A LONGITUDINAL CASE STUDY OF A LEARNING RESOURCE CENTER: MATH LAB FOR ACADEMICALLY DISADVANTAGED STUDENTS 1983 - 1991

BY

JANE S. BURGESS

Bachelor of Science
Bethany Nazarene College
Bethany, Oklahoma
1963

Master of Education
Northeastern State University
Tahlequah, Oklahoma
1977

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Graduate College of the
Oklahoma State University
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Thesis Approved:

Thesis Adviser

Dean of the Graduate College

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CHAPTER I

INTRODUCTION

The Vocational Education Amendments of 1976 (P.L. 94-482) required educators to prepare and implement educational programs to meet the needs of secondary and adult students with mental or physical disabilities (handicapped) and academic or economic handicaps (disadvantaged). The Carl D. Perkins Vocational Act of 1984 (P.L. 98-524) continued the provision for the handicapped and disadvantaged students by providing a basis for equal access to quality vocational education for special needs populations (The President's Committee, 1988). The Carl D. Perkins Vocational and Applied Technology Education Act Amendments of 1990 (P.L. 101-392) requires programs to integrate academic and occupational competencies while providing greater vocational opportunities to special needs students. Documentation of student progress, accountability, is required by the 1990 law.

In 1970, Learning Resource Centers were established in the area vocational schools in southeastern Oklahoma to help special needs students attain an academic and vocational skills level more appropriate for the world of work. With the advent of the 1976 Vocational Amendments, the Learning

Resource Centers became a way to respond to the federal mandates to meet the needs of youth and adults with handicaps and disadvantages which prevented them from succeeding in vocational programs and preparing for work (Shipp, 1981). The 1976 amendments specified that programs funded under the guidelines must evaluate (1) planning and operational processes; (2) results of student achievement; (3) results of student employment success; and (4) any additional services a state may provide under 1, 2, and 3.

A survey of the literature revealed that most researchers have concentrated on the handicapped students or the economically deprived students, but not the academically disadvantaged. Studies were found that looked at employment experiences of the handicapped and disadvantaged students (Hiltenbrand and Newton, 1980; Kulahci, 1981; Kim and Wright, 1984;); transition of handicapped and disadvantaged to post-secondary institutions (Brown, 1983); teacher and/or administrator perceptions regarding the program success or services provided to the handicapped and disadvantaged (Lowden, 1980; Nations, 1983; Smith, 1987); attitudes of vocational instructors toward special needs students in their programs (Tolbert, 1980); and the vocational needs of handicapped and disadvantaged women and Indians (Nacson and Kelly, 1980).

Numerous project descriptions exist giving guidelines for creating successful vocational learning centers for special needs students (West Virginia State Department of

Education, 1979; Bucher, 1979; Harris, 1979; Omvig and Tulloch, 1981; Henry and Omvig, 1981; Shipp, 1981; Wyoming State Department of Education, 1983; Wright et al., 1984;).

Few researchers have addressed or even mentioned the academic needs of the students. Only two studies were found, involving academically disadvantaged students in a Learning Resource Center type program, which concentrated on academic gains using pretest and posttest scores (Arkansas State Department of Education, 1982; Burrell, 1988).

Statement of the Problem

The problem addressed in this study is that there is no evidence to indicate the effectiveness of the Learning Resource Centers in meeting the academic needs of the students in a vocational setting.

Purpose of the Study

The purpose of this study was to determine the effectiveness of one Learning Resource Center: Math Lab located in Tulsa County, Oklahoma which served both secondary and adult special needs students over an eight-year span from 1983-1984 through 1990-1991. The secondary and adult students were integrated into the same programs and math classes. The study sought to answer the following five questions:

1. Do the students show an academic gain from pretest to posttest while participating in the program?

2. Do the posttest scores of secondary and adult students differ?
3. Does math ability level make a difference in the posttest scores for the two types of students (secondary and adult)?
4. Do the posttest scores of students who have worked individually using computers and other technology differ from the posttest scores of students doing group-work using lecture/demonstration and paper/pencil activities?
5. Do Learning Resource Center contact hours make a difference in student gain scores?

Definition of Terms

The following terms are defined to facilitate an understanding of this study:

Academically Disadvantaged Students: For purposes of this study, academically disadvantaged students are those who place at or below the 25th percentile, who are two or more years below grade level on an academic test, or who are not maintaining a passing grade in their program. Academically disadvantaged students may also be students who place above the 25th percentile but cannot apply the academic knowledge in a vocational-technical program situation.

Disadvantaged Students:

> ...individuals (other than handicapped individuals) who have economic or academic disadvantages and who require special services and

assistance in order to enable them to succeed in vocational education programs. The term includes individuals who are members of economically disadvantaged families, migrants, individuals who have limited English proficiency and individuals who are dropouts from, or who are identified as potential dropouts from secondary school. For the purpose of this definition an individual who scores below the 25th percentile on a standardized achievement or aptitude test, whose secondary school grades are below 2.0 on a 4.0 scale (where the grade "A" equals 4.0), or fails to attain minimal academic competencies may be considered 'academically disadvantaged.' The definition does not include individuals with learning disabilities (P.L. 98-524, 400.4).

Economically Disadvantaged Students:

...a family or individual which the State Board identifies as low income on the basis of uniform methods that are described in the State Plan. A State must use one or more of the following standards as an indicator of low income:

(1) Annual income at or below the official poverty line established by the Director of the Office of Management and Budget.

(2) Eligibility for free or reduced-priced lunch.

(3) Eligibility for Aid to Families with Dependent Children or other public assistance programs.

(4) Receipt of a Pell Grant or comparable State program of need-based financial assistance.

(5) Eligibility for participation in programs assisted under Title II of the JTPA (P.L. 98-524, 400.4).

Handicapped Students:

...individuals who are mentally retarded, hard of hearing, deaf, speech or language impaired, visually handicapped, seriously emotionally disturbed, orthopedically impaired, or other health impaired persons, or persons with specific learning disabilities, who by reason thereof require special education and related services and

> who, because of their handicapping condition, cannot succeed in the regular vocational education without special education assistance (P.L. 98-524, 400.4).

<u>Learning Resource Center</u>:

> ...supportive educational programs that will assist disadvantaged and handicapped secondary and adult students in succeeding in regular vocational programs (Shipp, 1981, p. ii). The primary purpose of the Learning Resource Center is to meet the needs of students ... who have a deficiency in basic education [reading, math, and communicative skills] that is related to the specific vocational training (Shipp, 1981, p. 3).

Synonyms used in this study for Learning Resource Center include the lab, the math lab, the center, and resource center.

<u>Special Needs Students</u>: For purposes of this study, special needs students is an inclusive term to mean disadvantaged, handicapped, economically disadvantaged, and academically disadvantaged students.

<u>Secondary students</u>: For purposes of this study, secondary students were defined as those 10th, 11th, and 12th grade students who attended the Tulsa Vocational-Technical School, Southeast Campus one-half day for technical skills and a comprehensive public school, a private school, or were home schooled the other one-half day for academic skills. This definition delineates from the traditional definition of secondary students being those students in grades 7 - 12.

<u>Adult students</u>: For purposes of this study, adult students were defined as those tuition paying patrons who attended the Tulsa Vocational-Technical School, Southeast Campus that

were secondary school graduates, high school dropouts who completed the General Educational Development test (GED), or high school dropouts. For this study, the term includes all students, regardless of age, who were not considered to be secondary students.

Scope and Limitations

According to available information, few resource centers located in a vocational setting use pretest and posttest measures to document student gains or do not report such gains. Therefore, this study was limited to one resource center having both pretest and posttest math scores. This study was further limited by the following:

1. Students were not randomly assigned.
2. A non-experimental group was not used for comparison.
3. Instruction was given on a group basis for two years and an individualized basis for five years, therefore all students did not receive the same treatment.
4. The school was located in an urban area, therefore comparisons to rural settings cannot be made.

Assumptions

The assumption of this research was that those subjects who had both a pretest and a posttest score were representative of the total population of students enrolled in the same vocational school.

Significance of the Study

Federal laws regarding assessment or accountability of vocational programs serving special populations have been obscure, causing many varied evaluation systems among the states and within the state of Oklahoma. Although measures of student achievement were called for in all vocational legislation, there has been a lack of studies reporting such measures. To the knowledge of the researcher, the current study is the only vocational education research to evaluate academic gains in a Learning Resource Center located in an area vocational-technical school in Oklahoma.

This study took an in-depth look at the methods, procedures, and technology used to teach math in a Learning Resource Center:Math Lab located in an urban setting. Pretest and posttest scores were used to measure the math achievement of secondary and adult students in five math ability levels.

As a result of this study, educators will have information on how to measure, report, and interpret academic gain scores in the vocational setting. In addition, vocational educators should be able to develop an understanding of the impact that differences in ability levels; in types of students, whether secondary or adult; in teaching methods and materials; in technology based individualized instruction; and in contact hours have on student achievement.

Organization of the Study

This study includes six chapters. Chapter I, an introduction, provides a statement of the problem, purpose of the study, definition of terms, scope and limitations, assumptions, significance of the study and organization of the study.

Chapter II reviews the literature pertinent to this study. This chapter includes the following sections: introduction, federal regulations for special needs students, historical background of learning resource centers in Oklahoma, elements of effective programs, methods of evaluating resource centers, methods of measuring academic achievement, and a summary of the literature review.

Chapter III identifies the special needs learners as specified by legislated definitions and by various education groups. Effective instructional methodology is also described.

Chapter IV covers the methodology and research questions. Included in the discussion are research design, population description, data collection and analysis of data. Chapter V presents the results of data by environment, population demographics, materials and methods, pretest and posttest scores, and results of the statistical analysis. Chapter VI summarizes the study, interprets the findings, presents conclusions, and makes recommendations for further study.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The purpose of this review of literature was to accrue information pertinent to federal guidelines governing Learning Resource Centers, to determine what characterizes an effective center, to review the guidelines for evaluation of these centers, and to review the processes for measuring academic achievement. The seven sections included in this chapter are titled: (1) Introduction, (2) Federal Regulations for Special Needs Students, (3) Historical Background of Learning Resource Centers in Oklahoma, (4) Elements of Effective Programs, (5) Evaluating Resource Centers, (6) Measuring Academic Achievement, and (7) Summary of the Literature Review.

Federal Regulations For Special Needs Students

The Vocational Education Act of 1963 (P.L. 88-210) encouraged states to develop vocational programs and services for unemployed youth, the socially disadvantaged, and the handicapped (Williams, 1971; Barlow, 1976;). State-level evaluations were conducted on the programs established under the 1963 Act. The National Advisory Council on Vocational Education in 1968 reviewed the state-level evaluations and questioned whether vocational programs had served the special needs populations. Congress, after reviewing the findings of the National Advisory Council's Report, required states in the 1968 Vocational Education Act Amendments (P.L. 90-576) to use specific percentages of federal funds for programs to meet the needs of handicapped and disadvantaged individuals. The amendments also prescribed new vocational education program evaluation requirements (Essex, 1968).

Evaluation requirements mandated in the 1968 Amendments were a source of confusion for many states (Lee, 1971; General Accounting Office, 1974; Wentling, 1980). A clear definition of evaluation and evaluation procedures was lacking in the legislation.

In 1975 the U.S. Office of Education contracted with the Olympus Research Centers to conduct a national assessment of the disadvantaged programs operating under the 1968 amendments. The 1976 Olympus Research Corporation Report (Walsh & Totten) found that remedial programs were carried out in learning laboratories used by both disadvantaged and nondisadvantaged individuals. Walsh and Totten (1976) found no attempt to evaluate or report the effectiveness of remedial instruction. On program planning and evaluation, Walsh and Totten (1976) found the state and local levels were unsystematic and inadequate as explained in the statement below:

> Considering the informality of the planning process, it should come as no surprise that the monitoring and evaluation of programs for the disadvantaged was equally as informal at both the state and local levels. (p. 161)

Walsh & Totten (1976) summarized the general state of monitoring and evaluation of vocational education programs for the disadvantaged as follows:

> Actual enrollment figures were not available, and in most states there was little information on completers, dropouts, and placements. Follow-up data were not available in any state. (p. 286)

Congress, responding to this lack of information about the impact of vocational education and the confusion of many states over federal evaluation requirements, prescribed at least 28 specific requirements related to federal, state, and local program evaluation activity in the 1976 Vocational Education Act Amendments (Wentling, 1980). The 1976 Amendments (P.L. 94-482) focused on program evaluation by the states and identified program evaluation as the responsibility of the State Education Agency:

> The State Board shall, during the five-year period of the State Plan, evaluate in quantitative terms the effectiveness of each formally organized program or project supported by Federal, state, and local funds. These evaluations shall be in terms of:
>
> a) planning and operational processes;
> b) results of student achievement;
> c) results of student employment success; and,
> d) results of additional services, as measured by a, b, and c of this section that the state provides to special populations. (Federal Rules and Regulations, October 3, 1977, pp. 53842-3)

The Carl D. Perkins Vocational Education Act of 1984 (P.L. 98-524) continued those guidelines. That act also included definitions of handicapped and disadvantaged students, as included earlier in Chapter I of this study. The law specified use of funds, determined state allocations, and established criteria for services. Smith (1987) responding to the charges of the 1976 law, stated that vocational educators must meet the special needs of youth and adults with academic or economic handicaps and mental or physical disabilities which prevent success in vocational programs that would prepare them for the world of work.

Research carried out as part of the National Assessment of Vocational Education (NAVE), conducted by Congress in 1990, led to reauthorization of the new Carl D. Perkins Vocational and Applied Technology Education Act Amendments of 1990 (P.L. 101-392). That act continues the trend of federal policy toward the concentration of resources on special populations while restructuring funding and delivery of vocational programs.

Emphasis in the new law is on integrating academic and vocational education. Wilcox (1991) states, "The primary effect of the new Perkins Act will be to provide greater vocational education opportunities to the disadvantaged people" (p. 16). John G. Wirt (1991) says, "In several respects, the new legislation is the inevitable result of the maturing of vocational education and of federal policy towards it" (p. 427). The law spells out an "agenda of priorities" to help states establish student performance measures (Wirt, 1991). Pertinent to this study are those priorities that include student gains in the mastery of basic and more advanced academic skills.

Historical Background of Learning Resource Centers in Oklahoma

Oklahoma Learning Resource Centers began in the Kiamichi Area Vocational-Technical Schools in the southeastern part of the state (Shipp, 1981). Studies revealed that the area was impoverished; the educational level of persons 25 years or older was below the national figure; one-third of the public school students dropped out of school instead of graduating; and at least a fourth of the population was disadvantaged educationally, socially, and culturally, according to American societal standards (Learning Centers for the Disadvantaged: A Proposal, 1970 cited in Shipp, 1981). The Kiamichi researchers believed that motivation and individualized vocational education would assist the people of the area in attaining a level more appropriate for the world of work (Learning Centers for the Disadvantaged: A Proposal, 1970 cited in Shipp, 1981).

According to Shipp (1981), evidence from the Kiamichi area indicated that students were improving educationally in the Learning Resource Center. As a result, in 1975, Central Area Vocational-Technical School located in Drumright implemented a three-year pilot Learning Resource Center. That pilot project had two purposes: (1) to assist students having difficulty with reading, math, and communicative skills as related to their vocational training and (2) to reinforce instruction for the slow learners.

Since 1975, Shipp (1991) reflects that Learning Resource Centers have become an integral part of the 28 area vocational-technical school districts and 13 skills centers. At the time of this writing, there were 44 Learning Resource Centers in operation in Oklahoma. In addition, three area vocational-technical schools provide in-program tutorial services which function under the same guidelines and purposes as the Learning Resource Centers.

The 1988 Annual Report of the Oklahoma Department of Vocational and Technical Education stated

> ... 8,880 disadvantaged and 1,549 handicapped students were assisted in learning resource centers to improve their vocationally related academics, ...

The 1988 Annual Report gave partial credit to the Learning Resource Centers for the placement of 300 of those special needs students, who would not have obtained jobs without their vocational education training.

Student needs are met through the cooperative planning of the vocational instructor and the Learning Resource Center coordinator. Shipp (1981) lists the objectives of the Learning Resource Center:

1. To determine each student's level of achievement in basic education (reading, math, and communicative skills) by administering

achievement and diagnostic tests.

2. To provide students remedial and individualized vocationally oriented instruction in basic education to assure success in the vocational field in which they are enrolled.

3. To reduce dropouts and to improve retention in vocational-technical education.

4. To provide educational techniques for individualized and/or group learning geared to satisfy different learning styles, rates, and abilities.

5. To provide vocationally related instructional programs which meet the unique needs and learning styles of each student who enters the program.

6. To provide an evaluation to determine the educational progress of each student (p. 3).

As with any organization, the success of the Learning Resource Centers is dependent upon fulfilling the established objectives. To determine whether objectives are met, evaluation must occur. Shipp (1981) presented considerations for the evaluation of these objectives: the state supervisor annually evaluates the planning and operational processes and the local districts or individual instructors may do additional evaluation.

With the restructuring changes required in the 1990 Vocational Amendments, some Learning Resource Centers were renamed Education Enhancement Centers. The purpose of the suggested name change was to remove any stigma which might result from the Learning Resource Centers' previous concentration on students who were at or below the 25th percentile. The Education Enhancement Center's new emphasis was on improving the academic performance of all vocational students while remaining cognizant and augmenting the skills of those with greatest need (Shipp, 1991).

Elements of Effective Programs

During the 1970's and 1980's the prevalent theme in research dealt with effective schools. Those studies demonstrated that some schools with similar populations are better than others (Brookover & Lezotte, 1977; Rutter, 1979). One study developed a procedure for predicting school effectiveness by using the socioeconomic status of the students and past achievement test scores (Dyer, 1972). Effective schools studies also indicated that some schools serving the lower socioeconomic students had higher academic achievement than was expected (Weber, 1971; Klitgaard & Hall, 1973; Edmonds, 1989). There were five factors consistent across the effective schools research as listed by Stellar:

1. Strong instructional leadership by the principal
2. Clear instructional focus
3. High expectations and standards
4. Safe and orderly climate
5. Frequent monitoring of student achievement (1988, p. 14)

While those factors identify elements of effective schools, it is obvious that the same elements must be evident within individual classrooms or programs in the school. Squires, Huitt, and Segars (1983) combined 20 years of effective school research to construct "A Model for

Improving School and Classroom Effectiveness" (p. 4). That model includes ways that leadership, supervision, school climate, teacher behaviors, and student behaviors all make a difference in student achievement.

Squires, Huitt, and Segars (1983) describe an effective school as one where leadership creates a school climate in which success is expected, academics are emphasized, and the environment is orderly. Classwork is conducted in a businesslike environment with periods of instruction and quiet work. Classroom routines of lessons starting and ending on time, students bringing the necessary materials to class, and teachers regularly assigning and correcting homework promote an orderly environment (Squires, Huitt, & Segars, 1983).

In their described effective school, Squires, Huitt, and Segars (1983) further state that the students are expected to reach the goals set for them. Teachers build student success into the lessons and provide consistent rewards for demonstrated achievement. Standards are high and reasonable. Students are expected to master the academic work and to graduate. Students feel that the teachers care about their academic performance and believe that hard work is more important than luck in their progress.

Feedback in the described school supports and recognizes successful achievement and appropriate behavior. Student success is directly related to the school climate which is related to leadership. Leadership comes from principals and teachers in the form of modeling appropriate behavior, feedback, and consensus building (Squires, Huitt, & Segars, 1983). Teachers impact the effectiveness of a school, classroom/program, and student achievement through planning, managing, and instructing in ways to keep the students involved and covering the appropriate content (Squires, Huitt, & Segars, 1983).

Evaluating Learning Resource Centers

Presidents, committees, and legislation have called for the establishment of accountability in education. Demands for educational accountability began soon after World War II, when people became concerned about the number of draftees rejected from the armed services because they were functionally illiterate (Wickline, 1971). Since that time, legislation has established the National Assessment of Educational Progress and many education acts have been mandated. The 1990 Carl Perkins Act makes accountability mandatory for vocational education.

The American Heritage Dictionary (1978) defines accountability as being "answerable" or "capable of being explained." Roberson (1971) in response to President Nixon's 1970 demand for educational accountability states, "This request appears simple until applied to the complexity of education and its effectiveness." The majority of evaluation studies according to Wickline (1971, p.9) report,

"...the number of books that have been purchased and the number of children that have been involved in the program. They talk very little about student performance."

Frasier (1983) conducted a literature search for evaluation practices in vocational education. His search was two-fold: (1) limited to state handicapped and disadvantaged program evaluation practices; and, (2) involving all state-level vocational education program evaluation practices. The search found one study related to state disadvantaged program evaluation practices and three studies under the all state-level vocational education program evaluation practices. Frasier listed several authors who had indicated the scarcity of information on evaluation practices. Frasier's study revealed that the main method of evaluation for handicapped and disadvantaged programs was a "walk through" by a state official or by a third party individual or group.

A search of the literature written about vocational resource center evaluation practices since 1983 revealed even less information. This researcher found no new reports on evaluating the handicapped and disadvantaged programs. One report was found which indicated that the state of Illinois was developing a "Computer-Aided Evaluation System for Vocational Education Programs" (Wentling & Roegge, 1989). That system could be of assistance in evaluating Learning Resource Centers in the future. No follow-up reports were found on the computer-aided evaluation system.

Oklahoma provides yearly evaluation of the planning and operational processes and results of student employment in follow-up reports (Shipp, 1981). Learning Resource Centers are also evaluated along with all vocational programs during the Joint North Central Accreditation and State Department of Education Evaluations which occur every five to seven years. However, measurement of student achievement is left to the individual learning resource center coordinator, director or area vocational-technical district operating policies.

Measuring Academic Achievement

The literature revealed that there was rarely an attempt to assess systematically the effects of various strategies, programs, and achievement of students in a vocational setting (Walsh & Totten, 1976; Nacson & Kelly, 1980). Two studies were found which utilized pretest and posttest scores in a vocational learning resource center environment -- Arkansas State Department of Education (1982) and Burrell (1988). Both studies used a pretest to identify students having difficulty in math, remediated the students' math skills in a special program, and posttested the students to measure gains.

The Arkansas State Department of Education (1982) reported that the Crowley's Ridge Vocational-Technical School in Forrest City, Arkansas, utilized comprehensive testing and remediation in the basic skills of reading, mathematics, and language, along with training in employability skills. The Individualized Manpower Training System (IMTS) was utilized to assess students's needs, prescribe a plan of action, and provide individualized instruction for students.

Fifty-four (54) students participated in the Crowley's Ridge Learning Resource Center Program during the 1980-1981 school term. Students were in the center one hour per day for an average of six months. The testing instrument utilized to measure student gains was the Test of Adult Basic Education (TABE) which showed an average gain of 1.7 grade levels. Scores of the individual tests, reading, mathematics, and language, were not reported (Arkansas State Department of Education, 1982).

Burrell (1988) wrote about a mathematics program developed and implemented at the Jefferson County Ohio Joint Vocational School. That program was designed to raise the mathematics functioning of special needs students in the 11th-grade by using interactive computers and individual assistance from a math teacher. A variety of commercial software selected to meet specific mathematical needs was utilized ranging from basic number concepts through algebra and geometry.

Students in the Jefferson County Ohio Joint Vocational School study were pretested and posttested with the Wide Range Achievement Test. Students were assigned to the lab one hour per day for 22 days. Data were collected on three consecutive 11th-grade groups over a three year span. One adult group utilized the program during a summer session. A total of 167 students averaged a raw score gain of 5.8 which equates to over a two-year grade level gain. Raw score gains for individual years were as follows: (1985-1986) 7.1; (1986-1987) 6.1; (1987, Adult) 5.0; (1987-1988) 5.1 (Burrell, 1988, p. 18). An explanation offered for the decline of gain scores of successive years was that students in later groups had higher pretest scores when entering the mathematics program (Burrell, 1988).

There were many general education studies on academic achievement. Dennis (1984), using the High School and Beyond database, compared students' math ability levels to math test scores using raw score gains. The low ability students scored lower than the middle level students who in turn scored lower than the high level students. Basically, the Dennis (1984) study showed that the higher ability students scored better; and conversely, showed that the low level students made the greatest gains. However, the researcher concluded, a raw score gain of 1.75 was small for the two-year interval between tests (Dennis, 1984).

Squires, Huitt, and Segars (1983) accumulated 20 years of student achievement studies and listed the research findings:

- Student achievement can be measured with validity and reliability in important areas.
- Teachers and schools make a difference in how well students succeed on standardized tests.
- Students who are involved in class generally succeed better than those who don't pay

attention.

- Students who succeed on daily assignments and tests are more likely to have higher achievement on standardized tests.
- When teachers teach most of the content and skills covered by standardized tests, students are likely to have higher achievement scores.
- Curriculum packages, in and of themselves, will not result in higher achievement for students.
- Schools can produce exceptional student achievement, even when students come from low socioeconomic backgrounds.
- The principal exerts a tremendous influence toward refining and maintaining a school's social system that promotes achievement and discipline.
- Change in school practices happens over a number of years. (p. 3)

Moon (1989) conducted a study of adult and secondary students enrolled in full-time programs in Oklahoma area vocational-technical schools. The purpose of the study was to determine whether there were differences between the learning growth levels of the two types of students when grouped separately and integrated together in vocational programs. Moon's study concluded that adults and secondary students have higher cognitive learning growth levels when separated into adult only and secondary only programs. The study also found that the adults had higher pretest and posttest scores than the secondary students.

While schools have other purposes and goals than teaching reading comprehension and mathematics computation, they probably will not be considered effective by students, the school board, and the public if students are not successful in these basic skills. For years, the effectiveness of schools has been measured with standardized achievement test scores. "Standardized tests provide a reliable and valid indicator of school outcomes, particularly in the basic skills areas of reading comprehension and mathematics computation" (Squires, Huitt, & Segars, 1983, p. 7).

Not only does research support standardized tests as a measure of academic achievement, it also points out how greater gains can be made on such tests. These gains are dependent upon time, content, and success as stated by Squires, Huitt, & Segars (1983):

> In effective classrooms, achievement on standardized tests is linked to the amount of time a student actively works on academic content, the amount of content the student covers that is on the standardized test, and the students's success on daily assignments and unit tests.

Although research supports the use of standardized tests to measure academic achievement, there are problems associated with that practice. The major problem of analyzing achievement scores as a gain from pretest to posttest is that each subject does not have the same room to gain. A subject who scores very low on a pretest has a great deal of room to grow; a subject who scores very high has only a little room to grow. This is referred to as the "ceiling effect" (Gay, 1987; Dennis, 1984).

Another problem associated with the use of standardized tests is the selection of an appropriate test. Van Dalen (1979) states that research findings "can be no better than the instruments employed to collect the data" (p. 135). Therefore, the researcher must evaluate the validity and reliability of the test selected to collect the data.

Validity is concerned with whether the test meets its purposes or measures what it is supposed to measure (Van Dalen, 1979; Bartz, 1988). Three types of validity have been identified which represent different ways to determine test validity: content validity, construct validity, and criterion-related validity (Van Dalen, 1979; Bartz, 1988). Content validity is used widely with achievement testing. The content of an area to be tested is analyzed and a test is constructed to appraise various aspects of that content (Van Dalen, 1979). Construct validity appraises the test and the theory behind the test to determine whether the test taps what is implied by the test makers established theoretical definition of properties to be measured and the supporting theory behind the test (Van Dalen, 1979). Criterion-related validity uses some other totally independent measurement to compare the selected test. This second measurement is called the "criterion" and must be a valid and reliable measure of what is being measured on the selected test (Bartz, 1988).

Test reliability refers to whether the test consistently generates the same results when repeated measures are taken (Van Dalen, 1979; Gay, 1987; Bartz, 1988). Test reliability means that if the same test is given to the same group of students twice, the results should be the same or nearly the same (Bartz, 1988). There are three methods of determining the reliability of a test: test-retest method, parallel forms method, and internal consistency method (Bartz, 1988). The test-retest method requires two administrations of the same test, to the same individuals, and under the same conditions at an appropriate time interval (Van Dalen, 1979). A correlation, Pearson r, is calculated on the results of the two test administrations to determine the reliability (Bartz, 1988). The parallel forms method requires two separate tests, each administered 5 days to two-weeks apart. The reliability is measured by the Pearson r calculated between the results of the two tests (Bartz, 1988). The internal consistency method or split-half method of determining reliability requires one administration of the test. The test is split into two halves, usually by odd and even numbers. The two results of the two halves are then compared using the Pearson r (Van Dalen, 1979; Bartz, 1988).

Bartz (1988) relates that reliability coefficients are usually higher than validity coefficients. Reliability coefficients using the split-half method may run as high as .90 or .95 (Bartz, 1988). Validity coefficients of .60 or .70 are considered quite high (Bartz, 1988).

Gay (1987) states that "a test is not valid per se; it is valid for a particular purpose and for a particular group" (p. 128). Therefore, when selecting a test one must consider what is being tested and to whom will the test be given. Gay (1987) also states that "a valid test is always reliable but a reliable test is not necessarily valid" (p. 136). This means that the person selecting a test must be cognizant of what makes tests valid and reliable.

Selecting a statistical analysis for pretest and posttest studies can also be a problem. The correct statistical analysis depends upon the groups' performance on the pretest. If the groups are essentially the same on the pretest, then the posttest scores can be directly compared to the pretest scores by finding the difference and conducting a *t* test or ANOVA. On the other hand, if the groups are different on the pretest, Gay (1987) states that "..the preferred posttest analysis is analysis of covariance" (p. 391).

Analysis of covariance (ANCOVA) has two major uses, (1) as a control of extraneous variables by equating groups on variables which reduces bias and (2) as a means of increasing power by reducing within error variance which is due to individual differences (Huck, Cormier, & Bounds, 1974; Stevens, 1986; Gay, 1987). ANCOVA is a statistical method that equates groups on one or more variables by adjusting the dependent variable (posttest) for initial differences on another variable (pretest) that is related to the performance on the dependent variable (Gay, 1987). The covariance then compares the adjusted means. Gay (1987) compares this adjustment to handicapping in bowling which attempts to equalize the teams by giving little or no handicap to high scorers and big handicaps to low scorers.

Huck, Cormier, and Bounds state that when using covariance, "... scores on the covariate variable and the dependent variable are often measured by means of the same measuring instrument." When the same instrument is used, the covariate can be referred to as the pretest and the dependent variable can be referred to as the posttest. Stevens (1986) states that analysis of covariance is a useful measure with intact groups, such as those found in school settings or classes.

Summary of the Literature Review

Oklahoma implemented Learning Resource Centers to respond to federal mandates in order to meet the needs of youth and adults with academic or economic handicaps and mental or physical disabilities. Those handicaps and disabilities prevent students' success in vocational programs and in the world of work. The 1976 amendments specified that programs funded under those guidelines must evaluate (1) planning and operational processes; (2) results of student achievement; (3) results of student employment success; and (4) any additional services a state may provide under 1, 2, and 3. Those same guidelines were continued in the 1984 amendments.

Mandated evaluation requirements were a source of confusion for many states. Therefore, evaluation at the state and local levels was unsystematic and inadequate. Congress in the 1976 amendments outlined program evaluation procedures. Evaluation guidelines have been continued in each of the legislated acts since 1976. However, with all this legislation, there still is a lack of states reporting results of student achievement. The 1990 Carl D. Perkins Vocational and Technology Act calls for the states to establish measures to show student performance in academic and vocational skills.

Oklahoma provides yearly evaluation of the planning and operational processes and results of student employment in Follow-Up Reports (Shipp, 1990). However, a state-wide evaluation of academic achievement has not been conducted. Some of the 44 Learning Resource Centers measure student achievement using a pretest and posttest. The review of the literature revealed that no other state has reported state-wide student academic achievement in the vocational setting.

Effective schools research prevailed during the 1970's and 1980's. Effective schools were described as having a strong instructional leadership by the principal, a clear focus on instruction, high expectations and standards for all students, a safe and orderly climate, and frequent monitoring of progress. These factors describe an effective school, but must be evident in the individual classrooms and programs within the school.

Two studies were found that reported academic gains of students in individual vocational settings -- Arkansas State Department of Education (1982) and Burrell (1988). The Arkansas State Department of Education's study of Crowley's Ridge Vocational-Technical School's Learning Resource Center reported comprehensive scores of reading, mathematics, and language without reporting individual scores for the three sections. Therefore the report lends little support to the current study. Burrell (1988), using the Wide Range Achievement Test, reported an overall math raw score gain of 5.8 which equates to over a two-year grade level gain.

General education studies were replete with information on pretest and posttest measures. A summary study on academic achievement (Squires, Huitt, and Segars, 1983) supported the measurement of academic gains and pointed to ways of improving those gains. One study (Dennis, 1984) which looked at math ability levels and test performance reported that high ability level students perform better on tests than low and middle level students. This same study indicated that the low achieving students tend to make greater raw score gains than the high achieving students.

There were no research studies found that identified an effective Learning Resource Center. However, effective schools and programs have been identified and specific characteristics were consistent in these schools and programs. Squires, Huitt, and Segars (1983) established a Model for Improving School and Classroom Effectiveness which shows ways that leadership, supervision, school climate, teacher behaviors, and student behaviors all make a difference in student achievement.

The literature supports the use of standardized tests to measure academic achievement, however there are problems associated with this practice. The major problem according to Gay (1987) is the "ceiling effect" which means that each subject does not have the same room to gain. Another problem is the selection of an appropriate, valid, and reliable test. Van Dalen (1979) stated that the research results can be no better than the instrument used to collect the data.

Selecting a statistical analysis for a pretest and posttest study can also be a problem, since the analysis depends upon the groups' performance on the pretest. The literature review described analysis of covariance as being the appropriate statistical analysis when groups are different on the pretest (Huck, Cormier, and Bounds, 1974; Stevens, 1986; Gay, 1987). The review also found analysis of covariance appropriate for intact groups (Stevens, 1986) using the same pretest and posttest (Huck, Cormier, and Bounds, 1974).

It appeared from this review of literature that there were no statewide studies to indicate the effectiveness of Learning Resource Centers in meeting the academic needs of the special needs students. There was also a lack of recorded research utilizing pretest and posttest scores in the vocational setting.

CHAPTER III

SPECIAL NEEDS LEARNERS

Special needs learners are formally defined in federal legislation (P.L. 94-142, The Education for All Handicapped Children Act of 1975; P.L. 98-524, The Carl Perkins Vocational Education Act of 1984) and by various education groups. This chapter identifies the types of special needs individuals within the formal definitions along with three types of special needs learners educators have identified. Some effective instructional methods to be utilized when working with these individuals are also included.

Identity of Special Needs Learners

Special needs students, defined in Chapter I, include the disadvantaged, handicapped, economically disadvantaged, and academically disadvantaged individuals. Handicapped individuals may be hard of hearing, deaf, speech impaired, language impaired, visually handicapped, mentally retarded, emotionally disturbed, orthopedically impaired or other health impaired persons, or persons with specific learning disabilities, who require special education and related services, and also require special assistance to complete a regular vocational education program (Sarkees & Scott, 1986).

Disadvantaged individuals, which does not include handicapped, have economic or academic disadvantages that require special services and assistance in order to complete a vocational education program (Sarkees & Scott, 1986). These individuals may be from economically disadvantaged homes, be migrants, have limited English skills, be dropouts, or be potential dropouts (Sarkees & Scott, 1986). The disadvantaged group also includes the criminal offender, single parents, and displaced homemaker or worker. The at-risk population may be included in this group as well. The 1990 vocational legislation uses the term special needs to identify disadvantaged individuals.

There are many levels and combinations of these handicaps and disadvantages which prevent individuals from progressing in the vocational programs. In addition to the individuals as listed, there are others who experience difficulty learning. The National Center for Research in Vocational Education has identified the talented and gifted individuals as a disadvantaged group when these individuals exhibit academic or economic problems (Sarkees & Scott, 1986).

Vocational educators tend to identify special needs learners as those individuals who "... need special assistance or services in order to enter a vocational program and complete the requirements" (Sarkees & Scott, 1986, p. 25). Stodden and Boone (1986) state that special needs students may be unsuccessful in completing their vocational programs because they are unable to apply basic skills required within specific vocational areas and not because of a lack of technical skills.

Math educators have also identified individuals who have difficulty learning which may or may not include individuals having the handicaps or disadvantages described in the federal legislation. Two terms that math educators use most often are individuals who are slow learners and individuals who have math anxiety.

The National Council of Teachers of Mathematics, Thirty-fifth Yearbook (Lowry, 1972) provides a general description of the slow learner as "students who are not achieving at the desired level" (p. vii). Cultural differences, deficient affective functioning, and deficient cognitive functioning are major influences on the behavior and achievement of the slow learners (Schulz, 1972). Schulz (1972) describes the slow learner as having a poor self-image; deficient intellectual skills or cognitive functioning; come from a disadvantaged culture; a reality set which requires relevance in their experiences; a tactile or physical learning style; a need for immediate gratification; a lack of school skills; a lack of social skills; deficient adult relationships; and distinct sex differences related to learning.

Kogelman and Warren (1978) define math anxiety as "...an intense emotional reaction to math based on past experiences" (p. 9-10). Individuals who are math anxious fear and dislike mathematics "...so strongly that their ability to memorize, concentrate, and pay attention..." is inhibited, thus making the learning of math impossible (Kogelman & Warren, 1978, p. 1). Math anxiety, unlike some of the other disadvantages individuals may have, can be overcome and performance in math improved (Kogelman & Warren, 1978). The difficulty that math anxious individuals have with math is related to an attitude rather than aptitude, therefore the anxiety and negative feelings can be overcome by changing the attitude. Kogelman and Warren (1978) state:

> "It is not surprising that someone would want to avoid the painful feelings math evokes. Doing math in the presence of intense anxiety is all but impossible. Once panic begins to take hold, normal functioning is impaired and the skills necessary for learning and performing become inaccessible. It is then impossible to work up to capacity or even discover what these capacities are. But since this is an emotional, not intellectual inhibition, it can be overcome (p. 12).

Math anxiety is a result of different factors working with bad experiences to contribute to negative feelings and attitudes toward math. Some of these experiences may be caused by an insensitive teacher or relative, a perception that math is a masculine subject, a prolonged absence from school or a move to a new school, and a perception that math is a rigid set of rules to be followed causing an authoritarian image which in turn may cause rebellion (Kogelman & Warren, 1978). Math anxiety causes math avoidance, thus individuals refuse to do things requiring math and limit their choices of classes and careers according to the math requirements.

Effective Instruction For Special Needs Students

Special needs learners are a diverse group of individuals, each one being unique. They do not all learn at the same rate or in the same manner. Sarkees and Scott (1986) state that the characteristics, abilities, interests, learning styles, and the needs of each student must be taken into consideration when teaching. Instructional success can be experienced by utilizing a variety of approaches which may also require some flexibility and experimentation to determine the best approach to meet the needs of the special needs students (Sarkees & Scott, 1986).

The one thing that most educators agree upon regarding instruction for special needs students, regardless of the cause of the disadvantage, is that self-concept must be dealt with (Schulz, 1972; Kogelman & Warren, 1978; Sarkees & Scott, 1986; Skemp, 1987). Schulz (1972) states that the teacher must create a "...warm, I-care-about-you relationship" with the special needs students and that the learner, on the other hand, must learn to respond in conversations with the teacher and peers (p. 14).

Sarkees and Scott (1986) list concerns that must be considered when selecting instructional techniques to be used with special needs learners:

1. individual differences among students' pace of learning
2. ability levels of the student (e.g., reading level, math level, vocational assessment results, objectives identified in the individualized education program [IEP] for handicapped students or the individual prescribed program [IPP] for disadvantaged students)
3. preferred learning styles(s) of the student (auditory, visual, psychomotor, or a blend of these styles)
4. difficulty of subject matter to be covered (e.g., readability level of books and materials, related terminology, level of related math involved) (p. 301).

Instructional techniques offered by Sarkees and Scott (1986) include:

- Demonstration method to introduce new material
- Field trips and job site visitations allowing first-hand exposure to specific occupations
- Flexible grouping to allow the special needs students integration and participation with their peers
- Individualized instruction activities allowing the students to work at their own pace
- Education media aids add variety, assist in presentation, reinforce concepts, provide simulated learning experiences, provide individualized learning experiences, and allow students to learn through their strongest style.
- Projects to provide the students an opportunity to develop independence and interpersonal skills
- Simulation and role-playing to help provide realistic experiences that lend themselves to a specific

occupational area and to the world of work

- Student-teacher contracts assist students in successful completation of program requirements
- Task analysis help the special needs student successfully complete a task one step at a time
- Team teaching combines the knowledge and expertise of several professionals in a common effort to help special needs learners succeed
- Tutors help special needs learners develop interpersonal relations with others, relieves the vocational teacher from spending too much time with one or two students, and enables slower students to develop the proficiencies needed for success in the program.
- Computer applications assist in individualization providing self-paced instruction, tailoring the sequences and levels of instruction to the needs of each student; students seem to be motivated by the use of computers; and the computers are interactive, providing immediate feedback regarding progress.

Instructional methods used with special needs students may make the difference between their success and failure in vocational programs (Sarkees & Scott, 1986). Since each special needs student is unique, a variety of techniques should be used. At the same time, consideration must be given to individual abilities, needs, learning styles, and occupational goals.

An evaluation system for reporting the academic achievement of the special needs learners should consider the needs and abilities of the student rather than being a competitive process or a comparison to other students. Sarkees and Scott (1986) recommend that the evaluation process include factors designed to provide feedback on student progress in relation to behaviors required in a specific job or occupation, such as performance competencies or tasks, work habits, attitudes, effort, and cognitive achievement.

CHAPTER IV

METHODOLOGY

The purpose of this study was to determine if Learning Resource Centers located in the vocational schools of Oklahoma were meeting the needs of the academically disadvantaged students. Research has shown the perceived effectiveness of the Learning Resource Centers in Oklahoma (Smith, 1987), however, statistical studies of academic gains were not found. This study evolved out of a felt need to know if the special needs students were making academic gains while attending a vocational school and receiving assistance in a Learning Resource Center. This chapter describes the research design, the population study, the collection of data, and the analysis of data.

Research Design

This study was a longitudinal, ex post facto, quasi-experimental design which combined a case study with a statistical analysis. It was longitudinal because it covered the eight school-years from 1983-1984 through 1990-1991. Ex post facto, meaning after the fact, is also called causal comparative. This type of study is an attempt to determine the cause or reason for existing differences in the behavior or status of groups of individuals. Both the effect and the alleged cause have already occurred and are studied by the researcher in retrospect.

Gay (1987) relates that causal comparative studies may identify relationships that lead to experimental studies by: (1) helping identify variables worthy of an experimental study, and (2) by determining the probable outcome of an experimental study. Gay (1987) goes on to point out limitations of this type of study:

1) The same kind of controls cannot be exercised as in experimental studies since the independent variable has already occurred.
2) Extreme caution must be applied in interpreting results -- the cause-effect may not be as it appears. The alleged cause may be an effect or a third variable may have caused both the identified cause and effect.

This study was a quasi-experimental design because it was not possible to assign subjects to groups randomly. Gay (1987) states that quasi-experimental designs provide adequate control of sources of invalidity. When using this design the researcher should make every effort to use groups that are as equivalent as possible. Gay (1987) further relates an advantage of this design, "...that since classes are used 'as is,' possible effects from reactive arrangements are minimized" (p. 320).

In addition, this study can be identified with Van Dalen's (1979) Design 1 and Campbell and Stanley's (1963) one-group pretest-posttest design (0 X 0). The subjects were pretested (0), given a treatment (X), and posttested (0). This type of design lends itself well to the educational setting of preformed groups without random assignment (Campbell and Stanley, 1963; Van Dalen, 1979).

Population of Study

The subjects in this study were 941 secondary and adult students who were enrolled in vocational programs at Tulsa County Area Vocational-Technical School District #18, Southeast Campus. The subjects were selected for this study because they received assistance in the Learning Resource Center: Math Lab and had a Wide Range Achievement Test mathematics pretest and posttest.

Permission to use the student data was granted through the Tulsa Vo-Tech administration. The letter of request is duplicated in Appendix A. The privacy of all subjects was protected.

Data Collection

Data for the 941 secondary and adult students were collected for the study over a seven-year span. Subjects were pretested at the beginning of the school year and posttested upon the completion of their math studies in the Learning Resource Center: Math Lab. The types of data collected for each student included age, sex, contact hours in the math lab along with pretest and posttest scores.

Data for each year were saved in a Lotus 123 file and were combined into one file for this study. Subjects' names were eliminated to assure privacy of individuals. Subjects not having both a pretest and posttest on the Wide Range Achievement Test were eliminated from the study. Additional data collected from the registrar and added to this file included ethnic origin, home school, and final grade. The Lotus 123 file was saved in ASCII form and then imported into Systat 5.01 for statistical analysis.

Analysis of Data

A case study analysis of the Learning Resource Center: Math Lab was completed using program enrollment reports, student accounting reports, registrar records, end-of-year reports, and teacher records. Demographic data, including age, sex, ethnic origin, and home school, were used to describe the population. Other data collected included final grade and hours completed in the Learning Resource Center.

Pretest and posttest data were analyzed using an analysis of covariance with the pretest as a covariate in order to equalize individual student differences. An F value at an alpha level of $p < 0.05$ was used to determine whether there was a significant interaction or main effect. The follow-up comparison of the three-way interaction included a test of simple effects using the adjusted least square means provided with the covariance analysis. These data were interpreted using tables and graphs.

A Pearson Product Moment correlation was done on the math lab contact hours and the difference scores of the posttest and pretest. This correlation was done to determine whether the contact hours made a difference in the achievement gains of the students.

Analysis of pretest and posttest percentile scores by quartiles for the total study determined whether academic gains were made by the secondary and adult students. Also, pretest and posttest percentile scores by quartiles were used to determine male and female academic gains.

For purposes of comparison to the Burrell (1988) study which used the same pretest and posttest, an analysis of the raw score gains was conducted. This analysis was simply mean gain score = mean posttest score - mean pretest score. The mean gain score was then compared to a table accompanying the Wide Range Achievement Test to determine the approximate grade level growth. The mean raw score gain was also used to compare to the Dennis (1984) study.

CHAPTER V

FINDINGS AND ANALYSIS OF THE DATA

The purpose of this study was to determine the effectiveness of one Learning Resource Center: Math Lab located in Tulsa County Oklahoma which served both secondary and adult special needs students over an eight-year span from 1983-1984 through 1990-1991. There were a total of 941 subjects in the study. Subjects were selected for this study if they

1. were enrolled in a full-time vocational program at the Southeast Campus of Tulsa Vo-Tech,
2. received services in the Learning Resource Center: Math Lab, and
3. had a mathematics pretest and posttest on the Wide Range Achievement Test.

Posttests were not given during the 1983-1984 school-year, therefore no subjects from that year were included in this study. The 1983-1984 year was included in this study only to establish background on the formation of the Learning Resource Center: Math Lab which began operation in October, 1983.

The findings in this study are based on those students who had both a pretest and posttest score, not on the total participants in the Learning Resource Center nor the total enrollment in the school. Therefore, demographic proportions stated herein do not reflect total enrollment in the Learning Resource Center: Math Lab nor school wide enrollment.

Environment

The Southeast Campus, one of four Tulsa Vo-Tech campuses serving the Tulsa metropolitan area, located near the western edge of the city of Broken Arrow, a bedroom community to Tulsa, opened as a new site in 1983. The campus has a rural setting, being surrounded by open fields, but serves the urban population in the city of Tulsa and in Tulsa County. Secondary students in this study attended the vocational-technical school one-half day (3-hour block) and a home high school one-half day. Adult students in this study attended either one-half day or a full day (two, 3-hour blocks).

The Southeast Campus programs in which subjects were enrolled during this study included:

1. Automotive Brakes, Steering, and Suspension (Originally called Auto Front-End and Brakes)
2. Automotive Engine Performance/Electricity and Air Conditioning
3. Automotive Fundamentals and Counter Sales (discontinued in May of 1990)
4. Automotive Transmission and Differential

5. Cashier Checker Program (Short-term, 40 hours)
6. Cosmetology (Secondary only)
7. Industrial Technology Electricity/Electronics
8. Industrial Technology Mechanics/Hydraulics/Pneumatics
9. Basic Microcomputers (Secondary only)
10. Advanced Microcomputers (Secondary only, began 1989)
11. Microcomputer Business Applications (Adult only, began January,1985)
12. Machine Tool Trades-Conventional (Originally combined with Production as one program)
13. Machine Tool Trades-Production (Originally combined with Conventional as one program)
14. Machine Tool Trades-Computer Numerical Controls
15. Motorcycle and Power Product Technician (Originally Motorcycles)

The majority of these programs traditionally have all male students. Only three of the programs, Cosmetology, Cashier Checker, and Microcomputer Business Applications, traditionally have all female students. However, each of the programs have had non-traditional enrollees.

On the opening day of school in August of 1983, the Learning Resource Center: Math Lab was an unfinished empty room. The classroom had approximately 682 square feet with eight learning carrels, two storage closets, and an office. Bulletin boards, marker-boards, and projector screens were ordered and installed. Tables were arranged in a u-shape in front of the marker-board and projector screen. The lab was decorated with attractive general posters, teacher made materials, math charts, and math posters. The lab was readily accessible to all students due to its location across the hall from the cafeteria, a popular hang-out for students.

In 1986, another room was added to the math lab increasing the size to approximately 1250 square feet. The smaller room was used for instruction and small group activities. The larger room housed the computers (which were increased to twelve), an interactive laser disk player integrated with a computer, the filmstrip viewers, cassette players, video players, two Digitor Tutors, and a workplace for the secretary/aide.

Materials and Methods

The only staff during the first two years of operation was a math specialist who reported to work for the first time on that opening day of school in 1983. Dr. Mary L. Ellis, Director of the Southeast Campus, directed the math specialist to design and establish a math program to serve the special needs students. The program was 1) to be in compliance with the 1976 Carl Perkins regulations, 2) to strengthen the basic math skills of individuals, and 3) to apply to the vocational program in which the students were enrolled.

Prior to the opening of the math lab, the math specialist consulted with Dr. Clyde Matthews, Coordinator of

Special Programs/Compliance, and Dr. Jeanetta Shipp, Assistant Coordinator of Special Programs/Compliance at the Oklahoma Department of Vocational Education, to learn about the rules and regulations of the 1976 vocational amendments. The state coordinator and assistant coordinator recommended visits to five effective established Learning Resource Centers in the state. Matters to be considered in these visits were:

1. What standardized & diagnostic tests were in use?
2. What materials were available and from where were they purchased?
3. How were students identified for the program?
4. What teaching methods were utilized?
5. How were students scheduled into the center?
6. How were the centers arranged?
7. How were the required math skills for vocational programs determined?
8. What length of time were students served per week and for how many weeks?
9. What types of records were to be maintained?
10. What techniques were used in coordinating and communicating with the vocational instructors, administrators, and the Oklahoma Department of Vocational Education?

The math specialist then met with the Southeast Campus vocational instructors to determine the math skills required in each program, to determine the types of services that might be expected, and to accumulate ideas for operational procedures. The outcome of this meeting was that, during the first year, the math lab would provide eligible students a basic math review and as time and resources permitted some vocational application. More vocational application would be added to the math teaching each successive year. There were two reasons for this decision:

(1) This was the opening year for the school; instructors and staff were working with new equipment and all the things involved in making something new work. In addition, instructors were accumulating and writing curriculum as the year progressed, leaving little time to coordinate with the math specialist.

(2) There was a lack of vocationally related math materials in 1983 which meant that those materials needed to be developed. This development would require the cooperative efforts of the vocational instructors and the math specialist.

The math specialist reviewed math tests and ordered supplies, materials, and tests. Work began on the establishment of a basic math skills scope and sequence which would be inclusive of the math skills taught the first year in the Learning Resource Center: Math Lab. This math scope and sequence was based on several general math text books in publication. The vocational program instructors reviewed and prioritized the skills on the math scope and sequence to indicate those categories and skills most important to their trade. (See Appendix B for the Math Scope and Sequence.) Materials were gathered or created to teach these skills.

Using the math scope and sequence along with vocational curriculum materials as a foundation, the Math Specialist compiled a taxonomy of math skills required in the vocational programs. This taxonomy was based on math skills required on the job, math skills needed for personal survival, and math skills prerequisite to those skills. Vocational instructors gave additional input to complete the taxonomy. The Math Specialist compared this taxonomy to the following in order to determine the completeness of the identified skills: 1) Adult Competency Education Kit (ACE, 1977), 2) "Generic Skills. Keys to Job Performance" which contained a mathematics competency list (Smith, 1979), and 3) "Math and Your Career" (Martin, 1983). The Tulsa Vo-Tech Taxonomy, in most cases, exceeded these lists and was therefore considered complete.

All vocational instructors and most program advisory committees verified the relevance of the math skills included in the taxonomy to the individual programs. Review and revision of this taxonomy occurred yearly throughout this study. (See Appendix C for the latest copy of the taxonomy.) A search for vocationally related math materials was ongoing and implementation of those materials into the students' individual math study plans occurred as soon as possible.

The Math Specialist administered the Wide Range Achievement Test school-wide at the beginning of each year and individually, as new students enrolled, to determine those students who placed at or below the 25th percentile. All test administration followed the guidelines established in the Wide Range Achievement Test Administration Manual.

Instructors, administrators, and students received the results of the tests. Lists of eligible students and a math lab schedule were then established. The Machine Tool Trades and the Industrial Technology instructors felt that the 25th percentile required by the Carl Perkins Amendments did not identify all students needing help in their programs. Therefore, for those programs, all students 25th percentile and below and any students above the 25th percentile identified by the vocational instructors as needing help attended the math lab on a regular basis. This identification process was consistent throughout the eight years of this study.

The math schedule for 1983-1984, 1984-1985, and 1985-1986, consisted of two 45-minute periods on Monday/Wednesday or Tuesday/Thursday for each vocational program. Enrollment was low during the first three years; therefore, in some cases, classes requiring similar math skills were scheduled at the same time. For example, students from two automotive classes, Auto Front-End and Brakes and Auto Fundamentals and Counter Sales, attended the math lab at the same time. On Friday, the math specialist graded papers, prepared worksheets and lessons for the following week, worked with drop-in students needing special help, held student conferences, visited in vocational programs, and helped students prepare for the GED and ACT. (See Appendix D for a reproduction of the 1984-1985 math lab schedule.)

Equipment ordered the first year included an overhead projector, two filmstrip viewers with audio players, two Classmate 88's (Forerunners to computers that provided math drill and practice from basic facts to simple algebraic equations.), two Digitor Tutors (Machines that provided students practice on the basic math facts in a variety of ways.), six IBM computers with printers, and two cassette players with headsets. The overhead projector, the Classmate 88's, and the Digitor Tutors arrived before classes started in October. The remaining equipment arrived during the second semester, too late for use that first year of operation. One Apple IIe was donated to the math lab in the fall of 1983.

Purchased math application software and filmstrip programs supplemented the basic math skills listed in Appendix B. The early software was strictly drill/practice with a few programs being in a game format. Beginning in the 1986-1987 school year software packages became more sophisticated. The new software tested the student, provided a tutorial and drill/practice on screen, provided printouts for additional practice, and provided progress reports. A few vocationally related materials were found.

Appendix E contains an inventory of software, filmstrips, and videos listed by year of implementation into the math program.

Instruction during the first three years consisted of lecture, demonstration, practice, and paper/pencil follow-up activities. The computers and filmstrip viewers provided reinforcement and practice of the math skills.

The addition of six more IBM computers (total of twelve) and a math aide in the fall of 1986 allowed some changes in the delivery process. Instruction changed to an individualized basis utilizing computers and an individualized basic math review developed by the math specialist. The basic math review consisted of diagnostic tests to determine strengths and weaknesses of students and worksheets for each of the math skills. (See Appendix E for an outline of the basic math review.) An individual math study plan developed for each student from the results of the tests directed the students to practice exercises, the computer, a video, a filmstrip, the instructor, or to the next level test. On the computer, students received tutorial help and math practice using the Science Research Association Computer Drill and Instruction: Math, Level D software for IBM computers.

In 1986-1987, an administrative decision to use the Armed Services Vocational Aptitude Battery (ASVAB) as a school-wide pretest for reading, math, and vocational counseling limited pretesting and posttesting using the

WRAT. The majority of the students took the ASVAB test on the assigned day at the beginning of the year. These students had no posttest. The Wide Range Achievement Test was given only to students who were not present on the day of the ASVAB test. Consequently very few students for that year had both a WRAT pretest and posttest. Comparisons between scores on the ASVAB and WRAT tests are beyond the scope of this study.

By this time, 1986-1987, vocationally related math was available to the Machine Tool Trades programs and the Electricity/Electronics programs through the use of text books and some computer software. These materials not only covered the same basic skills, life skills, and prerequisite math skills as listed in the Basic Mathematics Review (Appendix F), but also provided math related to the vocational programs as listed in the taxonomy (Appendix C). Limited trades related software, filmstrips, and videos were available for the other programs as well.

Calculators became an integral part of the math instruction beginning in 1986. The vocational program instructors and the math specialist believed that a calculator should be as comfortable a tool in the hands of the students as a micrometer. Students demonstrated competency with the basic math skills before being allowed use of the calculator on a full time basis. However, in order for the students to maintain their basic skills, calculators were not allowed on occasional worksheets throughout the year. This approach evolved because many employers in the Tulsa area require applicants to take a math test, some allow calculators and some do not. Also, this approach helped the high school students maintain their basic skills needed at their home schools.

As might be expected, allowances for some special needs students were necessary regarding the use of calculators and the basic skills requirements. These special students were taught to use the calculator and to check the reasonableness of the answer for themselves and/or get someone else to check their answer. In the time frame allowed to work with these students, this seemed to be the best approach. This approach was developed through a trial and error process of looking for something that worked for the special students, along with consulting program instructors and the Learning Resource Center Advisory Team.

In the spring of 1986, the addition of an interactive laser disk program integrated with an IBM-PC was added to the curriculum. This program covered the basic math concepts and Algebra I. The concept of seeing, hearing, and touching helped many of the special needs students gain confidence in learning math. The laser program enhanced the learning of small groups and individuals. Some of the vocational instructors utilized this program for self improvement.

Beginning in the 1987-1988 school year, enrollment increased enough that the classes needed to be separated in the math lab. Students from most programs were scheduled into the math lab for one hour once a week in order to obtain a smaller teacher/pupil ratio. Students from the Machine Tool Trades and Electricity/Electronics programs remained on the twice weekly schedule because of the level and amount of math required in these programs. Vocationally related math materials were added for automotive trades, microcomputers, and cosmetology programs. As the vocationally related materials were implemented into the curriculum, less emphasis was placed on the basic math skills which were addressed as needed within the vocational math skills.

Individualized math based on the vocational math skills continued in the 1988-1989 school year. With the implementation of vocationally related math, students asked less often, "Why do we have to do math at Vo-Tech?"

The 1989-90 school year saw one additional change, the Test of Adult Basic Education (TABE) was used with all students enrolled in the math lab as a diagnostic test to identify math strengths and weaknesses. The TABE test, scored on an NCS Scanner 3000 integrated with an IBM computer, provided printouts of mastered and non-mastered math skills used in conferencing with students and vocational instructors. An individualized math study plan for each student was created from the results of the test.

The largest enrollment in the Learning Resource Center occurred during the 1990-1991 school year. During this year the Math Specialist missed 36 days due to illness. The substitute had limited experience with the vocationally related math, consequently basic math skills, once again, became the major focus.

An orientation to the math lab, conducted on the first day students report, includes the purpose of the math lab, importance of regular attendance, an overview of the types of materials that will be used to teach and reinforce math skills, a list of the math skills required in the vocational program showing the logical progression and sequence of the math skills, a review of school-wide and math lab policies. The first session ends with a fun math activity related to the vocational trade. This one activity is the first step of dealing with math anxiety.

The next two or three times students attend the math lab lessons are kept short, require low math skills, and serve as an attempt to make the learning a fun process. This approach helps the instructor and aide develop rapport with the students. This approach also lets the special needs students know that the instructor and aide care about them and want them to succeed. Usually by the third or fourth day of attendance, students have developed a routine and are comfortable with attempting to work on their needed math skills. The instructor and aide work individually with students who need more confidence, by helping to build self esteem. Many times it takes nothing more than recognition that the student can do something and do it reasonably well.

The math specialist discovered that special needs students, whether secondary or adult, need this reinforcement with each new concept that is reviewed or taught.

High expectations were held for all students. It was believed that all students could learn and they were expected to demonstrate that learning by performing well on their daily work and tests. Students were in the math lab because they needed assistance. Therefore, all work was based on a mastery level concept. If problems were missed, then the math skill deficiencies had not been improved, therefore corrective measures were taken. Students learned early that they were to take the time to do the work correctly or else try again with the same or different materials.

Administration of the posttest occurred during April in the school years of 1984-1985 and 1985-1986. In subsequent years, administration of the posttest occurred when the students completed their individual math study plan. Thus, time between pretest and posttest varied for most students.

Population Description

Data collected on subjects in this study included type of student, gender, ethnic origin, age, home school, contact hours, and final grade. Frequencies, percents, ratios, ranges, and means summarize these descriptive data.

Subjects, in this study, represent all programs offered at the Southeast Campus and in addition, three classes of pre-nursing students from another Tulsa Vo-Tech campus. Subjects in the study were 571 secondary and 370 adult students for a total of 941. An overall secondary to adult percent ratio of 61 to 39 was fairly consistent through the years with a range from 56 to 44 up to 67 to 33. Table I shows the number and percent of secondary and adult subjects by year of participation.

TABLE I

NUMBER OF SECONDARY AND ADULT SUBJECTS BY PERCENT AND BY YEAR

YEAR	TOTAL	SECONDARY N	SECONDARY %	ADULT N	ADULT %
1984-1985	88	48	55	40	45
1985-1986	95	58	61	37	39
1986-1987	48	26	54	22	46
1987-1988	148	99	67	49	33
1988-1989	172	106	62	66	38
1989-1990	174	113	65	61	35
1990-1991	216	121	56	95	44
TOTALS/MEAN %	941	571	61	370	39

Gender distributions show that approximately 3 out of 4 subjects in the study were male with a total of 689 males and 252 females. The high number of male participants can be explained by the fact that the majority of programs offered at the Southeast Campus are traditionally male careers. The secondary male to female ratio was 72 percent to 28 percent. The adult male to female ratio was 75 percent to 25 percent. Table II lists the total secondary and adult subjects by male and female distribution by year of participation.

TABLE II

NUMBER OF SECONDARY AND ADULT SUBJECTS
BY MALE AND FEMALE DISTRIBUTION
BY YEAR OF PARTICIPATION

YEAR	TOTAL	SECONDARY M	SECONDARY F	ADULT M	ADULT F
1984-1985	88	22	26	38	2
1985-1986	95	19	39	27	10
1986-1987	48	17	9	21	1
1987-1988	148	85	14	34	15
1988-1989	172	83	23	33	33
1989-1990	174	93	20	45	16
1990-1991	216	91	30	81	14
TOTALS	941	410	161	279	91

NUMBER (PERCENT) OF MALES IN STUDY 689 (73)

NUMBER (PERCENT) OF FEMALES IN STUDY 252 (27)

Ethnic groups tracked in this study are those reported on the Oklahoma Enrollment Report:

1. American Indian or native Alaskan
2. Black, not of Hispanic origin
3. Hispanic
4. White, not of Hispanic origin
5. Asian or Pacific Islander

Over 87 percent of the subjects were white, approximately 4 percent were American Indian, over 5 percent were black, over 1 percent were Hispanic, and 2 percent were Asian. Table III lists the total number of subjects in each ethnic group by year.

TABLE III

ETHNIC ORIGIN OF SUBJECTS
BY NUMBER AND BY YEAR

YEAR	TOTAL	AMERICAN INDIAN	BLACK	HISPANIC	WHITE	ASIAN
1984-1985	88	0	7	2	79	0
1985-1986	95	2	6	1	82	4
1986-1987	48	1	7	0	38	2
1987-1988	148	7	9	1	125	6
1988-1989	172	7	8	1	154	2
1989-1990	174	9	4	1	159	1
1990-1991	216	11	10	6	186	3
TOTALS	941	37	51	12	823	18

Subjects' ages ranged from 15 years to 56 years with an average age of 22 years. Secondary students' ages ranged from 15 years to 20 years. Adult students' ages ranged from 15 years to 56 years. The 15-year old, in this group, was a tuition paying patron not attending high school; thus fitting the definition of an adult student in this study.

Adult students lived in and around the Tulsa metropolitan area. Secondary students came from 31 Tulsa area public and private schools or were home schooled.

Pretest and Posttest Data

The 1976 Carl Perkins Act defined the disadvantaged student as one who scores below the 25th percentile on a standardized achievement or aptitude test. The Wide Range Achievement Test (WRAT), math section only, selected as the standardized achievement test to screen and identify students who were below the 25th percentile was a short and easy screening tool for indicating whether a student might have a math deficiency. Reasons for selecting the WRAT follow:

1. It was normed with both secondary and adult aged individuals. The test was appropriate for individuals aged 12-0 (twelve years and zero months) to 74-11 (seventy-four years and eleven months).
2. The test interval was short, requiring only 10 minutes actual testing time. Students missed approximately twenty minutes of class-time to complete the test.

3. Scoring was easy even though hand scoring was required.
4. The test was a performance test. Students had to work the problems and provide the answers. There were no multiple-choice questions.

The WRAT was a valid and reliable test for this study. The test had content validity because it measured the math skills determined necessary for the vocational programs in this study. The test had criterion-related validity to other tests; i.e., the correlation to the California Achievement Test on Arithmetic was .81; a correlation of .60 and .70 to the Metropolitan Achievement Test in two different studies; and .60 to the Stanford Achievement Test (Wide Range Achievement Test, Administration Manual, 1984). Reliability of the test was demonstrated in the current study with a correlation of .81 between pretest and posttest.

Math ability level was a concern in this study. The pretest standard scores divided the secondary and adult subjects into five math ability levels: below average, low average, average, high average, and above average. Table IV shows the total number of subjects by year of participation and the number of subjects placing in each math ability level on the pretest, also by year. As would be expected, the majority of the students placed in the three levels that constitute average math ability. The below average math ability level had 173 subjects, 18 percent of the total, while the above average level had 23 subjects, 3 percent of the total participants. The distribution of the three levels of the average group is as follows: the low average level had 319 subjects, 34 percent of the total; the average level had 378 subjects, 40 percent of the total; the high average level had 48 subjects, 5 percent of the total.

The frequencies shown in Table IV do not constitute a normal distribution. The distribution is positively skewed with the bulk of the subjects placing in the average and low-average ability levels. A few subjects' math abilities spread over the high and above average levels.

TABLE IV

TOTAL NUMBER OF SUBJECTS BY MATH ABILITY LEVEL AND BY YEAR OF PARTICIPATION

YEAR	TOTAL	BELOW AVERAGE	LOW AVERAGE	AVERAGE	HIGH AVERAGE	ABOVE AVERAGE
1984-1985	88	6	17	57	5	3
1985-1986	95	13	22	52	5	3
1986-1987	48	12	21	10	3	2
1987-1988	148	31	67	40	8	2
1988-1989	172	43	53	68	6	2
1989-1990	174	36	61	62	8	7
1990-1991	216	32	78	89	13	4
TOTALS	941	173	319	378	48	23
PERCENT	100	18	34	40	5	3

Table V, on the following page, shows the number and percent of secondary and adult participants by five math ability levels and by year of participation. Table V indicates that overall the adult subjects had a slightly higher math ability level than the secondary subjects at the time of the pretest. Fifty (50) percent of the 370 adult participants were of average math ability, while only 34 percent of the 571 secondary subjects were of average math ability. Thirty-six (36) percent of the secondary subjects were in the low average ability level, while only 31 percent of the adults were at that same level. Only 11 percent of the adult subjects placed at the below average level compared to 23 percent of the secondary subjects placing at the below average level.

The amount of time between pretest and posttest for the 1984-1985 and 1985-1986 school years was approximately six months. During the following years, however, students worked on an individualized basis; consequently the amount of time between pretest and posttest varied for each student. For the subsequent years, the minimum time between pretest and posttest was three months and the maximum was six months. From its inception, it was known that the method of instruction in the math lab would be on an individualized basis, therefore student contact hours in the lab were recorded. Because of the variability in duration of each student in the lab, actual contact hours became the means of recording time between pretest and posttest.

TABLE V

NUMBER OF SUBJECTS BY MATH ABILITY LEVEL BY STUDENT TYPE AND BY YEAR

	ADULT					SECONDARY				
YEAR	BELOW	LOW	AVG	HIGH	ABOVE	BELOW	LOW	AVG	HIGH	ABOVE
84-5	2	4	28	4	2	4	13	29	1	1
85-6	5	9	21	1	1	8	13	31	4	2
86-7	4	10	6	1	1	8	11	4	2	1
87-8	5	25	14	4	1	26	42	26	4	1
88-9	13	15	34	3	1	30	38	34	3	1
89-0	5	25	26	3	2	31	36	36	5	5
90-1	8	26	56	4	1	24	52	33	9	3
TOTAL	42	114	185	20	9	131	205	193	28	14
%	11.4	30.8	50	5.4	2.4	22.9	35.9	33.8	4.9	2.5

NUMBER (PERCENT) ADULT PARTICIPANTS = 370 (39)

NUMBER (PERCENT) SECONDARY PARTICIPANTS = 571 (61)

TABLE VI

MEAN AND RANGE OF MATH LAB CONTACT HOURS BY YEAR

YEAR	MEAN HOURS	RANGE
1984-1985	14.1	1.2 - 82.4
1985-1986	21.3	0.8 - 24.9
1986-1987	15.5	0.8 - 40.5
1987-1988	16.3	0.3 - 35.7
1988-1989	15.2	1.0 - 33.6
1989-1990	17.6	1.0 - 55.2
1990-1991	15.0	1.3 - 46.3
OVERALL MEAN	15.1	

Table VI, on the previous page, shows the mean and range of contact hours by year. The least mean contact hours was the 1984-1985 year with 14.1 and the greatest mean was in 1985-1986 of 21.3 hours. One would expect that students would have greater mean contact hours in 1984 through 1986 when they were attending the lab twice weekly. However, Table VI shows that mean contact hours were greater from 1987 to 1991 when students were attending only once weekly, than the first year three years when students were attending twice weekly. The math lab contact hours overall mean for the seven years was 15.1 hours.

Table VII shows the mean and range of math lab contact hours by student type and ability level. The adults had higher mean contact hours than the secondary students with 17.3 and 13.8 respectively. The adults had a wider range in contact hours with a maximum of 82.4 contact hours compared to the secondary maximum of 47.9 contact hours.

TABLE VII

MEAN AND RANGE OF MATH LAB CONTACT HOURS BY STUDENT TYPE

TYPE OF STUDENT	MEAN HOURS	RANGE
ADULTS	17.3	1.3 - 82.4
SECONDARY	13.8	0.3 - 47.9
GRAND MEAN	15.1	

Table VIII lists the mean and range of Math Lab contact hours by math ability level. The below average level students had the greater mean contact hours with 16.4. The low average level had 15.9, the average level students had 14.4, and the high average level had 13.9 contact hours. As would be expected, the above average level students had the least mean contact hours of 10.4.

TABLE VIII

MEAN AND RANGE OF MATH LAB CONTACT HOURS BY MATH ABILITY LEVEL

LEVEL OF STUDENT	MEAN HOURS	RANGE
BELOW AVERAGE	16.4	2.2 - 82.4
LOW AVERAGE	15.9	1.2 - 64.0
AVERAGE	14.4	0.3 - 55.2
HIGH AVERAGE	13.9	0.6 - 40.4
ABOVE AVERAGE	10.4	0.8 - 41.8

Results of Statistical Analysis

An analysis of covariance was used to analyze the pretest and posttest data. The pretest raw scores were used as the covariance. The covariance adjusts the posttest means for individual differences which occur on the pretest. The covariance adjusts the posttest means to what they would have been if all subjects started out equally on the pretest or in other words at the grand mean (Stevens, 1986). Covariance is used with intact groups if there is a strong correlation between the pretest and the posttest (Stevens, 1986).

The strength of association between the pretest and posttest in this study is $r = 0.821$ as determined by the Pearson Product Moment Correlation. The coefficient of Determination is $r^2 = 0.674$. In other words, posttest scores differed partly because the students differed on the pretest. By statistically removing this part of the within-variability, a smaller error term results, and hence a more powerful test. The square of the correlation between pretest and posttest, r^2, can be interpreted as "variance accounted for" (Huck, Cormier, & Bounds, 1974, p. 151). Since $r = 0.821$ and $r^2 = 0.674$, then 67.4% of the within variability on the posttest can be accounted for by variability on the pretest (Stevens, 1986).

The grouping variables were years: 1984-1985, 1985-1986, 1986-1987, 1987-1988, 1988-1989, 1989-1990, and 1990-1991; math ability levels: below average, low average, average, high average, and above average; and type of students: secondary and adult. The dependent variable was the posttest raw scores.

The analysis of covariance, run on an IBM Personal System/2 Model 60 using Systat 5.01 by Intelligent Software, resulted in the summary table shown in Table IX. The error term, reduced by the covariance from 9377.466 to 10.779, removed a large portion of the within variability due to individual differences among the students in terms of their math ability on the pretest.

The summary table shows a significant F-value for the three-way interaction of year cross level cross type at the 0.001 alpha level which exceeded the preselected 0.05 alpha level. The F-value for the two-way interactions of level cross type and year cross level were both within the alpha 0.05 level of significance. Each of the F-values for the single variables, year, level, and type were also within the alpha 0.05 level of significance. The only variable not meeting the significance level was the interaction of year x type.

TABLE IX
ANALYSIS OF COVARIANCE SUMMARY TABLE
BY YEAR BY LEVEL BY TYPE UTILIZING
THE PRETEST AS THE COVARIATE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F VALUE	P
YEAR	138.515	6	23.086	2.142	0.047*
LEVEL	135.958	4	33.990	3.153	0.014*
TYPE	50.893	1	50.893	4.722	0.030*
YEAR X LEVEL	473.716	24	19.738	1.831	0.009*
YEAR X TYPE	59.969	6	9.995	0.927	0.474
LEVEL X TYPE	129.631	4	32.408	3.007	0.018*
YEAR X LEVEL X TYPE	566.938	24	23.622	2.192	0.001*
ERROR	9377.466	870	10.779		
TOTAL (N - 2)		939			

Alpha ≤ 0.05
* = Statistical Significance Exists

To interpret the Analysis of Covariance, one must examine the adjusted posttest means. This study had unequal numbers of subjects per cell, therefore, Systat treated the study as a regression and reported adjusted least square means. Table X lists the least square means by type by level by year to show the three-way interaction. The means were rounded to the nearest tenth.

TABLE X

POSTTEST ADJUSTED LEAST SQUARE MEANS
BY TYPE BY LEVEL BY YEAR

	ADULT					SECONDARY				
YEAR	BELOW	LOW	AVG	HIGH	ABOVE	BELOW	LOW	AVG	HIGH	ABOVE
84-5	47.3	31.0	35.2	33.5	35.2	31.3	32.5	33.3	34.7	36.0
85-6	34.8	36.1	36.8	37.0	38.1	36.0	34.1	34.0	36.1	37.5
86-7	37.3	37.8	38.0	39.3	35.4	38.4	37.7	40.2	34.6	35.2
87-8	36.0	36.0	35.7	36.5	38.0	35.3	35.2	35.8	34.4	34.9
88-9	34.4	32.7	35.8	38.9	41.9	36.4	35.5	36.5	34.6	31.7
89-0	36.4	35.6	36.5	38.5	36.9	37.2	37.8	35.6	36.5	37.3
90-1	36.9	34.7	34.1	34.8	36.0	35.1	36.1	34.1	34.6	35.8

NUMBER OF ADULT PARTICIPANTS = 370

NUMBER OF SECONDARY PARTICIPANTS = 571

The follow-up analysis for a three-way interaction, an investigation of simple effects, consists of a comparison of the individual cell means from the analysis (Huck, Cormier, & Bounds, 1974). Examination of the adjusted least square means shown in Table X occurred in one-year segments due to the complexity of the current study.

The 1984-1985 secondary students' scores, shown in Table X, progressed in a positive linear direction from a low of 31.3 to a high of 36. The adults' adjusted scores for that same year were sporadic. The below average group had a high score of 47.3. The scores of the low average group dropped below those of the secondary students at that level; the average adult group scores rose above the secondary average group scores; the high and above average adults' scores dropped below the secondary scores at those levels. (See Figure 1 in Appendix G for a line graph used to assist in the interpretation of the secondary and adult adjusted least square means by math ability by type and by year.)

The 1985-1986 adjusted means, shown in Table X, reveal the adults progressing in a positive linear direction beginning with the below average mean of 34.8 to 38.1 for the above average mean. The below level mean score of the secondary students was higher than the adult below level mean score. The remaining secondary scores were below the adult scores. (See Figure 2 in Appendix G for a line graph used to assist in the interpretation of the secondary and adult adjusted least square means by math ability by type and by year)

The 1986-1987 adjusted scores in Table X show the secondary students scored higher than the adults at the below average and average levels, approximately equal at the low average level, and then below the adults in the high and above average levels. (See Figure 3 in Appendix G for a line graph used to interpret the secondary and adult adjusted least square means by math ability by type and by year.)

The 1987-1988 adjusted scores in Table X show the secondary students scored below the adult students at all levels except the average ability level. Here the secondary and adult students were approximately equal. (See Figure 4 in Appendix G for a line graph used to assist in the interpretation of the secondary and adult adjusted least square means by math ability by type and by year.)

The 1988-1989 adjusted scores in Table X show that the secondary students scored above the adults at the below average and the low average levels, reasonably close but still above the adults at the average level, and far below the adults at the high average and above average levels. (See Figure 5 in Appendix G for a line graph used to assist in the interpretation of the 1988-1989 secondary and adult adjusted least square means by math ability by type and by year.)

The 1989-1990 adjusted means from Table X show that the secondary students at the below average and low average levels scored higher than the adults. At the average level, the scores were again reasonably close, but the secondary score was lower than the adult score. The secondary students' scores remained below the adults at the high average level and then had a slightly higher score than the adults at the above average level. (See Figure 6 in Appendix G for a line graph used to assist in the interpretation of the 1989-1990 secondary and adult adjusted least square means by math ability by type and by year.)

The 1990-1991 adjusted means from Table X show that the secondary students scores were below the adult scores at the below average level, higher at the low average level, equal at the average level, and slightly below at the high average and above average levels. (See Figure 7 in Appendix G for line graph used in the interpretation of the 1990-1991 secondary and adult adjusted least square means by math ability by type and by year data.)

Table XI shows the adjusted least square means by math ability level and by student type -- secondary and adult.

TABLE XI

ADJUSTED LEAST SQUARE MEANS
BY LEVEL AND BY TYPE

TYPE OF STUDENT	MATH ABILITY LEVEL					GRAND MEAN
	BELOW AVERAGE	LOW AVERAGE	AVERAGE	HIGH AVERAGE	ABOVE AVERAGE	
ADULT	37.6	34.9	36.0	36.5	37.4	36.5
SECONDARY	35.7	35.6	36.8	35.1	35.5	35.5

Overall, the adult students' adjusted least square means were higher than the secondary students' means at the below average, high average, and above average levels. The adult scores were slightly higher at the average level and below the secondary scores at the low average level. The grand adjusted least square mean for adults was 36.5 and the grand adjusted least square mean for the secondary students was 35.5. (See Figure 8 in Appendix H for a line graph illustrating the adjusted least square means by level and by type data.)

The adjusted least square means by math ability level, shown in Table XII, indicate that the scores are fairly equal for all groups. However, the below average scores are slightly higher than all other groups including the above average group. The low average group had the lowest adjusted least square means. (See Figure 9 in Appendix I for a bar graph illustrating the adjusted least square means by math ability level data.)

TABLE XII

ADJUSTED LEAST SQUARE MEANS
BY MATH ABILITY LEVEL

MATH ABILITY LEVEL	MEAN
BELOW AVERAGE	36.6
LOW AVERAGE	35.2
AVERAGE	35.9
HIGH AVERAGE	35.8
ABOVE AVERAGE	36.4
GRAND MEAN	36.0

Adjusted least square means by year are shown in Table XIII. The lower scores occurred in 1984-1985, rose in 1985-1986, and then peaked in 1986-1987. Scores dropped and remained constant for 1987-1988 and 1988-1989. There was an increase in the adjusted scores in 1989-1990 followed by a decrease in 1990-1991. (See Figure 10 in Appendix J for a bar graph illustrating the adjusted least square means by year.)

TABLE XIII

ADJUSTED LEAST SQUARE MEANS BY YEAR

MATH ABILITY LEVEL	MEAN
1984-1985	35.0
1985-1986	35.8
1986-1987	37.4
1987-1988	35.8
1988-1989	35.8
1989-1990	36.8
1990-1991	35.2
GRAND MEAN	36.0

The ANCOVA showed that differences existed between the two types of students, between the five math ability levels, and the between the years of the study. Another concern of this study was to determine whether academic gains were made within the groups from pretest to posttest. One method of determining whether students' scores improved from pretest to posttest involves the comparison of pretest percentile scores by quartile to the posttest percentile scores by quartile. This method is used in order to avoid using grade level equivalencies which tend to place labels on students and are often considered by adult students as an embarrassment. The first or low ability quartile is comprised of the percentile scores ranging from below the 1st to the 25th percentile. The second or low average ability quartile ranges from the 26th to the 50th percentile. The third or high average ability quartile ranges from the 51st percentile to the 75th percentile. The fourth or high ability quartile ranges from the 76th percentile to above the 99th.

Table XIV contains the comparison of the pretest and posttest percentiles by quartile, showing the number and percent of the total students placing in each of the quartiles. From Table XIV one can see that 53 percent of the students in the study placed in the first quartile on the pretest and on the posttest 19.3 percent of the students remained in the first quartile. There were 25.5 percent of the students who placed in the second quartile on the pretest and on the posttest the percent increased to 32.9 for that quartile. The table indicates that 14.1 percent of the students placed in the third quartile on the pretest and on the posttest the percent of students increased to 28.6

for that quartile. The percent of students placing in the fourth quartile was 7.3 on the pretest and on the posttest the percent increased to 19.1 for that quartile. Appendix K contains pie charts illustrating the pretest and posttest percentiles by quartiles.

TABLE XIV

PRETEST AND POSTTEST PERCENTILES BY QUARTILE

QUARTILE	RANGE	PRETEST N	PRETEST %	POSTTEST N	POSTTEST %
FIRST	1 - 25	499	53.0	182	19.3
SECOND	26 - 50	240	25.5	269	32.9
THIRD	51 - 75	133	14.1	310	28.6
FOURTH	76 - 99	69	7.3	180	19.1

N = 941

Table XV presents the pretest and posttest percentiles for adult students by quartile. Of the 370 adults in the study, 44.1 percent placed in the first quartile on the pretest compared to 17.6 percent remaining in that quartile on the posttest; 33.8 percent placed in the second quartile on the pretest compared to 29.5 percent remaining in that quartile on the posttest; 14.9 percent placed in the third quartile on the pretest compared to 30.8 percent placing in that quartile on the posttest; 7.3 percent placed in the fourth quartile on the pretest compared to 22.2 percent on the posttest. Appendix L contains pie graphs depicting the percentiles by quartiles for adults.

TABLE XV

PRETEST AND POSTTEST PERCENTILES
FOR ADULT STUDENTS
BY QUARTILE

QUARTILE	RANGE	PRETEST N	PRETEST %	POSTTEST N	POSTTEST %
FIRST	1 - 25	163	44.1	65	17.6
SECOND	26 - 50	125	33.8	109	29.5
THIRD	51 - 75	55	14.9	114	30.8
FOURTH	76 - 99	27	7.3	82	22.2

N = 370

Table XVI contains the pretest and posttest percentiles for secondary students by quartile (See Appendix M for Pie Charts). Of the 571 secondary students in the study, 58.8 percent placed in the first quartile on the pretest compared to 20.5 percent remaining in that quartile on the posttest; 20.1 percent of the secondary students placed in the second quartile on the pretest compared to 28.0 percent placing in that quartile on the posttest; 12.7 percent of the secondary students placed in the third quartile on the pretest compared to 34.3 percent placing in that quartile on the posttest; and, 7.4 percent of the secondary students placed in the fourth quartile on the pretest compared to 17.2 percent placing in that quartile on the posttest.

TABLE XVI

PRETEST AND POSTTEST PERCENTILES
FOR SECONDARY STUDENTS
BY QUARTILE

QUARTILE	RANGE	PRETEST N	PRETEST %	POSTTEST N	POSTTEST %
FIRST	1 - 25	336	58.8	117	20.5
SECOND	26 - 50	115	20.1	160	28.0
THIRD	51 - 75	78	13.7	196	34.3
FOURTH	76 - 99	42	7.4	98	17.2

N = 571

The amount of time students spent in the Math Lab had a low moderate effect on the gain scores. A Pearson product-moment correlation utilized to determine whether there was a significant relationship to the number of contact hours in the math lab and the raw score differences between pretest and posttest resulted in 0.38, a low moderate correlation.

Discussion of gain scores and the use of grade level equivalents occurred only for the purpose of comparisons to the studies found in the review of the literature. First, in order to compare to Burrell's (1988) study, the pretest and posttest difference scores in the current study were examined. The mean of the pretest raw scores was 31 and the mean of the posttest raw scores was 36. Using the method Burrell used of gain score = posttest mean - pretest mean, there was a difference of 5 raw score points in the current study. This equated to approximately two grade levels, from the beginning of one year to the end of a second year, on the Wide Range Achievement Test in an average of 15.1 contact hours. The subjects in Burrell's study had a mean gain of 5.8 raw score points, a little over two years, in 22 contact hours. The hours in the current study were accumulated once weekly, during most years, while the hours in the Burrell study were accumulated on consecutive days.

Gain scores were discussed again for purposes of comparison to the Dennis (1984) study of the High School and Beyond database which found that a raw score gain of only 1.75 points was made over a two-year span, compared to a raw score gain in the current study of 5 points in 15.1 contact hours.

Results Related to Research Questions

There were five research questions raised in this study which will be discussed one at a time.

Question 1: Do the students show an academic gain from pretest to posttest while participating in the program?

The analysis of percentile scores by quartiles indicated that both secondary and adult students made academic gains while participating in the program. The pretest and posttest gain score comparisons to the Burrell (1988) and Dennis (1984) studies indicated that students were making approximately a two year grade level equivalent gain in 15.1 contact hours.

Question 2: Do the posttest scores of secondary and adult students differ?

The secondary and adult scores were different. The pretest raw scores indicated that the adult students' scores were slightly higher than those of the secondary students. After the adjustment by the analysis of covariance on the posttest scores, the adult scores remained higher than those of the secondary students. The percentile comparisons by quartile indicated that the adults had a larger percent placing in the highest quartile than secondary students did. Overall, the adult students in this study out-performed the secondary students.

Question 3: Does math ability level make a difference in posttest scores for the two types of students (secondary and adult)?

Math ability level makes a difference in the posttest scores for secondary and adult students at the different math ability levels. The secondary below average, low average, and average students tended to have higher adjusted means than the secondary high and above average students. The adult below average, high average, and above average students tended to have higher adjusted means than the adult low average and average students. The adults scored higher than the secondary students at the below average, high average, and above average levels. The secondary students scored higher than the adults at the low average and average levels.

Question 4: Do the posttest scores of students who have worked individually using computers and other technology differ from the posttest scores of students doing group-work using lecture/demonstration and paper/pencil activities?

The method and emphasis of instruction made a difference in the posttest scores of the students. The 1984-1985 and 1985-1986 method of instruction was lecture/demonstration and paper/pencil activities with an emphasis upon the basic math skills. Beginning in the fall of 1986, the method of instruction became individualized utilizing computers and other technology with an emphasis on the vocationally related math skills for each program. Scores of students peaked at the beginning year of the individualized method and dropped the following two years, but remained above the scores of the two lecture years. Scores dropped again in 1990-1991 when instruction remained on an individualized basis and emphasis was placed on the basic math skills. The 1990-1991 scores were not as low as the 1984-1985 scores.

Question 5: Do Learning Resource Center contact hours make a difference in student gain scores?

Contact hours in the Learning Resource Center had only a low moderate effect on the gain scores of students. An $r = .381$ was found and $r^2 = .145$ which means 14.5% of the variability on the posttest scores can be attributed to time spent in the Learning Resource Center.

CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF THE STUDY

The purpose of this study was to determine the effectiveness of one Learning Resource Center: Math Lab located in Tulsa County, Oklahoma which served both secondary and adult special needs students over an eight-year span from 1983-1984 through 1990-1991. Academic achievement was the main concern of this study which sought to determine whether students were making academic gains, whether there were differences between secondary and adult academic gains, whether math ability level made a difference in academic achievement, whether individualization utilizing technology or lecture/demonstration and paper/pencil activities made a difference in academic achievement, and whether contact hours made a difference in academic achievement.

A review of the literature indicated that effectiveness of programs funded under the Carl Perkins guidelines should be determined by evaluations that include planning and operational processes, results of student achievement, and results of student employment. However, the guidelines established in the amendments for evaluation were vague and confusing. Therefore, many different evaluation procedures surfaced across the states. Within Oklahoma differences existed; i.e., some schools required pretests and posttests for measuring academic achievement, while others did not. Although some schools did pretest and posttest students, there were no recorded results available.

Two studies found in the literature review measured academic achievement in a vocational setting similar to the Learning Resource Centers in Oklahoma. The Crowley's Ridge Vocational-Technical School study (Arkansas State Department of Education, 1982) reported comprehensive scores of reading, mathematics, and language without reporting individual subject scores. Therefore, the report provided no support for the current study. The Jefferson County, Ohio study (Burrell, 1988) reported over a two year math gain using the Wide Range Achievement Test, the same test used in this study. Students in the Ohio study attended the lab one-hour per day for 22 consecutive days.

The Dennis (1984) study indicated that students made a raw score gain of 1.75 over a two-year span. This study utilized the High School and Beyond database.

Subjects in the current study were secondary and adult students integrated into a full-time vocational program who received assistance in the Learning Resource Center: Math Lab and had a pretest score along with a posttest score on the Wide Range Achievement Test. There were a total of 941 subjects; 571 were secondary and 370 were adults.

The data were analyzed on an IBM Personal System/2 using Systat 5.01. The Pearson Product Moment Correlation was conducted to determine the correlation of the pretest and posttest. The strength of association was $r = 0.821$, a strong correlation. This number squared ($r^2 = 0.674$ or 67.4%) means that 67.4% of the variance on the posttest can be accounted for by the individual variability on the pretest. An Analysis of Covariance using the pretest as the covariate adjusted the posttest scores for individual differences and reduced the error term. The Analysis of Covariance indicated a significant three-way interaction of year x math ability level x type of student. Follow-up to the three-way interaction consisted of the test of simple effects which determined that the program was most effective with the secondary below average, low average, and average ability level students. The program was also effective with the adult below average, high average and above average ability level students.

An analysis of percentile scores by quartile showed that both secondary and adult students made academic gains from pretest to posttest. The number of students remaining in the low ability quartile was reduced from 53.0 percent to 19.3 percent and the number of students in the high ability quartile was increased from 7.3 percent to 19.1 percent. The number of students in the low average quartile increased from 25.5 percent to 32.9 percent and in the high average ability quartile increased from 14.1 percent to 32.9

percent. Overall, on the posttest, there was a greater percentage (53%) of adult students placing in the two higher quartiles than secondary students (51.5%).

An analysis of gain scores, used to compare the current study to the Burrell (1988) study and the Dennis (1984) study, resulted in a mean gain of approximately two grade levels or 5 raw score points in 15.1 contact hours.

Interpretation of the Findings

The review of the literature revealed that lower students make greater gains while higher students make better scores (Dennis, 1984). The below average students in this study did make greater gains, but they also had a higher adjusted least square mean than the above average students on the posttest. This difference may be due to the fact that the main emphasis of the Learning Resource Center is for the lower level students.

Analysis of the data resulted in the following findings:

1. Students made math gains while enrolled in a vocational program and participating in the Learning Resource Center Program. Percentile comparisons of pretest and posttest scores by quartile showed gains were made by both the secondary and adult students in this study. Using the Burrell (1988) method of gain score = posttest - pretest, there was approximately a two-year grade level gain in an average of 15.1 contact hours.

2. Adult scores were better in general than the secondary scores. The adults scored slightly higher than the secondary students on the pretest, and their scores remained higher on the posttest adjusted means. These findings support the Moon (1989) study.
3. Math ability level made a difference in this study. The adult below average, high average, and above average students had higher adjusted scores than the low average and average adults. The secondary below average, low average, and average students had higher adjusted scores than the high and above average secondary students. It was surprising that the adult high average and above average students made higher adjusted scores than the average and low average adults. According to Gay the "ceiling effect" does not allow the higher students as much room to gain.

The program seemed most favorable for the below average, high average and above average adults and the below average, low average, and average secondary students. The program seemed least likely to help the low average adults and the high and above average secondary students.

It is reasonable for the scores of the lower level students to improve significantly because those are the ones for whom the program was designed. There is no explanation why the adult low average and average students made less gains than the other levels of adult students. Neither is there an explanation why the adult high average and above average students had higher adjusted scores than the secondary high average and above average students.

4. Students using an individualized method of instruction utilizing vocationally related math had scores slightly higher than students doing group-work using lecture/ demonstration and paper/pencil activities using basic math skills. This concept was reinforced during the year that the math specialist was out for an extensive period and basic math was once again reinforced. Scores fell during that year. Since basic math skills were emphasized in group-work the first time and on an individualized basis the second time, it appears from this study that the vocationally related math may be the key to the difference in student achievement gains rather than the method of instruction. This finding supports the special needs individuals' reality set which requires relevance in learning as described by Schulz (1972).

5. Time was not found to be a major factor in this study. Possibly the individualized method of instruction removed part of the time factor. Those who learn quickly finished their individual plan in the least amount of time and could make as good or better scores than those who needed more time to complete their study plan.

6. Both secondary and adult students in this study made significant gains. The secondary and adult students were integrated in the same vocational programs and in the Learning Resource Center. Moon's (1989) study concluded that adults and secondary students made greater gains when in separate classes. The findings of this study neither refutes nor supports the Moon study on this point.

Conclusions

The 1990 Carl D. Perkins Vocational and Technology Act mandates the establishment of measures to show student performance in academic and vocational skills. The results of this study demonstrate that academic gains in mathematics on a standardized test can be accomplished in the vocational setting using vocationally related math skills. This finding should indicate to vocational educators that academics can be measured and significant achievement gains shown.

This study also indicates that secondary and adult students can make significant gains when integrated in the same programs and math classes. Vocational educators should be able to use this knowledge in planning and organizing programs. Adult and secondary students integrated in the same programs are more cost effective, saving space, personnel, and supplies. On the other hand, there may be some licensure procedures which require the separation of secondary and adult students in which case they should obviously be separated.

The use of technology was not indicated as a significant factor in this study, however its use did allow larger numbers of students to be served. Thereby, making the program more efficient and effective. The computer software allowed each student to move ahead at their own individual rate. The management system of the software allowed immediate diagnosis, results of progress, and generation of reinforcement activities. Software packages implemented in 1990-1991 allowed greater concentration on problem solving and higher order thinking skills. Vocational educators should consider these findings on the utilization of technology when planning, developing, or improving their programs. Vocational educators should be sure that the software selected for their labs are consistent with the goals and objectives of the instructional process. Software should meet the needs of the students providing tutorial assistance, drill/practice, immediate feedback, reinforcement activities, and a management system.

One factor found prevalent in this study was the difference between the use of basic math skills and vocationally related math skills in the Learning Resource Center. Students made greater gains when using vocationally related math and had less cause for concern about studying math at vo-tech. This should indicate to vocational educators that students can and will learn when they have an immediate need or direct application for that learning (relevance in learning). Therefore, Learning Resource Centers should be linked closely with the vocational programs in order to maximize the need for the skill being taught and the immediate application of that skill to the vocation.

This study, overall, indicates that the Learning Resource Center was effective in improving the academic skills of both secondary and adult special needs students.

Recommendations

Although this study was not an experimental design and findings are not conclusive, the implications can be of considerable assistance to vocational educators. This study merely touches the surface of the types of inquiry needed to in order to determine the strengths and weaknesses of Learning Resource Centers and other vocational programs.

Further studies are needed on the integration of secondary and adult students in the same classes and the use of technology as opposed to paper/pencil activities. A similar study needs to be conducted in the reading labs testing reading and communication skills. Studies need to be conducted in the vocational programs as well to measure competencies, academics, and attitudes.

Further studies are needed in order to determine whether significant academic gains are made when more of the impacting variables are controlled. Future studies need to be experimental in design thus controlling variables so that conclusions can be more definitive.

Learning Resource Centers can be a viable and important part of the curriculum offered in the vocational schools. It is recommended that the centers be continued in the schools where established and implemented in schools which do not have such service for their students. Also, some established centers may need to be expanded in order to serve more students.

The changes in the 1990 Carl Perkins Technology and Education Act indicate a change in the nature of the Learning Resource Centers in Oklahoma. The law does not specify that students receiving services be at the 25th percentile and below, which indicates that the centers may serve all students. Opening the centers to all students supports the act's provisions for academic achievement for all students and provides a place for that achievement to be measured.

The role of the coordinator of the centers will change as the purposes and clientele serviced change. The coordinator will need to expand the curriculum for the higher achieving students and become a resource to the vocational instructors in methods of teaching the academic skills within the vocational content.

Finally, academic achievement is only one measure of achievement and in this researchers mind should not stand alone. Vocational educators have traditionally measured planning/operational processes, vocational competencies, and student employment. Academic achievement included with these measures will form a more accurate picture of what is happening in the vocational setting and provide the measure of effectiveness and achievement desired by those who seek accountability.

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APPENDIXES

APPENDIX A

LETTER REQUESTING PERMISSION TO USE STUDENT DATA

TO: Sheila Hellen

FROM: Jane Burgess

DATE: October 9, 1990

RE: **Use of Southeast Campus Student Data for Dissertation**

Before meeting with my doctoral committee to propose my dissertation project, I would like to have permission to use the pre- and post- test data collected on students in the math lab at Southeast. All students would be treated anonymously, by being assigned a number which identifies their pretest score and their posttest score. Once that is done the names will be erased so that individuals cannot be identified. This information without names will be copied to my personal computer at home and all work from that point will be handled by a special statistical package.

I have two different proposals planned to present to my committee. One would involve using data from the 1990-1991 school year. This study would report test gains by ability level and by secondary and adult. The second proposal would use all the data collected from 1983-1984 to the present and would identify any trends that may have occurred over that eight year span. This would be the most beneficial study revealing many different aspects about the math lab and the services that students have received.

It is my guess that the committee will prefer the trend analysis. At any rate, I need to know if Tulsa Vo-Tech is willing to allow me to use the student data.

Thank you for your consideration and support.

APPENDIX B

BASIC MATH SKILLS

TULSA VOCATIONAL-TECHNICAL SCHOOL
SOUTHEAST CAMPUS

LEARNING RESOURCE CENTER: MATH LAB

BASIC MATHEMATICS SKILLS

WHOLE NUMBERS
- ADDITION BASIC FACTS
- SUBTRACTION BASIC FACTS
- MULTIPLICATION BASIC FACTS
- DIVISION BASIC FACTS
- PLACE VALUE SYSTEM
- ADDITION PROPERTIES
- MULTIPLICATION PROPERTIES
- ADDITION COMPUTATION
- SUBTRACTION COMPUTATION
- MULTIPLICATION COMPUTATION
- DIVISION COMPUTATION

FRACTIONS AND MIXED NUMBERS
- MEANING OF FRACTIONS
- COMMON DENOMINATORS
- CHANGE TO HIGHER TERMS
- COMPARISON FOR SIZE
- REDUCE TO LOWER TERMS
- IMPROPER TO MIXED
- ADDITION
- SUBTRACTION
- MIXED TO IMPROPER
- MULTIPLICATION
- DIVISION

DECIMALS
- MEANING
- READ DECIMALS
- WRITE DECIMALS
- ROUNDING
- COMPARES FOR SIZE
- ADDITION
- SUBTRACTION
- MULTIPLICATION
- DIVISION

CONVERSION OF
- FRACTION/DECIMAL
- FRACTION TO DECIMAL
- DECIMAL TO FRACTION
- DECIMAL/FRACTION

PERCENT
- UNDERSTANDING A PERCENT
- DECIMAL TO PERCENT
- FRACTION TO PERCENT
- PERCENT TO DECIMAL
- PERCENT TO FRACTION
- FIND A PERCENT OF A NUMBER
- FIND A NUMBER WHEN A PERCENT IS KNOWN
- FIND WHAT PERCENT ONE NUMBER IS OF ANOTHER

RATIO AND PROPORTION
- MEANING OF RATIO
- SIMPLEST FORM
- DECIMAL RATIOS
- MEANING OF PROPORTION
- SOLVING PROPORTION

APPENDIX C

TAXONOMY OF VOCATIONALLY RELATED MATH SKILLS BY VOCATIONAL PROGRAM

EXPLANATION OF THE TAXONOMY OF VOCATIONALLY RELATED MATH SKILLS

Math concepts are listed down the left side of the page and abbreviated names of vocational programs are listed across the top below the title. An "*" at the intersection of a math skill and vocational program indicates that the skill is required or strongly recommended knowledge in that occupation. Below is an explanation of the program abbreviations:

AFCS - Automotive Fundamental and Counter Sales

AFEB - Auto Front-End and Brakes (Now Automotive Suspension, Steering and Brakes

ATD - Automotive Transmission and Differential

ATU - Automotive Tune-up, Electricity and Air Conditioning

MTCN - Machine Tool: Computer Numerical Control

MTML - Machine Tool: Milling

MTTR - Machine Tool: Turning

ITEE - Industrial Technology: Electricity/Electronics

ITMH - Industrial Technology: Mechanics/Hydraulics and Pneumatics

Cos - Cosmetology

COMP - Microcomputers

MCY - Motorcycles and Small Engines

CC - Cashier Checker

TULSA COUNTY AREA VOCATIONAL-TECHNICAL SCHOOL DISTRICT NO. 18
SOUTHEAST CAMPUS - BROKEN ARROW, OKLAHOMA

LEARNING RESOURCE CENTER: MATHEMATICS
TAXONOMY OF VOCATIONALLY RELATED MATH SKILLS BY VOCATIONAL PROGRAM

MATH CONCEPT	**AFCS**	**AFEB**	**ATD**	**ATU**	**MTCN**	**MTML**	**MTTR**	**ITEE**	**ITMH**	**COS**	**COM**	**MCY**	**CC**
WHOLE NUMBERS													
ADDITION FACTS	*	*	*	*	*	*	*	*	*	*	*	*	*
SUBTRACTION FACTS	*	*	*	*	*	*	*	*	*	*	*	*	*
MULTIPLICATION FACTS	*	*	*	*	*	*	*	*	*	*	*	*	*
DIVISION FACTS	*	*	*	*	*	*	*	*	*	*	*	*	*
PLACE VALUE	*	*	*	*	*	*	*	*	*	*	*	*	*
ADDITION PROPERTIES	*	*	*	*	*	*	*	*	*	*	*	*	*
ADD COMPUTATION	*	*	*	*	*	*	*	*	*	*	*	*	*
SUB COMPUTATION	*	*	*	*	*	*	*	*	*	*	*	*	*
MUL COMPUTATION	*	*	*	*	*	*	*	*	*	*	*	*	*
DIV COMPUTATION	*	*	*	*	*	*	*	*	*	*	*	*	*
USING CALCULATOR	*	*	*	*	*	*	*	*	*	*	*	*	*
FRACTIONS/MIXED NUMBERS													
FRACTION MEANING	*	*	*	*	*	*	*	*	*	*	*	*	
COMPARES FOR SIZE	*	*	*	*	*	*	*	*	*	*	*	*	
LOWER TERMS	*	*	*	*	*	*	*	*	*	*	*	*	
HIGHER TERMS	*	*	*	*	*	*	*	*	*	*	*	*	
COMMON DENOM	*	*	*	*	*	*	*	*	*	*	*	*	
IMPROPER TO MIXED	*	*	*	*	*	*	*	*	*	*	*	*	
MIXED TO IMPROPER	*	*	*	*	*	*	*	*	*	*	*	*	

MATH CONCEPT	AFCS	AFEB	ATD	ATU	MTCN	MTML	MTTR	ITEE	ITMH	COS	COM	MCY CC	
FRAC/MIXED, cont'd													
ADDITION/MIXED FRACTIONS	*	*	*	*	*	*	*	*	*	*	*	*	
SUBTRACTION/MIXED FRACTI	*	*	*	*	*	*	*	*	*	*	*	*	
MULTIPLICATION/MIXED FRA	*	*	*	*	*	*	*	*	*	*	*	*	
DIVISION/MIXED FRACTIONS	*	*	*	*	*	*	*	*	*	*	*	*	
DECIMAL FRACTIONS													
DECIMAL MEANING	*	*	*	*	*	*	*	*	*	*	*	*	
READS DECIMALS	*	*	*	*	*	*	*	*	*	*	*	*	
WRITES DECIMALS	*	*	*	*	*	*	*	*	*	*	*	*	
ROUNDS DECIMALS	*	*	*	*	*	*	*	*	*	*	*	*	
COMPARES FOR SIZE	*	*	*	*	*	*	*	*	*	*	*	*	
COMPARES/ORDER	*	*	*	*	*	*	*	*	*	*	*	*	
ADDITION	*	*	*	*	*	*	*	*	*	*	*	*	
SUBTRACTION	*	*	*	*	*	*	*	*	*	*	*		
MULTIPLICATION	*	*	*	*	*	*	*	*	*	*	*	*	
DIVISION	*	*	*	*	*	*	*	*	*	*	*	*	
FRACTION TO DECIMAL	*	*	*	*	*	*	*	*	*	*	*	*	
DECIMAL TO FRACTION	*	*	*	*	*	*	*	*	*	*	*	*	
USING CALCULATOR	*	*	*	*	*	*	*	*	*	*	*	*	
PERCENT													
MEANING OF PERCENT	*	*	*	*	*	*	*	*	*	*	*	*	*
DECIMAL TO PERCENT	*	*	*	*	*	*	*	*	*	*	*	*	*
PERCENT TO DECIMAL	*	*	*	*	*	*	*	*	*	*	*	*	*
FRACTION TO PERCENT	*	*	*	*	*	*	*	*	*	*	*	*	*

MATH CONCEPT	AFCS	AFEB	ATD	ATU	MTCN	MTML	MTTR	ITEE	ITMH	COS	COM	MCY	CC
PERCENT, continued													
FIND PERCENT OF A NUMBER	*	*	*	*	*	*	*	*	*	*	*	*	*
FIND NUMBER WHEN % IS KNOWN	*	*	*	*	*	*	*	*	*	*	*	*	*
FIND % A NUMBER IS OF ANOTHER	*	*	*	*	*	*	*	*	*	*	*	*	*
AVERAGE/ESTIMATE	*	*	*	*	*	*	*	*	*	*	*	*	*
USING CALCULATOR	*	*	*	*	*	*	*	*	*	*	*	*	*
RATIO/PROPORTION													
MEANING OF RATIO		*	*	*	*	*	*	*	*	*	*	*	
SIMPLEST FORM		*	*	*	*	*	*	*	*	*	*	*	
DECIMAL RATIOS		*	*	*	*	*	*	*	*	*	*	*	
MEANING OF PROPORTION		*	*	*	*	*	*	*	*	*	*	*	
SOLVE PROPORTIONS		*	*	*	*	*	*	*	*	*	*	*	
FORMULAS													
CONCEPTS		*	*	*	*	*	*	*	*	*	*	*	
SEQUENCE OF OPERATIONS		*	*	*	*	*	*	*	*	*	*	*	
USING CALCULATOR		*	*	*	*	*	*	*	*	*	*	*	
RADICALS													
CONCEPT					*	*	*	*	*		*	*	
TABLES					*	*	*	*	*		*	*	
USING CALCULATOR					*	*	*	*	*		*	*	

MATH CONCEPT	AFCS	AFEB	ATD	ATU	MTCN	MTML	MTTR	ITEE	ITMH	COS	COM	MCY	CC
SCIENTIFIC NOTATION													
MEANING								*	*		*		
USING CALCULATOR								*	*		*		
GEOMETRIC LINES AND SHAPES													
LINES, ANGLES		*	*	*	*	*	*		*	*			
PLANE SHAPES					*	*	*		*				
SOLID SHAPES				*	*	*	*		*				
TRIANGLES													
RIGHT TRIANGLES					*	*	*	*	*			*	
ACUTE TRIANGLES					*	*	*	*	*			*	
OBLIQUE TRIANGLES					*	*	*	*	*			*	
USING CALCULATOR					*	*	*	*	*			*	
MEASUREMENT: DIRECT/COMPUTED													
LINEAR MEASURE	*	*	*	*	*	*	*		*	*		*	
ANGULAR MEASURE		*			*	*	*		*	*		*	
CIRCULAR MEASURE				*	*	*	*		*	*			
SURFACE MEASURE				*	*	*	*		*	*		*	
VOLUME MEASURE	*	*	*	*	*	*	*		*	*		*	
USING CALCULATOR	*	*	*	*	*	*	*		*	*		*	
MEASURE:PRECISION													
DIMENSIONING(+/-)	*	*	*	*	*	*	*		*			*	
SCALES: 8THS, 16THS, 32NDS,	*	*	*	*	*	*	*		*			*	

MATH CONCEPT	AFCS	AFEB	ATD	ATU	MTCN	MTML	MTTR	ITEE	ITMH	COS	COM	MCY	CC
MEAS:PRECISION, cont'd													
SCALES: 64THS					*	*	*		*			*	
SCALES:													
10THS, 100THS	*	*	*	*	*	*	*		*			*	
MICROMETER:													
INSIDE/OUTSIDE	*	*	*	*	*	*	*		*			*	
DEPTH	*	*	*	*	*	*	*		*			*	
VERNIER CALIPER	*	*	*	*	*	*	*		*			*	
GAGE BLOCKS					*	*	*		*				
METRIC SYSTEM													
PREFIXES	*	*	*	*				*	*	*	*	*	
CONVERT METRIC	*	*	*	*				*	*	*	*	*	
METRIC TO													
CUSTOMARY	*	*	*	*				*	*	*	*	*	
CUSTOMARY TO													
METRIC	*	*	*	*				*	*	*	*	*	
FINANCE													
MONEY CALCULATIONS	*	*	*	*						*	*		*
TIME CALCULATIONS	*	*	*	*	*	*	*	*	*	*	*	*	*
COSTS/DISCOUNTS	*									*			*
PAYROLLS/TAXES	*	*	*	*	*	*	*	*	*	*	*	*	*
GRAPHS/STATISTICS													
BAR GRAPHS	*										*		
LINE GRAPHS	*										*		
CIRCLE GRAPHS	*										*		
MEAN, MEDIAN, MODE	*										*		

APPENDIX D

LEARNING RESOURCE CENTER: MATH LAB

1984 - 1985 CLASS SCHEDULE

APPENDIX D

REPRODUCED 1984-1985 MATH LAB SCHEDULE

TULSA COUNTY AREA VOCATIONAL-TECHNICAL SCHOOL DISTRICT #18
SOUTHEAST CAMPUS,
LEARNING RESOURCE CENTER: MATH LAB 1984-1985 CLASS SCHEDULE

DAY \ TIME	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8:15-9:00	AFEB/ AFCS	COS	AFEB/ AFCS	COS	PROGRAM VISITS
9:00-9:45	EE/MHP & MICROS	ATU	EE/MHP & MICROS	ATU	GED/ACT
9:45-10:30	ATD/ MCY	CNC/TR	ATD/ MCY	CNC/TR	DROP-INS
LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
12:15-1:00	AFEB/ AFCS	COS	AFEB/ AFCS	COS	PROGRAM VISITS
1:00-1:45	EE/MHP & MICROS	ATU	EE/MHP & MICROS	ATU	GED/ACT
1:45-2:30	ATD/ MCY	CNC/TR	ATD/ MCY	CNC/TR	DROP-IN
2:30-4:00	DROP-INS	DROP-INS	DROP-INS	DROP-INS	DROP-INS

AFCS = AUTO FUNDAMENTALS AND COUNTER SALES
AFEB = AUTO FRONT-END AND BRAKES
ATU = AUTO TUNE-UP
ATD = AUTO TRANSMISSION/DIFFERENTIAL
COS = COSMETOLOGY
EE = INDUSTRIAL TECHNOLOGY: ELECTRONICS/ELECTRICITY
MHP = INDUSTRIAL TECHNOLOGY: MECHANICS/HYDRAULICS/ PNEUMATICS
CNC = MACHINING - COMPUTER NUMERICAL CONTROL
TR = MACHINING - TURNING
MICROS = MICROCOMPUTERS
MCY = MOTORCYCLES

APPENDIX E

LEARNING RESOURCE CENTER: MATH LAB

INVENTORY OF SOFTWARE, FILMSTRIPS

VIDEOS

APPLE SOFTWARE

SOFTWARE TITLE	PRODUCER	DATE PURCHASED
Basic Math Computation	Educational Activities	11-28-83
Long Division	Educational Activities	11-23-83
Percentages	Educational Activities	11-28-83
Equations	Educational Activities	11-23-83
Algebraic Expressions	Educational Activities	11-23-83
Learning Styles	Educational Activities	02-29-84
Change Maker	Career Aids, Inc	07-23-84
Micro Survival Math	Career Aids, Inc	07-23-84
Blueprint Reading	Career Aids, Inc	07-23-84
Computer Math	Career Aids, Inc	07-23-84
Personal Money Series	Career Aids, Inc	07-23-84
The Money Manager	Career Aids, Inc	07-23-84
Business Package	Career Aids, Inc	07-23-84
Gears	Sunburst	04-10-85
ACT Preparation	K-12 Micromedia	05-01-85
Basic Electricity	k-12 Micromedia	05-01-85
Understanding Checkbook & Statements	Gamco Industries, Inc	05-20-85

IBM SOFTWARE

SOFTWARE TITLE	PRODUCER	DATE PURCHASED
Fact Track	IBM	12-14-83
SRA, CDIM, Math Games I	IBM	12-14-83
SRA, CDIM, Math Games II	IBM	12-14-83
Multiplication Tables	IBM	12-14-83
Free Enterprise	IBM	12-14-83
Hot Dog Stand	Sunburst	04-26-83
Math Blaster	Davidson & Associates	02-28-84
Metric I:Fund of Math	Classroom Consortia	05-15-84
Metric II: Math App	Classroom Consortia	05-15-84
Metric III: Units of Mea	Classroom Consortia	05-15-84
Metric IV: Linear Units	Classroom Consortia	05-15-84
Metric V: Area/Dens	Classroom Consortia	05-15-84
Algebra Arcade	Wadsworth Elec Pub Co	05-22-84
SAT Preparation	Center for Humanities	01-15-85
Computer Drill & Instruc Level D	SRA	05-26-85
Pizza Fractions	HRM Software	07-03-85
Learning Ctr Report Sys	Sooner Microcomputer	12-17-85
Lotus 1-2-3	Lotus Dev Corp	06-18-86

SOFTWARE, continued

SOFTWARE TITLE	PRODUCER	DATE PURCHASED
Algebra, Vol I, II, III	McGraw Hill/Webster	12-12-86
IBM SOFTWARE, continued		
Trigonometry,Vol I	McGraw Hill/Webster	12-12-86
Geometry, Vol I, II	McGraw Hill/Webster	12-12-86
Physics, Vol I, II	McGraw Hill/Webster	12-12-86
Pre-Vocational Math	Career Aids, Inc	04-15-88
Blueprint Reading I	Career Aids, Inc	04-15-88
Blueprint Reading II	Career Aids, Inc	04-15-88
Blueprint Reading/Details	Career Aids, Inc	04-15-88
Voc Math/Automotive	Career Aids, Inc	04-15-88
Shop Math	Career Aids, Inc	04-15-88
Whole Numbers	Gamco	05-31-88
Addition & Subtraction	Gamco	05-31-88
Multiplication & Division	Gamco	05-31-88
Fractions: Add & Subtract	Gamco	05-31-88
Fractions: Mult & Div	Gamco	05-31-88
Rounding	Gamco	05-31-88
Decimals	Gamco	05-31-88
Perimeter, Area, & Volume	Gamco	05-31-88
Learning Place Value	Mindscape, Inc	06-02-88
Word Perfect	Word Perfect, Corp	04-04-89
GED Mathematics	Queue, Inc	04-04-89
GED Social Studies	Queue, Inc	04-04-89
GED Science	Queue, Inc	04-04-89
Money	Gamco	09-17-90
Word Perfect 5.1	Word Perfect Corp	01-24-90
Applied Physics	I. T. E.	09-17-90
Everyday Math	I. T. E.	05-20-90
Computer Drill & Insruc Level C	SRA	11-15-90

FILMSTRIPS

FILMSTRIP TITLE	PRODUCER	DATE PURCHASED
Fractions A New Approach	Society/Visual Ed	11-29-83
New Dimensions Dec/Perc	Society/Visual Ed	11-29-83
Basic Measurement Math	Photocom Productions	12-20-83
Metrics in the Shop	Photocom Productions	12-20-83
Digital Codes & Numb Sys	Career Aids, Inc	07-23-84
Math Skills for Real Wor	Center for Humanities	02-15-85
Shop Math	Bergwall Productions	07-03-85

FILMSTRIPS, continued

FILMSTRIP TITLE	PRODUCER	DATE PURCHASED
Prepare for Comp Test	Guidance Associates	04-12-87
Metal Shop	Career Aids, Inc	06-14-88
Electrical Shop	Career Aids, Inc	06-14-88
Own/Oper Own Business	Vocatnl Media Assoc	01-26-88
Basic Measurement Math	Vocatnl Media Assoc	01-26-99
Business Math Skills	Vocatnl Media Assoc	01-26-88
The Right Triangle	Natl Innavative Media	06-30-89
The Circle	Natl Innavative Media	06-30-89

VIDEO TAPES

VIDEO TITLE	PRODUCER	DATE PURCHASED
Essential Study Skills	Guidance Associates	04-12-87
How To use Your Time and Improve your Grades	Guidance Associates	04-12-87
Study Skills For Math	Carolina Biological	05-20-87
Scientific Notation	Carolina Biological	05-20-87
Intro to Business	Voctnl Media Assoc	01-26-88
The Paycheck Puzzle	Voctnl Media Assoc	01-26-88
Measuring Elec Quant	Voctnl Media Assoc	03-21-88
Video Review for ASVAB	Guidance Associates	05-06-88
Review for GED	Career Aids, Inc	06-14-88
Math Review for ACT	Career Aids, Inc	06-14-88
Verbal Review for ACT	Career Aids, Inc	06-14-88
Be a Winner: Self Motivation	Sunburst Communications	06-20-88
Integrated Math Series (Nine Videos)	Math Tutor	06-09-89
Geometry	Gamco Industries, Inc	06-13-89
Reading A Ruler	Natl Innavative Media	06-30-89
The Math Tutor (Seven Videos)	Lakeshore Lifeskills	03-05-90
Applied Mathematics	C.O.R.D.	11-22-90

APPENDIX F

LEARNING RESOURCE CENTER: MATH LAB

BASIC MATH SKILLS OUTLINE

LEARNING RESOURCE CENTER: MATH LAB
BASIC MATHEMATICS REVIEW

1.0 GENERAL
- 1.1 INTRODUCTION TO FILING SYSTEM
- 1.2 OKLAHOMA LRC CATALOGS
- 1.3 DIAGNOSTIC SURVEY
- 1.4 DIAGNOSTIC SURVEY ANSWER KEY
- 1.5 WORKSHEET ANSWER KEYS

2.0 WHOLE NUMBERS
- 2.0A PLACEMENT
- 2.0B REVIEW
- 2.1 TIPS
- 2.1 ADDITION FACTS
- 2.2 TIPS
- 2.2 SUBTRACTION FACTS
- 2.3 TIPS
- 2.3 MULTIPLICATION FACTS
- 2.4 TIPS
- 2.4 DIVISION FACTS
- 2.5 TIPS
- 2.5 PLACE VALUE
- 2.6 TIPS
- 2.6 ADDITION PROPERTIES
- 2.7 TIPS
- 2.7 MULTIPLICATION PROPERTIES
- 2.8 TIPS
- 2.8 ADDITION COMPUTATION
- 2.9 TIPS
- 2.9 SUBTRACTION COMPUTATION
- 2.10 TIPS
- 2.10 MULTIPLICATION COMPUTATION
- 2.11 TIPS
- 2.11 DIVISION COMPUTATION

3.0 FRACTIONS AND MIXED NUMBERS
- 3.0A PLACEMENT
- 3.0B REVIEW
- 3.1 TIPS
- 3.1 MEANING
- 3.2 TIPS
- 3.2 COMMON DENOMINATORS
- 3.3 TIPS
- 3.3 CHANGE TO HIGHER TERMS
- 3.4 TIPS
- 3.4 COMPARES FOR SIZE
- 3.5 TIPS
- 3.5 COMPARES FOR ORDER

3.6 TIPS
3.6 REDUCE TO LOWER TERMS
3.7 TIPS
3.7 IMPROPER TO MIXED
3.8 TIPS
3.8 ADDITION
3.9 TIPS
3.9 SUBTRACTION
3.10 TIPS
3.10 MIXED TO IMPROPER
3.11 TIPS
3.11 MULTIPLICATION
3.12 TIPS
3.12 DIVISION

4.0 DECIMALS
4.0A PLACEMENT
4.0B REVIEW
4.1 TIPS
4.1 MEANING
4.2 TIPS
4.2 READ DECIMALS
4.3 TIPS
4.3 WRITE DECIMALS
4.4 TIPS
4.4 ROUNDING
4.5 TIPS
4.5 COMPARES FOR SIZE
4.6 TIPS
4.6 COMPARES FOR ORDER
4.7 TIPS
4.7 ADDITION
4.8 TIPS
4.8 SUBTRACTION
4.9 TIPS
4.9 MULTIPLICATION
4.10 TIPS
4.10 DIVISION

5.0 CONVERSION OF FRACTION/DECIMAL
5.0A PLACEMENT
5.0B REVIEW
5.1 TIPS
5.1 FRACTION TO DECIMAL
5.2 TIPS
5.2 DECIMAL TO FRACTION

Basic Mathematics
Page 3

5.3 TIPS
5.3 DECIMAL/FRACTION EQUIVALENT
5.4 TIPS
5.4 FRACTION/DECIMAL
5.5 TIPS
5.5 RATIO/PROPORTION

6.0 PERCENT
6.0A PLACEMENT
6.0B REVIEW
6.1 TIPS
6.1 UNDERSTANDING A PERCENT
6.2 TIPS
6.2 DECIMAL TO PERCENT
6.3 TIPS
6.3 FRACTION TO PERCENT
6.4 TIPS
6.4 PERCENT TO DECIMAL
6.5 TIPS
6.5 PERCENT TO FRACTION
6.6 TIPS
6.6 FIND A PERCENT OF A NUMBER
6.7 TIPS
6.7 FIND A NUMBER WHEN A PERCENT IS KNOWN
6.8 TIPS
6.8 FIND WHAT PERCENT ONE NUMBER IS OF ANOTHER

APPENDIX G

GRAPHS OF ADJUSTED LEAST SQUARE MEANS

BY YEAR BY LEVEL BY TYPE

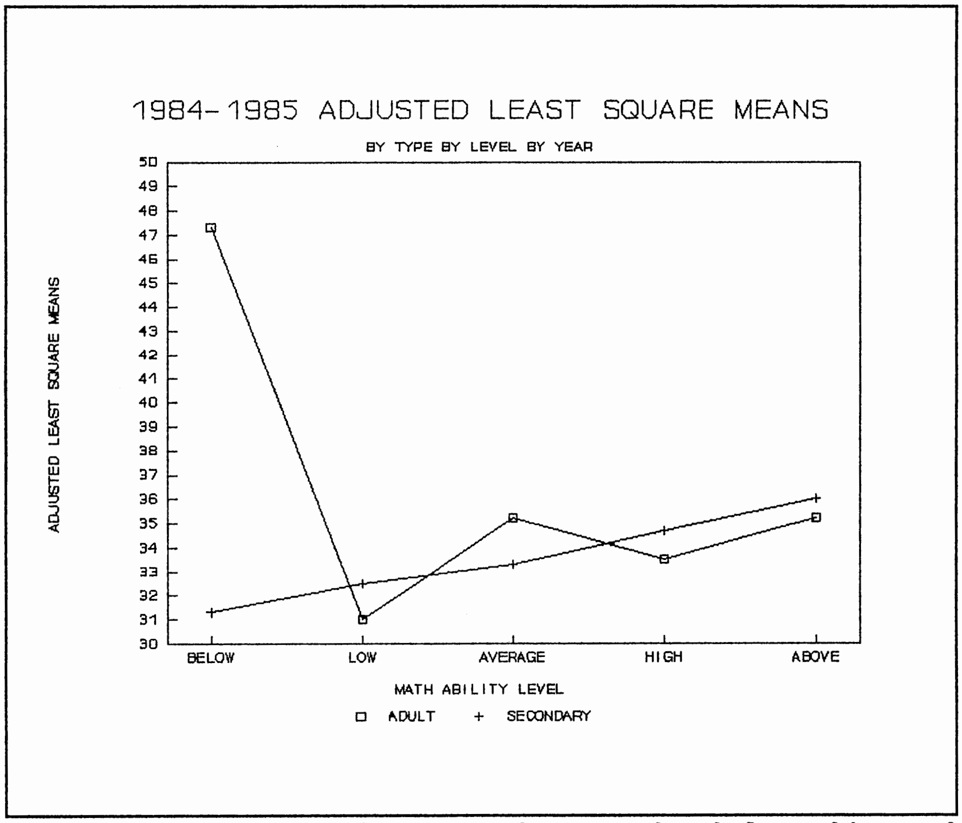

Figure 1: 1984-1985 Secondary and Adult Adjusted Least Square Means by Math Ability by Type by Year

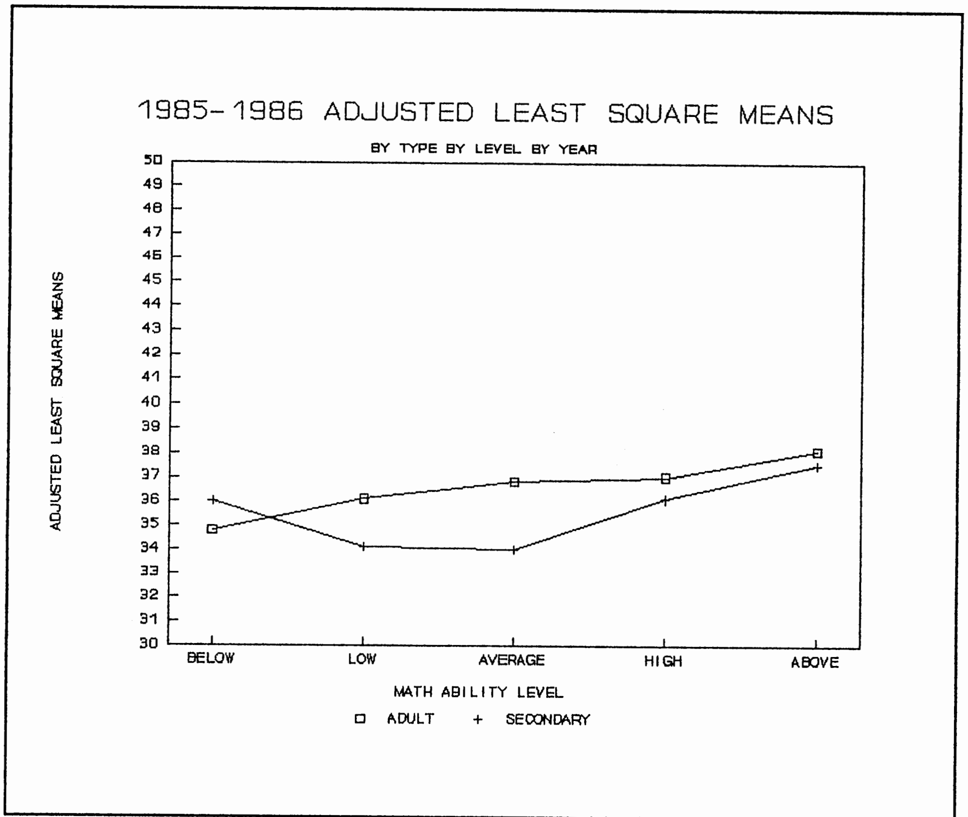

Figure 2: 1985-1986 Secondary and Adult Adjusted Least Square Means by Math Ability

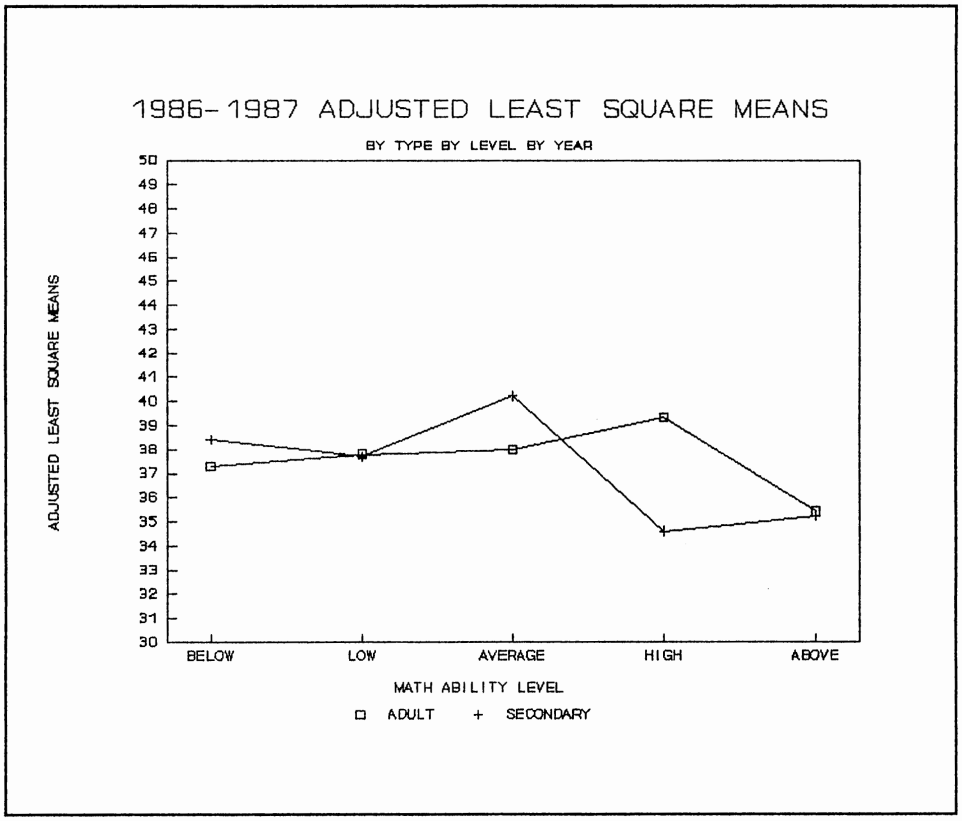

Figure 3: 1986-1987 Secondary and Adult Adjusted Least Square Means by Math Ability by Type by Year

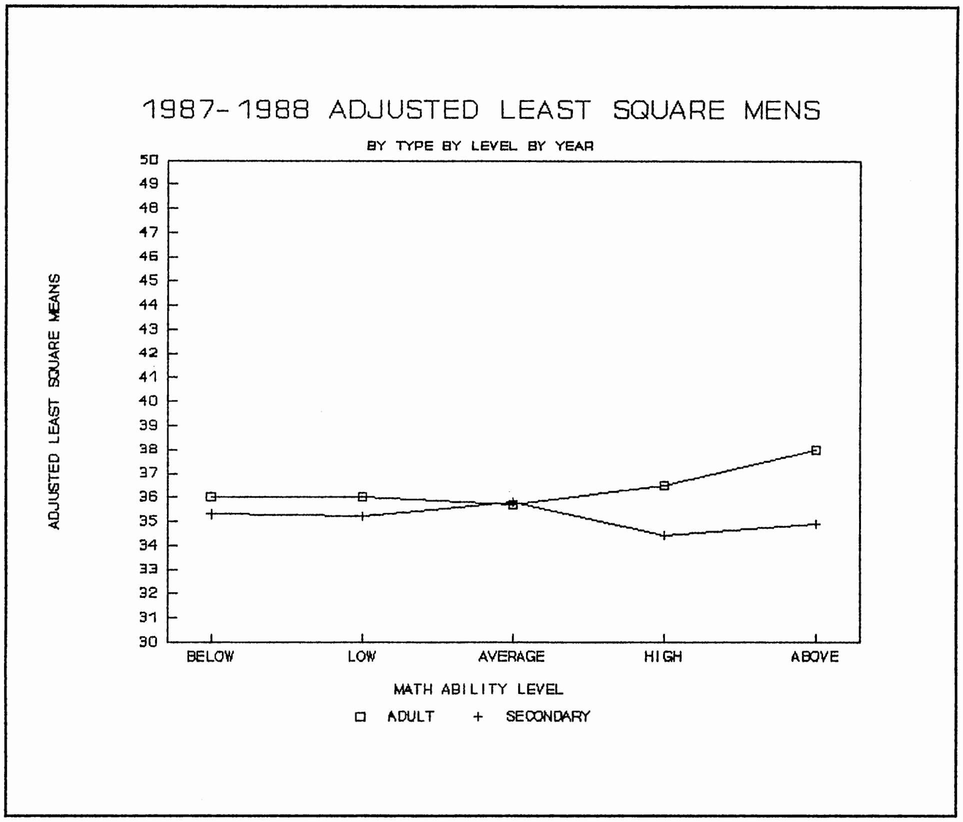

Figure 4: 1987-1988 Secondary and Adult Adjusted Least Square Means by Math Ability by Type by Year

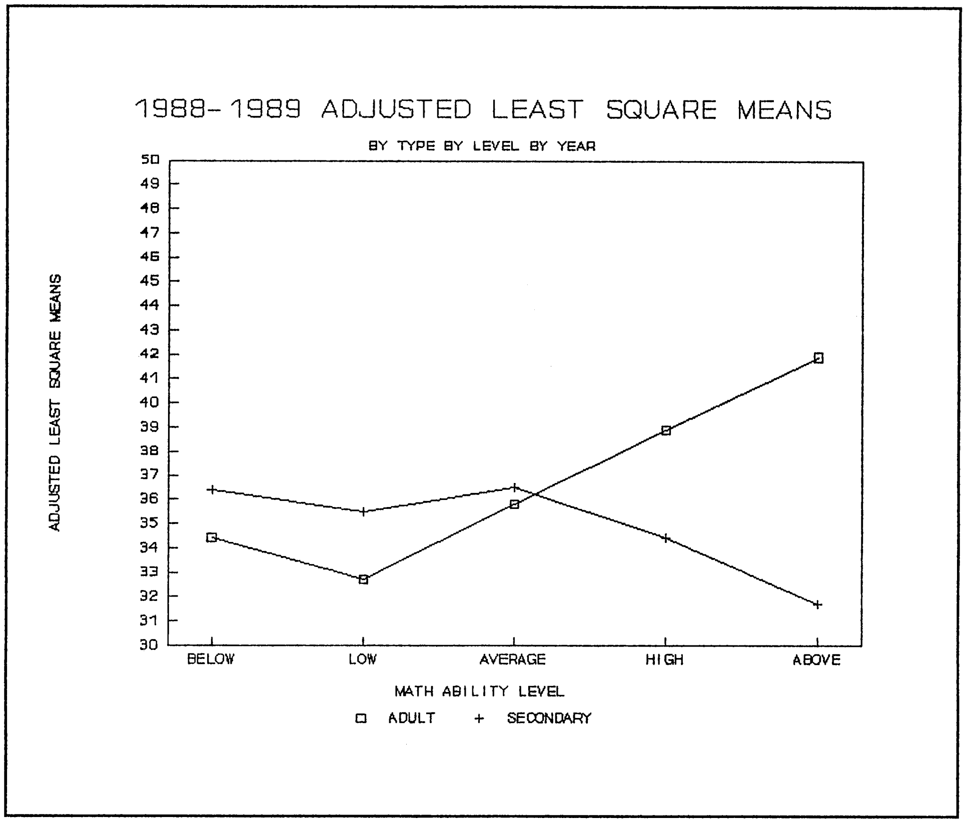

Figure 5: 1988-1989 Secondary and Adult Adjusted Least Square Means by Math Ability by Type by Year

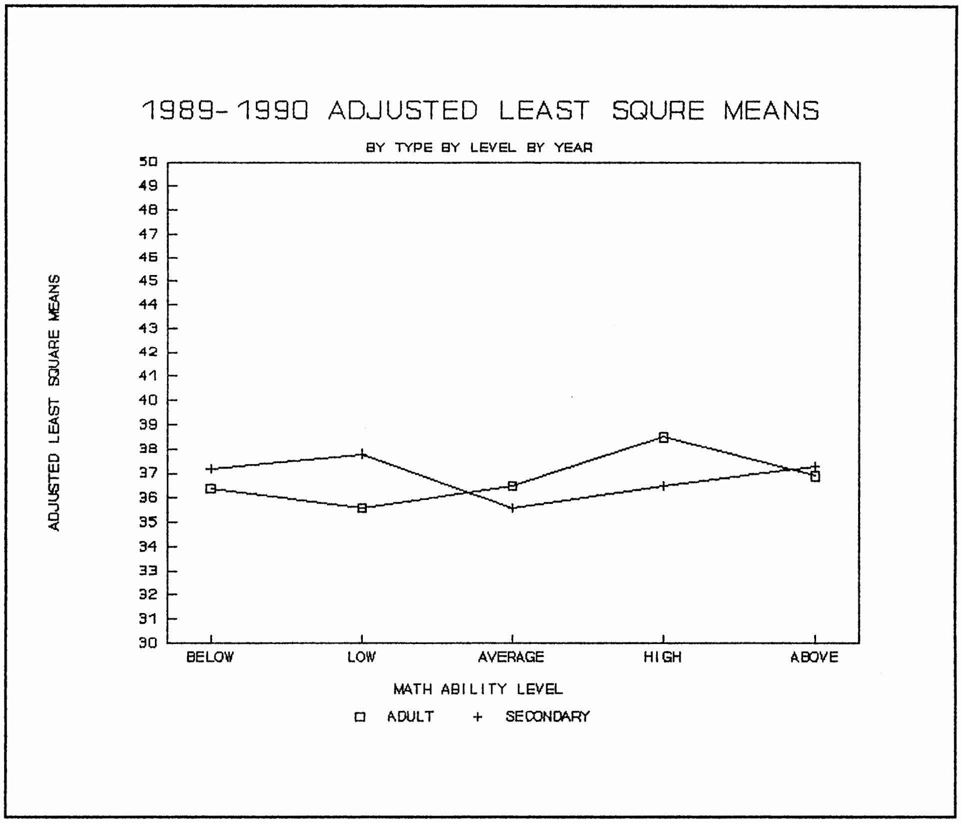

Figure 6: 1989-1990 Secondary and Adult Adjusted Least Square Means by Math Ability by Type by Year

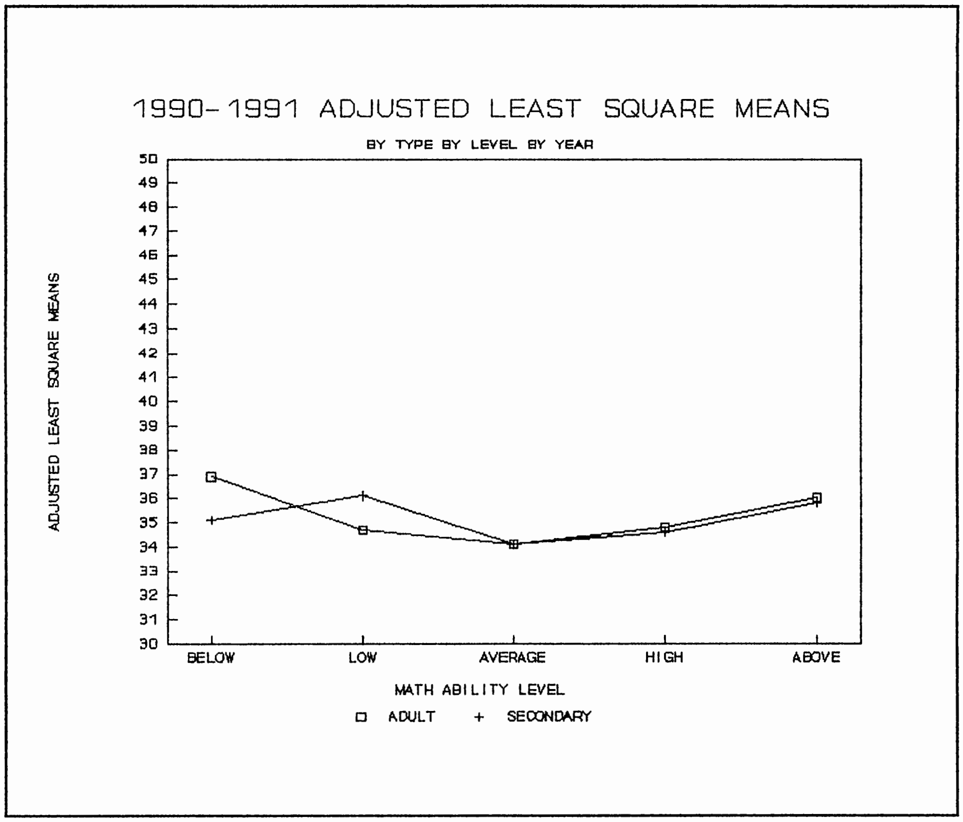

Figure 7: 1990-1991 Secondary and Adult Adjusted Least Square Means by Math Ability by Type by Year

APPENDIX H

GRAPH OF ADJUSTED LEAST SQUARE MEANS

BY LEVEL AND BY TYPE

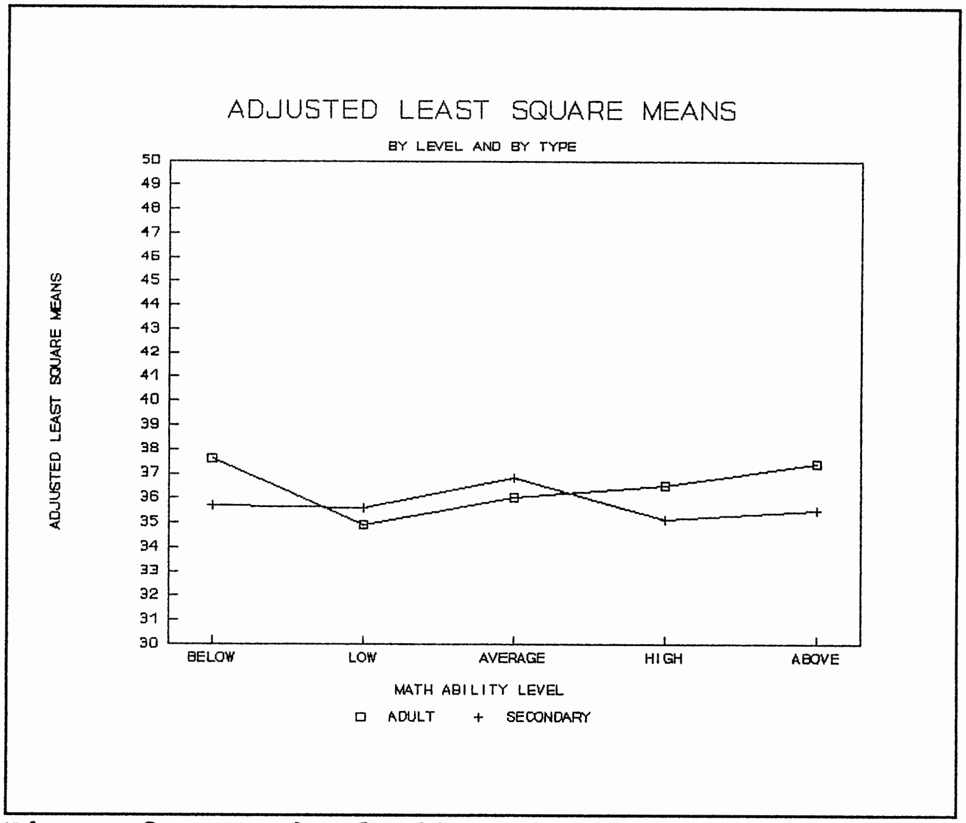

Figure 8: Graph of Adjusted Least Square Means by Level by Type

APPENDIX I

GRAPH OF ADJUSTED LEAST SQUARE MEANS

BY MATH ABILITY LEVEL

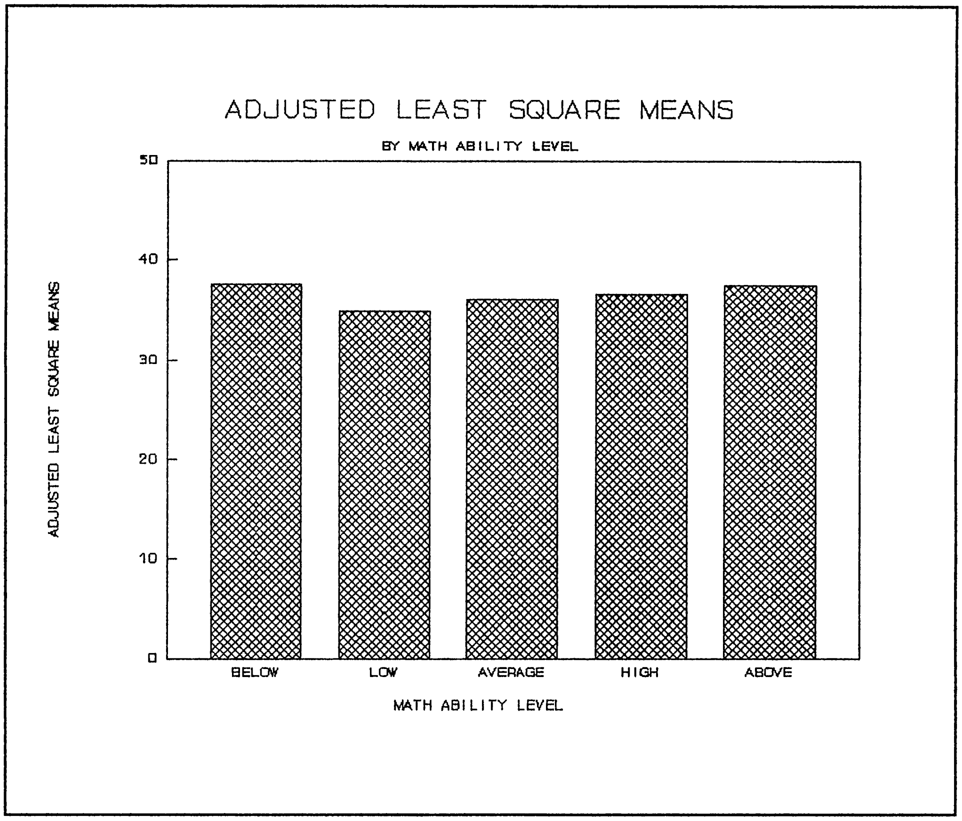

Figure 9: Graph of Adjusted Least Square Means by Math Ability Level

APPENDIX J

GRAPH OF ADJUSTED LEAST SQUARE MEANS

BY YEARS OF STUDY

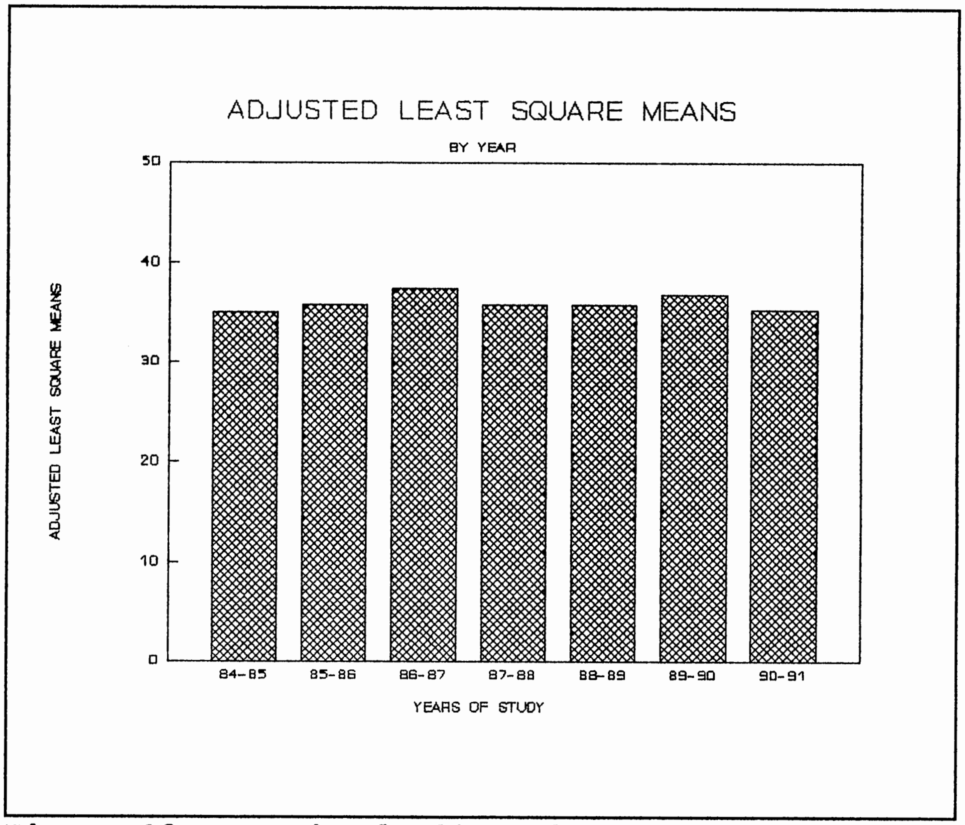

Figure 10: Graph of Adjusted Least Square Means by Years of Study

APPENDIX K

PIE CHARTS OF PRETEST AND POSTTEST

PERCENTILES BY QUARTILES

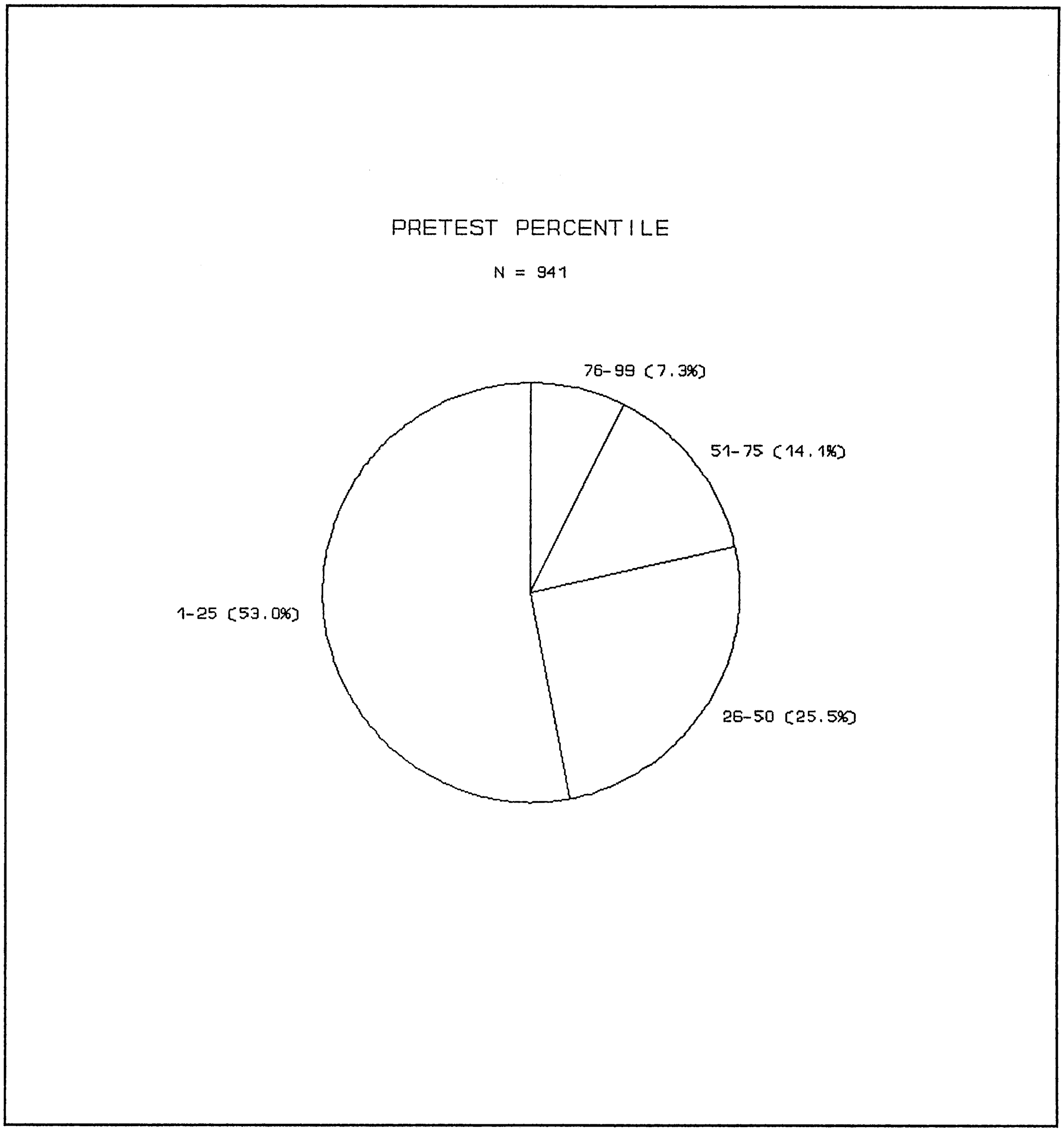

Figure 11: Pie Chart of Pretest Percentiles by Quartiles

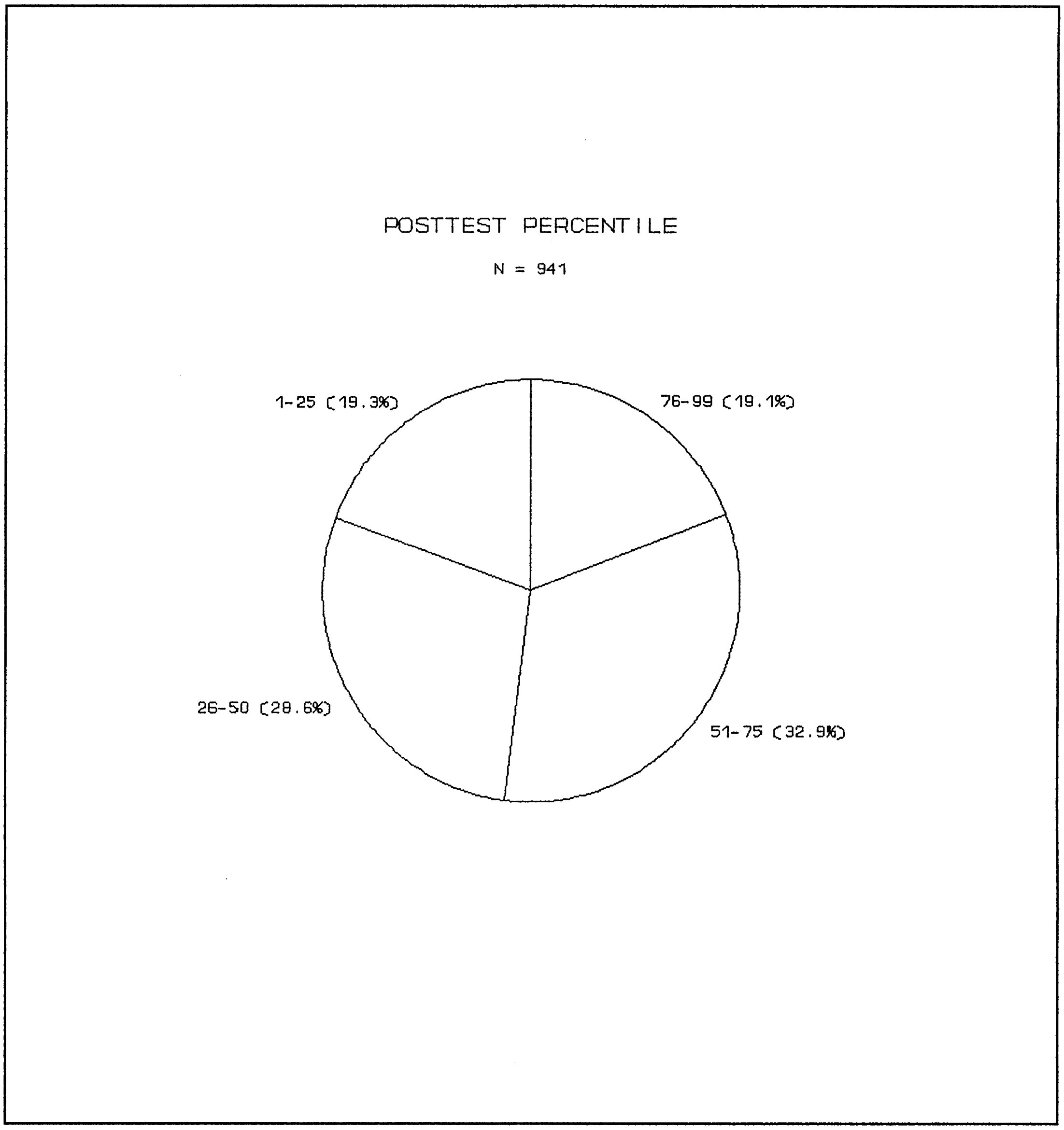

Figure 12: Pie Chart of Posttest Percentiles by Quartiles

APPENDIX L

PIE CHARTS OF ADULT PRETEST AND POSTTEST PERCENTILES

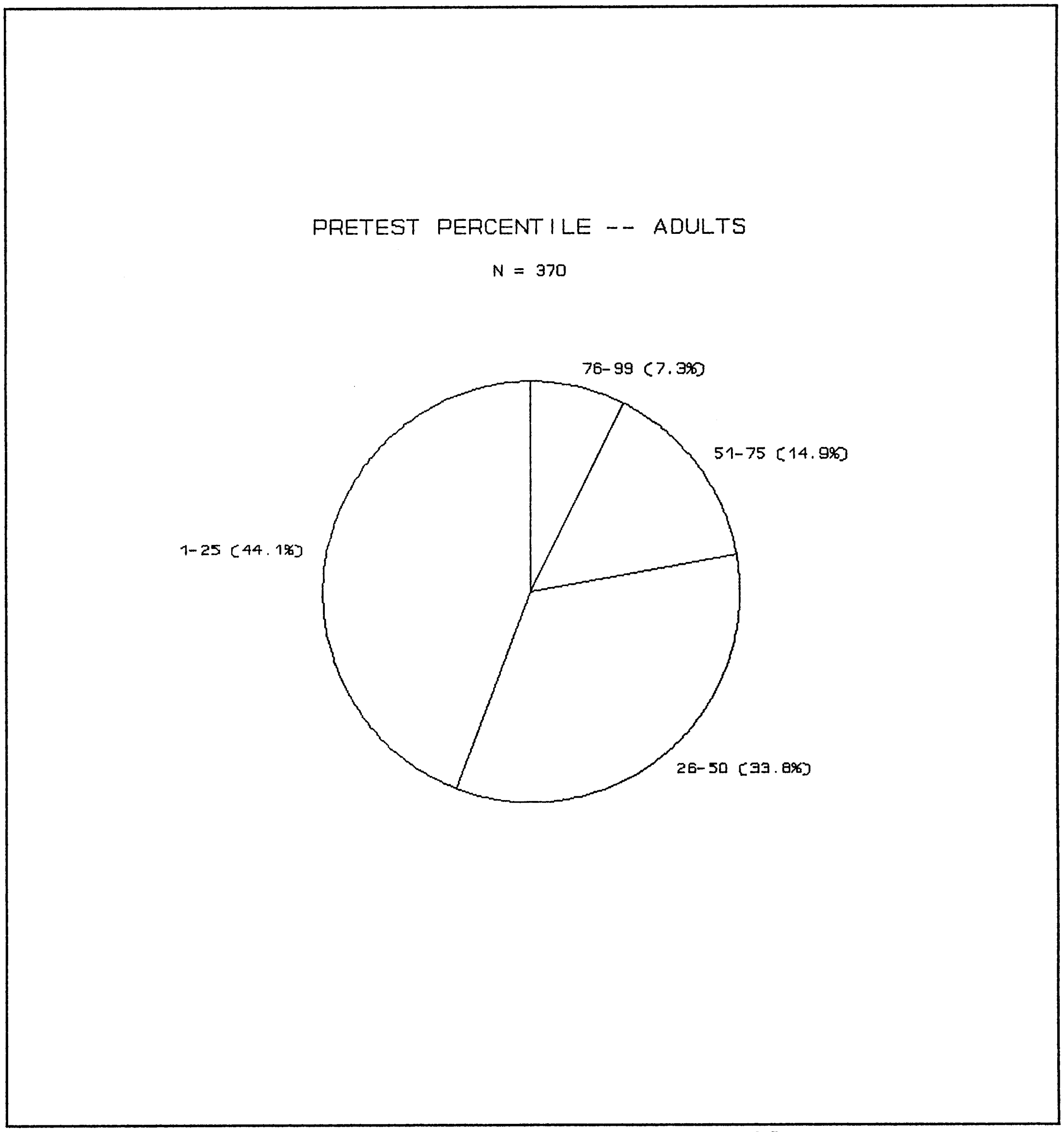

Figure 13: Pretest Percentiles by Quartile
Adults

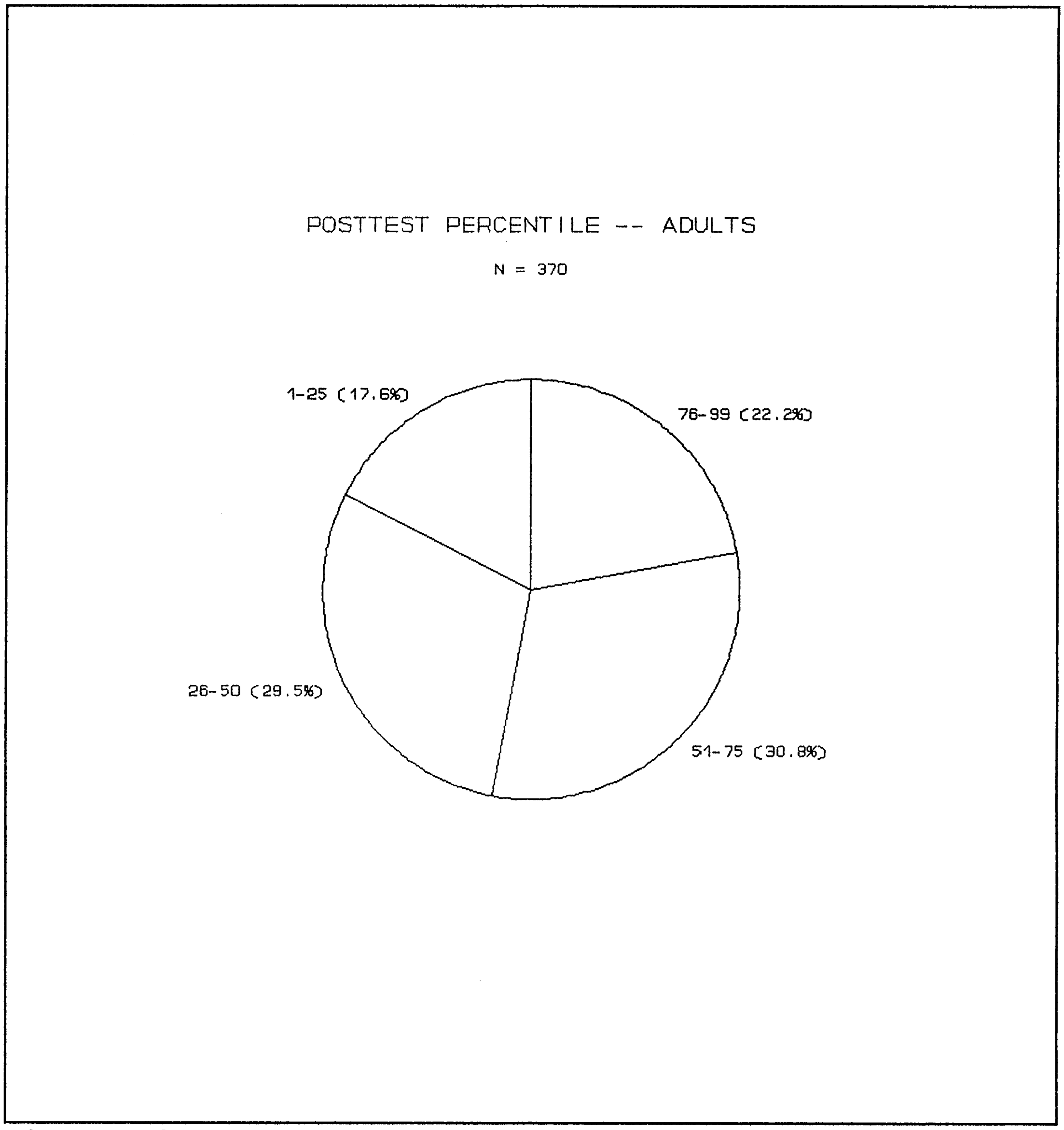

Figure 14: Posttest Percentiles by Quartiles
Adults

APPENDIX M

PIE CHARTS OF SECONDARY

PRETEST AND POSTTEST

PERCENTILES

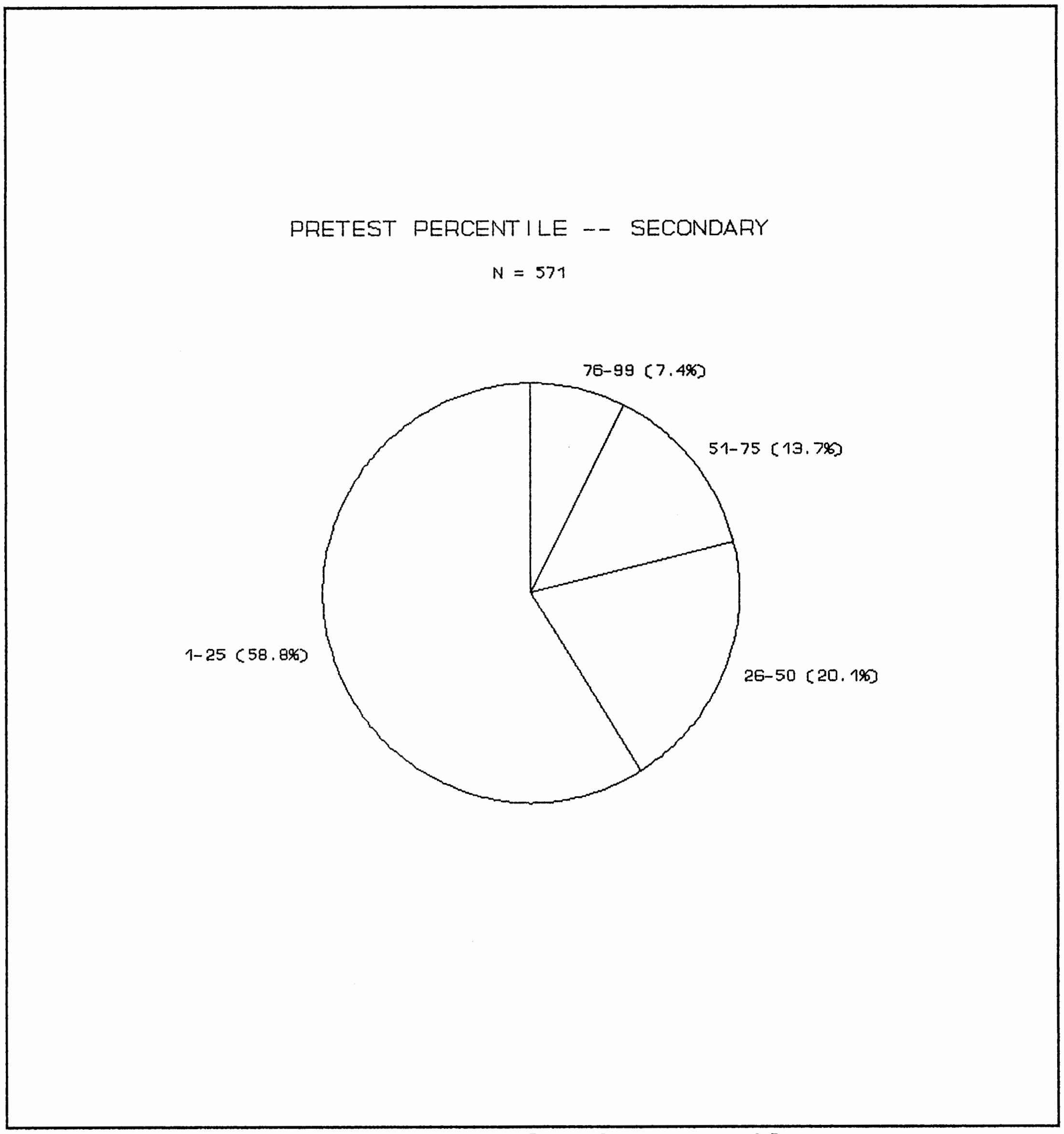

Figure 15: Pretest Percentiles by Quartiles Secondary

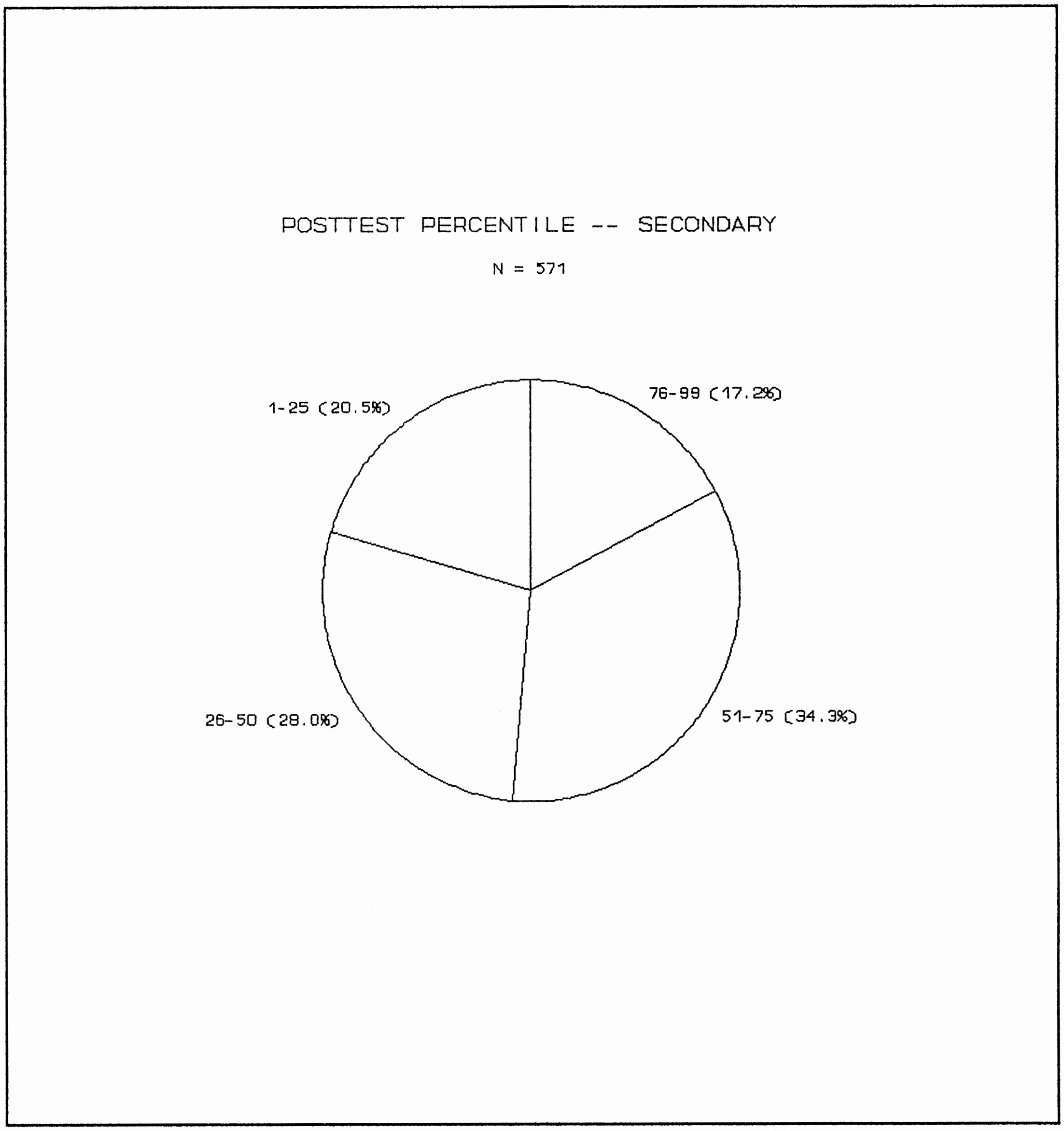

Figure 16: Posttest Percentiles by Quartiles
Secondary

2

VITA

Jane S. Burgess

Candidate for the Degree of

Doctor of Edrcation

Thesis: A LONGITUDINAL CASE STUDY OF A LEARNING RESOURCE CENTER: MATH LAB FOR ACADEMICALLY DISADVANTAGED STUDENTS, 1983-1991

Major Field: Occupational and Adult Education

Biographical:

Personal Data: Born in Coldwater, Missouri, September 7, 1939, the daughter of Timothy Earl and Stella Mae Blaylock; married Elmer Lee Burgess; daughter Dianna Dawn Lewis; son-in-law Richard Ethan Lewis; grandson Jason Carranza Lewis.

Education: Graduated from Normandy Senior High School, St. Louis, Missouri in June, 1957; received Bachelor of Science degree in Elementary Education from Bethany Nazarene College at Bethany, Oklahoma in 1963; received Master of Science degree in Education from Northeastern State University at Tahlequah, Oklahoma in 1977; completed requirements for the Doctor of Education degree in Occupational and Adult Education at Oklahoma State University at Stillwater, Oklahoma in December, 1991.

Professional Experience: Elementary teacher, Tulsa Public Schools, September, 1971 to June 1978; Coordinator of Title I Math Programs, Tulsa Public Schools, September 1978 to June, 1982; Coordinator, Summer Math Programs, Tulsa Public Schools, 1979-1983; Elementary Specialist, Tulsa Public Schools, September, 1982 to June, 1983; Math Specialist, Tulsa County Area Vocational-Technical School District #18, August, 1983 to Present.