Goldston, 1982). This was evident in the Intermediate Algebra class where the mathematics laboratory students were just as prepared as the other students and were indistinguishable in terms of attitude from that group.

After the completion of Intermediate Algebra, cumulative GPAs of 2.6 and 2.3 were found for the math lab and other students, respectively. T-test results found these to not be significantly different at alpha = .05. Literature indicates, the higher cumulative GPA's of these students is a good retention indicator. As deficiencies in mathematics are corrected, attitude will relate to achievement (Joyce & Weil, 1986). Learning will cause a favorable attitude. Those who learn most are adequately rewarded, but those who learn less receive fewer rewards, and so attitudes are influenced. Favorable attitude leads to achievement and vice versa (Wambach, 1993).

<u>Age and Sex</u>

Older students are one of the fastest growing population groups on community-college and university campuses. Data also suggest that women, who comprise 52% of the U.S. adult population, are enrolling in higher education at a much higher rate than men (Rountree & Lambert, 1992). Because the numbers of undergraduates over age 25 continues to grow, it is important for community colleges to become aware of the reasons why adults do well in various programs. By providing the appropriate programs for adult students, the community college will continue to be the leader in meeting and assisting in educational goals. Several factors have been identified as contributing to participation in the community college: (1) to secure professional or job advancement, (2) to get relief from routine or boredom, and (3) to seek knowledge for the sake of learning (Adam & Lindoo, 1989; Cross, 1981; DeVoll, 1989).

Adults have preferred modes of learning, and when teaching methods are structured according to those modes, significant gains have been achieved. This group ranked programed instruction, workbooks, audiovisual presentations, receiving feedback from professors, and individual student tutor sessions as the most important techniques in their learning (Cross, 1981; Rountree & Lambert, 1992). The remedial mathematics program in the mathematics laboratory uses all these techniques to assist learning. This may be why the older learners seems to have a better achievement record than the traditional age group.

Women were a majority in the Basic Mathematics class (73.5%). The average age in this course was 27.6 years with the average female being 28.3 years old, compared to 25.6 for the average male.

A 53.4% of the students in this class belonged to the nontraditional age group (23 years of age or older). This group had a larger success rate (57.1%) than the traditional age group (43.7%).

Upon further investigation it was found that the males and females in this nontraditional age group had success rates of 54% and 58% respectively, whereas the traditional age male and female groups had success rates of 37% and 47% respectively. As a group, the older students are clearly out-performing the younger students, thereby confirming the literature reports of Goldston (1982) and Roberts (1986).

The older student may have previously learned this Basic Mathematics curriculum, but lack of use has caused the need for a refresher course. This student was possibly the typical unmotivated 16-year-old, who is now older and determined to succeed. Perhaps, with the uncertain economy and large numbers of the population out of work, this may be the person who needs to be retrained to gain employable skills. Grant money or financial aid is easily obtainable for low-income groups, if a need is shown (LMC, 1993). Many of these students are eligible and are receiving this money.

## Norm and Criterion Referenced Tests

When students enter LMC, they must take the norm referenced ASSET Numerical Skills test to determine mathematics competencies. If a student's score is less than 41 (on a scale of 23 to 55), the student is assigned to the mathematics laboratory. It was initially feared that this test might not have enough variance to be a significant indicator of achievement, but this variable was proven significant in the results of Hypothesis 5 using MANOVA and discriminant analysis confirmation. It was found that the mean scores for this variable were 36.052 and 33.234 for the successful and nonsuccessful student. In general, the successful student had three more correct answers on this test than the nonsuccessful student. This indicates that the higher the score on this norm referenced test, the more likelihood of successful completion. This is obviously true since the higher the score, the better the mathematics ability of the student and the greater likelihood for success.

Contrary to the findings of Roberts (1986), when the ASSET reading and writing tests were included in the discriminant analysis, they were eliminated by the program. They were found to be nonsignificant in differentiating between successful and nonsuccessful basic mathematics completion.

The criterion referenced tests on whole numbers and fractions were significant in differentiating between successful and nonsuccessful completion. If the students have not learned these fundamental mathematical concepts prior to taking the course, it is almost impossible for them to successfully complete the course in one semester. Whole number and fractions concepts are fundamental to successful completion. If the student is extremely weak in these concepts and has not learned them in 12 years in the K-12 system, they are not likely to learn these concepts in one semester.

In the discriminant analysis, the criterion referenced fraction test was the most significant, and outranked the other criterion referenced tests. This is quite logical since the properties of fractions are fundamental to the mathematical concepts of decimals, ratios and proportions, and percentages.

Race

Diversity will be the hallmark of the future. An increasing factor in diversity is the growth of racial and ethnic minorities (Cross, 1981; Hodgkinson, 1985).

Even though race was not a significant factor in the discriminant analysis, 64% of the minority group were nonsuccessful. The variance in this group is explained by the variables left in the discriminant analysis. This confirms the findings of Cross (1981) and Roberts (1986) that race has little influence on college grades.

Equation

The prediction equation generated for successful and nonsuccessful completion was based on the Criterion Referenced Test units of whole numbers and fractions, the ASSET Numerical Skills Test, age, and gender. The prediction equation when raw scores are used is:

(success or nonsuccess) = .3412118*Fractions + .0946206*ASSET + .6799866*Age - .7472308*Gender + .2202144*Whole numbers - 5.530288

This equation correctly classified about 65.4% of the students in the class and explained about 28.5% of the variance associated between the discriminant scores and the two achievement groups (successful or nonsuccessful). This is larger than the 19% explained variance in Pascarella et al. (1986).

Student scores are evaluated in the above equation. If its value is less than or equal to 0, then the student will more than likely be nonsuccessful in the class. However, if it has a value greater than 0, then the student will more than likely be successful.

Once the students enter the mathematics laboratory and take the criterion referenced test, the last piece of needed data will be available. The raw score equation will be used by LMC to evaluate whether a student lies in the successful or nonsuccessful student group. If the student has a score in the nonsuccessful group, that student will be monitored by the mathematics laboratory teaching personnel, encouraged with words of praise, and advised to seek help. Such a student should be encouraged to think that he/she is wanted and valued, thus raising his/her self-esteem.

## Summary

Older students generally outperformed their younger counterparts. These students had better attendance, and thus used their time for academic achievement. Female students outperformed male students in both age groups.

Statistical procedures using discriminant analysis found the variables fractions, whole numbers, ASSET (Numerical Skills), age, and gender significant in the prediction of successful or nonsuccessful achievement in the Basic Mathematics class. The variables race, decimals, ratios and proportions, and percentages were shown to be nonsignificant.

Results from grade analysis in the Intermediate Algebra course demonstrated that the mathematics laboratory had removed the mathematics deficiencies and these students were academically comparable with the other students. At the end of the semester the mathematics laboratory students in this course had a higher cumulative GPA than their counterparts.

## CHAPTER V

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This research project explored the relationships between successful and nonsuccessful at-risk remedial mathematics students on the variables: age, norm and criterion referenced mathematics tests, class attendance, mathematics attitude, educational goals, race, and sex. These variables were used to identify and differentiate between academically successful and nonsuccessful students in the community college's remedial basic mathematics course.

Also explored was achievement of these remedial students in the first college-level mathematics class, Intermediate Algebra 101.

### Introduction

The "open door" at the community college has removed all barriers to enrollment and has given equal opportunity for all in higher education. This has increased access to higher education for large numbers of nontraditional students. Many of these students never intended to go to college and therefore did not take the proper high-school courses for college preparation. Now they lack the basic skills to enter the college environment, mathematics being one of these skills. The problem is that 50%-75% of the entering community-college freshmen need remediation in mathematics in order to succeed in a college environment.

Identification and monitoring of these students is essential to their academic success. With identification and monitoring, these students can be placed in courses in which they have a chance of succeeding while removing their deficiencies.

A need exists for ongoing research to develop useful tools and techniques to identify the nonsuccessful remedial students for correct placement and continuous monitoring. Unless research studies are conducted and adequate intervention strategies are developed, the availability of programs for a vast population will be nonexistent. This restricts the careers and social mobility of many groups in the population. With accuracy of placement, quality and excellence of student learning and retention can be increased.

## Summary of the Literature

Increasingly, more at-risk students are enrolling in the community colleges. Programs are being designed that facilitate student development in deficient areas. Some community colleges are achieving results using: (1) mandatory entry testing with the ASSET test and mandatory placement; (2) various teaching methods (programed learning, personalized instruction, and individualized self-paced mastery learning); and (3) smaller student teacher ratios. Pretest and posttest score results indicate that remediation is bringing the at-risk students to the academic level of the nonremedial students; thereby, increasing these students' GPA which increases retention and program completion. However, little is known about the effectiveness of remediation in later courses (Jones, 1986; Pascarella, et al., 1986; Roueche, 1984; Tinto, 1987b; Webb, 1988).

Very little research has been done on the at-risk mathematics community-college student. In fact, research on remedial programs in the open-door community college is practically non-existent (DeVoll, 1989; Hackworth, 1991; Rotman, 1991). Schools apparently use trial and error techniques in setting up programs because of insufficient research and funding. The research that is being done is mainly at the 4-year institutions using variables that most "open door" community colleges do not have.

## Nature of the Study

This study addressed an aspect of the most frequently raised issue regarding the at-risk remedial basic mathematics student: Can the nonsuccessful student be identified? Identification is imperative. Counselors and teachers must have the ability to monitor and supervise these students.

This research was undertaken in an attempt to significantly add to the current body of knowledge dealing with remedial education and to develop a useful tool for monitoring the nonsuccessful remedial student. This will give vital information to developmental educators in the fastest growing area of the college curriculum where little is known about these students.

Specifically, this study endeavored to determine to what extent basic mathematics performance on the part of at-risk community-college students can be predicted from norm and criterion referenced mathematics assessment test results, coupled with registration demographic information. Other aspects of this research studied the performance of the at-risk mathematics laboratory students in the first college-level mathematics class.

It was essential that this research design conform to existing conditions at the community college rather than a hypothetical environment. Information to be used is available to any teacher in the classroom, so that the model may be implemented in other institutions of higher education. The methodology utilized in this study was designed to have extensive applications for community colleges and other institutions of higher learning.

## Research Design

This inquiry was an empirical *ex post facto* research design that used statistical analysis to explore relationships between successful and nonsuccessful at-risk mathematics students at the community college. This *ex post facto* study sought to determine to what extent the two groups differed on norm and criterion referenced pretest scores, attitudinal measures, attendance profile, and registration demographic information and how these successful students performed in the first college-level mathematics class.

The resulting data were statistically analyzed utilizing data description procedures, ANOVA, Chi-square, discriminant analysis, Kolmogorov-Smirnov Goodness of Fit, and MANOVA. These statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS). The null hypotheses were tested at the .05 level of significance.

Andrews University's Statistics Departmental guidelines and "A Guide for Selecting Statistical Techniques for Analyzing Social Science Data," published by the Institute for Social Research at the University of Michigan (1981), were used to ensure that proper statistical procedures were followed.

## Research Findings

Three hundred and fifty-eight students were enrolled in the fall 1992 and winter 1993 remedial Basic Mathematics classes at LMC. Descriptive information on success, sex, age, race, and educational goals with respect to these students is given in Tables 20 and 21.

Table 20

Numbers and Percentages of Dichotomized Groups of Success, Sex, Race, Age, and Educational Goals in the Basic Mathematics Course (090)

| Group | n | % of Population |
|---|---|---|
| Successful | 182 | (50.8) |
| Nonsuccessful | 176 | (49.2) |
| Male | 95 | (26.5) |
| Female | 263 | (73.5) |
| White | 246 | (68.7) |
| Nonwhite | 112 | (31.3) |
| Traditional age | 167 | (46.6) |
| Nontraditional age | 191 | (53.4) |
| Transfer student | 90 | (25.1) |
| Nontransfer student | 268 | (74.9) |

Table 21

Basic Mathematics (090) Dichotomized Groups as They Relate to Successful and Nonsuccessful Completion With Row Percentages

| Groups | Successful | Nonsuccessful |
|---|---|---|
| Male | 42(44.2%) | 53(55.8%) |
| Female | 140(53.2%) | 123(46.8%) |
| White | 142(57.7%) | 104(42.3%) |
| Non-White | 40(35.7%) | 72(64.3%) |
| Traditional age | 73(43.7%) | 94(56.3%) |
| Nontraditional age | 109(57.1%) | 82(42.9%) |
| Transfer student | 44(48.9%) | 46(51.1%) |
| Nontransfer student | 138(51.5%) | 130(48.5%) |

Eighty-eight students in LMC's Intermediate Algebra (first college-level mathematics class) portion of the study were used to evaluate the success of the remedial mathematics program. Two groups of students in this class were from the remedial mathematics laboratory; 20 were from the Basic Mathematics class and 20 were from the remedial Elementary Algebra class. The remaining 48 were traditional Intermediate Algebra students who were starting their mathematics courses with Intermediate Algebra.

Tests of Hypotheses

Hypothesis 1. The grades of the Basic Mathematics class are normally distributed.

This hypothesis was rejected. Grades do not exhibit a normal distribution in the Basic Mathematics class. Approximately 48% of the students did not complete the course and received a W for a grade, whereas 44% received A's or B's for grades in the course, thus leaving about 8% for the remaining C's and D's.

Hypothesis 2. There is no significant difference between the means of the successful and nonsuccessful remedial students in mathematics attitude as measured by the Aiken-Dreger Mathematics Attitude Test.

This hypothesis was retained. The mathematics attitudes of the successful and nonsuccessful groups were not significantly different ($p = .801$). Successful and nonsuccessful groups had a mean score on the Aiken-Dreger Mathematics Attitude Test of 39.3692 and 38.6038 respectively, with standard deviations of 16.068 and 16.744 respectively. These two mean scores differed by only .7654.

Hypothesis 3. There is no significant relationship between performance on the criterion referenced test and success or nonsuccess in the Basic Mathematics course.

This hypothesis was rejected. The performance of the successful and nonsuccessful students differs on the criterion referenced tests for the sections dealing with whole numbers, fractions, and decimals. The first two sections, whole numbers and fractions, were significant at the .01 level, whereas the decimal section was significant at the .05 level.

The remaining two sections of the criterion referenced test dealing with ratios and proportions and percentages were not significantly different at the .05 level for the performance of the successful and nonsuccessful students.

Hypothesis 4. Regularity of attendance in the classroom until completion is not significantly different for the grades A to W and, therefore, cannot be used to differentiate student performance in this course.

This hypothesis was rejected. Regularity of attendance until completion was not significantly different for the grades A to D at the .05 level. Each of these four groups had a mean attendance of about 73% until completion. However, these did significantly differ from the W's at the .05 level, which had a mean attendance of approximately 43%.

Hypothesis 5. There is no significant difference between the two group centroids of successful and nonsuccessful remedial students with respect to the variables: the criterion referenced test, the mathematics attitude, the norm referenced test, age, sex, race, and educational goals.

This hypothesis was rejected. A comparison of the two group centroids on the 11 variables found a combination of 5 variables significantly discriminating between the two groups. These were: the criterion referenced test on fractions, norm referenced ASSET test, age, gender, and criterion referenced whole numbers test. These were significant at the .00005 level. With these 5 variables, approximately 65.36% of the total group in the Basic Mathematics classes were correctly classified.

Hypothesis 6. There is no significant grade difference in achievement in a subsequent college-level mathematics class (Intermediate Algebra) between the students who took the mathematics laboratory and the students who were not required to take a remedial mathematics laboratory course.

This hypothesis was retained. The first college-level mathematics class (Intermediate Algebra) had a total population of 88 students. Three types of students were found in this class: (1) the student whose mathematics career started with this class (n = 48); (2) the student whose first mathematics class started with Elementary Algebra (n = 20); and (3) the student who started with Basic Mathematics (n = 20). The weakest student group in this class started with Basic Mathematics, whereas the strongest group started with Elementary Algebra. The only significant difference in grades, at the .05 level, was between these two groups. The Elementary Algebra students had a mean grade point of 3.0, while the Basic Mathematics students had a mean grade point of 2.0. When these two mathematics laboratory groups were categorized as a single group, their mean grade point was 2.5 compared with the mean 2.42 of the other students. These were not significantly different at the .05 level.

Relevant Information Found

Relevant information was found with respect to the review of the literature in chapter 2. There was no significant difference between the higher mean cumulative GPA of the mathematics laboratory students (2.646) and the traditional students (2.251) in this class. This confirms the findings of Lovell and Fletcher (1989) and Wynn and Fletcher (1987) that no significant difference exists in GPA's between the at-risk and not-at-risk student enrolled in the first college level mathematics class.

## Conclusion

Unless research studies are conducted and adequate interventions developed, the large attrition rate of the at-risk student will continue. The nonsuccessful remedial students must be identified as they enter the community college. Norm and criterion referenced tests with registration demographic information are an integral part of this identification process. Yet little research has been done on this group of students who have a large attrition rate. Any model that can contribute to this identification of the nonsuccessful at-risk student will make a significant contribution to higher education.

Past predictive studies at 4-year institutions have used information from the student's high-school background. With "open door" admissions at community colleges, this information is often not available. The combination of two sections of a criterion referenced test, the numerical section of a norm referenced test, with sex and age, were found as good indicators of successful or nonsuccessful achievement, with a 65.4% correct classification. The results of this investigation suggest that knowledge of a community-college student's demographic information with a norm and criterion referenced mathematics test can, to a limited extent, aid in predicting whether a student will or will not finish the first remedial mathematics course. The findings of this study should encourage further research into the characteristics relating to the successful and nonsuccessful course completion of the remedial community college mathematics student.

## Recommendations for Research

The results of this research study suggest that knowledge of a community-college student's results on a criterion and norm referenced test with demographics of gender and age can, to a limited extent, aid in predicting whether a student will successfully or nonsuccessfully complete a remedial basic mathematics class.

Nevertheless, data limitations identified earlier in this paper may have restricted the overall power of the community-college retention/nonretention prediction. Thirty-four students did not have the mathematics section of the ASSET test. Sixty-eight students did not take the Aiken-Dreger Mathematics Attitude Test during the winter semester (n = 186), which was the only semester this test was given.

Further, qualitative research may be needed to find important characteristics that have not been used in this research or other research studies. This will provide a more complete longitudinal picture of the at-risk student. Since the qualitative researcher does not start with specific hypotheses, he/she is less likely than the conventional researcher to overlook phenomena that do not fit the researcher's expectations. Hypotheses are grounded by observational data in the naturalistic setting.

Additional areas of recommended research are:

1. Application of this model to other community colleges

2. Application of this model to different subject areas within the community college (reading, English, nursing, elementary algebra, etc.)

3. Development of an intervention program for students who score in the nonsuccessful group

4. Investigation of different modes of teaching for the special learning styles of students younger and older students.

5. Investigation of the possible use of calculators to help at-risk students succeed in this remedial mathematics course

6. Investigation of the need for a day care center to help with children, since a majority of the students are older females

7. Determination of the number of students who receive financial aid but seldom attend class, in order to consider making attendance a prerequisite for such aid

8. Investigation of why students stop attending

9. Investigation of why more mathematics laboratory students did not continue into Intermediate Algebra

10. Investigation of what happened to the students after they leave the remedial program.

APPENDICES

# APPENDIX A

# CRITERION REFERENCED TEST

# CRITERION REFERENCED TEST

Used to test mathematics proficiency in the following areas:

1. Whole numbers (questions 1 - 8)
2. Fractions (questions 9 - 16)
3. Decimals (questions 17 - 24)
4. Ratios and Proportions (questions 25 - 32)
5. Percentages (questions 33 - 40)

# Criterion Referenced Test



Certain levels of mathematical proficiency are always helpful (often necessary) in various courses. This test will be used to assist in determining your current proficiency level. The results will be used to aid you in proper course selection and placement.

INSTRUCTIONS: Do not write on this test. Use the answer sheet provided.

Complete the information requested on the answer sheet.

When finished, return both answer sheet and test to the instructor for grading.

THIS IS NOT A TIMED TEST

1. What is another name for the number represented by 6000 + 400 + 7?

   a. 6047
   b. 6407
   c. 6470
   d. 60047

2. What is the numeral for sixty million?

   a. 60,000
   b. 600,000
   c. 6,000,000
   d. 60,000,000

3. Round 3948 to the nearest hundred.

   a. 3000
   b. 3900
   c. 3950
   d. 4000

4. Divide 748743 by 249.

   a. 37
   b. 307
   c. 3007
   d. None of these

5. Subtract 1388 from 3976.

   a. 2688
   b. 2612
   c. 2588
   d. 1588

6. $2^4$ is another name for:

   a. 8
   b. 12
   c. 16
   d. 32

7. Write 100,000 as a power of 10.

   a. $10^4$
   b. $10^5$
   c. $10^6$
   d. None of these

8. Which of the following numbers can be divided evenly by 3?

   a. 4333
   b. 6016
   c. 2370
   d. 6313

9. Add: $1\frac{2}{3} + 3\frac{3}{4}$ .
   a. $4\frac{5}{7}$
   b. $4\frac{5}{12}$
   c. $5\frac{5}{12}$
   d. None of these

10. What is the least common denominator for $\frac{1}{12}$ and $\frac{1}{8}$ ?
   a. 4
   b. 8
   c. 12
   d. 24

11. Which is the least of these fractional numbers?
   a. $\frac{1}{5}$
   b. $\frac{1}{4}$
   c. $\frac{3}{11}$
   d. $\frac{4}{17}$

12. Subtract $3\frac{5}{6}$ from 8.
   a. $4\frac{5}{6}$
   b. $5\frac{5}{6}$
   c. $5\frac{1}{6}$
   d. $4\frac{1}{6}$

13. Subtact $2\frac{3}{4}$ from $4\frac{2}{3}$ .
   a. $2\frac{1}{12}$
   b. $1\frac{11}{12}$
   c. $1\frac{3}{4}$
   d. None of these

14. $9 \div 12 =$
   a. $\frac{3}{4}$
   b. $1\frac{1}{3}$
   c. $\frac{2}{3}$
   d. None of these

15. $\frac{3}{4} \times 2\frac{1}{3} =$ _____.
   a. $\frac{1}{2}$
   b. $\frac{9}{28}$
   c. $2\frac{1}{4}$
   d. None of these

16. $1\frac{3}{4} \div 2\frac{1}{8} =$
   a. $\frac{14}{17}$
   b. $1\frac{1}{2}$
   c. $\frac{119}{32}$
   d. None of these

17. Which names the greatest number?

    a. $\frac{2}{3}$
    b. 0.231
    c. 0.668
    d. 0.6667

18. Round 3.0086 to the nearest hundredth.

    a. 3.009
    b. 3.01
    c. 3.10
    d. 3.010

19. Which of the following is six hundred-thousandths?

    a. 0.06
    b. 0.006
    c. 0.0006
    d. 0.00006

20. Add: 1.34 + 10.4

    a. .238
    b. 2.38
    c. 11.38
    d. 11.74

21. Subtract .08 from 12.8.

    a. 11.28
    b. 12.0
    c. 12.72
    d. None of these

22. Multiply: 3.2 x .008

    a. 0.0256
    b. 0.256
    c. 2.56
    d. 25.6

23. Divide .4 by .08.

    a. 5
    b. 2
    c. $\frac{1}{2}$
    d. None of these

24. Divide: $.63\overline{)21.42}$

    a. .34
    b. 3.4
    c. 34
    d. None of these

25. Which of the following is not a proportion?

a. 3:4 = 6:8

b. $\frac{5}{6} = \frac{1}{2} + \frac{1}{3}$

c. $\frac{3}{6} = \frac{1}{2}$

d. $\frac{1}{1.5} = \frac{2}{3}$

26. If a class has 10 girls and 15 boys, what is the ratio of boys to girls?

a. $\frac{2}{3}$

b. $\frac{3}{2}$

c. $\frac{3}{5}$

d. $\frac{2}{5}$

27. The ratio of $\frac{2}{3}$ to $\frac{1}{2}$ is equivalent to the ratio of ______.

a. 4 to 3
b. 1 to 3
c. 3 to 4
d. None of these

28. The ratio of 16 to 36 is equivalent to the ratio of ______.

a. 1 to 3
b. 4 to 9
c. 7 to 9
d. 36 to 16

29. The ratio of .02 to .4 is equivalent to the ratio of ______.

a. 1 to 20
b. 2 to 1
c. 1 to 2
d. None of these

30. The ratio of $2\frac{1}{2}$ to $3\frac{1}{2}$ is equivalent to the ratio of ____.

a. 2 to 3
b. 2 to 2
c. 5 to 7
d. 21 to 31

31. Solve the following proportion for x:

$\frac{3}{4} = \frac{7}{x}$

a. $x = 5\frac{1}{4}$

b. $x = 8$

c. $x = 9\frac{1}{3}$

d. None of these

32. Divide 12 inches into two parts which are in the ratio 3 to 2.

a. 7 inches and 5 inches
b. 8 inches and 4 inches
c. $7\frac{1}{5}$ inches and $4\frac{4}{5}$ inches
d. $8\frac{1}{3}$ inches and $3\frac{2}{3}$ inches

33. 20 is what percent of 400?

a. .5%
b. 5%
c. 20%
d. 50%

34. Write 0.027 as a percent.

a. 0.027%
b. 2.7%
c. 27%
d. 270%

35. To find $37\frac{1}{2}\%$ of a number, you multiply the number by ______.

a. $\frac{2}{75}$
b. $\frac{75}{2}$
c. $\frac{3}{8}$
d. $\frac{5}{6}$

36. $23\frac{1}{2}\%$ written as a decimal number is:

a. 0.235
b. 2.35
c. 23.5
d. 23.12

37. $\frac{1}{2}\%$ of 6 is ______.

a. 12
b. 3
c. .3
d. .03

38. $\frac{7}{8}$ written in percent notation is:

a. $67\frac{1}{2}\%$
b. 78%
c. $87\frac{1}{2}\%$
d. 92%

39. 2.4% of 12.5 is ______.

a. 30
b. 3
c. .3
d. .03

40. 250% of 80 is:

a. 20
b. 32
c. 200
d. 320

## APPENDIX B

## AIKEN-DREGER MATHEMATICS ATTITUDE TEST

APPENDIX C

BASIC MATHEMATICS PROGRAM OUTLINE

Basic Mathematics Program

NAME ____________________

INSTRUCTOR ______________

CLASS HOUR ______________

TIME CARD NUMBER ________

**LAKE MICHIGAN COLLEGE**
**COURSE HANDOUT**
BASIC MATHEMATICS PROGRAM

**REQUIRED TEXTBOOK AND MATERIALS**

1. BASIC COLLEGE MATHEMATICS a Text/Workbook, Third Edition, by Miller, Salzman, Lial
2. Headphones with 1/8" jack, 1/4" adapter (optional).
3. Pencils and Paper

**OTHER MATERIALS**

In the Math Center are video and audio tapes, and computer assisted instruction.

**ATTENDANCE POLICY**

You are expected to attend class at your scheduled time. If you need additional time, you may use the Math Center during any OPEN hour as long as seating is available, except for the first and last weeks of class when you may attend only at your scheduled class time.

**ALWAYS COME PREPARED WITH BOOK, HEADSET, PENCIL AND PAPER.**

HOW TO WORK IN THIS COURSE

You are to work through each chapter section by section in the following manner:

I. View the video lesson for each section and read the corresponding section in the text. PLEASE REWIND THE VIDEO TAPES.

II. Do the Required Exercises as assigned for each section in the following manner: (TO KEEP PACE, YOU SHOULD DO AT LEAST ONE SECTION PER CLASS HOUR.)

1. Include name, time card number, chapter and section number.
2. Number and write each problem; SHOW ALL YOUR WORK NEATLY.
3. Clearly show the final answer.
4. If you solve a problem more than once, cross out the work you do not want, leaving only the work you want considered.

A. If you don't understand the lesson or have problems with the Exercises, listen to the audio tape which accompanies the text.

B. For more practice, do the optional Exercises which correspond to the section you're having problems with.

C. If you still have problems, see your instructor.

III. When you have completed a section, have your Required Exercises graded. A score of 75% or better means you're ready to continue to the next section. When you have completed all of the required exercises for a chapter you are to hand them in before taking the Chapter Test. *There is a chapter test at the end of each chapter which you may want to use for practice.*

IV. Take the Chapter Test. You will get this test at the counter. This test must be taken in the Math Center. Follow the same procedure as listed under numeral II for Required Exercises. Be sure to allow enough time to complete the test in one sitting. An instructor will grade your test.

V. When you have completed all chapters, do the Final Examination located in the back of your text. Have this examination graded. A score of 75% or better is required before you can take the final exam for the course.

IV. Take your Final Exam. Follow the same procedure described in Numeral IV.

NOTE: Answers to all odd-numbered section exercises as well as answers to every chapter review and test problem are given at the back of the text. A separate section presents solutions to alternate odd-numbered section exercises, providing a source of extra worked-out examples.

TEST OUTLINE FOR COURSE

| | TEST NO. | TOPIC |
|---|---|---|
| | 1 | Whole Numbers |
| | 2 | Multiplication & Division of Fractions |
| | 3 | Addition and Subtraction of Fractions |
| | 4 | Decimals |
| | 5/7 | Ratio and Proportion plus Measurement |
| | 6 | Percent |
| Choose | 8 | Geometry |
| One | 9 | Algebra |
| | FINAL EXAM | Chapters 1 through 6 plus either 8 or 9 |

CHAPTER TESTS

I. Student must have 70% on Chapter Test to continue to next chapter.

II. If student scores < 70% on Chapter Test, additional attempts will be scored as follows:

A. On second attempt, 90% will be highest possible grade. (Instructor must sign time card after 2nd attempt.)
B. On third attempt, 80% will be highest possible grade.
C. On fourth attempt, 70% will be highest possible grade.

III. If Chapter Test passed with ≥ 70% on first attempt student may take test once again to raise grade before continuing to the next chapter. The highest grade possible on the second attempt is 90%.

FINAL EXAM

The Final Exam may be taken only once. However, you may choose to take it in 2 sections -- Part I (Chapters 1-4) then Part II (Chapters 5-7, and 8 or 9).

GRADING CRITERIA

70% of final grade will be based on Chapter Test scores.
30% of final grade will be based on Final Exam Score

90% - 100% = A
80% - 89% = B
70% - 79% = C
60% - 69% = D
Below 60%, student will receive "WP".
On written request, student may choose grade of "E".

## QUESTIONS YOU MAY HAVE

### WHAT IF I CAN'T KEEP UP WITH THE SCHEDULE?

Remember, not everyone is the same. Some students will need more time than others to complete their course work. Perhaps you're someone who needs to spend more time on math. Plan your schedule to allow for the extra time necessary.

You may be spending too much time on one section or chapter. If you don't understand the material after viewing the video and listening to the audio tape, go to your instructor for help. Don't let yourself get bogged down in one area.

### WHAT IF I'M AHEAD OF THE SCHEDULE?

Keep up the good work, but don't take a vacation. Some of the chapters may be more difficult for you than others and you'll welcome the extra time. Remember, the schedule is only a guide.

### WHEN SHOULD I TAKE MY FINAL EXAM?

You should take your exam as soon as you're ready for it, in other words, when you have completed all of the assigned chapters and work.

### WHAT IF I FINISH BEFORE THE END OF THE SEMESTER?

Congratulations! Take a vacation - you've earned it!

NOTES: ____________________________________________

**BASIC MATH - COURSE 090**
**BASIC COLLEGE MATHEMATICS, THIRD EDITION, by MILLER/SALZMAN/LIAL**

| SECTION | REQUIRED READING | REQUIRED EXERCISES | OPTIONAL If more practice is needed: |
|---|---|---|---|
| 1.1 | pp. 1-3 | pp. 5-6; #2-20, even # (2,4,..) | pg. 83; #1-10 |
| 1.2 | pp. 7-9 | pp. 13-15; #4-68, every 4th (4,8,..) and #76, 78, 80 | pg. 83; #11-17 |
| 1.3 | pp. 17-22 | pp. 23-25; #4-104, every 4th (4,8,..) | pg. 84; #18-25 |
| 1.4 | pp. 27-31 | pp. 33-36; #4-108, every 4th | pg. 84; #26-53<br>pg. 85, #54-71 |
| 1.5 | pp. 37-43 | pp. 45-48; #4-96, every 4th | pg. 85; #72-81 |
| 1.6 | pp. 49-51 | pp. 53-54; #2-44, even # | pg. 86; #82-88 |
| 1.7 | pp. 55-59 | pp. 61-63; #2-36, even # | pg. 86; #89-96 |
| 1.8 | pp. 65-66 | pp. 67-70; #2-44, 78-90, even # | pp. 86-87; #97-110 |

*__SPECIAL EXCEPTION FOR CHAPTER 1 ONLY__: Your instructor may waive the above problems __IF__ you can do the problems on pp. 91-92 correctly. You must show __ALL__ your work. Papers with no work shown will not be graded.*

| | | | |
|---|---|---|---|
| | CHAPTER 1 TEST | | CHAPTER REVIEW<br>pp. 91-92; #1-25 |
| 2.1 | pp. 93-95 | pp. 97-98; #2-20, even # | pg. 155; #1-5 |
| 2.2 | pp. 99-100 | pp. 101-102; #2-60, even # | pg. 155; #6-9 |
| 2.3 | pp. 103-107 | pp. 109-112; #2-64, even # | pg. 155; #10-20 |
| 2.4 | pp. 113-116 | pp. 117-118; #2-44, even # | pg. 156; #21-27 |
| 2.5 | pp. 119-124 | pp. 125-126; #2-36, even # | pg. 156; #28-33 |
| 2.7 | pp. 137-139 | pp. 141-142; #2-22, even # | pp. 156; #34-42 |
| 2.8 | pp. 145-147 | pp. 149-151; #2-26, even # | pg. 157-160; #47-54, 56, 77, 78<br>CHAPTER REVIEW<br>pp. 161-162; #1-15, 18-24 |
| | CHAPTER 2 TEST | | |

| | REQUIRED | REQUIRED | OPTIONAL |
|---|---|---|---|
| SECTION | READING | EXERCISES | If more practice is needed: |
| 3.1 | pp. 163-166 | pp. 167-168; #2-38, even # | pg. 207; #1-10 |
| 3.2 | pp. 169-174 | pp. 175-177; #2-46, even # | pg. 207; #11-22 |
| 3.3 | pp. 179-181 | pp. 183-185; #2-40, even # | pg. 207-208; #23-36 |
| 3.4 | pp. 187-189 | pp. 191-194; #2-42, even # | pp. 208-209; #37-48 |
| 3.5 | pp. 197-200 | pp. 201-204; #2-60, even # | pg. 209; #49-93<br>CHAPTER REVIEW<br>pp. 211-212; #1-25 |
| | CHAPTER 3 TEST | | |
| 4.1 | pp. 217-222 | pp. 223-225; #2-50, even # | pg. 277; #1-16 |
| 4.2 | pp. 227-230 | pp. 231-232; #2-32, even # | pg. 277-278; #17-27 |
| 4.3 | pp. 233-234 | pp. 235-237; #2-30, even # | pg. 278; #28-33 |
| 4.4 | pp. 239-240 | pp. 241-242; #2-42, even # | pg. 278-279; #34-41 |
| 4.5 | pp. 245-246 | pp. 247-251; #2-56, even # | pg. 279; #42-49 |
| 4.6 | pp. 253-256 | pp. 257-261; #2-64, even # | pg. 280; #50-57 |
| 4.7 | pp. 263-265 | pp. 267-274; #4-92, every 4th (4,8,..) | pg. 281; #58-88<br>CHAPTER REVIEW<br>pp. 283-284; #1-22 |
| | CHAPTER 4 TEST | | |
| 7.1 | pp. 417-421 | pp. 423-425; #2-42, even # | pg. 463; #1-13 |
| 7.2 | pp. 427-431 | pp. 433-435; #2-26, even # | pg. 463; #14-16 |
| 5.1 | pp. 285-290 | pg. 291-292; #2-26, even # | pp. 327; #1-20 |
| 5.2 | pp. 295-297 | pp. 299-301; #2-30, even # | pg. 328; #21-24 |
| 5.3 | pp. 303-304 | pp. 305-307; #2-30, even # | pg. 328-329; #25-36 |
| 5.4 | pp. 309-313 | pp. 315-318; #2-30, 38-40, even # | pg. 329; #37-44,<br>CHAPTER REVIEW<br>pp. 333-334; #1-12, 14-16<br>pg. 467; #1-5, 7 |
| | CHAPTER 5/7 TEST | | |

| SECTION | REQUIRED READING | REQUIRED EXERCISES | OPTIONAL If more practice is needed: |
|---|---|---|---|
| 6.1 | pp. 335-337 | pp. 339-341; #2-46, even # | pg. 403; #1-8 |
| 6.2 | pp. 343-348 | pp. 349-352; #4-76, every 4th (4, 8,..) | pg. 403; #9-22 |
| 6.4 | pp. 357-358 | pg. 359-360; #2-12, even # | pg. 403-404; #25-30 |
| 6.5 | pp. 363-368 | pp. 369-372; #2-44, even # | pg. 404-405; #31-44 |
| 6.6 | pp. 375-378 | pp. 379-381; #2-40, even # | pg. 405; #45-50 |
| 6.7 | pp. 383-386 | pp. 387-391; #2-44, even # | pp. 405-406; #51-56 |
| 6.8 | pp. 393-394 | pp. 395-397; #2-42, even # | pg. 406; #57-62, 87-88<br>CHAPTER REVIEW<br>pp. 409-410; #1-8, 11-26 |
| | CHAPTER 6 TEST | | |
| GEOMETRY OPTION | | | |
| 8.3 | pp. 481-485 | pp. 487; #1-12 | pg. 544; #17-23 |
| 8.4 | pp. 489-492 | pg. 493; #1-12 | pg. 545; #24-26 |
| 8.5 | pp. 495-497 | pg. 499; #1-6 | pg. 545; #27-31 |
| 8.6 | pp. 501-505 | pg. 507; #1-14 | pg. 545; #32-36<br>CHAPTER REVIEW<br>pp. 551-552; # 9-17 and 19 |
| | CHAPTER 8 TEST | | |
| ALGEBRA OPTION | | | |
| 9.1 | pp. 553-556 | pp. 557-560; #4-80, every 4th (4, 8,..) | pg. 621; #1-12 |
| 9.2 | pp. 561-567 | pp. 569-572; #2-76, even # | pg. 621; #13-23 |
| 9.3 | pp. 573-574 | pp. 575-577; #4-76, every 4th | pg. 622; #24-42 |
| 9.4 | pp. 579-581 | pp. 583-586; #4-64, every 4th | pg. 622-623; #43-54 |
| 9.5 | pp. 587-588 | pp. 589-591; #2-32, even # | pg. 623; #55-61 |

Continued on next page.

ALGEBRA OPTION (cont.)

| SECTION | REQUIRED READING | REQUIRED EXERCISES | OPTIONAL If more practice is needed: |
|---|---|---|---|
| 9.6 | pp. 593-596 | pp. 597-600; #2-70, even # | pg. 624; #62-84 |
| 9.7 | pp. 601-603 | pp. 605-607; #2-42, even # | pg. 625-626; #93-102 |
| | | | CHAPTER REVIEW pp. 627-628; #1-23 |
| | CHAPTER 9 TEST | | |

REQUIRED PRACTICE FINAL EXAM pp. 721-723; #1-32

Geometry Option pg. 723; #35-38

Algebra Option pg. 724; #41-45

FINAL EXAM may be taken in 2 sections: Part I (Chapters 1-4)
Part II (Chapters 5-7, 8 or 9)

A reminder: The exam may be taken only once.

RECORD OF TESTS

You may wish to keep a record of your chapter test scores as you procede through the course. Be sure to record only the chapter test grade that will count. *Remember, anything less than 70% should not be recorded.*

Chapter 1 ______

Chapter 2 ______

Chapter 3 ______

Chapter 4 ______

Chapter 5 ______

Chapter 6 ______

Chapter 8 ______
- or -
Chapter 9 ______

TOTAL ______
(A)

EXAM SCORE ______ x 3 = ______
(B)

$\frac{(A) + (B)}{10}$ = Your Average for the Course

## BASIC MATH 090

### Goals and Objectives

Upon course completion, students should be able to:

A. Perform computations with whole numbers.

1. Read and write whole numbers.
2. Add whole numbers.
3. Subtract whole numbers.
4. Multiply whole numbers.
5. Divide whole numbers.
6. Perform long division.
7. Solve word problems with addition, subtraction, multiplication, or division.
8. Round numbers.
9. Find perfect square roots of numbers.
10. Simplify expressions with exponents.
11. Use the order of operations with whole numbers.

B. Perform multiplication and division with fractions.

1. Identify numerators, denominators, proper and improper fractions.
2. Identify and write mixed numbers and improper fractions.
3. Find prime factors of numbers.
4. Write fractions in lowest terms.
5. Multiply and divide fractions.
6. Multiply and divide mixed numbers.
7. Solve word problems with mixed numbers.

C. Perform addition and subtraction with fractions.

1. Add and subtract like and unlike fractions.
2. Find the least common multiple.
3. Add and subtract mixed numbers.
4. Subtract with borrowing.
5. Identify the larger of two fractions.
6. Use exponents with fractions.
7. Use order of operations with fractions.

D. Perform operations with decimals.

1. Write and read decimals.
2. Change decimals to fractions.
3. Round decimals to any given place.
4. Add, subtract and multiply decimals.
5. Divide a decimal by a whole number or by a decimal.
6. Use the order of operations with decimals.
7. Change fractions to decimals.
8. Compare the size of fractions and decimals.

E. Perform operations with measurements.

1. Know the basic units in the English system.
2. Convert among units.
3. Simplify denominate numbers.

4. Add, subtract, multiply and divide denominate numbers.
5. Write ratios as fractions.
6. Solve ratio problems involving mixed numbers.
7. Solve ratio problems after converting units.
8. Find ratios.
9. Write proportions.
10. Decide if proportions are true.
11. Find diagonal products.
12. Find missing numbers in proportions.

F. Perform operations with percents.

1. Write percents as decimals.
2. Write decimals as percents.
3. Write percents as fractions.
4. Write fractions as percents.
5. Identify the parts in a percent problem: percent, base, and amount.
6. Use proportions to solve percent problems.
7. Use the percent equation to solve for amount, base, or percent.
8. Solve applications of percent: sales tax, commissions, discounts.
9. Find the simple interest on a loan.
10. Find the total amount due on a loan.

G. Geometry Option.

1. Find the perimeter and area of rectangles.
2. Find the perimeter and area of squares.
3. Find the perimeter and area of parallelograms.
4. Find the perimeter and area of trapezoids.
5. Find the perimeter and area of triangles.
6. Identify the parts of a circle.
7. Find the circumference and area of a circle.

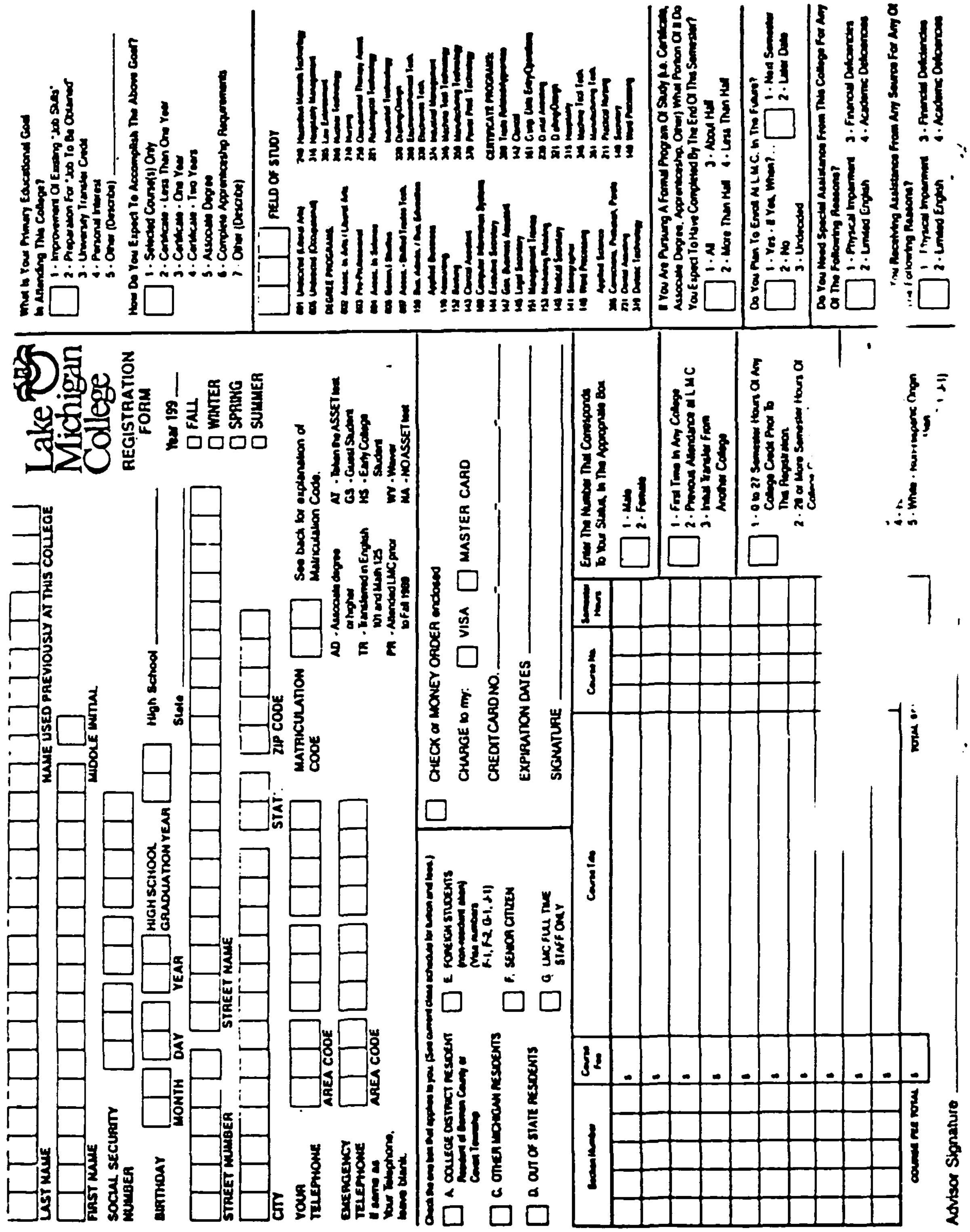
H. Algebra Option.

1. Write negative numbers.
2. Draw number lines.
3. Graph numbers.
4. Tell which of two numbers is smaller.
5. Find absolute value.
6. Find the opposite of a number.
7. Add signed numbers with and without a number line.
8. Subtract signed numbers.
9. Add or subtract a series of numbers.
10. Multiply or divide two signed numbers.
11. Use the order of operations with exponents.
12. Find the value of an expression when values of the variable are given.
13. Solve equations with the addition property of equality.
14. Solve equations by multiplying or dividing each side by the same number.
15. Solve equations with several steps.
16. Use the distributive property to combine terms.
17. Combine like terms.

Appendix D

LAKE MICHIGAN COLLEGE REGISTRATION FORM

Lake Michigan College Registration Form



# APPENDIX E

## BASIC MATHEMATICS RESEARCH DATA

# BASIC MATHEMATICS RESEARCH DATA

Data variables are as following:

1. V1 is the age of the student;
2. V3 is the gender of the student (Female = 1, Male = 2);
3. V4 is the race of the student (Minority = 1, Nonminority = 2);
4. V5 is whether the student plans to transfer after completion (Transfer = 1, Nontransfer = 2);
5. V8 is the ASSET Test score for Numeric Skills;
6. V10 is the score in the Whole Numbers section of Criterion Referenced Test;
7. V11 is the score in the Fraction section of the Criterion Referenced Test;
8. V12 is the score in the Decimal section of the Criterion Referenced Test;
9. V13 is the score in the Ratios and Proportions section of the Criterion Referenced Test;
10. V14 is the score in the Percentage section of the Criterion Referenced Test;
11. V15 is the percentage of student attendance until completion;
12. V16 is the student's grade for the Basic Mathematics course;
13. V23 is the student's score on the Aiken-Dreger Mathematics Attitude Test.

# Basic Mathematics Data

| Case# | V1 | V3 | V4 | V5 | V8 | V10 | V11 | V12 | V13 | V14 | V15 | V16 | V23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 26 | 1 | 1 | 2 | 39 | 7 | 3 | 6 | 2 | 4 | 59 | A | . |
| 2 | 20 | 1 | 2 | 2 | 40 | 4 | 4 | 6 | 4 | 5 | 23 | C | . |
| 3 | 31 | 1 | 2 | 2 | 28 | 7 | 0 | 0 | 0 | 0 | 97 | A | . |
| 4 | 19 | 2 | 2 | 1 | . | 7 | 2 | 4 | 6 | 3 | 66 | D | . |
| 5 | 21 | 1 | 2 | 2 | 36 | 6 | 0 | 1 | 2 | 1 | 33 | W | . |
| 6 | 21 | 1 | 2 | 2 | 34 | 5 | 1 | 2 | 8 | 2 | 50 | W | . |
| 7 | 21 | 2 | 2 | 2 | 34 | 6 | 3 | 6 | 4 | 2 | 7 | W | . |
| 8 | 23 | 1 | 2 | 2 | 40 | 5 | 4 | 6 | 4 | 4 | 14 | W | . |
| 9 | 19 | 1 | 1 | 2 | 31 | 3 | 1 | 3 | 2 | 3 | 53 | W | . |
| 10 | 19 | 2 | 2 | 2 | 33 | 5 | 3 | 3 | 2 | 2 | 33 | W | . |
| 11 | 19 | 2 | 2 | 1 | 28 | 7 | 2 | 5 | 2 | 4 | 20 | W | . |
| 12 | 42 | 1 | 1 | 1 | . | 2 | 2 | 2 | 4 | 1 | 57 | C | . |
| 13 | 37 | 1 | 2 | 2 | 39 | 5 | 2 | 2 | 1 | 1 | 20 | W | . |
| 14 | 50 | 1 | 2 | 2 | 37 | 6 | 2 | 4 | 4 | 2 | 87 | B | . |
| 15 | 20 | 2 | 1 | 1 | 38 | 8 | 4 | 8 | 2 | 1 | 12 | W | . |
| 16 | 31 | 2 | 2 | 2 | 40 | 7 | 1 | 6 | 0 | 0 | 41 | A | . |
| 17 | 28 | 1 | 1 | 2 | 34 | 5 | 1 | 3 | 2 | 4 | 99 | A | . |
| 18 | 29 | 2 | 2 | 2 | 35 | 6 | 0 | 4 | 4 | 2 | 10 | W | . |
| 19 | 42 | 2 | 1 | 2 | 33 | 4 | 1 | 2 | 4 | 0 | 99 | W | . |
| 20 | 24 | 1 | 2 | 2 | 41 | 7 | 4 | 5 | 0 | 0 | 62 | A | . |
| 21 | 19 | 1 | 1 | 1 | 33 | 5 | 2 | 4 | 3 | 5 | 51 | W | . |
| 22 | 23 | 1 | 2 | 2 | 43 | 7 | 2 | 3 | 0 | 1 | 7 | W | . |
| 23 | 40 | 1 | 2 | 2 | 32 | 4 | 2 | 2 | 2 | 0 | 92 | A | . |
| 24 | 27 | 1 | 2 | 2 | 44 | 6 | 4 | 7 | 3 | 0 | 20 | W | . |
| 25 | 24 | 1 | 2 | 2 | 34 | 4 | 1 | 3 | 3 | 2 | 27 | W | . |
| 26 | 49 | 1 | 2 | 2 | 30 | 2 | 2 | 1 | 1 | 4 | 20 | W | . |
| 27 | 29 | 2 | 2 | 2 | 41 | 5 | 4 | 4 | 2 | 0 | 43 | B | . |
| 28 | 20 | 2 | 2 | 1 | 37 | 4 | 1 | 3 | 2 | 3 | 76 | B | . |
| 29 | 40 | 1 | 2 | 2 | 38 | 5 | 1 | 3 | 2 | 3 | 30 | W | . |
| 30 | 34 | 1 | 1 | 2 | 32 | 5 | 0 | 2 | 2 | 5 | 20 | W | . |
| 31 | 25 | 1 | 1 | 2 | 33 | 4 | 0 | 4 | 2 | 1 | 50 | C | . |
| 32 | 45 | 1 | 2 | 2 | 35 | 2 | 3 | 3 | 7 | 8 | 67 | C | . |
| 33 | 26 | 2 | 2 | 2 | 31 | 4 | 1 | 6 | 3 | 3 | 40 | W | . |
| 34 | 19 | 1 | 2 | 1 | 33 | 6 | 2 | 6 | 3 | 5 | 40 | W | . |
| 35 | 24 | 1 | 1 | 2 | 41 | 3 | 7 | 5 | 3 | 1 | 86 | B | . |
| 36 | 22 | 1 | 2 | 1 | 36 | 4 | 3 | 3 | 4 | 4 | 3 | W | . |
| 37 | 27 | 2 | 2 | 2 | 35 | 6 | 4 | 6 | 4 | 2 | 43 | B | . |
| 38 | 21 | 2 | 2 | 1 | 37 | 6 | 2 | 2 | 2 | 3 | 50 | B | . |
| 39 | 25 | 1 | 2 | 2 | . | 4 | 0 | 2 | 2 | 4 | 13 | W | . |
| 40 | 41 | 1 | 1 | 2 | 30 | 5 | 5 | 4 | 1 | 2 | 57 | W | . |
| 41 | 36 | 1 | 2 | 2 | 38 | 6 | 5 | 5 | 4 | 1 | 17 | W | . |
| 42 | 26 | 1 | 2 | 2 | 31 | 4 | 4 | 5 | 4 | 1 | 23 | W | . |
| 43 | 30 | 1 | 2 | 2 | 37 | 4 | 2 | 4 | 1 | 3 | 99 | B | . |
| 44 | 23 | 1 | 1 | 2 | 34 | 7 | 1 | 3 | 0 | 3 | 20 | W | . |
| 45 | 19 | 1 | 2 | 2 | 37 | 4 | 4 | 6 | 1 | 1 | 13 | B | . |
| 46 | 20 | 1 | 1 | 2 | 32 | 4 | 1 | 1 | 1 | 0 | 31 | W | . |
| 47 | 19 | 1 | 2 | 2 | 31 | 5 | 1 | 2 | 1 | 2 | 50 | W | . |

| Case# | V1 | V3 | V4 | V5 | V8 | V10 | V11 | V12 | V13 | V14 | V15 | V16 | V23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48 | 19 | 1 | 2 | 1 | 36 | 5 | 1 | 7 | 3 | 4 | 40 | D | . |
| 49 | 19 | 1 | 2 | 1 | 37 | 8 | 1 | 6 | 2 | 2 | 40 | W | . |
| 50 | 23 | 2 | 1 | 2 | 31 | 5 | 0 | 4 | 0 | 1 | 65 | W | . |
| 51 | 24 | 1 | 1 | 2 | 35 | 6 | 4 | 3 | 1 | 3 | 99 | B | . |
| 52 | 43 | 2 | 2 | 2 | 36 | 5 | 2 | 5 | 2 | 0 | 80 | B | . |
| 53 | 46 | 1 | 2 | 2 | 29 | 6 | 4 | 1 | 0 | 0 | 99 | B | . |
| 54 | 23 | 2 | 2 | 2 | 33 | 4 | 3 | 4 | 2 | 2 | 43 | W | . |
| 55 | 21 | 2 | 2 | 2 | 37 | 4 | 0 | 5 | 3 | 4 | 43 | W | . |
| 56 | 45 | 1 | 2 | 2 | 35 | 6 | 4 | 4 | 3 | 3 | 94 | B | . |
| 57 | 19 | 2 | 2 | 1 | 35 | 6 | 2 | 3 | 2 | 4 | 20 | W | . |
| 58 | 53 | 1 | 1 | 1 | 32 | 5 | 0 | 4 | 1 | 2 | 67 | W | . |
| 59 | 19 | 1 | 2 | 2 | 32 | 6 | 0 | 4 | 1 | 1 | 22 | W | . |
| 60 | 30 | 1 | 1 | 1 | 33 | 2 | 1 | 1 | 1 | 2 | 54 | W | . |
| 61 | 21 | 1 | 2 | 2 | 40 | 6 | 3 | 6 | 4 | 2 | 3 | W | . |
| 62 | 30 | 2 | 2 | 2 | . | 2 | 1 | 1 | 2 | 0 | 54 | W | . |
| 63 | 36 | 1 | 2 | 2 | . | 6 | 4 | 6 | 2 | 2 | 95 | W | . |
| 64 | 29 | 1 | 1 | 2 | 31 | 6 | 1 | 2 | 0 | 2 | 53 | W | . |
| 65 | 25 | 1 | 2 | 1 | 38 | 4 | 1 | 5 | 1 | 3 | 66 | W | . |
| 66 | 20 | 2 | 2 | 2 | . | 4 | 1 | 2 | 2 | 2 | 72 | C | . |
| 67 | 20 | 1 | 2 | 1 | 43 | 6 | 4 | 6 | 5 | 4 | 99 | A | . |
| 68 | 45 | 1 | 2 | 2 | 35 | 5 | 2 | 3 | 5 | 3 | 87 | B | . |
| 69 | 31 | 2 | 1 | 2 | 32 | 5 | 1 | 0 | 0 | 1 | 73 | W | . |
| 70 | 26 | 1 | 2 | 2 | 36 | 4 | 1 | 2 | 3 | 0 | 72 | B | . |
| 71 | 23 | 1 | 2 | 2 | 35 | 5 | 1 | 6 | 2 | 0 | 60 | W | . |
| 72 | 31 | 1 | 2 | 2 | 32 | 7 | 2 | 4 | 4 | 0 | 50 | A | . |
| 73 | 32 | 1 | 1 | 2 | 30 | 8 | 2 | 5 | 3 | 2 | 99 | C | . |
| 74 | 35 | 1 | 2 | 2 | 37 | 8 | 1 | 5 | 8 | 2 | 99 | A | . |
| 75 | 22 | 1 | 1 | 1 | 36 | 6 | 2 | 3 | 1 | 5 | 49 | A | . |
| 76 | 25 | 1 | 1 | 2 | 34 | 4 | 2 | 1 | 0 | 2 | 60 | W | . |
| 77 | 21 | 1 | 2 | 1 | 33 | 6 | 1 | 6 | 4 | 1 | 99 | B | . |
| 78 | 24 | 1 | 2 | 2 | 38 | 7 | 7 | 2 | 1 | 4 | 85 | B | . |
| 79 | 22 | 2 | 2 | 2 | 24 | 7 | 5 | 7 | 2 | 6 | 0 | W | . |
| 80 | 38 | 1 | 2 | . | . | 7 | 3 | 3 | 2 | 2 | 49 | B | . |
| 81 | 19 | 1 | 2 | 2 | 38 | 5 | 2 | 3 | 4 | 1 | 27 | W | . |
| 82 | 29 | 2 | 1 | 2 | 32 | 1 | 1 | 3 | 1 | 3 | 27 | W | . |
| 83 | 23 | 1 | 1 | 1 | . | 7 | 2 | 5 | 5 | 4 | 99 | A | . |
| 84 | 20 | 2 | 1 | 2 | 36 | 6 | 3 | 6 | 2 | 3 | 41 | C | . |
| 85 | 27 | 1 | 2 | 1 | . | 7 | 1 | 5 | 3 | 2 | 65 | B | . |
| 86 | 37 | 2 | 1 | 2 | 36 | 5 | 3 | 4 | 4 | 4 | 72 | W | . |
| 87 | 24 | 1 | 2 | 1 | 36 | 3 | 0 | 2 | 2 | 4 | 35 | W | . |
| 88 | 19 | 1 | 2 | 2 | 44 | 7 | 5 | 7 | 4 | 1 | 99 | A | . |
| 89 | 36 | 1 | 2 | 2 | . | 7 | 1 | 7 | 3 | 2 | 57 | B | . |
| 90 | 22 | 1 | 1 | 1 | 35 | 7 | 1 | 5 | 2 | 2 | 3 | W | . |
| 91 | 31 | 1 | 2 | 2 | 38 | 6 | 4 | 5 | 2 | 3 | 99 | B | . |
| 92 | 20 | 1 | 2 | 2 | . | 7 | 1 | 3 | 3 | 3 | 76 | A | . |
| 93 | 31 | 1 | 1 | 2 | 34 | 2 | 3 | 1 | 5 | 2 | 27 | W | . |
| 94 | 19 | 1 | 2 | 1 | 38 | 6 | 4 | 4 | 4 | 2 | 99 | B | . |

| Case# | V1 | V3 | V4 | V5 | V8 | V10 | V11 | V12 | V13 | V14 | V15 V16 | V23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95 | 44 | 1 | 2 | 2 | 35 | 5 | 1 | 3 | 3 | 1 | 93 A | . |
| 96 | 37 | 2 | 2 | 1 | . | 5 | 0 | 1 | 2 | 2 | 23 W | . |
| 97 | 20 | 1 | 2 | 2 | 37 | 8 | 4 | 7 | 4 | 2 | 33 W | . |
| 98 | 46 | 1 | 2 | 2 | 30 | 6 | 2 | 1 | 2 | 3 | 50 W | . |
| 99 | 20 | 2 | 2 | 2 | 37 | 7 | 2 | 3 | 3 | 1 | 49 W | . |
| 100 | 29 | 1 | 2 | 2 | 25 | 7 | 1 | 4 | 2 | 3 | 17 W | . |
| 101 | 32 | 1 | 2 | 2 | 32 | 4 | 3 | 3 | 3 | 0 | 33 W | . |
| 102 | 22 | 2 | 2 | 1 | 45 | 6 | 3 | 5 | 6 | 5 | 33 A | . |
| 103 | 20 | 1 | 2 | 1 | 37 | 8 | 0 | 4 | 4 | 3 | 24 A | . |
| 104 | 19 | 1 | 2 | 1 | 38 | 5 | 2 | 3 | 2 | 2 | 23 B | . |
| 105 | 23 | 1 | 1 | 2 | 36 | 2 | 1 | 3 | 1 | 2 | 87 B | . |
| 106 | 32 | 1 | 1 | 2 | 28 | 3 | 1 | 3 | 3 | 0 | 50 C | . |
| 107 | 38 | 2 | 1 | 1 | 29 | 4 | 3 | 4 | 2 | 0 | 99 B | . |
| 108 | 22 | 1 | 2 | 2 | 44 | 7 | 3 | 7 | 4 | 1 | 99 A | . |
| 109 | 33 | 2 | 2 | 2 | 41 | 5 | 6 | 2 | 2 | 2 | 71 A | . |
| 110 | 40 | 1 | 2 | 2 | 35 | 8 | 0 | 5 | 3 | 1 | 52 B | . |
| 111 | 25 | 2 | 2 | 2 | 39 | 7 | 1 | 5 | 2 | 2 | 50 A | . |
| 112 | 32 | 1 | 1 | 2 | 30 | 6 | 2 | 3 | 1 | 1 | 50 B | . |
| 113 | 24 | 2 | 1 | 2 | 37 | 6 | 3 | 4 | 3 | 5 | 35 B | . |
| 114 | 20 | 1 | 1 | 1 | 31 | 7 | 2 | 4 | 0 | 0 | 68 W | . |
| 115 | 26 | 2 | 2 | 2 | 36 | 7 | 3 | 7 | 3 | 2 | 93 A | . |
| 116 | 32 | 1 | 2 | 2 | 34 | 7 | 3 | 4 | 0 | 0 | 99 A | . |
| 117 | 24 | 1 | 2 | 2 | 50 | 3 | 1 | 3 | 0 | 0 | 95 B | . |
| 118 | 34 | 2 | 2 | 2 | 43 | 5 | 6 | 6 | 3 | 2 | 50 A | . |
| 119 | 20 | 2 | 2 | 1 | 39 | 2 | 0 | 2 | 3 | 3 | 12 W | . |
| 120 | 21 | 2 | 2 | 1 | 41 | 6 | 5 | 5 | 2 | 3 | 2 W | . |
| 121 | 22 | 2 | 2 | 1 | 36 | 7 | 3 | 4 | 2 | 3 | 7 W | . |
| 122 | 35 | 2 | 2 | 2 | . | 3 | 3 | 3 | 1 | 2 | 98 A | . |
| 123 | 21 | 1 | 1 | 1 | 30 | 5 | 2 | 4 | 4 | 2 | 25 W | . |
| 124 | 21 | 1 | 2 | 1 | 33 | 8 | 5 | 5 | 5 | 3 | 33 W | . |
| 125 | 49 | 1 | 2 | 2 | . | 3 | 3 | 2 | 1 | 0 | 95 B | . |
| 126 | 21 | 1 | 2 | 2 | 38 | 7 | 5 | 5 | 3 | 2 | 45 B | . |
| 127 | 19 | 1 | 2 | 2 | 36 | 8 | 3 | 7 | 3 | 2 | 99 A | . |
| 128 | 19 | 1 | 2 | 1 | 42 | 7 | 3 | 7 | 4 | 4 | 36 A | . |
| 129 | 23 | 2 | 2 | 2 | 35 | 4 | 3 | 5 | 1 | 1 | 39 C | . |
| 130 | 24 | 2 | 2 | 1 | 36 | 7 | 1 | 5 | 1 | 0 | 40 W | . |
| 131 | 46 | 1 | 2 | 2 | . | 7 | 6 | 5 | 3 | 4 | 60 A | . |
| 132 | 18 | 2 | 1 | 2 | 32 | 7 | 2 | 4 | 2 | 1 | 99 B | . |
| 133 | 19 | 1 | 2 | 2 | 31 | 7 | 1 | 3 | 1 | 0 | 0 W | . |
| 134 | 56 | 1 | 1 | 2 | 30 | 1 | 3 | 2 | 3 | 2 | 55 W | . |
| 135 | 24 | 1 | 2 | 3 | 25 | 2 | 0 | 2 | 0 | 3 | 0 W | . |
| 136 | 24 | 1 | 1 | 2 | 32 | 2 | 0 | 1 | 1 | 2 | 67 W | . |
| 137 | 19 | 1 | 1 | 1 | 35 | 7 | 1 | 6 | 3 | 0 | 14 W | . |
| 138 | 38 | 2 | 2 | 2 | . | 4 | 3 | 2 | 2 | 4 | 49 W | . |
| 139 | 19 | 2 | 2 | 1 | . | 7 | 3 | 5 | 3 | 1 | 50 W | . |
| 140 | 33 | 1 | 2 | 2 | 30 | 6 | 2 | 2 | 3 | 0 | 2 W | . |
| 141 | 20 | 2 | 2 | 2 | 37 | 7 | 1 | 6 | 5 | 3 | 99 C | . |

| Case# | V1 | V3 | V4 | V5 | V8 | V10 | V11 | V12 | V13 | V14 | V15 | V16 | V23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 142 | 13 | 2 | 2 | 2 | 36 | 6 | 2 | 5 | 2 | 2 | 32 | B | . |
| 143 | 19 | 1 | 2 | 2 | 37 | 5 | 2 | 3 | 2 | 3 | 60 | W | . |
| 144 | 19 | 2 | 2 | 1 | 34 | 7 | 2 | 6 | 3 | 3 | 36 | W | . |
| 145 | 20 | 1 | 2 | 2 | 33 | 7 | 3 | 5 | 3 | 3 | 50 | W | . |
| 146 | 20 | 1 | 1 | 2 | 39 | 5 | 2 | 4 | 4 | 2 | 2 | W | . |
| 147 | 39 | 2 | 2 | 2 | 39 | 6 | 0 | 2 | 4 | 2 | 70 | B | . |
| 148 | 20 | 1 | 1 | 2 | . | 7 | 3 | 5 | 2 | 0 | 33 | W | . |
| 149 | 20 | 2 | 2 | 2 | . | 7 | 3 | 6 | 5 | 4 | 35 | A | . |
| 150 | 19 | 1 | 2 | 2 | 38 | 6 | 0 | 4 | 1 | 3 | 50 | B | . |
| 151 | 32 | 1 | 1 | 2 | 41 | 5 | 1 | 3 | 1 | 1 | 50 | W | . |
| 152 | 19 | 1 | 2 | 1 | 32 | 6 | 0 | 3 | 2 | 1 | 42 | C | . |
| 153 | 28 | 2 | 2 | 2 | 33 | 5 | 2 | 3 | 3 | 2 | 99 | B | . |
| 154 | 19 | 2 | 2 | 1 | 34 | 6 | 1 | 4 | 3 | 3 | 99 | A | . |
| 155 | 27 | 1 | 2 | 2 | 33 | 8 | 4 | 2 | 2 | 0 | 99 | A | . |
| 156 | 23 | 1 | 2 | 2 | 37 | 7 | 5 | 6 | 3 | 4 | 50 | A | . |
| 157 | 21 | 2 | 2 | 1 | 38 | 6 | 3 | 4 | 2 | 2 | 33 | A | . |
| 158 | 20 | 2 | 2 | 1 | 37 | 5 | 3 | 4 | 1 | 1 | 67 | A | . |
| 159 | 23 | 1 | 2 | 2 | 42 | 5 | 0 | 7 | 2 | 3 | 35 | A | . |
| 160 | 32 | 1 | 1 | 2 | 31 | 3 | 0 | 3 | 0 | 0 | 15 | W | . |
| 161 | 35 | 1 | 2 | 2 | 39 | 7 | 7 | 5 | 1 | 2 | 92 | A | . |
| 162 | 21 | 1 | 1 | 2 | 34 | 4 | 2 | 2 | 2 | 0 | 3 | W | . |
| 163 | 36 | 1 | 2 | 2 | 31 | 3 | 1 | 3 | 1 | 1 | 23 | W | . |
| 164 | 19 | 1 | 2 | 2 | 42 | 5 | 3 | 6 | 5 | 4 | 50 | A | . |
| 165 | 22 | 1 | 2 | 1 | 42 | 8 | 3 | 6 | 4 | 1 | 30 | A | . |
| 166 | 21 | 1 | 2 | 2 | 37 | 6 | 3 | 1 | 5 | 1 | 99 | A | . |
| 167 | 22 | 1 | 1 | 2 | 32 | 5 | 1 | 3 | 1 | 2 | 80 | W | . |
| 168 | 22 | 2 | 2 | 2 | 37 | 6 | 5 | 3 | 1 | 2 | 70 | A | . |
| 169 | 37 | 1 | 1 | 2 | 32 | 6 | 1 | 2 | 3 | 1 | 99 | C | . |
| 170 | 45 | 1 | 2 | 2 | 26 | 7 | 1 | 1 | 0 | 0 | 80 | W | . |
| 171 | 20 | 1 | 2 | 2 | 37 | 7 | 4 | 6 | 4 | 4 | 13 | W | . |
| 172 | 20 | 1 | 2 | 1 | 37 | 8 | 1 | 3 | 1 | 1 | 63 | W | 26 |
| 173 | 28 | 1 | 1 | 1 | 31 | 5 | 0 | 3 | 2 | 2 | 99 | W | 16 |
| 174 | 21 | 1 | 2 | 1 | 34 | 5 | 4 | 2 | 3 | 1 | 51 | W | 22 |
| 175 | 21 | 1 | 2 | 2 | 38 | 6 | 3 | 4 | 2 | 0 | 57 | W | 21 |
| 176 | 22 | 2 | 2 | 2 | 37 | 4 | 2 | 5 | 1 | 1 | 40 | W | . |
| 177 | 45 | 1 | 1 | 2 | 31 | 2 | 0 | 0 | 0 | 0 | 98 | W | . |
| 178 | 22 | 1 | 1 | 2 | 31 | 4 | 2 | 1 | 2 | 2 | 46 | W | . |
| 179 | 25 | 1 | 2 | 2 | 25 | 8 | 1 | 2 | 4 | 2 | 50 | W | 38 |
| 180 | 19 | 1 | 1 | 2 | 34 | 3 | 3 | 2 | 2 | 0 | 44 | W | 10 |
| 181 | 20 | 2 | 2 | 2 | 38 | 5 | 4 | 5 | 4 | 3 | 13 | W | . |
| 182 | 19 | 1 | 1 | 1 | 34 | 4 | 2 | 3 | 3 | 1 | 60 | W | . |
| 183 | 25 | 1 | 1 | 2 | . | 7 | 3 | 4 | 3 | 3 | 40 | W | . |
| 184 | 39 | 1 | 2 | 2 | . | 5 | 4 | 4 | 4 | 1 | 53 | A | . |
| 185 | 23 | 2 | 1 | 2 | . | 7 | 3 | 3 | 3 | 0 | 99 | W | 60 |
| 186 | 22 | 1 | 2 | 2 | 39 | 8 | 3 | 3 | 3 | 0 | 36 | B | 46 |
| 187 | 21 | 1 | 1 | 2 | 29 | 5 | 2 | 2 | 3 | 1 | 50 | C | 53 |
| 188 | 24 | 1 | 1 | 2 | 30 | 6 | 0 | 2 | 0 | 2 | 99 | W | 32 |

| Case# | V1 | V3 | V4 | V5 | V8 | V10 | V11 | V12 | V13 | V14 | V15 V16 | V23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 189 | 23 | 1 | 2 | 2 | 41 | 7 | 3 | 7 | 5 | 6 | 50 A | 71 |
| 190 | 33 | 1 | 2 | 1 | . | 6 | 1 | 4 | 1 | 1 | 31 W | 12 |
| 191 | 23 | 2 | 1 | 1 | 28 | 4 | 2 | 1 | 3 | 5 | 86 W | . |
| 192 | 25 | 1 | 2 | 2 | 34 | 4 | 2 | 7 | 2 | 1 | 84 A | 5[illegible] |
| 193 | 44 | 1 | 2 | 2 | 35 | 7 | 4 | 5 | 4 | 4 | 99 B | 16 |
| 194 | 51 | 2 | 2 | 1 | 34 | 6 | 2 | 5 | 5 | 1 | 99 B | 44 |
| 195 | 25 | 1 | 1 | 2 | . | 2 | 1 | 3 | 1 | 1 | 33 W | 47 |
| 196 | 21 | 2 | 1 | 2 | 38 | 8 | 6 | 5 | 4 | 4 | 65 B | 39 |
| 197 | 19 | 1 | 1 | 2 | 38 | 5 | 2 | 4 | 1 | 1 | 38 W | 53 |
| 198 | 35 | 1 | 2 | 2 | 38 | 5 | 4 | 6 | 3 | 1 | 99 A | 40 |
| 199 | 22 | 2 | 2 | 1 | 43 | 8 | 5 | 3 | 1 | 2 | 23 W | . |
| 200 | 58 | 1 | 2 | 2 | 28 | 3 | 0 | 3 | 1 | 1 | 65 C | . |
| 201 | 19 | 2 | 2 | 2 | 32 | 6 | 1 | 4 | 0 | 2 | 53 W | 59 |
| 202 | 27 | 1 | 1 | 2 | 41 | 7 | 7 | 3 | 2 | 1 | 83 A | . |
| 203 | 20 | 1 | 2 | 2 | 36 | 7 | 5 | 7 | 5 | 5 | 90 B | 31 |
| 204 | 21 | 1 | 1 | 2 | 31 | 4 | 0 | 3 | 1 | 8 | 56 A | . |
| 205 | 31 | 2 | 2 | 2 | 37 | 4 | 4 | 4 | 3 | 2 | 40 W | . |
| 206 | 32 | 1 | 2 | 2 | 29 | 4 | 1 | 0 | 0 | 0 | 99 B | 39 |
| 207 | 29 | 2 | 1 | 2 | 30 | 5 | 2 | 4 | 2 | 0 | 46 W | . |
| 208 | 32 | 1 | 1 | 2 | 29 | 4 | 2 | 1 | 1 | 0 | 80 B | . |
| 209 | 31 | 1 | 1 | 2 | 34 | 5 | 1 | 2 | 1 | 0 | 85 W | 55 |
| 210 | 19 | 2 | 2 | 1 | 36 | 5 | 3 | 8 | 4 | 1 | 46 W | 74 |
| 211 | 29 | 1 | 1 | 2 | 33 | 5 | 1 | 2 | 0 | 2 | 99 A | . |
| 212 | 40 | 1 | 2 | 2 | . | 6 | 3 | 3 | 1 | 0 | 96 A | 58 |
| 213 | 19 | 1 | 1 | 2 | 34 | 5 | 1 | 2 | 3 | 2 | 40 W | 27 |
| 214 | 24 | 2 | 2 | 1 | 29 | 6 | 1 | 3 | 1 | 0 | 36 W | 15 |
| 215 | 22 | 1 | 2 | 2 | 30 | 6 | 4 | 4 | 1 | 3 | 76 W | . |
| 216 | 32 | 2 | 1 | 2 | 30 | 6 | 2 | 2 | 4 | 0 | 73 D | . |
| 217 | 30 | 1 | 1 | 1 | 37 | 8 | 3 | 8 | 2 | 4 | 60 A | 48 |
| 218 | 21 | 1 | 1 | 1 | 30 | 3 | 0 | 1 | 4 | 2 | 30 W | 37 |
| 219 | 19 | 2 | 2 | 2 | . | 5 | 3 | 4 | 2 | 2 | 80 B | . |
| 220 | 50 | 1 | 2 | 2 | . | 6 | 1 | 3 | 2 | 2 | 99 A | 55 |
| 221 | 25 | 1 | 1 | 2 | 30 | 3 | 1 | 1 | 1 | 2 | 20 W | . |
| 222 | 22 | 1 | 1 | 2 | 34 | 4 | 0 | 2 | 0 | 2 | 36 W | . |
| 223 | 19 | 1 | 1 | 2 | 34 | 5 | 0 | 3 | 0 | 0 | 33 C | 20 |
| 224 | 23 | 1 | 2 | 2 | 33 | 6 | 4 | 4 | 2 | 1 | 92 B | . |
| 225 | 26 | 1 | 2 | 2 | 43 | 7 | 3 | 6 | 5 | 3 | 73 A | 69 |
| 226 | 19 | 1 | 1 | 2 | 37 | 6 | 2 | 5 | 2 | 3 | 58 A | 26 |
| 227 | 31 | 1 | 2 | 2 | 30 | 6 | 3 | 3 | 0 | 0 | 80 A | 45 |
| 228 | 35 | 1 | 2 | 2 | . | 7 | 4 | 5 | 5 | 4 | 50 A | 53 |
| 229 | 21 | 2 | 2 | 2 | . | 3 | 4 | 3 | 0 | 1 | 30 W | . |
| 230 | 21 | 2 | 2 | 1 | 37 | 6 | 2 | 6 | 1 | 4 | 76 A | . |
| 231 | 34 | 1 | 2 | 2 | 33 | 5 | 2 | 4 | 0 | 0 | 70 W | 22 |
| 232 | 29 | 1 | 1 | 2 | 34 | 4 | 2 | 3 | 1 | 1 | 35 W | 38 |
| 233 | 20 | 1 | 1 | 1 | 33 | 6 | 2 | 3 | 0 | 0 | 55 W | . |
| 234 | 21 | 1 | 2 | 2 | 43 | 7 | 6 | 4 | 1 | 1 | 60 A | . |
| 235 | 30 | 1 | 1 | 2 | 28 | 3 | 2 | 2 | 3 | 0 | 53 W | . |

| Case# | V1 | V3 | V4 | V5 | V8 | V10 | V11 | V12 | V13 | V14 | V15 | V16 | V23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 236 | 30 | 1 | 1 | 2 | . | 2 | 2 | 2 | 3 | 1 | 99 | W | . |
| 237 | 26 | 1 | 2 | 2 | 37 | 5 | 4 | 3 | 2 | 5 | 75 | A | 26 |
| 238 | 42 | 1 | 2 | 1 | . | 6 | 2 | 2 | 3 | 4 | 70 | A | 27 |
| 239 | 22 | 1 | 2 | 2 | 36 | 7 | 3 | 6 | 5 | 2 | 33 | C | 27 |
| 240 | 21 | 2 | 1 | 2 | 32 | 3 | 0 | 1 | 3 | 2 | 36 | W | 46 |
| 241 | 25 | 1 | 2 | 2 | 32 | 6 | 1 | 7 | 3 | 3 | 26 | W | . |
| 242 | 22 | 1 | 1 | 2 | 33 | 3 | 2 | 3 | 0 | 1 | 36 | W | . |
| 243 | 20 | 1 | 2 | 2 | 31 | 5 | 5 | 5 | 4 | 5 | 70 | A | 36 |
| 244 | 31 | 2 | 2 | 2 | 22 | 8 | 3 | 5 | 3 | 5 | 37 | A | 57 |
| 245 | 22 | 2 | 1 | 1 | 34 | 4 | 2 | 2 | 0 | 1 | 70 | W | 51 |
| 246 | 20 | 2 | 2 | 1 | 33 | 5 | 3 | 5 | 3 | 4 | 99 | A | 17 |
| 247 | 30 | 1 | 2 | 1 | 32 | 4 | 1 | 3 | 0 | 0 | 99 | B | 4 |
| 248 | 30 | 1 | 1 | 2 | 30 | 4 | 1 | 5 | 1 | 1 | 77 | D | . |
| 249 | 32 | 1 | 2 | 2 | 36 | 5 | 2 | 4 | 1 | 0 | 86 | B | 23 |
| 250 | 21 | 1 | 2 | 2 | 36 | 4 | 1 | 5 | 1 | 1 | 22 | W | 41 |
| 251 | 20 | 1 | 2 | 2 | 34 | 5 | 1 | 5 | 1 | 2 | 73 | W | 41 |
| 252 | 21 | 1 | 1 | 2 | 34 | 5 | 1 | 4 | 1 | 2 | 27 | W | 23 |
| 253 | 26 | 1 | 1 | 1 | 34 | 4 | 3 | 2 | 1 | 2 | 93 | B | 12 |
| 254 | 19 | 1 | 2 | 2 | 32 | 4 | 0 | 6 | 2 | 2 | 33 | W | 60 |
| 255 | 21 | 1 | 2 | 2 | 35 | 4 | 5 | 4 | 0 | 2 | 3 | W | . |
| 256 | 40 | 1 | 2 | 2 | 31 | 6 | 2 | 2 | 1 | 2 | 83 | B | 48 |
| 257 | 51 | 1 | 1 | 2 | . | 2 | 1 | 1 | 0 | 1 | 57 | W | 10 |
| 258 | 31 | 1 | 2 | 2 | . | 5 | 2 | 1 | 4 | 2 | 73 | W | . |
| 259 | 32 | 1 | 2 | 2 | . | 7 | 2 | 3 | 3 | 0 | 43 | W | 55 |
| 260 | 22 | 2 | 2 | 2 | 30 | 5 | 4 | 3 | 2 | 3 | 70 | W | 44 |
| 261 | 20 | 1 | 2 | 1 | 38 | 6 | 5 | 3 | 3 | 4 | 57 | B | . |
| 262 | 27 | 1 | 2 | 1 | 29 | 4 | 0 | 1 | 1 | 1 | 83 | W | 34 |
| 263 | 20 | 1 | 1 | 2 | 35 | 8 | 1 | 4 | 1 | 1 | 83 | A | 25 |
| 264 | 19 | 1 | 2 | 2 | . | 8 | 3 | 6 | 5 | 1 | 27 | W | . |
| 265 | 30 | 2 | 2 | 2 | 37 | 5 | 2 | 5 | 2 | 4 | 82 | W | 41 |
| 266 | 29 | 1 | 2 | 2 | 34 | 7 | 3 | 2 | 3 | 3 | 35 | A | 35 |
| 267 | 20 | 1 | 1 | 1 | 37 | 5 | 2 | 4 | 1 | 3 | 99 | C | 45 |
| 268 | 23 | 1 | 1 | 2 | 30 | 3 | 2 | 3 | 1 | 0 | 38 | W | 34 |
| 269 | 21 | 1 | 1 | 1 | 33 | 2 | 2 | 3 | 2 | 0 | 99 | C | 48 |
| 270 | 31 | 2 | 2 | 2 | 38 | 6 | 4 | 3 | 3 | 4 | 75 | B | 33 |
| 271 | 22 | 2 | 2 | 2 | 32 | 7 | 2 | 1 | 1 | 1 | 38 | W | . |
| 272 | 24 | 1 | 1 | 1 | 34 | 5 | 2 | 2 | 2 | 1 | 93 | C | 30 |
| 273 | 20 | 1 | 2 | 2 | . | 8 | 0 | 5 | 5 | 2 | 48 | B | 15 |
| 274 | 22 | 1 | 2 | 2 | 31 | 5 | 1 | 5 | 3 | 2 | 58 | B | 30 |
| 275 | 40 | 1 | 2 | 2 | 36 | 5 | 3 | 6 | 0 | 0 | 81 | A | 47 |
| 276 | 40 | 1 | 2 | 2 | 48 | 6 | 1 | 4 | 4 | 0 | 93 | A | 26 |
| 277 | 28 | 2 | 2 | 2 | 33 | 8 | 1 | 4 | 3 | 0 | 64 | B | 35 |
| 278 | 32 | 1 | 2 | 1 | 36 | 4 | 2 | 5 | 1 | 2 | 78 | B | . |
| 279 | 47 | 1 | 2 | 2 | . | 5 | 2 | 6 | 6 | 3 | 96 | A | 23 |
| 280 | 23 | 1 | 2 | 1 | 34 | 2 | 2 | 3 | 1 | 2 | 63 | W | 58 |
| 281 | 22 | 2 | 2 | 2 | 34 | 4 | 2 | 4 | 3 | 2 | 23 | W | . |
| 282 | 28 | 1 | 2 | 2 | 44 | 8 | 4 | 5 | 1 | 4 | 57 | A | 42 |

| Case# | V1 | V3 | V4 | V5 | V8 | V10 | V11 | V12 | V13 | V14 | V15 | V16 | V23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 283 | 20 | 1 | 2 | 2 | . | 6 | 1 | 7 | 1 | 1 | 73 | A | 73 |
| 284 | 38 | 2 | 2 | 2 | 40 | 7 | 3 | 4 | 3 | 2 | 99 | A | 56 |
| 285 | 27 | 1 | 2 | 2 | . | 7 | 2 | 5 | 2 | 4 | 87 | A | 20 |
| 286 | 21 | 1 | 1 | 2 | . | 5 | 2 | 4 | 1 | 1 | 55 | B | 60 |
| 287 | 26 | 1 | 1 | 1 | 33 | 5 | 1 | 3 | 0 | 1 | 30 | W | . |
| 288 | 30 | 1 | 1 | 2 | 30 | 5 | 2 | 1 | 2 | 2 | 38 | W | . |
| 289 | 20 | 1 | 2 | 1 | 42 | 5 | 3 | 2 | 2 | 3 | 30 | A | 7 |
| 290 | 36 | 1 | 2 | 2 | 32 | 7 | 2 | 6 | 3 | 0 | 83 | A | 50 |
| 291 | 41 | 1 | 1 | 2 | . | 5 | 3 | 2 | 0 | 3 | 77 | W | 43 |
| 292 | 25 | 1 | 2 | 1 | . | 3 | 0 | 1 | 1 | 2 | 90 | D | . |
| 293 | 24 | 2 | 2 | 1 | 32 | 5 | 0 | 5 | 2 | 0 | 43 | W | 64 |
| 294 | 50 | 1 | 1 | 2 | 38 | 4 | 5 | 7 | 3 | 1 | 87 | C | . |
| 295 | 20 | 1 | 2 | 2 | 37 | 5 | 1 | 3 | 3 | 3 | 58 | B | 20 |
| 296 | 27 | 2 | 2 | 2 | 36 | 5 | 3 | 5 | 3 | 2 | 43 | A | 50 |
| 297 | 23 | 1 | 1 | 2 | 27 | 5 | 1 | 5 | 3 | 2 | 63 | B | 31 |
| 298 | 22 | 1 | 1 | 2 | 35 | 6 | 2 | 2 | 3 | 3 | 73 | B | . |
| 299 | 19 | 1 | 1 | 2 | 30 | 5 | 1 | 4 | 1 | 1 | 80 | W | 36 |
| 300 | 19 | 1 | 1 | 1 | 37 | 7 | 5 | 4 | 4 | 1 | 37 | W | 13 |
| 301 | 30 | 1 | 1 | 2 | . | 7 | 5 | 5 | 3 | 3 | 99 | A | 63 |
| 302 | 49 | 1 | 2 | 2 | 33 | 5 | 3 | 2 | 1 | 3 | 87 | W | 33 |
| 303 | 22 | 2 | 1 | 2 | 29 | 4 | 2 | 1 | 3 | 3 | 72 | W | 45 |
| 304 | 24 | 1 | 1 | 2 | 34 | 6 | 2 | 5 | 1 | 5 | 53 | W | . |
| 305 | 45 | 1 | 2 | 2 | 30 | 4 | 1 | 0 | 1 | 0 | 80 | W | 41 |
| 306 | 36 | 1 | 1 | 2 | 27 | 4 | 2 | 7 | 3 | 2 | 87 | B | . |
| 307 | 41 | 1 | 2 | 1 | . | 4 | 2 | 2 | 4 | 2 | 99 | A | 36 |
| 308 | 41 | 1 | 2 | 2 | 38 | 6 | 3 | 3 | 3 | 2 | 60 | A | . |
| 309 | 21 | 2 | 2 | 2 | 32 | 4 | 0 | 2 | 4 | 1 | 38 | W | 45 |
| 310 | 25 | 2 | 2 | 2 | 38 | 7 | 3 | 3 | 4 | 4 | 99 | A | 53 |
| 311 | 19 | 1 | 2 | 1 | 28 | 7 | 3 | 4 | 4 | 2 | 99 | A | . |
| 312 | 44 | 2 | 2 | 2 | 27 | 6 | 0 | 6 | 4 | 2 | 50 | W | 35 |
| 313 | 19 | 2 | 2 | 2 | 38 | 6 | 3 | 4 | 4 | 4 | 63 | B | 35 |
| 314 | 20 | 1 | 1 | 2 | . | 5 | 1 | 2 | 1 | 1 | 53 | W | 53 |
| 315 | 19 | 1 | 1 | 1 | . | 5 | 1 | 4 | 2 | 3 | 23 | W | . |
| 316 | 21 | 2 | 1 | 1 | 41 | 5 | 6 | 5 | 2 | 6 | 38 | A | . |
| 317 | 36 | 2 | 2 | 2 | . | 8 | 2 | 2 | 3 | 2 | 73 | B | . |
| 318 | 26 | 1 | 2 | 1 | 37 | 8 | 4 | 7 | 2 | 3 | 39 | A | . |
| 319 | 21 | 2 | 2 | 2 | 30 | 3 | 0 | 3 | 2 | 3 | 17 | W | 17 |
| 320 | 20 | 1 | 2 | 2 | 32 | 7 | 2 | 3 | 4 | 0 | 40 | W | 53 |
| 321 | 34 | 1 | 2 | 2 | 31 | 5 | 2 | 4 | 2 | 0 | 37 | B | . |
| 322 | 19 | 1 | 2 | 2 | 32 | 3 | 1 | 1 | 0 | 1 | 99 | C | 23 |
| 323 | 43 | 1 | 2 | 2 | 36 | 5 | 4 | 5 | 3 | 4 | 50 | A | 60 |
| 324 | 21 | 1 | 2 | 1 | 32 | 7 | 1 | 3 | 2 | 4 | 68 | A | . |
| 325 | 32 | 1 | 2 | 2 | 32 | 5 | 1 | 5 | 1 | 0 | 99 | A | 26 |
| 326 | 38 | 1 | 2 | 1 | 38 | 6 | 2 | 3 | 1 | 2 | 72 | C | . |
| 327 | 38 | 1 | 2 | 1 | . | 7 | 5 | 5 | 6 | 4 | 50 | A | . |
| 328 | 23 | 1 | 2 | 2 | 37 | 6 | 1 | 5 | 3 | 1 | 25 | W | 62 |
| 329 | 47 | 1 | 2 | 2 | . | 8 | 4 | 4 | 5 | 0 | 23 | W | . |

| Case# | V1 | V3 | V4 | V5 | V8 | V10 | V11 | V12 | V13 | V14 | V15 | V16 | V23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 330 | 27 | 1 | 1 | 2 | 30 | 6 | 0 | 3 | 1 | 0 | 83 | B | 54 |
| 331 | 28 | 1 | 1 | 2 | 33 | 5 | 2 | 5 | 2 | 3 | 53 | W | 73 |
| 332 | 24 | 1 | 1 | 1 | 37 | 5 | 4 | 6 | 5 | 0 | 99 | A | 61 |
| 333 | 33 | 2 | 2 | 2 | 31 | 5 | 2 | 2 | 2 | 2 | 72 | W | 31 |
| 334 | 27 | 1 | 2 | 2 | 34 | 7 | 1 | 3 | 1 | 3 | 45 | B | . |
| 335 | 26 | 2 | 2 | 2 | 42 | 7 | 3 | 7 | 4 | 6 | 50 | A | 50 |
| 336 | 28 | 1 | 1 | 2 | 28 | 5 | 2 | 4 | 1 | 0 | 52 | W | . |
| 337 | 48 | 1 | 2 | 2 | 37 | 7 | 4 | 0 | 0 | 0 | 83 | B | 41 |
| 338 | 34 | 1 | 2 | 2 | 32 | 5 | 3 | 3 | 3 | 1 | 3 | W | . |
| 339 | 40 | 2 | 2 | 2 | 33 | 3 | 0 | 2 | 0 | 2 | 87 | W | . |
| 340 | 54 | 1 | 2 | 2 | 54 | 4 | 0 | 2 | 0 | 0 | 99 | C | . |
| 341 | 26 | 1 | 1 | 2 | 31 | 6 | 0 | 0 | 2 | 1 | 52 | W | 52 |
| 342 | 19 | 1 | 2 | 2 | 31 | 6 | 2 | 1 | 0 | 1 | 60 | C | . |
| 343 | 19 | 1 | 2 | 1 | 38 | 6 | 5 | 6 | 5 | 4 | 50 | W | 50 |
| 344 | 25 | 1 | 2 | 2 | 36 | 4 | 1 | 2 | 3 | 1 | 99 | B | . |
| 345 | 32 | 1 | 2 | 2 | 30 | 2 | 2 | 1 | 0 | 1 | 99 | W | 29 |
| 346 | 21 | 1 | 2 | 2 | 33 | 5 | 5 | 4 | 3 | 3 | 23 | W | . |
| 347 | 20 | 2 | 1 | 2 | 35 | 4 | 2 | 4 | 2 | 2 | 37 | W | 45 |
| 348 | 50 | 1 | 2 | 2 | . | 5 | 5 | 5 | 5 | 5 | 73 | A | . |
| 349 | 25 | 1 | 2 | 2 | 31 | 5 | 2 | 3 | 3 | 1 | 22 | W | 13 |
| 350 | 21 | 2 | 1 | 2 | 26 | 1 | 1 | 4 | 0 | 2 | 99 | W | 45 |
| 351 | 51 | 1 | 2 | 2 | . | 6 | 4 | 5 | 1 | 3 | 42 | A | 47 |
| 352 | 20 | 1 | 2 | 1 | 35 | 7 | 5 | 7 | 3 | 4 | 25 | B | 26 |
| 353 | 33 | 1 | 2 | 2 | 28 | 4 | 2 | 4 | 2 | 2 | 67 | C | . |
| 354 | 21 | 1 | 2 | 1 | 37 | 5 | 0 | 1 | 3 | 1 | 88 | B | 51 |
| 355 | 35 | 1 | 2 | 2 | 33 | 5 | 1 | 3 | 0 | 1 | 83 | B | . |
| 356 | 19 | 1 | 2 | 1 | . | 6 | 1 | 4 | 4 | 2 | 50 | W | . |
| 357 | 40 | 1 | 2 | 2 | 36 | 5 | 1 | 4 | 4 | 2 | 99 | W | 16 |
| 358 | 45 | 1 | 2 | 2 | . | 6 | 5 | 6 | 1 | 1 | 99 | A | . |

# APPENDIX F

# INTERMEDIATE ALGEBRA RESEARCH DATA

INTERMEDIATE ALGEBRA RESEARCH DATA

Data variables are as following:

1. GPA is the accumulative grade point average of each student;
2. GRADE is the grade received in the Intermediate Algebra course;
3. STUDENT designates whether the student in the Intermediate Algebra course started with Basic Mathematics, Elementary Algebra, or Intermediate Algebra as the first college mathematics course.

# INTERMEDIATE ALGEBRA RESEARCH DATA

| Case# | GRADE | GPA | STUDENT |
|---|---|---|---|
| 1 | W | 1.33 | 3 |
| 2 | B | 3.21 | 3 |
| 3 | A | 2.34 | 1 |
| 4 | A | 3.72 | 3 |
| 5 | C | 2.03 | 1 |
| 6 | C | 2.27 | 3 |
| 7 | C | 2.17 | 2 |
| 8 | E | 1.86 | 1 |
| 9 | C | 2.00 | 3 |
| 10 | A | 3.68 | 3 |
| 11 | W | 2.23 | 2 |
| 12 | C | 3.17 | [illegible] |
| 13 | W | 0.00 | 3 |
| 14 | B | 3.34 | 1 |
| 15 | W | 0.66 | 1 |
| 16 | W | 1.60 | 3 |
| 17 | W | 0.00 | 3 |
| 18 | A | 3.59 | 2 |
| 19 | C | 2.00 | 1 |
| 20 | E | 0.00 | 3 |
| 21 | C | 2.01 | 2 |
| 22 | C | 2.90 | 3 |
| 23 | E | 0.00 | 3 |
| 24 | E | 0.68 | 3 |
| 25 | C | 2.00 | 3 |
| 26 | C | 2.15 | 3 |
| 27 | E | 0.00 | 1 |
| 28 | B | 2.83 | 2 |
| 29 | W | 3.00 | 1 |
| 30 | B | 1.68 | 3 |
| 31 | C | 2.33 | 1 |
| 32 | C | 2.37 | 1 |
| 33 | A | 3.87 | 3 |
| 34 | C | 2.03 | 1 |
| 35 | C | 2.01 | 3 |
| 36 | A | 2.13 | 3 |
| 37 | W | 2.06 | 3 |
| 38 | W | 2.02 | 1 |
| 39 | A | 3.55 | 1 |
| 40 | E | 0.00 | 3 |
| 41 | D | 1.47 | 3 |
| 42 | A | 3.58 | 3 |
| 43 | W | 1.00 | 3 |
| 44 | W | 0.00 | 3 |
| 45 | A | [illegible] | [illegible] |
| 46 | C | [illegible] | 3 |
| 47 | B | 3.03 | 2 |
| 48 | C | [illegible] | 1 |
| 49 | C | [illegible] | 3 |
| 50 | A | 2.61 | 1 |
| 51 | A | 3.40 | 3 |
| 52 | C | 1.95 | 1 |
| 53 | E | 0.00 | 3 |
| 54 | C | 3.05 | 1 |
| 55 | B | 2.85 | 3 |
| 56 | W | 2.23 | 2 |
| 57 | A | 3.74 | 3 |
| 58 | A | 3.75 | 2 |
| 59 | A | 3.21 | 2 |
| 60 | W | 1.48 | 2 |
| 61 | C | 2.40 | 3 |
| 62 | W | 1.38 | 2 |
| 63 | B | 3.12 | 3 |
| 64 | A | 2.03 | 3 |
| 65 | W | 2.52 | 1 |
| 66 | A | 3.30 | 2 |
| 67 | B | 3.36 | 3 |
| 68 | A | 2.86 | 2 |
| 69 | E | 1.52 | 2 |
| 70 | B | 1.95 | 3 |
| 71 | B | 1.69 | 3 |
| 72 | D | 2.15 | 1 |
| 73 | C | 2.04 | 1 |
| 74 | E | 1.68 | 1 |
| 75 | E | 0.46 | 3 |
| 76 | B | 1.74 | 3 |
| 77 | B | 2.48 | 3 |
| 78 | C | 2.41 | 1 |
| 79 | A | 3.02 | 3 |
| 80 | A | 3.66 | 2 |
| 81 | B | 2.46 | 3 |
| 82 | E | 0.25 | 1 |
| 83 | C | 2.58 | 1 |
| 84 | E | 1.14 | 3 |
| 85 | W | 1.00 | 1 |
| 86 | W | 3.20 | 2 |
| 87 | W | 1.90 | 2 |
| 88 | E | 0.78 | 3 |

| Case# | GRADE | GPA | STUDENT |
|---|---|---|---|
| 89 | * | 2.55 | 3 |
| 90 | C | 2.21 | 1 |
| 91 | * | 0.00 | 1 |
| 92 | A | 2.04 | 3 |
| 93 | A | 4.00 | 2 |
| 94 | * | 2.68 | 3 |
| 95 | * | 2.58 | 3 |
| 96 | B | 3.30 | 3 |
| 97 | * | 2.16 | 2 |
| 98 | D | 1.93 | 3 |
| 99 | A | 0.75 | 3 |
| 100 | B | 3.66 | 1 |
| 101 | C | 2.30 | 1 |
| 102 | A | 3.88 | 2 |
| 103 | A | 3.25 | 3 |
| 104 | D | 1.63 | 3 |
| 105 | A | 3.57 | 3 |
| 106 | A | 3.76 | 3 |
| 107 | C | 3.20 | 3 |
| 108 | B | 2.69 | 1 |
| 109 | C | 2.13 | 3 |
| 110 | A | 3.50 | 2 |
| 111 | C | 2.04 | 3 |

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