THE RELATIONSHIP BETWEEN MATH PREPARATION IN HIGH SCHOOL AND MATH SKILLS OF ENTERING COLLEGE STUDENTS

By

RACHELLE DEAWN DUNCAN

Bachelor of Science
Northeastern State University
Tahlequah, Oklahoma
1984

Master of Science
Northeastern State University
Tahlequah, Oklahoma
1989

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF EDUCATION
December, 2000

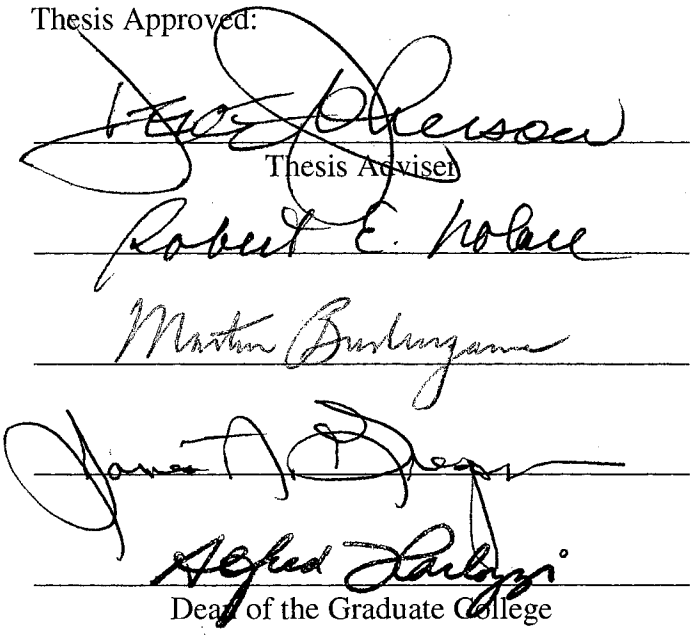
THE RELATIONSHIP BETWEEN MATH PREPARATION IN

HIGH SCHOOL AND MATH SKILLS OF

ENTERING COLLEGE

STUDENTS

Thesis Approved:



Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGMENTS

The completion of this graduate program was by no means done alone, and it requires that I acknowledge many debts owed to my faculty advisers and my family.

I wish to express my sincere appreciation to my major advisor, Dr. Deke Johnson, for his guidance, inspiration, understanding and patience with my efforts. My sincere appreciation extends to my other committee members Dr. Martin Burlingame, Dr. Robert Nolan and Dr. James Gregson, whose guidance and assistance are also invaluable.

I also express my sincere gratitude to those who provided special expertise, assistance and suggestions for this study: Dr. Larry Davis, Jan Coulson, Sharon Mouss and Paula Blair. Their support, encouragement and friendship are invaluable and I pray that I have not imposed too much.

I wish to express my appreciation to the faculties and chairs of Tulsa Community College and Oklahoma State University that were, in spite of their busy schedules, willing to assist with the survey. A special recognition goes to Dr. Barney Ryan and Dr. Paula Hunter for their assistance with the distribution and collection of data. A special thanks must certainly go to Jacquinita Rose, whose assistance and support made the completion of this study possible.

Finally, I thank my fiancé, Robert, for his continual support, encouragement, love and understanding throughout the completion of this project. Thanks also go to my family, although miles away, for their support, encouragement, reassurance and their willingness to understand my efforts during these years of study and research.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

Chapter 1

Introduction

Student achievement in basic reading, writing and mathematics in the United States has deteriorated over the past decade, putting the United States far behind other nations in student skills measurements. The problem affects all segments of the economy – businesses cannot hire employees with the requisite skills; colleges must focus efforts on remediation rather than teaching new skills; and state funding must be adjusted in order to support additional educational programs for the vast number of remedial students entering college. The competitiveness of our nation is put at risk in a competitive global environment if our education system is judged inferior. Robert Reich (Reich, 1991), former U.S. Secretary of Labor, in his book "Work of Nations," points out that we are experiencing a shortage of labor which will get worse over the next decade, a shortage exacerbated by the lack of basic skills in candidates available to employers.

Data shows 41% of students today entering college need some form of remedial education. These students typically take at least three remedial courses, and may take a specific course three or four times. The National Center for Education Studies (NCES), part of the U.S. Department of Education, reports that the percentage of freshmen enrolled in remedial courses changed little between 1989 and 1995. Remedial courses are defined as courses in reading, writing or mathematics for college students lacking skills necessary to perform college-level work at the level required by the institution (NCES, 1996). In 1992, the National Assessment of Educational Progress (NAEP) found that only 16 percent of high school seniors were proficient in math and two-fifths failed to reach even the basic math level (Elliott, 1993). NAEP also reported that less than half

of high school seniors attain a seventh grade math level and only five percent can use basic algebra (Mullis, 1991). Other data show that over 20% of employees being hired by corporations today lack basic reading and math skills.

According to research, a vast majority of students are forced to enroll in zero-level remedial courses to compensate for educational deficiencies caused by the public school system's failure to prepare these students for college (Astin, 1982; Conrad & Haworth, 1990; Sykes, 1988; Carnegie, 1976; Weingartner, 1993). The undergraduate curriculum is overburdened with zero-level remedial courses, especially in math and English, which are required of deficient students before they can enroll in a college level general education course.

Conceptual Framework

In particular, math illiteracy among college students is a growing problem, along with the deterioration of other general education disciplines (Marzano, 1988 & Weingartner, 1993). High school students are graduating with substandard skills and proficiencies, particularly in math, English, and science (Marzano, 1988 & Weingartner, 1993). The public and educators themselves are asking where this degeneration of skills stems from. How we arrived at this point of academic decadence is a major concern for educational organizations today. The contemporary challenge facing educators is where to place responsibility for the remedial and developmental education programs - the common schools or higher education. There exists a dichotomy of philosophical perspectives regarding the "back to basics" curriculum in education. One perspective asserts that colleges should offer remedial and developmental education programs and provide open access to anyone, regardless of preparation. The opposing perspective

contends that colleges should not be everything to everyone and that developmental work should not be part of the college curriculum. This paper will discuss the history that led to the development of these perspectives, and the implications that they have in the preparation of students for college. In order to follow specific ramifications of, and curricular reactions to, the influx of low-skilled students, this study will focus on one discipline in particular: mathematics.

The public has finally noticed that educators must face the realities of a system under great stress. Much of the math taught in the United States' colleges and universities is equivalent to high school level math. The math skills of today's college freshmen are considerably lower than those 20 or 30 years ago. The past 20 years have seen a lowering of math scores on ACT and SAT college entrance examinations which is believed to represent a real decline in the level of math skills, rather than changes in the pool of students taking the tests (Mitchell, 1984 & Usiskin, 1985).

Inadequate high school preparation seems to be a major contribution to college freshmen's poor math skills, increasing the need for remedial math courses in colleges and universities. In order to improve their math skills, many college freshmen must enroll in remedial math courses. There has been a drastic increase in college students' demand for "remedial" college math courses which cover the same material taught in high school math classes. Beginning with the late 1970s, there has been a steady increase in the number of college students needing remedial college math courses (Chang, 1983; Graph, 1993; Lappan & Phillips, 1984; Lively, 1995; & Manno, 1995). Enrollment in remedial math courses at four-year colleges and universities increased by 72 percent, while overall math enrollments increased only 22 percent (Leitzel, 1983). Even though

many students graduate from high school with a high grade point average, they actually enter college with below average math skills.

There are several explanations in the literature for the deficiencies of college students in this area. One reason given is that students are taking fewer math courses in high school than they used to, in response to lowered math requirements for high school graduation and for admission to college. Many students no longer take the standard high school sequence of Algebra I, Geometry and Algebra II, and many do not progress beyond, and some do not ever complete, Algebra I (Mitchell, 1984). The other factors cited for the decline in math skills are: (1) inadequate learning of math in high school courses (Usiskin, 1985) and (2) forgetting the math learned in the past (Fredrick, Mishler, & Hogan, 1984).

Statement of The Problem

Research shows that the majority of students entering college are inadequately prepared to take college level mathematics.

Purpose of the Study

The purpose of this study is to investigate the relationship between math preparation in high school and low math skills of entering college students.

Importance of The Study

Poor math skills put students at a serious disadvantage both in choosing a college major and in terms of career opportunities and educators need to investigate the causes of this problem in order to work on solutions (Whitesitt, 1982). One researcher feels that many remedial math courses are ineffective because they are designed as "refresher"

courses when in fact many of the students are learning the material for the first time because it was not required in high school (Whitesitt, 1982).

Consider the fact that nearly all college majors now require some non-remedial college math (Leitzel, 1983 & Whitesitt, 1982). Those students who come to college with poor math skills must either choose one of the few remaining "math-free" majors or take remedial math before pursuing their programs. Some of them do not even attempt remedial math, and many of those who do, do not complete it successfully (Whitesitt, 1982). These students find that their lack of math skills sharply limits their choices both in college and the job market. They have been referred to as "victims of the invisible mathematics filter" (Sells, 1978).

Many colleges and universities are attempting to decrease the number of remedial courses offered (Chang, 1983 & Lively, 1995). Some colleges are accepting the challenge and are attempting experimental pilot programs and other innovative methods of dealing with this remedial problem (Budros, 1992; Chang, 1983; Lang, 1992; & Robinson, 1990). If these institutions would require all incoming students to have the full sequence of Algebra I, Geometry, and Algebra II, then the demand for remedial math courses would decline. If inadequate high school preparation is the major reason for students' poor math skills, this change would substantially decrease the need for remedial courses.

Inadequate preparation of students' math skills significantly affects all areas of higher education and its functions – curricular programs, faculty assignments, courses offered, scheduling new sections, reallocating funding and resources, decisions regarding requirements and standards, student placement and assessment procedures – and other

operations within colleges and universities that have to be altered in order to accommodate the increase in remedial course offerings (Boyd, 1994; Eldersveld, 1983; Gibbons, 1994; Graph, 1993; & Manno, 1995).

Colleges and universities are faced with faculty concerns regarding assignments, teaching load, motivation, morale problems, resistance, faculty development programs to teach developmental classes, and other factors that are associated with teaching lower level classes. Colleges are faced with decisions regarding which classes to eliminate and which to maintain and class size limits. Issues regarding transferability, credit/no credit, time constraints to complete programs of study, and failure and retention problems also must be addressed. However, the most critical area in higher education affected by remediation is the assessment of the mission, goals, and priorities of the college. Therefore, should the college place emphasis on gaining more students and lowering standards or should the college emphasize a higher quality of education for students with selective standards?

The number of students who are inadequately prepared with deficiencies in math is steadily increasing and the problem can no longer be ignored at the college level. The college administration and faculty are significantly affected by these students. The math departments are faced with various barriers to hurdle due to these students. The institution itself is burdened with the extra cost of remedial courses and tutoring. The math department and faculty are forced to lower their standards and teach the high school level math that should have been taught in high school. Institutions are torn between the need to admit all students (regardless of ability) in order to retain high numbers and the desire to maintain high standards and offer quality education to their clientele.

This academic degeneration of skills and proficiencies not only causes the students great difficulty, it also creates major problems for the faculty, the individual departments, the university as a whole, and the state's funding and resource budget.

The results of this study could have a positive effect on the students' college education. Students who are adequately prepared with a solid background in high school mathematics would not have to take remedial mathematics once they enter college. The administration and faculty at the college level would also be affected. The math departments would not have the extra cost of remedial courses and tutoring, and the faculty would not have to reteach the math that should have been taught in high school.

Specific Objectives of the Study

The purpose of this study was to investigate the major cause (inadequate high school preparation) of poor math skills among entering college students. Specific objectives were to:

1. Determine the number of college freshmen in remedial math courses.
2. Determine the number of college freshmen in remedial math and those college freshmen with little or no high school math.
3. Compare the number of college freshmen in remedial math with those college freshmen with little or no high school math.
4. Compare the number of college freshmen in remedial math with those college freshmen with an adequate math background in high school.

Research Questions

The research study addressed questions concerning the relationship between the math skills of entering college students and the math requirements in high school:

1. Do the students who have had the full sequence of high school math (Algebra I, Geometry, and Algebra II) have better math skills in college than those students who have not had the full sequence of high school math?
2. Do the students who have not had the full sequence of high school math (Algebra I, Geometry, and Algebra II) have lower math skills in college than those students who have had the full sequence of high school math?
3. Do the math requirements in high school have a relationship to entering college students' math skills?
4. Do the students with an adequate math background have poor math skills?

General Procedure

A questionnaire was administered to remedial math classes, Basic Mathematics (Math 0123) and Elementary Algebra (Math 0124), at Oklahoma State University and at Tulsa Community College. Students indicated what math courses they took in high school, rated the importance of each of the factors in determining their need to take a remedial math course, and indicated which factor they considered the most important.

1. What is the high school math preparation of these students?
2. How important do they consider each of the following factors in their having inadequate math skills?
   A. Not taking enough high school mathematics.
   B. Not learning enough in the high school mathematics.

Definition of Terms

Following is a list of definitions relative to this study:

Math Requirements: the amount of math students are required to take in high school.

Math Skills: indicate the level of performance as measured by the ACT, SAT, high school or college math classes, and college placement exams. This does not refer to aptitude for or potential ability in math.

Remedial Mathematics: freshmen college courses which cover high school level math material.

Summary

In recent years, documented evidence reveals a significant increase in the number of entering college students needing remedial math. According to the most recent research, the problem of poor math skills of today's high school graduates is widespread and the number of students deficient in math has escalated and continues to rise. This remedial epidemic has caused higher education to re-design their curriculum in order to accommodate the increase in the demand for remedial math.

The responsibility is being placed on the high schools. Both higher education and the government are holding the high schools accountable for the remediation problem. Researchers, educators, and policy makers are investigating the causes for the widespread innumeracy among entering college students. There are two perspectives regarding this issue: (1) high school students are not taking enough math in high school or (2) high school students are not adequately learning the math they have taken in high school.

Therefore, students enter college inadequately prepared to take college level math. In order for educators to resolve this problem, it is important to investigate the reasons "why" high school students' math skills are so low.

This study addressed the issue of the remediation problem in higher education and its relationship with the low math skills of high school students. Specifically, the study investigated the breadth and depth of the math preparation in high school and the causes for innumeracy among high school students. Two areas of concern that were addressed were: (1) Is the traditional teaching pedagogy in high school math classes inadequate for effective learning? and (2) Are the math requirements too relaxed in high school for sufficient learning of math?

Colleges and universities must accommodate the large number of low-skilled students entering their doors, thus, they are forced to modify the math curriculum in order to compensate for the deficiency needs of their students. Consequently, higher education is concerned for their reputation and their responsibility to provide quality education for their clientele. Their original purpose has shifted due to the lack of preparation in math among entering college students. This study examined the different areas in higher education that is affected by the remediation problem and discloses the magnitude of innumeracy and its impact on higher education.

Chapter 2

Summary of Related Literature

Introduction

In order to better understand the relationship between math preparation in high school and the remedial escalation in higher education, it is critical to look back at the beginnings of both secondary and higher education and re-examine the original purposes and functions of these institutions. It is also useful to build a comprehensive concept of their development, to include an examination of the historical shifts in both areas.

Throughout the history of education, educational issues typically have been resolved by, first, reviewing what has been done in the past, and, second, by analyzing previous solutions and applying them to similar current situations. Problem solving involves going back to the point of origin, discovering when the problem began. Catalysts are often concealed within the social and economical developments during that time period. The current situation of innumeracy and remediation can only be resolved if educators understand what caused the historical changes in the secondary and higher education math curricula.

The current reform in K-12 math education and the modifications in the undergraduate curriculum stem from previous shifts or changes in education. The present situation in secondary education reveals relaxed standards and insufficient requirements for high school graduation. In turn, this has caused colleges to lower their standards and reduce their entrance requirements. Remedial education has evolved into a large

proportion of the undergraduate curriculum at the expense of high standards and quality education.

This study will also examine other states' high school math requirements and college remedial programs. Math preparation in high school and the undergraduate curriculum of Oklahoma will be compared with other states in order to understand the implications for Oklahoma's educational system.

Historical Shift in Secondary Education

From the very beginning, public schools in the United States have had, as a major function, to prepare students for college. By the end of the nineteenth century, that preparation consisted of two years of math, two years of English, two years of foreign language, one year of history, and one year of science (Carnegie, 1976). These components are still regarded as basic preparation for students attending college.

The current situation shows that the preparation provided by the high schools does not match the level of learning required for college admissions. The changes began in 1910 when high schools became less the institutions for college-bound students and more the schools for everyone. Their functions were expanded to include a general preparation for social responsibilities and career and occupational training. During this period, college enrollments grew slowly and high school enrollments increased very rapidly, reaching 75% in 1940 and 94% in 1975 (Carnegie, 1976).

In the 1940s, college enrollments increased, and colleges began to serve a more diversified student body. Junior/community colleges were open to all high school graduates. State colleges and universities were open to high school graduates but often were restricted to students who were in the top percentage of their graduating class.

Selective state universities' admissions policies, however, were more restrictive, limiting admission to students within the top 10-15 percent (Carnegie, 1976). Private colleges included both highly selective and relatively low selective admission policies.

Historical Shift in Higher Education

In order to understand the changes in higher education, it is important to look back at its beginnings. The Colonial Era (1636-1776) reflected an elitist philosophy regarding who should attend college and what the purpose of a college education should be (Conrad & Haworth, 1990 & Rudolph, 1962). Harvard was known as the rich man's college and wealthy parents sent their sons to Harvard "where, for want of a suitable genius, they learn little more than to carry themselves handsomely, and enter a room genteelly ..." (Conrad & Haworth, 1990). These elitist colleges discouraged enrollment of the "common man" with their exclusive curriculum and excessive fees. Their curriculum did not appeal to men of practical inclination. The curriculum consisted of the ancient languages Latin and Greek, Aristotle's three philosophies, Liberal Arts of the Medieval curriculum, logic, rhetoric, ethics, metaphysics, astronomy, physics, and math. In addition, the impractical curriculum and expensive fees also helped keep the middle and lower class families away (Conrad & Haworth, 1990).

Consequently, few colonial Americans received any formal education beyond the elementary subjects. Secondary schools were rare. Private tutors and clergymen carried the main burden of college preparation. Only the elite families prepared their children for college. Usually, a college education was a tradition in their families and they sent their sons to private preparatory schools to prepare them at an early age.

The original colonial colleges' curricular emphasis was the preparation for professions in medicine, law, and theology. They were considered the "class-bound and classical-bound" and "liberal gentlemen" colleges (Rudolph, 1962). Their function was to prepare leaders in government and society and their curriculum reflected a broad education in the liberal arts, the ancient classics, and the ideal "gentleman's education." Few colonial Americans attended these colleges.

The Post-War Era (1860-1900) brought about the land-grant colleges and the Morrill Act of 1862 which caused a monumental historical shift and changed the outlook of the American people toward going to college (Conrad & Haworth, 1990 & Rudolph, 1962). The purpose of the land-grant colleges was to provide a liberal and practical education for the industrial classes in the various occupations and professions in life. The curriculum of the land-grant colleges replaced the ancient studies of European scholarship with a more practical and utilitarian education. The curriculum emphasized a vocational and technical education and liberated higher education from the "class-bound, classical-bound" traditions of the elite colleges (Rudolph, 1962).

The land-grant colleges were established to prepare Americans for practical employment such as agricultural, mechanical, and technical occupations, rather than preparation for the professional fields. They emphasized an open access policy to the "common man" and the "blue-collar" worker. These colleges made efforts to increase enrollments and open their admissions to all people.

As an example of these efforts, in 1892, the University of Arkansas paid the agricultural students who made the best butter (Rudolph, 1962). These colleges almost completely abandoned admission standards. Their slogan was "come, and we will do

what we can," even for those who did not go to high school. In 1877, Ohio State dropped algebra from their entrance requirements and college enrollment immediately increased (Rudolph, 1962).

Other colleges drastically lowered or eliminated already low admission standards. It was a common admission standard to admit a student if he, or she, had one year of college preparatory work beyond the eighth grade. The philosophy ingrained in the land-grant idea was the concept of collegiate education for everyone at public expense. In 1868, Cornell University, the "star in the crown of the land-grant system," proclaimed their mission as "any person, any study" (Conrad & Haworth, 1990).

The Progressive Era (1900-1917) brought about the progressive educational movement and the establishment of junior (community) colleges (Conrad & Haworth, 1990 & Rudolph, 1962). In 1912, in 40 states, 160 community colleges developed out of onetime normal schools of high school level. The junior college motto was "let each become all he is capable of being" (Rudolph, 1962). Junior colleges responded to the desire for education beyond the high school, less expensive, and more convenient than that provided by the universities. The junior college became the agency for meeting the needs of "the non-academically minded high school graduate" (Rudolph, 1962).

The junior college philosophy and curriculum reflected individual programs to fit each student's needs, abilities, and interests; an orientation toward contemporary society, wide student options, student independence in course-work and construction of programs, elevation of the fine arts curriculum; a de-emphasis of traditional practices such as grades, exams, degree criteria, and entrance requirements. Their goal was to accommodate every type of student and to cater to each student's needs.

The junior colleges were a response to the dilemma of high school graduates inhibited by the admissions standards of colleges and universities. These colleges served a purpose of catering to the poorly motivated, low-quality students not able to complete a four-year degree. They established a curriculum with less emphasis on the academic life and more emphasis on life adjustment and preparation, social orientation, and a diluted version of general education (Rudolph, 1962). This curriculum appealed to youth of doubtful academic potential, many of whom had failed at the universities. The junior colleges were perceived as a wholesomely democratic opportunity for all people, without regard to class system or ability level. They reflected an American commitment to the idea that in democratic America there are no failures!

Meiklejohn's vision of a junior college was an example of this democratic philosophy (Conrad & Haworth, 1990). In 1928, Meiklejohn's goal was to create a community of liberal learning by accepting a broad range of applicants. He hoped to create a curriculum that would enable the "ordinary American boy to make some vital connection with the great traditions of the liberal arts" (Rudolph, 1962). Subject courses were avoided and the curricular emphasis was on student initiative and motivation.

To summarize the philosophical basis of student level of readiness for college in regard to these three historical movements, this paper will expound the philosophical approaches these different types of colleges implemented in their admission practices and their ideas regarding the issue of student preparation and their roles in that preparation.

Colleges with the colonial or elitist college philosophy viewed college education appropriate for those youth from elite families who maintained a tradition of college-attending and handed this tradition down to their children. If students entered their

colleges unprepared, the college held the philosophy that those students did not belong there. Their philosophy reflected the idea that "college is not for everyone."

In contrast to elitist schools, colleges with the land-grant system college philosophy had students who were typically the first member of their family to attend college; it was not a family traditional practice. Many of these students were unprepared for college level work but the colleges did not discourage them or turn them away. They admitted anyone, but made no efforts to prepare the low-quality students once they were admitted.

With the new junior/community college philosophy, a new trend evolved which allowed students to enter with very little or no preparation for college. The main difference with the junior college was that when students entered unprepared, a significant effort was made to prepare them. Their philosophy was "if you are not ready, we will help you get ready."

In the evolution of higher education, a significant philosophical shift has occurred along with these different historical movements from elitist to land-grant to junior/community colleges. The significance in this shift regards how the different colleges approached the issue of a student's level of readiness for college. The past perspective was basically interpreted as such: "If you are not ready for college level work, then you don't belong here." The current perspective can be basically interpreted this way: "If you are not ready for college, we will help you get ready."

Low Math Skills of Entering College Students

Innumeracy of High School Graduates

Research studies show that the success, competency, and persistence rates of entering college students in mathematics classes are not only low, but also steadily declining while the number of college students in mathematics is escalating rapidly. We are experiencing an influx of students in remedial college mathematics education like never before. With the methodologies, foundations and practices predominantly used in K-12 mathematics education today, the future for the college freshmen in mathematics education classes is dismal. The results from the research studies in this area provide strong evidence that a change is necessary in the way we teach mathematics education.

Numeracy – mathematical ability – is one of the major intended outcomes of schooling, and mathematics occupies a central position in virtually every school curriculum. However, K-12 mathematics teaching fails to produce numerate high school graduates. As our society has become increasingly informationally and technologically saturated, the innumerate are increasingly disadvantaged. They are unable to participate as effective and informed citizens, primarily because of the societal and individual consequences of innumeracy. Numeracy is commonly recognized as a major determinant for job and career choices, and a key to economic productivity and success in modern, industrial societies. The extent of mathematical ability operates as a social filter, and access to social effectiveness and privilege is restricted to those with sufficient mathematical ability.

The mathematical abilities of Americans are a major concern for the government, business, and educational sectors of our society. Research provides strong evidence that

the mathematical skills, awareness, and understanding of high school graduates have deteriorated drastically in recent years. High school graduates have little knowledge and understanding of mathematics, have little facility with simple mathematical operations, and find difficulty in solving the simplest of mathematical problems. Many high school graduates are forced to accept statistical information and their stated conclusions because they are not skilled enough to look beyond the numbers to interpret what the statistics mean.

Many people view mathematics as an esoteric subject, having little to do with their everyday lives. Indeed, the traditional K-12 teaching of mathematics presents a body of ultimately abstract, objective, and timeless truths, far removed from the concerns and values of humanity. Thus, K-12 mathematical education promotes the erroneous perception that it does not seem so critical if people cannot do mathematics well. The way mathematics is taught is so far removed from everyday life; its importance is lost. Mathematics is important if only because it is capable of empowering so many.

Of particular concern is the recently revealed research in the innumeracy of entering college students. Research studies on mathematical abilities show that performance is lower among entering college students than ever before. Why are entering college students' mathematical abilities as low as they are? The primary contribution appears to be the poor teaching in K-12 school mathematics classrooms (Frankenstein, 1981; Paulos, 1988).

Traditionally, mathematics education is taught as an abstract and hierarchical series of objectives and decontextualized facts, rules, and answers. Predominant teaching methods use largely passive, authoritarian, and individualizing techniques that depend on

memorization, rote calculation, and frequent testing (Bishop, 1988). Knowledge is commonly portrayed as largely separate from learners' thought processes, and mathematics education is experienced as a static, rather than dynamic, process.

Entering college students who seek to improve their mathematical skills are exposed to the same curricula and teaching methods common in traditional K-12 mathematics. Given the inadequacy of current educational approaches and the innumeracy epidemic among traditional high school mathematics classes, it seems apparent what the outcomes will be for entering college students placed in the same environment. With the rapid decline in math numeracy and its social consequences combined with the inadequacy of the current system, the teaching processes in K-12 mathematics classrooms calls for a necessary and immediate change.

Math Preparation in High School

K-12 Math Curriculum Reform

The recent increase in enrollments in college remedial mathematics courses makes clear the need for the development of pedagogy and curricula in high school designed to better prepare the students for college-level work. Besides the need for more courses which teach mathematics, a growing concern for better teaching practices that promotes better thinking skills among high school mathematics students has added an important new dimension to the teaching of mathematics. K-12 teachers are the catalyst for empowering mathematically weak students to think critically and quantitatively.

The movement to reform mathematics education began in the mid-1900's in response to the document failure of traditional K-12 methods of teaching mathematics, to the curriculum changes necessitated by the widespread availability of computing devices,

and to a major paradigm shift in the scientific study of mathematics learning (Battista, 1999). Mathematics reform recommendations deal with how mathematics is taught, what mathematics is taught, and the diversity of the learners in mathematics classes.

The failing of the "Three R's" at the K-12 levels of education has created chaos within our higher education programs, especially in mathematics. An influx of students with a wide range of deficiencies is enrolling in mathematics classes. Tough (as cited in Darkenwald, et al., 1982) estimates that 90% of the adult population undertakes at least one major learning effort per year. It is not surprising then, that the call is heard for "major ... educational reform which should consist of redistributing educational programs throughout the life-span" (as cited in Darkenwald, et al., 1982).

After two decades of growth of remedial mathematics programs, colleges continue to enroll a vast number of entering students with deficiencies in mathematics. Remedial mathematics programs seem to be gaining more momentum, and the population of entering college students needing to remediate in mathematics is growing out of proportion. Enrollment in mathematics courses at four-year institutions of higher education increased 72% between 1975 and 1980, while the total student population increased by only 7% (Coleman & Selby, 1982). The report of the National Science Board indicated that 25% of mathematics courses at four-year institutions are remedial. Myers (1983) reported that 42% of all mathematics courses at two-year institutions are remedial. From 1960 to 1980, enrollment at four-year institutions in remedial mathematics has increased by 165% (Usiskin, 1985).

According to many researchers, K-12 mathematics education will be influenced by future educators who respond to the following observations: 1) the dramatic rise in

enrollment of students in mathematics classes; 2) the increased demand for remedial mathematics courses indicates the need for pre-college training in content areas which are considered prerequisite not only for college but for the vocations also; 3) students who have taken several courses in high school mathematics still do not demonstrate an understanding of the material sufficiently to use it; and 4) the current research about how students learn mathematical ideas, what mathematical concepts should be taught, and how they should be taught. Several research studies have revealed that even those high school students who have taken and successfully completed several mathematics courses do not develop a conceptual understanding of the theories in a way to apply them in their daily experiences or their vocations (Carpenter, 1978; Clement, 1982; Fey, Albers, & Fleming, 1981; Lockhead, 1980; and Usiskin, 1985). Apparently, conceptual understanding is not assured through academic success.

Dealing with remediation of entering college students was described as the biggest problem faced by two-year college mathematics faculty (Fey, Albers, & Fleming, 1981). As the student population in remedial mathematics education continues to rise, the need to address the issue of innumeracy among high school students is paramount in K-12 education.

Results from the First Mathematics Assessment of the National Assessment of Educational Progress (NAEP) indicate that 60% of high school graduates were able to correctly answer word problems with decimals and percents, perhaps the most frequently applied topics in mathematics today (Carpenter, et. al., 1978). Similar error rates were identified in the interpretation of mathematical application problems. Other studies show

that about 70% of high school students in mathematics classes were unable to translate or interpret simple mathematical algorithm problems (Clement, 1982 & Lockhead, 1980).

The mathematics education community has appealed to K-12 teachers, state board of education, local administrators, test writers, and textbook publishers to make problem solving and conceptual understanding of mathematics fundamental to the K-12 mathematics curriculum. The two foremost recommendations derived from the research are: 1) that problem solving, interpretation, and application of mathematical concepts be the focus of K-12 mathematics education; and 2) that basic skills and remedial mathematics programs be defined to encompass more than computational facility.

Project Equality of the College Board (1993) echoes this appeal by declaring that mathematics understanding is prerequisite to competency in all area of college education. In addition to the ability to use calculators and computers, the report makes clear the need for conceptual understanding and the ability to demonstrate that understanding in problem solving. Many government reports on education have stated that the teaching of mathematics at *all* levels of education should equip learners with an understanding of basic mathematics concepts which will enable them to solve problems in everyday experiences and in the workplace.

Clearly, the stated emphasis in mathematics education has shifted from rote computational facility and the manipulation of algebraic symbols toward an understanding of the concepts of basic mathematics which can be demonstrated through problem solving and critical thinking. Educators and education researchers are beginning to acknowledge that the way mathematics is currently taught to K-12 students is inadequate and failing students in their quest for understanding mathematics.

Remedial mathematics education has traditionally served to "remediate" mathematical deficiencies by drilling students in arithmetic computation and mathematical symbol manipulation in order to provide them with "basic math skills" that was previously taught in K-12 mathematics classes. Remedial mathematics education courses generally attempt to "fill in the gaps" or help students "brush up" their math skills, replicating the K-12 math curriculum. Traditionally, high school math classes teach math by presenting one mathematical technique after another in quick succession in order to cover all the content in the established curriculum. Textbooks present topics with only the tersest descriptions of proof, followed by example problems which students subsequently practice repeatedly in exercises. Word application problems are not emphasized and they are not used to teach concepts but to illustrate how techniques are applied. Obviously, if the concepts have not been understood, students experience great difficulties in solving word problems. It is not surprising that word application problems are cited as the least appreciated feature of mathematics courses for all students (Lester & Garofalo, 1982).

College level math education was not originally designed to duplicate the K-12 mathematics curriculum. College math programs should consist of post-secondary mathematical concepts and applications. Educators must investigate the causes for the inadequate learning of math in high school. A change must be made in the way math is taught in K-12 education. Critical thinking skills can be developed within the context of a mathematics curriculum designed to teach high school students. Alternative teaching methods can serve as a vehicle for helping high school students develop conceptual understanding rather than serving as "knowledge transmissions" from authorities. For

this shift to occur, the pedagogy of *'proof, example, drill, and test'* needs to be subordinate to a pedagogy based on the discovery of concepts by the learner who needs those concepts to develop a conceptual understanding of mathematics. The success of students in K-12 mathematics classes is dependent on the teachers' delivery approaches and their respective epistemologies.

The traditional K-12 positivist approach views ideas as the currency of instruction; teachers teach ideas by presenting them in lecture, while students demonstrate their *'learning'* by performing rote computations and manipulations. Contrary to the view of knowledge as "ideas proved true", the constructivist approach considers ideas to be idiosyncratic mental constructions; teachers cannot teach ideas, but the "probe" the learners with stimulating questions to that the students can construct ideas for themselves. The highest value of this "constructivist" approach for students is the intellectual autonomy of the learner. The goal of constructivist mathematics is to empower the learner to think mathematically and critically. The intent of the curriculum is mainly to prepare students to reason quantitatively and to apply mathematics to a variety of problems which then encounter in their daily experiences.

According to Simon and Schifter (1991), the current perspective on what is meant by "understanding mathematics" is the view that learning is primarily a process of concept construction and active interpretation -- as opposed to the traditional absorption and accumulation of received information. This theory is derived from Piaget's central insights into learning and understandings of knowledge and it is currently referred to as "constructivism." While this core principle of constructivism is not new, it has in recent years been greatly elaborated, both theoretically and empirically (Kamii, 1985;

Labinowicz, 1980; Piaget, 1972, 1977; Von Glaserfeld, 1983, 1990). In particular, the adoption of this perspective by cognitive researchers has resulted in considerable insight into how mathematics is learned (Davis, 1984; Ginsberg, 1977, 1986; Hiebert, 1986; Resnick, 1987; Silver, 1985; Steffe, Cobb, & Von Glaserfeld, 1988; Narode, 1989; O'Loughlin, 1989; Taylor, 1990; Grigoriu, 1997; Simon & Schifter, 1991; Von Glaserfeld, 1991; Owens, 1998; Perry, 1998; Conroy, 1998; Howe, 1998; Geoghegan, 1998; Battista, 1999; and Mikusa & Lewellen, 1999).

According to recent research on mathematics in secondary education, in order to teach mathematics effectively to high school students, a pedagogy that centers on conjecture, conceptual explanation, and discursive interchange must combat a well-entrenched pedagogical practice that emphasizes memorization and computational routine conveyed through lecture, demonstration, or textbook (Cohen, 1988; Fosnot, 1989; & Kennedy, 1991).

The numerous recent calls for K-12 mathematics education reform tend to converge around a vision of the mathematics classroom evoked by the constructivist paradigm (Mathematical Association of America, 1991; National Council of Teachers of Mathematics, 1989, 1991; and National Research Council, 1989, 1990). The current mathematics education literature provides examples upon which teachers convey their experiences with this new paradigm through case studies, as they face the challenge of constructing new ways of teaching/being teachers. The literature provides case studies of mathematics teachers' experiences written by researchers (Fennema, Carpenter, Franke, & Carey, 1993; Schifter & Fosnot, 1993; and Wilcox, Lanier, Schram, & Lappan, 1992); case studies written by educators in mathematics education (Ball, 1993a, 1993b; Borasi,

1992; and Lampert, 1988, 1989); and case studies written by K-12 mathematics teachers (Barnett, Goldenstein, & Jackson, 1994; and Countryman, 1992). Studies like these provide rich accounts of teaching/learning processes, illustrating the kinds of dilemmas that arise in mathematics instruction and explicating how teachers experience, think about, and resolve them.

Research indicates that the traditional teaching approaches in K-12 math education are deficient, yielding high rates of academic failure, and resulting in students not proficient in mathematics (Budros, 1992). The issue of "how can we better teach these low-achieving math students" is such a major concern because all over the country, the remedial problem is epidemic (Chang, 1983). Researchers claim this is due to the failure of public schools in teaching the three R's, causing an influx of students with a wide range of deficiencies to enroll in colleges and universities. The problem of poor math skills needs to be addressed before these students enter college. The remedial program trend is gaining momentum and the population of students needing to remediate is growing out of proportion (Chang, 1983). This is why so many educators and state officials are concerned about the educational experience and the teaching/learning process of students in K-12 math education. Thus, the implications for practice for educators in higher education are significant enough to warrant such in-depth research in this area. The importance of these studies and their implications for educators are unquestionably justifiable.

To complicate matters, state policy makers propose to eliminate remedial programs in higher education on the rationale that they prove to be ineffective and inappropriate at the college level, despite the "remedial epidemic" and its rapid growth

(Chang, 1983). After several decades of remediation, colleges continue to struggle with academic deficiencies contributed by the profoundly low math skills of entering students. State officials do not deem these programs effective and, by cutting such programs, can save enormous educational expenditures (Chang, 1983).

Chang's (1983) research involved a mailed survey to 200 two-and four-year remedial educators all over the United States to evaluate the effectiveness of college remedial math programs and their students. Chang concluded that even though many states are trying to alleviate remedial programs at the college level, colleges continue to enroll a vast number of math deficient students. Today, most colleges have to offer remedial math before their students can successfully enroll in a college level math course.

Even after students complete remedial math, only about half of them are capable of successfully completing a college level math course. This situation has caused educators and researchers to question "how effective are high school math programs and are they the cause of the 'remediation epidemic', producing this widespread crisis of deficient entering college students incompetent in math?"

Math Preparation and the Undergraduate Curriculum

Today, colleges' attention to the design of the undergraduate curriculum is reflected in the academic confusion, lowered standards, zero-level remedial programs, "guts" and "puff" courses, abundant electives, and self-designed majors – essentially, a deterioration of academic standards in the undergraduate curriculum (Sykes, 1988). The colleges play the numbers game – this type of curriculum keeps the colleges well-stocked, pacifies most students, and demands as little effort as possible from the faculty

and students. The undergraduate curriculum has become a melange of incoherence that students experience upon entering the modern college.

"What passes as a college curriculum has degenerated into almost anything goes" (Sykes, 1988). In the last several decades, the bachelor's degree has been so completely stripped of meaning that employers cannot even be sure if its holder has minimum skills that were once common to all college graduates. In the design of the undergraduate curriculum, colleges lost track of the need to teach students reading, writing, and math skills at a high enough level to provide students with the necessary knowledge and proficiency in the subject areas.

This epidemic of ignorance can in large be attributed to the lack of student readiness for college, which has a significant impact on the undergraduate curriculum and educational experience these students have in college. This lack of student readiness for college has generated the various trends of the academic culture toward mediocrity and ignorance that has filtered down from this problem and collected in the undergraduate curriculum (Astin, 1982 & Sykes, 1988).

The condition of mediocrity and ignorance remains entrenched in the undergraduate curriculum today. It is education's version of the "spiral-effect" theory (Sykes, 1988). What begins in the lower levels of education – elementary, middle, and secondary levels – where the basic issues of academic literacy are at stake, reaches up through the educational system and inevitably works its way into shaping the undergraduate curriculum. This legacy of lower academic standards and remedial courses in college (college work at high school level) is a generation of kids unable to

read, write, or even do basic math – in other words, "illiterate college graduates" (Sykes, 1988).

Today, public schools have, as a major function, the preparation of students for attending college, and the achievement and ability levels of their graduates determine the threshold level of the undergraduate curriculum. There exists a significant correlation between the readiness level of high school graduates and the undergraduate curriculum design (Astin, 1982 & Sykes, 1988).

However, many educators believe that the preparation of students for adult responsibilities should be provided in the public schools prior to their entering college (Battista, 1999; Chambers, 1994; Graph, 1993; Lappan & Phillips, 1984; Lively, 1995; Manno, 1995; Mckenna, 1994; NCTM, 1989; & Sykes, 1988). This preparation includes fundamental general education skills. Public schools have a responsibility for providing all of their students, not just the college-bound students, with appropriate instruction and foundation in general education. All youth need to acquire skills in reading, writing, communications, and math. High schools need to articulate with colleges and persist to reduce the deficiencies in these skills among their high school graduates.

Both public schools and colleges have a responsibility to assure that students are not impeded in their progress toward completion of their educational goals. Those students who plan to attend college should be assisted to attain their educational goals through early high school graduation and admission to college, and the opportunity to attain college-level instruction and college credit while attending high school.

Among general education studies, the basic skill requirements include English, math, and science, along with foreign languages. Studies indicate that during the late

1960s and early 1970s there was a decline in the number of colleges requiring these subjects (Carnegie, 1976). The percentage requiring English declined from 90 to 72 between 1967 and 1974. During this same period, the percentage of colleges requiring math dropped from 33 to 20, and the percentage of colleges requiring a foreign language dropped from 73 to 53 (Carnegie, 1976).

Many educators argue that the introductory level general education skills that now are acquired in college should be provided by the high schools (Battista, 1999; Chambers, 1994; Graph, 1993; Lappan & Phillips, 1984; Lively, 1995; Manno, 1995; Mckenna, 1994; NCTM, 1989; & Sykes, 1988). They feel that much of the instruction which provides a foundation for general education should be shifted to the public schools and colleges can award college-level credit for it. The particular subjects suited for advance credit are math, English, science, and foreign languages.

In addition, colleges have an obligation to the high schools to clarify which skills students need to be successful in college before they are admitted. They should clarify which skills students should learn in high school and what criteria the student must meet to satisfy college entrance requirements. A thoroughly articulated general education program between the colleges and high schools accommodates students' needs. It also assists them toward their progress in completing their educational goals.

College Entrance Requirements and Remedial Education

Implications for Oklahoma Educational System

In 1994, the Oklahoma State Board of Regents passed a requirement calling for a mandatory placement of students in a zero-level remedial course in math, English, or science if they score below 19 on the ACT or if they do not score high enough on the

institutional assessment exam, and the passing score for these exams is dependent on the individual institution (Oklahoma State Regents for Higher Education, Policy Revisions, 1994). If students do not pass these tests, they are placed in appropriate remedial courses in those areas in which they show deficiencies. These tests are used for student placement in the appropriate level of math, English, or science.

In the past, student placement in math courses was based on the student's high school deficiencies. If students were deficient in their high school math units, then they were placed in a remedial math course. The listing of curricular deficiency requirements and placement were based on what the students took in high school. The 11 high school core units determined placement in college.

With the present system, student placement is based on ACT and institutional assessment scores. In 1997, general admission to four-year colleges in Oklahoma was based on 15 high school core units, rather than 11. With this new requirement, many college freshmen had to enroll in 3 or 4 zero-level remedial courses, depending on their scores in each of those areas. This had a significant impact on their progress toward a degree and on the design of the undergraduate curriculum.

The student level of readiness for college is the compelling force that has generated the mandatory remedial placement policy, which in turn, is the force that is causing colleges to reshape their undergraduate curriculum. Due to the abundant lack of student readiness for college, a large number of students are affected by this policy. This has drastically increased the number of zero-level remedial math courses offered in order to accommodate this great flux of deficient students. This has caused colleges to rearrange their course offerings in order to create new sections of zero-level remedial

courses and also eliminated normal course offerings that typically made up their undergraduate curriculum. This dramatically altered the schedule of course offerings in math, English, and science. In turn, this caused the administration to shift faculty assignments around to accommodate the new zero-level courses offered. Finally, the mandatory policy delays students in their program of study by at least a semester and has a significant impact on student retention and degree attainment.

In addition to this policy, the Oklahoma State Board of Regents is now requiring colleges to charge an additional $18.50 per credit hour for all zero-level remedial courses (Oklahoma State Regents for Higher Education, Policy Revisions, 1994). Their justification for this extra fee is to compensate for the additional costs for adding these zero-level remedial courses to the undergraduate curriculum. In reality, they are penalizing the students who enter college with deficiencies by charging them an extra $55.50 for each three credit hour zero-level math, English, or science course.

The additional fee is also reflective of their argument that these remedial programs should not be part of the undergraduate curriculum but should be provided for in high school. This argument is justifiable in terms of student level of readiness for college. Remedial programs consisting of basic skills that should have been taught in high school should not be part of the undergraduate curriculum. But, the Oklahoma State Board of Regents needs to redirect their focus – rather than penalize the entering college students who are deficient, the responsibility should be shifted to where it belongs in the first place – at the secondary level.

The high schools should be accountable for the knowledge level and math skills of these students. The public schools should be forced to recognize their responsibility

and implement a legitimate curriculum to substantiate their responsibility to their students. Instead, the Oklahoma State Regents for Higher Education seem to be making a statement by penalizing the deficient students, the very ones we should be trying to help since they are the ones who have fallen through the cracks of the public school system. Why penalize students for a shortcoming of the public school system?

Students who enter college deficient in math need remediation, are at risk, low college material, and least retainable; and now they must confront a double penalty by this extra course fee. Many of these students are older, non-traditional students who are forced to change employment and need a college education in order to gain employment. This is a "poverty fee" for those students who are already poverty stricken.

Some students will need to take 3 or 4 deficiency courses in different areas and so they face an extra $166.50 to $222.00 in tuition and fees. These barriers will inevitably affect the retention rate of those students who cannot afford the extra costs and the extra time needed to complete their education. This problem can be dealt with before it ever reaches the college curricular level. The regents need to take a serious look at the secondary level curriculum and take the necessary steps to prepare these students for college rather than impede their progress with more barriers.

We need to redirect our focus to the public school system and to raise the standards and requirements at that level so the students will be more prepared for college once they are admitted. Rather than forcing the student to pay the extra costs, the state should require high schools to pay for remediation, since they are the cause of the problem. If public schools claim a student will graduate with the necessary skills and abilities required at the college level, then their curriculum should reflect this.

The undergraduate curriculum is not the appropriate place to compensate for the deficiencies that students accumulated during their high school years. Students should not have to enter college and waste time and expenses for non-credit remedial courses that should have been required in high school. The undergraduate curriculum should reflect college-level work, rather than a duplication of the high school curriculum. Students should acquire the necessary exposure to math early, and if they do not, the remedial requirements can be established at the high school level, not in college. Math proficiency exams at each grade level could help alleviate the problem of students progressing to the next grade level without adequate math skills.

On the other hand, there are a number of older, non-traditional students who have deficiencies because they have been out of school for so long. Remediation for these students can only be obtained in colleges. Someone will need to provide some form of remedial program for these older, returning students who either did not get the exposure in high school or have been out of school for so long they don't remember the material. These adults enter college with different experiences and different exposure backgrounds than those students graduating from high school and they will require different guidance and instruction.

If the public schools fail to do their job – provide students with an education – then the students enter college unprepared and are forced to enroll in remedial programs. The students enter college and discover that the general education requirements of every degree program are beyond their capabilities. Students have been told, "you don't need math to graduate" yet when they enter college, they are required to take general education requirements and discover they are not ready at the level required of them. The

undergraduate curriculum has been exploited and misused, compelled to make up for lost ground in the public schools. This should not be an objective of the undergraduate curriculum.

The state has tried to solve the issue of "student level of readiness for college" with the "trickle-down effect" of House Bill 1017. Through this bill state officials and educators attempted to prepare students early, channeling through grade school, middle school, high school, and eventually affecting higher education. The theory was to prepare students better at the lower levels, hoping this preparation would filter through the system reaching the college level. Theoretically, student level of readiness would progress its way up through the curriculum from the bottom level.

House Bill 1017 was the major overhaul of K-12 education in Oklahoma. The law was passed by the Oklahoma Legislature in 1990. In theory, House Bill 1017 affects the curriculum of all levels in education. It was established to help prepare students early with the philosophy that it would reach the preparation of entering college students. The two main factors proposed in this plan to help achieve this goal were smaller classes with a better student-teacher ratio and the requirement of more high school units. Now, the factors also include the mandatory remedial placement of ACT and institutional assessment scores to test for student level of readiness for college; and if students do not pass these exams, they are required to take zero-level remedial courses in those areas they failed.

Why are so many students dropping out of their freshman college math course? Because they are not prepared when they enter college. How did we get to this point – this deterioration of student level of readiness for college in math?

The issue concerning student level of readiness for college has a significant impact on the design of the undergraduate curriculum (Astin, 1982; Sykes, 1988; & Weigngartner, 1993). Actually, student level of readiness for college creates a "chain of events" impacting three major areas: (1) the design of the undergraduate curriculum; (2) public schools' curriculum – with smaller classes, the increase in core requirements, and proficiency exams; and (3) a decrease in financial support to all state agencies – the financial commitment to financing House Bill 1017 caused the state to cut budgets of all other state agencies because there was no money left for them. In theory, if House Bill 1017 worked, we would not need remedial and placement programs because students would already be prepared for college.

Recent History of Mathematics Curriculum

In the late 1960s and 1970s high schools and colleges reduced core requirements in their curriculum. Topical courses were introduced, attempting to make the curricula more responsive to students' interests. Nationally, students' test scores in mathematics declined during this period. The colleges and universities began to strengthen their requirements in math for most majors by late 1970's and early 1980's. The gap between students' preparation and collegiate expectations widened and became costly to students and to institutions attempting to remediate severe deficiencies in mathematics (Leitzel, 1983).

In every country in the world except the United States, school math curriculum ordinarily includes a year in calculus; even though not all students take the course, it is part of the pre-university curriculum for college-bound students (Steen, 1986). According to Steen, by this world-standard definition, nearly 90 percent of all United

States math course enrollments in post-secondary education are at the high school level. Even if the educators adopt the less stringent definition that identifies calculus as part of the post-secondary curriculum, we find that two-thirds of the math taught in colleges and universities is at the high school level. Traditionally, high school math has followed a rather well-defined route with only minor side excursions: Algebra I, Geometry, Algebra II, Pre-calculus, and calculus. Twenty percent of the college-bound students begin the sequence in eighth grade and complete it by twelfth grade; the others begin it in ninth grade and complete it, if at all, during college (Steen, 1986).

A 1980 report showed a twenty-two percent increase in undergraduate math enrollments in four-year colleges and universities between 1975 and 1980; during the same period remedial enrollments in these institutions increased by 72 percent (Leitzel, 1983). Although the math preparation of entering students has declined measurably, the math requirements of many university degree programs have increased markedly (Leitzel, 1983). At comprehensive universities, virtually all programs now require some university-level math. Finding "math-free" majors for students with weak math preparation is no longer possible, especially in today's math/science oriented society and educational climate.

Concern is increasingly raised, not only about the number of math courses taken by college-bound students, but also about the need for students to study math the year before they enter college. NCTM's "An Agenda for Action" calls specifically for all students who plan to continue their study of math beyond high school to enroll in math courses throughout their last year of high school (Leitzel, 1983).

Insufficient High School Mathematics

According to a recent National Science Foundation report, the enrollment in high school second-year algebra in the United States has followed a steady decline during the past twenty years (Whitesitt, 1982). Many authors, Braswell, Edson, Ferguson, and Gussett, have also reported a significant decline in the ACT and SAT mathematics scores during the past twenty years (Hiebert, 1999). One reason commonly given for the below average math skills of today's college students is that they are not taking enough math at the high school level (Usiskin, 1985 & Whitesitt, 1982).

One of the major problems faced by high school counselors and teachers of mathematics is convincing students with college potential to remain in a mathematics program until they have completed at least two years of algebra and one year of geometry. Although many arguments are offered to students concerning the importance of high school mathematics, strong evidence suggests that far too many students are dropping out of their mathematics programs, sometimes before they have successfully completed a first course in algebra, because they are unaware of college admission requirements. Part of this evidence can be seen in remedial or developmental mathematics courses in college (Mitchell, 1984). Additional evidence is suggested by the general decline in students' performance on the mathematics sections of the ACT and SAT examinations during the past twenty years and by the general belief that this decrease in scores undeniably represents a decline in mathematical ability (Hiebert, 1999 & Mitchell, 1984).

The importance of three years of high school math should be emphasized from another perspective – preparedness for beginning courses in college math. Research

literature reveals that the three most frequently cited reasons for students not taking three years of high school math were that the courses were not deemed important, were not required for graduation, and were in conflict with other courses (Mitchell, 1984).

Mitchell (1984) conducted a study at Tennessee State University to determine why students did not take three years of high school mathematics. Students reported that they felt the courses were not important for their career choice or that they were not required for graduation. Students were also asked whether their high school mathematics courses had prepared them for initial college-level courses in mathematics. Of the students with fewer than three years of high school mathematics, about two-thirds responded negatively. The vast majority of students who did complete three or more years of high school mathematics were satisfied with their preparation for college (Mitchell, 1984).

A similar student survey was done with Wyoming high school students concerning the mathematics program (Bell, 1983). The survey asked students to describe their pre-college mathematical education. The two most cited reasons for not taking enough high school mathematics were: (1) The mathematics was not required at their high school, and (2) Remedial college mathematics courses were available to correct any mathematical deficiencies.

It is apparent that far too many college-bound students are not taking the high school math courses that are necessary for success in college. This large proportion of students with insufficient math courses may change now that some colleges are requiring college-bound students to successfully complete two years of high school algebra and one year of geometry. Since many students do not decide on their major until they are in

college, all college-bound students should be required to take this math sequence of courses in high school. But this does not mean students will receive adequate knowledge and skills in math just because they are exposed to three years of math. NCTM's recommendation that "more math study must be required for all students" has been implemented in recent years and colleges are still faced with many entering freshmen needing remedial math, even though they had three years of high school math.

Remedial College Mathematics

Remedial mathematics is defined to include courses in arithmetic, algebra, geometry, and trigonometry, similar to those courses customarily taught in elementary and secondary schools. When students enter college with inadequate knowledge and skills in math, they almost always have trouble in other college courses. The economic and psychic costs of "remediation" are very high, and the success rates very low (Steen, 1986). Most two-year institutions, and many comprehensive universities, are forced to reteach junior high school math to a large number of entering students. At many colleges and universities, enrollment in remedial courses has been growing at a much more rapid pace than enrollment in math courses in general (Carriuolo, 1994; Chang, 1983; Eldersveld, 1983; Lively, 1995; Manno, 1995; Myers, 1983; & Student Remediation Report, 1993).

Between 1975 and 1980 there was a 75 percent increase in remedial math courses at four-year colleges and scholastic aptitude tests fell continuously between 1963 and 1980 (West, 1983). In a national college and university student survey study, Berkeley reported that 41 percent of the incoming freshmen needed remedial mathematics (Maxwell, 1975). Harvard reported that 35 percent of the entering freshmen failed to

achieve a score of 50 percent on a placement exam covering basic mathematics. Montana State University reported that the remedial math enrollment has doubled in the past ten years.

In the same national survey study, college mathematics faculty report that many freshmen enter college without the mathematics background needed for success in college level math. Many of these students reported that their high school advised them to wait until they enter college to take mathematics so they would not jeopardize their high school grade point average. Other students reported that they did not think they would go to college so they took as little high school math as possible (Maxwell, 1975).

Whtesitt claims, "the problem is not, as some have suggested, poor teaching in the mathematics curriculum, but poor enrollment in that curriculum." Whitesitt gives several disadvantages for students if they wait until college to take prerequisites in math. First, remedial courses at the college level tend to have very low success rates. For example, 35-40 percent enrolled in Basic Mathematics and Introductory Algebra succeed (Whitesitt, 1982). Sixty-one percent in Intermediate Algebra and 74 percent in Trigonometry succeed. Second, many of the students who successfully complete these remedial courses still do not have the skills needed for subsequent math courses. Third, remedial courses require students to sacrifice additional time, money, and energy for non-credit courses when they could be expending these resources for regular college credit courses. These courses would have been free if taken at the secondary level and would have counted toward high school graduation. Another consideration students should realize is the delay it will cause them in attaining their degree, especially if they need to take several remedial courses in different subject areas. This study revealed that 30-40

percent of the "successful students" failed to demonstrate mastery of skills necessary for the next mathematical course. Any student who goes to college without a minimum of two years of algebra and one year of geometry in high school will continue to be at a serious disadvantage.

The results of studies from several colleges and universities in the United States concluded that the main causes for the increased number of remedial math students were as follows (Michigan Council of Teachers of Mathematics, 1983):

1. Minimal state and high school math requirements for high school graduation;
2. Minimal college entrance requirements;
3. More students entering college who have not planned an appropriate high school program to allow for options in their choice of college career;
4. Their high school counselor did not encourage them to take more math;
5. Students are less prepared in elementary and junior high schools;
6. Several levels of high school math resulting in "watered down" courses for the lower level; and
7. Many students claimed they were unaware that they would need math for their chosen career.

About 50% of the students in this study came from high schools requiring only one year of high school mathematics and another 25-30 percent came from schools requiring two years of high school mathematics. About 20% of each group indicated there was only one level of mathematics offered beyond basic mathematics.

Most of the research literature revealed that the two most prominent factors which appeared to be the main reasons for students taking remedial math courses when entering

college were (1) insufficient amount of math in high school and (2) inadequate learning of math taken in high school. The studies conducted on remedial math students show that these two factors essentially have equal influence on the causes for college freshmen needing remediation in math (Mitchell, 1984).

Similar Studies

A study was conducted with 73 Wyoming high schools concerning the mathematics program (Bell, 1983). The survey asked the students to indicate the last year of school in which they took a mathematics course. The data was examined in two categories: college-bound and non-college-bound. Each of these categories was further divided according to sex. The data showed that college-bound women terminated their study of mathematics much earlier than the college-bound men. By the end of the tenth grade an average of 15 percent more women than men had already ended the study of pre-college mathematics, while 17 percent more men than women took mathematics during their senior year. Moreover, whereas the female/male enrollment ratio in the twelfth grade math classes was about 2 to 3 for the total college-bound group, the ratio was 1 to 2 in the largest schools.

The student survey in the Wyoming study also asked students to describe their pre-college mathematics education. Specifically, they were asked to indicate whether they had completed certain familiar courses: General Mathematics, Algebra I, Algebra II, and Geometry. The courses and topics of the survey were used to define the six levels of mathematical preparation found in Table 1.1. These six levels were then used to classify, from highest (Level 1) to lowest (Level 6), the summative pre-college

mathematical experience of each college-bound student. The classification of student responses into these six levels is summarized in Table 1.2.

TABLE 1.1

DESCRIPTION OF SIX LEVELS OF MATHEMATICAL PREPARATION AMONG WYOMING SENIORS

Level	Description
1	Algebra I and II; synthetic and analytic geometry; trigonometry; logarithmic functions (common and natural) and their graphs; mathematical induction; algebra of functions; basic operations on matrices; limits; continuity and differentiation of polynomial functions.
2	Algebra I and II; synthetic and analytic geometry; trigonometry; logarithmic functions (including common and natural) and their graphs; mathematical induction; algebra of functions; basic operations on matrices.
3	Algebra I & II; synthetic geometry
4	Algebra I; synthetic geometry
5	Algebra I
6	General Mathematics

Bell J. E. (1983). Survey of Remedial Math Students. Northeastern State University, Tahlequah, Ok.

Table 1.2 reveals that the upper three levels of mathematical preparation are attained by a decidedly larger percentage of males than females. In general, the male and female subgroups are equal on Levels 5 and 6 only. The figures of Table 1.2 are of particular importance in that they show the populations reaching the highest level of pre-college mathematical preparation. The ratio of women to men who reach the highest level is one to two (i.e., 15 percent to 30 percent).

TABLE 1.2

PERCENT OF COLLEGE-BOUND SENIORS ATTAINING EACH OF SIX LEVELS OF MATHEMATICAL PREPAREDENESS

Level of Preparation	Sub-group Percents		
	Female	Male	Total
1	15	30	22
2	21	36	28
3	54	64	59
4	71	78	74
5	93	94	93
6	100	100	100

Bell J. E. (1983). Survey of Remedial Math Students. Northeastern State University, Tahlequah, Ok.

Students had terminated their study of pre-college mathematics as early as possible on the assumptions that:

(1) No mathematics was required for the fields they wished to pursue or

(2) College mathematics courses were available wherein they could correct any mathematical deficiencies.

For many students, both assumptions had proved erroneous. In conclusions, they asserted that "someone should have told us we would need so much mathematics."

Summary

A historical shift in American education reveals that most of today's youth is innumerate. Students are graduating from high school deficient in math, with lower math skills than those of their cohorts from previous generations. Also, students entering college do not have the necessary skills to take college math. Thus, remedial education has saturated the undergraduate curriculum.

Most of the research literature reveals that the two most prominent factors which appears to be the main reasons for students taking remedial math courses when entering college are: (1) insufficient amount of math in high school; and (2) inadequate learning of math taken in high school. The studies conducted on remedial math students show that these factors essentially have equal influence on the causes for college freshmen needing remediation in math (Mitchell, 1984).

Alternative Causes for Low Achievement in High School

Much of the literature focuses on the relationship between the amount of math required in high school and math skills of entering college students. This study introduces a different perspective -- the relationship between inadequate teaching of math in high school and math skills of entering college students. These are only two perspectives that address the issue of inadequate learning in high school math classes. There are several other possible causes for low student achievement in high school math classes that are certainly worth mentioning.

Bowles and Gintis (1976), published an explosive book, *Schooling in Capitalistic America*, which put forth a radical criticism of the U.S. educational system. In their analysis of schools as agents in the reproduction of the inequalities in the American economic system, Bowles and Gintis focus on the school's reinforcement of the social-class differences students bring with them to school and on the different kinds of socialization students from various social classes receive there. According to their perspective of schooling, groups of students, sorted largely on race and class differences, receive different treatments that result in differences in academic outcomes. Bowles and Gintis suggest that the function of schooling is not to provide a meritocratic avenue to academic achievement and success in school. They view schools as serving primarily to reproduce the current inequalities of our social, political, and economic systems.

In other words, high school students are sorted according to their socioeconomic backgrounds and the purpose of schooling is not to teach them math or English but to teach them their place in society. Bowles and Gintis assert that schools socialize students to meet the demands of the occupations they will be expected to assume within the existing class structure. In this view, social relationships and interactions in schools are structured to fragment students into stratified groups where different capabilities, attitudes, and behaviors are rewarded. Thus the educational system turns lower-class children into lower-class workers.

Willis (1977) and Everhart (1983) have elaborated this view to show how differential treatment and student resistance interact in this process. Rather than seeing students as basically passive, submissive recipients of school socialization, this view on classroom interaction points out that students, especially lower-class students, actively

resist what schools try to teach them. These students openly reject both the behaviors schools expect and the content they value. The existence of student resistance offers a different perspective on reasons for poor achievement in high schools, however, this view does not contradict Bowles and Ginits's view of the role and function of schools in reproducing the work force. It explains how this reproduction happens in a way consistent with what we know about how low-achieving students behave. The act of resisting what schools offer is part of how social and economic reproduction occurs.

Willis shows how the struggle between school and students takes place. By disrupting routines and breaking rules, these students assert some control over the school. But with their rejection of the values and expected behaviors of the school, the students also reject school learning -- or any form of "mental" as opposed to "manual" work. Willis suggests that the resistance of schooling is an important part of learning to become low-level workers and recognizing industrial work as desirable and appropriate for them.

Following Bowles, Gintis, Willis, and Everhart, Basil Bernstein (1977) adds another dimension to the social and economic reproduction and differential socialization of students. In Bernstein's view, schools become differentiated as they attempt to fulfill the needs of society by imparting specific knowledge and skills to selected students. This process can be a divisive influence when students are separated into groups, often reflective of social class, to aid the development of specific skills in selected students. Bernstein asserts that a lower-class student with initial low involvement, placed in a homogeneous group, will become increasingly uninvolved and alienated from the school. According to Bernstein, this results because the nature of the teacher-pupil relationships

and an emphasis on reward and punishments lead to greater or lesser achievement depending on the student's placement.

An essential element in the cultural-reproduction perspective is that the differential treatments groups of students receive result in cognitive outcomes. Students in high-track classes (predominantly white children from upper socioeconomic levels) are those students presented with high-status knowledge. The high-track students are provided with more time in which to learn and they are more exposed than the low-track groups to instructional practices that are associated with student achievement and success. The low-track classes (predominantly poor minority children) are characterized by alienation, distance, and authority. Students in low-track classes are not exposed to the same high-status knowledge and instruction as the high-track groups. They are not expected to learn the same kinds of skills. Prominent in these classes are instruction of low-level basic skills. The course content in low-track classes reflects simple memory tasks or comprehension. Students in low-track groups have lower levels of academic achievement and aspirations of success. The low-track classes characterize those classes where students learn less and expect less.

This theory asserts that there exists an unequal distribution of knowledge in a direction that favors the already privileged. Track levels in schools, reflective of social and economic grouping in society, are designed in such a way that the students from upper socioeconomic levels have greater access to the kind of knowledge and instruction that permit them academic achievement and success in school.

Jeannie Oakes' book, *Keeping Track: How Schools Structure Inequality*, represents a distinctive contribution to the understanding of grouping, particularly

represented as tracking (Oakes, 1985). Oakes' research addresses the effect of alternative practices on student achievement. She examines the degree to which grouping and tracking accomplish the intended purpose of achieving student homogeneity. Oakes discusses the differences in viewpoints that revolve around whether it is advantageous to seek homogeneity in groups and classes or to let placement occur randomly.

Oakes asserts that tracking, in essence, is sorting -- a sorting of students that has certain predictable characteristics. First, students are identified in a rather public way as to their intellectual capabilities and accomplishments and separated into a hierarchical system of groups for instruction. Second, these groups are labeled openly and characterized in the minds of teachers and others as being of a certain academic type. Third, individual students in these groups come to be defined by others in terms of these group types. Fourth, on the basis of these sorting decisions, the groupings of students that result, and the way educators see the students in these groups, students are treated by and experience schools very differently. Oakes asserts that tracking retards the academic progress of students. It exists to deny opportunity and to create further differences. This view suggests that negative academic results come about for the low-track students because of tracking. Classroom differences that inhibit learning of those in low groups are a result of placing these similar students together for instruction.

Oakes' fundamental argument is that heterogeneous groups could equalize students' educational experience. The belief is that if students were given a common curriculum, comprised of the high-status knowledge primarily reserved for students in high-tracks, the closing off of students' access to future opportunities would be lessened.

All students would be at least exposed to those concepts and skills that permit access to higher education.

Oakes provides one alternative to homogeneous grouping and traditional teaching methods -- a group of strategies developed from a model of cooperative learning. Cooperative learning approaches are based on the assumption that students learn best when they are actively working with others in small heterogeneous groups, in which the substantial instructional potential of student-to-student interaction is exploited. The way students interact with one another is to a large extent a result of how teachers structure learning and instructional goals. This perspective asserts that the use of cooperative learning structures could be very effective in attaining increased academic achievement.

The alternative strategies of cooperative learning has three advantages over competitive and individualistic methods: (1) a built-in incentive for students to interact with one another as learning resources; (2) a means of accommodating learner differences in the learning process; and (3) a way of minimizing or eliminating the effects of initial differences in students' skill levels or learning rates in the assigning of rewards for learning. Oakes argues that cooperative learning strategies are the key ingredients of an instructional mode designed to counter the limited, uninspired classroom practices and homogeneous groupings predominant in American schooling.

Chapter 3

Collection and Presentation of Data

The purpose of this study was to investigate the relationship between minimal math requirements in high school and low math skills of entering college students. In order to do this, data were collected and presented by administering a Likert-scale questionnaire to college remedial math classes.

The Sample

The subjects in the study were students chosen from Basic Mathematics (Math 0123) and Elementary Algebra (Math 0124) classes. The math classes were randomly selected at Oklahoma State University and at Tulsa Community College. This resulted in 398 subjects in Basic Mathematics classes and 866 subjects in Elementary Algebra classes.

The Instrument Used

Data were gathered by means of a Likert-scale questionnaire (see Appendix A) which included a section relating to: Students' age, sex, year of high school graduation, year of most recent math course, specific math courses taken in high school, and permission to access their ACT scores. Students also rated the importance of the two factors in determining their need to take remedial math. The two factors were:

1. Not taking a sufficient amount of high school math
2. Not learning high school math adequately

The purpose of this questionnaire was to investigate the math background of the remedial students and to determine the major reason for taking the course.

Description of the Instrument

The questionnaire has a paragraph at the top of the page to explain the purpose of the instrument (see Appendix A). The students were assured confidentiality in their responses and that they would not have any bearing on their grade in the course. Questions pertained directly to the mathematical background of the student. The directions for each question were read aloud and explained before the students completed the questionnaire.

The instrument was believed to possess satisfactory content validity as each question, which was evaluated by a panel of judges, pertained directly to the information obtained. High reliability was assured for the factual questions in the instrument. Some indication of the reliability of the remaining questions was obtained by checking them for internal consistency.

Method of Collecting Data

The questionnaires were administered by the math teacher of each class. It was given to students in the Basic Math and Elementary Algebra courses during the Fall semester of 2000. Subjects were asked to complete it anonymously. The completed questionnaires were coded and the data analyzed by computer.

In each course about 16% of students were absent and did not complete the questionnaire. This left 398 Basic Math students and 866 Elementary Algebra students, a total of 1264 completed questionnaires. The breakdown of students were as follows:

398 Basic Math students:

1. 254 Oklahoma State University students
2. 144 Tulsa Community College students

866 Elementary Algebra students:

1. 220 Oklahoma State University students
2. 646 Tulsa Community College students

All subjects gave permission to use their ACT scores. Math, English and composite scores were obtained from the Admissions and Records offices.

How Data Were Presented

Results of the data were presented in frequency tables and cross-tabulations of target variables were also given. The two factors in determining the reason for taking a remedial math course referred to:

Factor 1: Not taking enough math in high school

Factor 2: Not learning high school math adequately

The following frequency tables were included:

TABLE 1

Factors Rated Most Important By
Basic Math and Elementary Algebra Students

	Most Important Factor	
	F_1	F_2
Basic Math		
Elementary Algebra		

TABLE 2

Ratings Given to F_1 and F_2 by Basic Math Students

	F_1	F_2
Very Important		
Somewhat Important		
Not Important		

TABLE 3

Ratings Given to F_1 and F_2 By Elementary Algebra Students

	F_1	F_2
Very Important		
Somewhat Important		
Not Important		

The chi square statistical test was used and the level of significance was .05.

Chapter 4

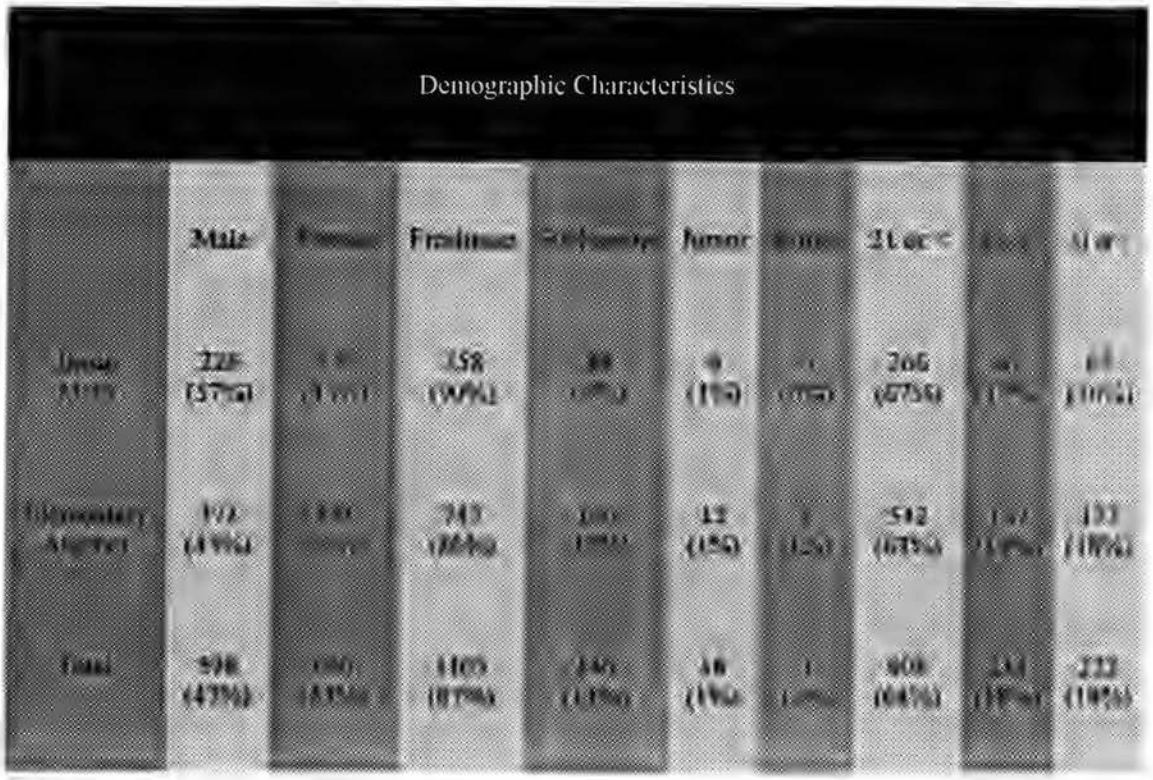
Descriptive Information

Demographic Data

As seen in Table 1, the demographic data gathered from the questionnaires provides useful information about the students in each course. Males and females are about equally represented with 53 percent females and 47 percent males. There are 87 percent freshmen, 11 percent sophomores, 1 percent juniors, and 1 percent seniors.

Table 1

Demographic Data of Students
In Basic Math and Elementary Algebra Courses



The Basic Math courses have 67 percent of students under 21 and 16 percent over 30. The Elementary Algebra courses have 63 percent under 21 and 18 percent are over 30 (see Figure 1).

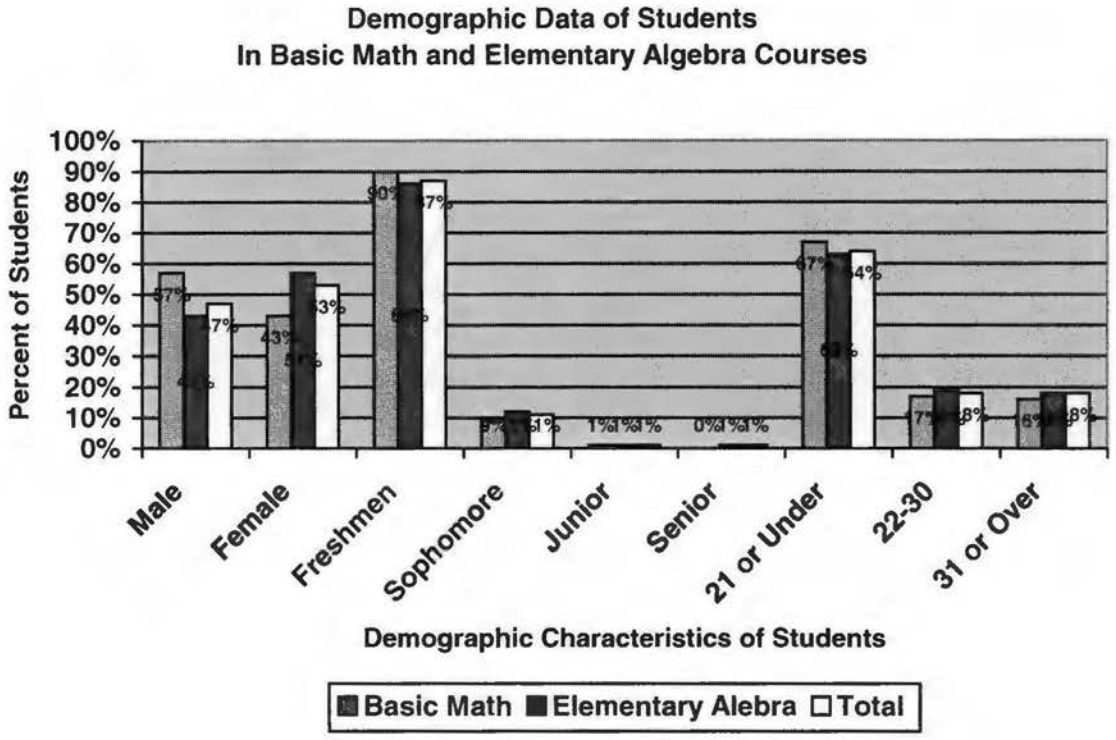


Figure I

In the questionnaire the students were asked to list a major and most of them indicated an intended major or career plan. As shown in Table 2, even with their poor math skills, many students chose a major in a math-dependent field.

Table 2

Intended Majors of Students
In Basic Math and Elementary Algebra Courses

	Type of Major		
	Math-Dependent	Possibly Math-Dependent	Not necessarily Math-Dependent
Basic Math	220 (55%)	88 (22%)	90 (23%)
Elementary Algebra	521 (60%)	173 (20%)	172 (20%)
Total	741 (58%)	261 (21%)	262 (21%)
	Finance Drafting Psychology Accounting Aviation Technology Electronics Business Biology Industrial Technology Marketing Computer Science Medical Fields	Wildlife Pre-law Home Economics	Art Journalism Horticulture Criminal Justice Speech Pathology Social Studies History Social Work Education

55 percent of Basic Math students and 60 percent of Elementary Algebra students indicated math-dependent majors (see Figure 2).

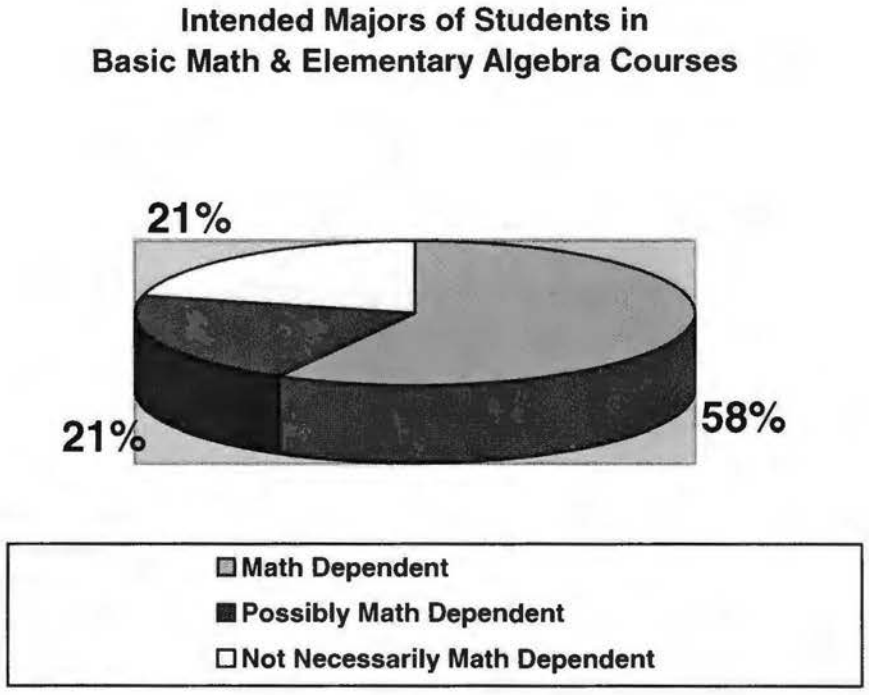


Figure 2

High School Math Preparation

As shown in Table 3, the students were divided into four categories according to the amount of math taken in high school. A total of 17 percent of students only had General, Business or Consumer Math and 16 percent have completed math through Algebra I. At total of 18 percent had taken two years of high school math – Algebra I and Geometry. A total of 49 percent of students completed at least three years of high school math – Algebra I, Geometry and Algebra II or possibly higher (See Figure 3).

Table 3

High School Math Taken By
Basic Math and Elementary Algebra Students

	General Math	General Math & Algebra I	Algebra I & Geometry	Algebra I, II & Geometry
Basic Math	96 (24%)	78 (20%)	78 (20%)	146 (36%)
Elementary Algebra	126 (15%)	119 (14%)	151 (17%)	470 (54%)
Total	222 (17%)	197 (16%)	229 (18%)	616 (49%)

Table 3 shows the breakdown of responses for Basic Math and Elementary Algebra students. When comparing the two courses, the Elementary Algebra students report more high school math: 15 percent had taken General Math, 14 percent had taken math through Algebra I, 17 percent had taken Algebra I and Geometry, and 54 percent have completed three or more years of high school math. The Basic Math students reported less high school math: 24 percent had taken General Math, 20 percent had taken math through Algebra I, 20 percent had taken Algebra I and Geometry, and only 36 percent had completed three or more years of high school math.

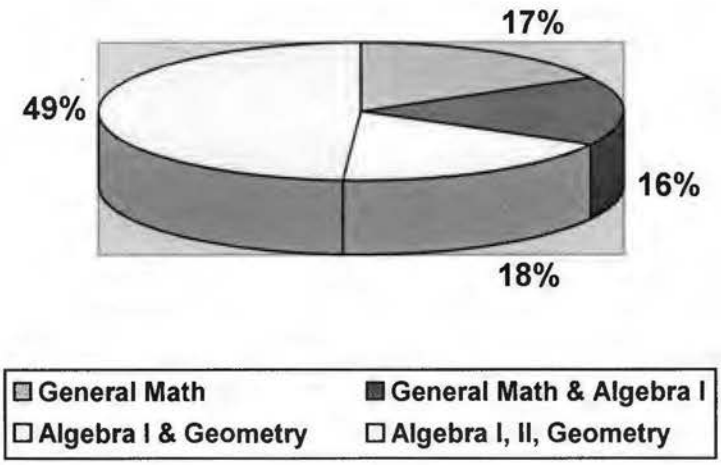


Figure 3

Table 4 shows the amount of time since the students took their last math course. Many students reported that they have taken a math course fairly recently. A total of 43 percent had taken math in the last two years and 27 percent in the last four years.

Table 4

Time Since Last Math Course For
Basic Math and Elementary Algebra Students

	1-2 Years	3-4 Years	5-10 Years	Over 10 Years
Basic Math	124 (31%)	128 (32%)	51 (13%)	95 (24%)
Elementary Algebra	419 (48%)	217 (25%)	64 (8%)	166 (19)
Total	543 (43%)	345 (27%)	115 (9%)	261 (21%)

A total of 30 percent had not taken math within the last five years or longer (see Figure 4). Table 4 also shows that 37 percent of Basic Math students had not taken math in the past five years and they are less likely to have taken math recently.

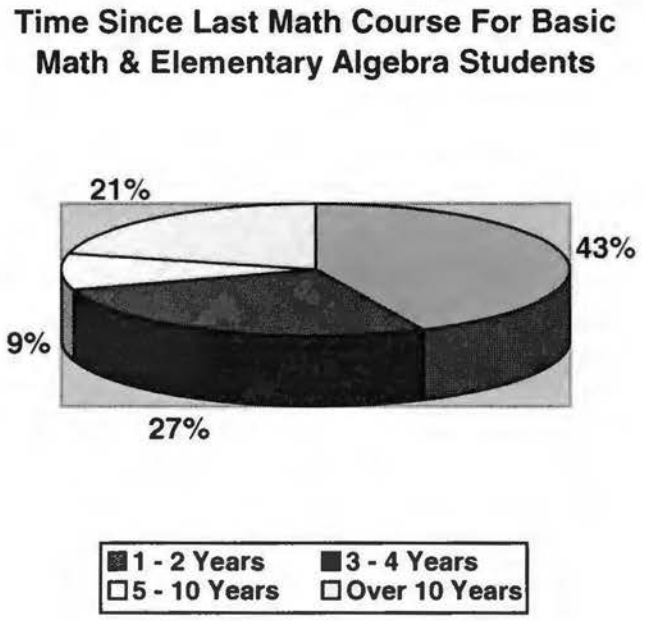


Figure 4

ACT Scores

A large number of the students in the sample (62%) have lower ACT Math scores than Reading, Science or Composite scores. The Math and English scores were about the same. Many of these students in both courses had lower math scores that range from 10 to 19 points lower. The mean English score was 14.73, the mean Reading score was 16.49, the mean Science score was 16.81, the mean composite score was 16.00, while the mean Math score was only 14.78, with the Math scores ranging from 6 to 19. The Basic

Math mean Math score (14.35) was lower than the mean score for the Elementary Algebra students (15.22). These scores were similar to the mean ACT scores for all entering freshmen at OSU and TCC (Admissions & Records Offices, Fall 2000).

Reasons For Taking Remedial Math Courses

As shown in Table 5, the majority of students indicated that the most important reason for taking remedial math was because they "didn't learn" the material well the first time they took it in high school. This reason was selected by the largest number of students in both the Basic Math and Elementary Algebra courses. The response "didn't learn" was given by 87 percent of all students and the response "never had" the material was chosen by only 13 percent of students (see Figure 5).

Table 5

Reasons For Taking Remedial Math Courses
Chosen By Basic Math and Elementary Algebra Students

	"Never Had Math"	"Didn't Learn Math"
Basic Math	42 (11%)	356 (89%)
Elementary Algebra	128 (15%)	738 (85%)
Total	170 (13%)	1094 (87%)

Table 5 also shows responses given for the total group as well as for students in each course. The response pattern was similar for Basic Math students compared to Elementary Algebra students. Elementary Algebra students more often chose "didn't

learn" the material well (85%) and less often chose "never had" the material (15%). Similarly, Basic Math students more often chose "didn't learn" the material well (89%) and less often chose "never had" the material (11%).

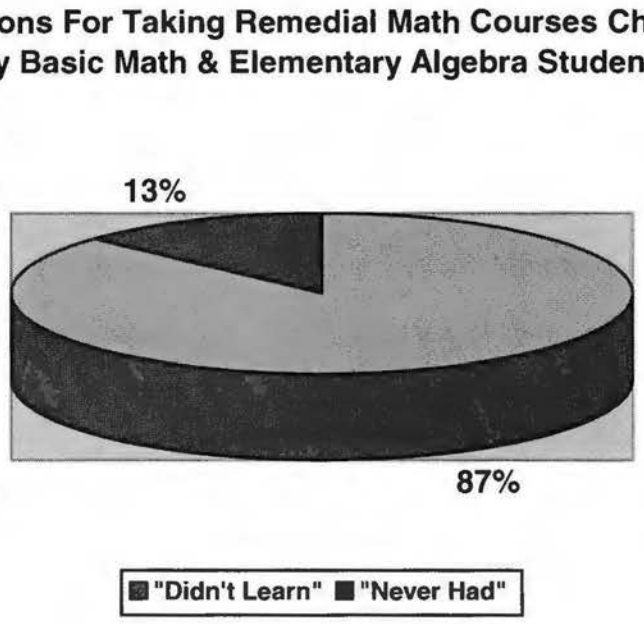


Figure 5

Effect of Amount of High School Math Taken

Table 6 shows the response pattern of students with similar math backgrounds. For example, the students that have one, two or three years of high school math had similar responses to the two factors. This group was more likely to choose "didn't learn" the material (94%) and less likely to choose "never had" the material (6%).

Table 6

Effect of Amount of High School Math
On Reason For Taking Remedial Math

	"Never Had Math"	"Didn't Learn Math"
General Math	103 (46%)	119 (54%)
General Math & Algebra I	25 (13%)	172 (87%)
Algebra I & Geometry	28 (12%)	201 (88%)
Algebra, I, II & Geometry	14 (2%)	602 (98%)

Even the students with only high school General Math were more likely to choose "didn't learn" the material (54%) and less likely to choose "never had" the material (46%). Even though both groups selected "never learned" more often, the General Math students showed a clearly different response pattern than students with more math background. They chose "never had" the material much more frequently than the group of students with more math background (see Figure 6). This difference was significant at the .05 level.

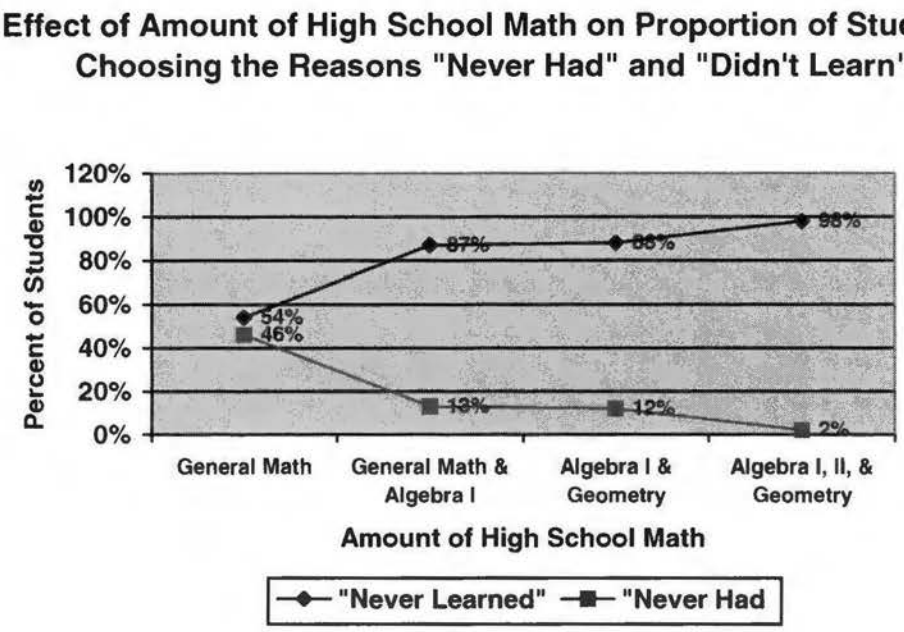


Figure 6

Effect of Time Since Last Math Course

As seen in Table 7, even the students who have been away from math longer are also more likely to choose "never learned" as their most important reason for taking remedial math. Although, an interesting correlation occurred between time away from math and the amount of math taken. As their time away from math increased, the proportion of students choosing "didn't learn" decreased while the proportion choosing "never had" increased. The results are the same for both Basic Math and Elementary Algebra students.

Table 7

Effect of Time Since Last Math Course
On Reason For Taking Remedial Math

	"Never Had Math"	"Didn't Learn Math"
1 - 2 Years	69 (13%)	474 (87%)
3 - 4 Years	26 (8%)	319 (92%)
5 - 10 Years	10 (9%)	105 (91%)
Over 10 Years	65 (25%)	196 (75%)

The graph in Figure 7 shows the effect of time away from math on the proportion of students choosing the reasons "didn't learn" and on the proportion choosing "never had." The effect on the proportion choosing "didn't learn" is significant at the .05 level.

From this data, a test of correlation between a nominal and an ordinal-level variable was completed. There was a correlation of .36 found between time away from math and choosing "didn't learn." A smaller correlation of .16 was found between time away from math and choosing "never had."

Even with this response pattern, a large percentage (75%) of those students away from math for more than 10 years chose "didn't learn" the material well, which indicated that these students were still exposed to the material even 10 years ago.

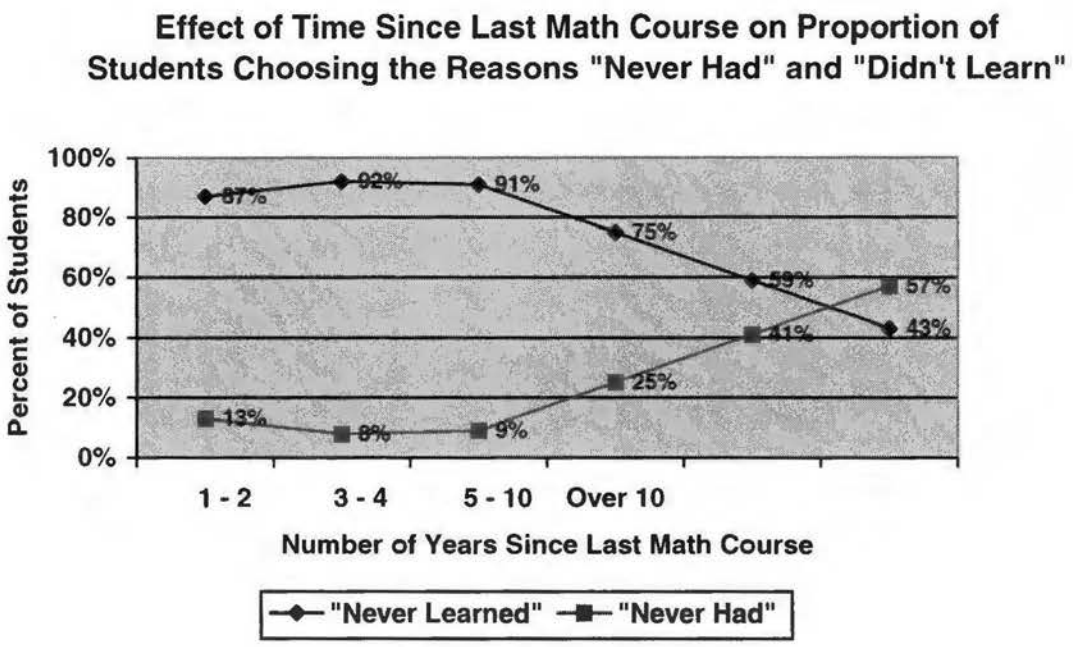

Effect of Time Since Last Math Course on Proportion of Students Choosing the Reasons "Never Had" and "Didn't Learn"
Percent of Students
100%
80%
60%
40%
20%
0%
87%
92%
91%
75%
59%
43%
13%
8%
9%
25%
41%
57%
1 - 2
3 - 4
5 - 10
Over 10
Number of Years Since Last Math Course
"Never Learned"
"Never Had"

Figure 7

Chapter 5

Discussion and Conclusions

Introduction

There are certain limitations in this study that must be acknowledged in order to verify the validity and reliability of the results found in Chapter 4. One limitation is the fact that approximately 16 percent of students in each of the two courses did not complete questionnaires because they were absent from class. Thus, the group of students completing questionnaires is not the true representation of the student population in these courses. Theoretically, the absent students were likely to represent the less motivated students than those 84 percent of reliable students in the course. If the total group had completed questionnaire, it is likely that more alarming facts would have been found (poorer math preparation in high school, lower ACT scores, weaker math skills, etc.). Thus, the results of this study are obtained from the 84 percent of the population of students present in the sample selected.

Another restriction in the study is the assumption that students were able to recall accurately the math courses they took in high school. Other studies have used similar methods of examining high school math preparation with considerable success (Mitchell, 1984 & Kansky & Olsen, 1981). Also, the math background results obtained in this study are very similar to those in the previous studies of remedial math students (Bell, 1983).

Math Background

Many of the students in remedial math courses had several years of math in high school. This was especially true in Elementary Algebra where 86% of students had one,

two or three years of high school math (see Table 3). Surprisingly, many of the Basic Math students (76%) had one, two or three years of high school math. Also, a large number of students (37%) in Basic Math and Elementary Algebra (27%) had been away from math for five years or longer (see Table 4). Similar results were found in several previous studies (Bell, 1983; Mitchell, 1984).

Causes for Poor Math Skills

In the early stages of this study two factors were selected from the data which appeared to be the two main reasons for students taking remedial math courses when entering college:

1) Insufficient Amount of Math in High School

2) Inadequate Learning of Math in High School

All students in the sample identified each of the two factors as an important reason for taking remedial math.

Never Having the Material

Only a small percentage of the total students (13%) chose "never had" as the most important reason for taking remedial math. Even those students who have had General Math and Algebra I felt that they had been exposed to the material before (71%). This was apparent since most of the material in Basic Math and Elementary Algebra is at or below the level of high school Algebra I.

From the results in Table 5, "never had" the material in high school was not the most important reason for students taking remedial college math. This holds true even with the group of students who have been away from math for a considerable period of time. Table 7 shows that 91 percent of students who had been away from math for more

than five years and 75 percent of those away from math for more than 10 years still reported that they had the material in high school but never learned it well.

The group of students that have been out of school for five years or more reported that they needed remedial math because they had forgotten the material since high school. Only 9 percent of those that have been away for five years and 25% of those that have been away for more than 10 years indicated that they "never had" the material in high school. Clearly, this is not a reflection on the high school curriculum of 10 years ago. It is possible that some students forgot that they ever saw the material before. About the same percentage who indicated they "never had" the material had only taken General Math in high school. The material in Basic Math and Elementary Algebra has not really changed that much in the past ten years. The group of students who had been away from math for more than five years consists of 30 percent of the population in these courses. The group of students who have been away from math is increasing in today's college enrollment patterns and they have special needs which should be considered individually.

Not Learning the Material Adequately

A disturbing result shows that 83 percent of students in these remedial math courses have had two or more years of high school math. Other studies that examined the high school math preparation of remedial students also concluded that a high percent of students in college remedial math courses have had three or more years of high school math (Bell, 1983 & Lappan & Phillips, 1984). These students had been exposed to the math yet they were taking the same course material over again in college. These students report "inadequate learning" as the most important factor for taking remedial math.

Most of the students in the sample have had the material in high school and reported "inadequate learning" as their reason for taking remedial math. This is the most common reason, given by 87 percent of students. Surprisingly, "inadequate learning" is chosen most often by those who have taken math in the last five years.

Implications for the Students

From the results in Table 2, many students in the sample (58%) listed an intended major which is clearly in the math-dependent fields, such as accounting, computer science, engineering, business, and finance. However, studies show that most students enrolled in remedial college math do not improve their math skills sufficiently for pursuing careers in these areas (Whitesitt, 1982 & Mitchell, 1984). These studies report that many remedial math students change their major to an area that is not math-dependent, such as art, criminal justice, social work, and education.

Implications for Oklahoma State University

At both institutions, OSU and TCC, there was a visible difference between Basic Math students and Elementary Algebra students. This study, along with others, showed they have different characteristics, interests, backgrounds, and needs. Generally, Basic Math students have taken less math in high school and their math ACT scores are substantially lower. They are usually older and have been away from math longer. At both these institutions, only11 percent of these students reported they are taking Basic Math because they "never had" the material in high school, whereas, 89 percent indicated they are taking the course because they didn't learn math well in high school.

Implications for Basic Mathematics Courses

The college admissions requirements for Oklahoma went into effect in August of 1988 which required all entering freshmen to have Algebra I, Geometry and Algebra II. In order to be admitted into OSU, or any other university in Oklahoma, students were required to have three years of high school math (Oklahoma State Regents for Higher Education, 1988). Clearly, a Basic Math course will cover previously taught material for these students. Theoretically, the need for this course should then be substantially reduced.

Yet, we are seeing an increase in the number of students entering college that need remedial Basic Math. At this time, 64 percent of students presently in Basic Math have had less than the required three years of high school math. These students that have not been exposed to a sufficient amount of math will need a remedial course before taking a college-level math course.

There is still some need for a course at the level of Basic Math. Although the course sections should be reduced, there are several reasons why it should not be completely withdrawn from the curriculum. One reason is because 36 percent of students in the course report having taken math through Algebra II in high school but needed the remedial course to review forgotten material. The need of this group for this course will likely remain the same.

Secondly, the 64 percent of students in the course that have had less than the required amount of high school math most likely have not had sufficient exposure and need this course before they can successfully take a college-level math course. The need of this group for this course should decrease if Oklahoma high schools and colleges

enforce the admissions requirement. At this time, many colleges are ignoring this policy, admitting a large number of students without three years of high school math. This study shows that some students enter college without any high school math preparation, and some of these are recent high school graduates. Out of the 64 percent of students that indicated they had less than three years of high school math, 25% percent of these graduated in the last 10 years. This indicated that the colleges are not enforcing the admissions requirement policy mandated by the Oklahoma State Regents in 1988.

Thirdly, OSU attracts many older, non-traditional students who do not meet the math admissions requirements. Many of the Basic Math students in this study fall into this group and this course would be necessary to prepare them for college-level courses, even if it means taking the course without credit.

Finally, the group of college-bound students who must take the high school math through Algebra II will include those students who now avoid high school math. Such students entering under the revised admissions requirements with three years of high school math are likely to be poorer in math and did not learn as well as those entering now with three years of high school math. Again, these students need to improve their math skills before taking college-level courses.

Implications for Elementary Algebra Courses

Elementary Algebra students are quite different from Basic Math students; they are not simply the same population of students one semester later. The content covered in Elementary Algebra should also be review material for the students with math through high school algebra II. In the sample, 71 percent of the Elementary Algebra students have had two to three years of high school math and take this course for review purposes.

Since all college-bound students are required to take three years of high school math under the Oklahoma college admissions requirements, the need for this course should be considerably reduced.

Implications for High School

Math Teaching and Requirements

This study indicated that the high school math preparation of these students does not run parallel with their college major ambitions (see Table 2). Other studies on remedial math students report similar results (Bell, 1983). Surprisingly, many of these college-bound students in a math related field had minimal courses of high school math – 17 percent had only General Math and 16 percent had only up to Algebra I.

This study, along with several others, indicated the need for much more rigid math requirements for college admission and for high school graduation. Oklahoma requires high school students to take Algebra I, Geometry and Algebra II for admission into state colleges. Other states have even more relaxed admission requirements which impede students' academic progress, setting them up for failure. It will be detrimental to students and society if other states do not increase their admission requirements.

However, a large proportion of the students in this study (83%) did have the required amount of high school math and still needed a review course when they entered college. Much research has been done on the remedial needs of students and these studies indicate that many students are entering college seriously deficient in math skills even though they have had the required amount of math in high school (Adelman, 1999; Astin, 1998; Chambers, 1994; Lappan & Phillips, 1984; Selingo, 2000; & Waida, 1999). The admissions requirements will not change the need for this pool of students. Since

these students had the sufficient amount of math in high school it is very likely that they did not receive adequate learning of math taken in high school. Theoretically, there should not be such a large number of students entering college with this background and without the math skills to do college-level work, especially now, with the state regents' mandated math requirements for admission to college.

Measures must be taken to help improve the math skills of these students before they reach college. Just because they report taking courses in high school does not necessarily mean they gained adequate math skills to perform at the college level. Several studies in the literature report that many high school graduates with the required high school math background still enter college needing one or two remedial math courses before they can do college level work in math (Bell, 1983 & Mitchell, 1984).

It is important for these students not just to enroll in these courses in high school, but to receive the proper instruction to ensure them sufficient math skills necessary to enter college without needing a remedial math course before they begin their degree program.

When Oklahoma increased the math requirements for all college-bound high school students – that was the first step. Obviously, this does not solve the problem. To ensure proper high school instruction in order to guarantee the students adequate math skills – is the second step.

Conclusions

The problem of poor basic math skills in college students is clearly serious and widespread and severely limits the career options of many students. One key is raising the level of college admissions requirements. This will help reduce the number of

students entering college with poor math skills, but only to a point. The other key is the enhancement of math instruction at the high school level. We must increase the content and rigor of the math curriculum in our public school systems. This is not to say that students take required math credits, graduate from high school, and consequently, they are readily admitted into college. It says we must ensure that students receive sufficient learning and instruction in their math courses taken in high school for adequate preparation for college.

Research shows that too many high school teachers pass students for various reasons (Battista, 1999 & Mathematical Association of America, 1991). The teacher has a professional obligation to pass these students only when they have achieved the proper math skills to advance to the next course of sequence, not herd them through the "revolving door" just because it is easier and less pressure to pass them. This simply forces the student to take a non-credit remedial course before they can pursue their degree. Until this problem is confronted, colleges must deal with math deficiencies in their students.

In order to successfully resolve this dilemma, both educational sectors must combine their efforts to reform the math curriculum in their institutional programs. High schools will need to demand a higher level of math skills from their students, rather than just increasing the amount of math required for graduation. They must raise the level of content and rigor in the math curriculum and offer serious math courses. Higher education will need to raise the level of admission requirements and send out a message to high school graduates that academic ability will be a determining factor in the

admission procedures and abolish the democratic philosophy that higher education means to educate the masses regardless of qualifications or academic ability.

Implications for Practice

When educational environments are serious about the quality of teaching, then the design of the curriculum will receive the attention it deserves. Most of the literature criticized the university environment, claiming that it is anything but serious about the quality of teaching (Finn, 1988; Leo, 1994; Lively, 1995; Manno, 1995; & Sykes, 1988). They claim its attention to the design of the curriculum is reflected in the non-existent standards, low-level remedial courses, watered-down programs, intellectually shallow departments, and a narrow scholarly focus that is the shame of American higher education institutions.

Researchers suggest that this degenerated curriculum is designed to keep the universities well-stocked and the students pacified, while demanding as little as possible from them (Astin, 1982 & Sykes, 1988). Many criticized higher education for offering unchallenging basic programs and failing to teach critical thinking skills, producing graduates with minimal skills and knowledge. Higher education is characterized as an "epidemic of ignorance" whose value has degenerated to a worthless commodity (Sykes, 1988).

The literature especially criticized state universities where budget priorities are closely tied to statistical measurements of enrollment and an elaborate numbers game shapes the curriculum and colors the entire academic landscape (Finn, 1988; Kelly, 1989; Lively, 1995; & Sykes, 1988). Student contact hours in academe are compared to the return on investment in corporations – where systematic misuse of reductionist measures

has been the cause of organizational decline. The literature suggests that the politics of the numbers game dictates the destruction of traditional standards of performance and intellectual integrity – regressing to undemanding, unchallenging courses of low standards in effort to keep classrooms stocked with tuition-paying bodies.

The university curriculum is portrayed as the "gut culture" that produces illiterate students unable to read, write, or do even basic math. Higher education is labeled as the "home office of educational mediocrity in America" (Sykes, 1988).

Researchers blame this trend of the academic culture toward "mediocrity and ignorance" on higher education (Astin, 1982 & Sykes, 1988). But given the impervious logic of the numbers game, academia must make compromises. Low-level remedial programs are part of the curriculum to keep the bottom half of the skill range from fleeing in panic. If two-thirds of entering freshmen do not possess the skills necessary for college success, what alternatives do colleges have?

Minimal academic standards and low-level remedial programs are a growing problem for colleges, but are they the ones at fault? This growth of degenerated programs and reduced standards have penetrated academic departments and administrators realize something must be done to reestablish quality standards. But they have been forced to compromise their standards because of the increased number of poorly prepared entering freshmen. This does not mean they are not concerned about these issues, but that they are restricted by the diversity of the clientele entering their doors.

The bottom line is this -- colleges are being forced to reshape their curriculum to reteach high school basic skills and knowledge because entering students cannot perform

at the college level. The problem begins with the pre-college education of these students. There has to be a better "link" or "connection" between students' pre-college and college education.

In order for colleges to raise their standards and offer quality education, students must receive adequate educational training prior to college. For this to occur, secondary and post-secondary educational sectors must unite their efforts and collaborate their curricular designs to link the transition from secondary to post-secondary education with less friction.

Alternative Explanations for Student Outcomes

Much of the research on poor math skills of entering college students has addressed the effect of the amount of high school math on student achievement. This study offers a different perspective -- that schools need to focus on the quality of teaching math rather than the amount of math students take in high school. As opposed to the traditional belief that "more is better," this study proposes that less math may be more effective and conducive to student learning if it is delivered in an appropriate manner. The constructivist perspective emphasizes the link between the way math is taught and student achievement levels in math classes. In the constructivist view, the way math is delivered and how the teacher interacts with students determine student outcomes.

Insufficient amount of math and inadequate teaching practices are only two possible explanations for low student achievement in high school math classes. As discussed in chapter two, the literature provides several other possible causes for students not learning math in high school. It is very likely that other processes are occurring in schools that impede student learning and produce poor skills in high school math classes.

It is possible, of course, that the poor math skills and abilities of high school students may be more determined by the existence of a powerful and oppressive force that works to ensure school failure and maintain social inequity rather than poor teaching or insufficient amount of math.

The blame for low student achievement in high school cannot be addressed without the discussion of the cultural-reproduction theories discussed in chapter two. The different perspectives provided by Bowles and Gintis (1976), Willis (1977), Everhart (1983), Bernstein (1977) and Oakes (1985) merit some attention. The differential classroom process discussed in these theories -- social and economic reproduction, differential socialization, homogeneous grouping, sorting and tracking of students, student resistance -- may well be responsible for the low achievement outcomes in high school math classes. The possible link between student achievement and these alternative theories is clearly a subject for further inquiry.

In all areas of classroom processes -- curricular content, instructional practices, and social relationships and interactions -- the differences found among track levels are illustrative of the cultural-reproduction theory. It is almost impossible not to accept this view that differences in educational outcomes result from this process.

The possible link between educational inequities, reflective of the inequities in the larger social structure, and student achievement outcomes has important implications for educational reform. It seems important that school reforms focus their efforts toward making schools themselves fair and equitable places for students to learn. This focus on creating more equitable schools seems to imply reforms toward two separate but related goals. First, schools must relinquish their role as agents in reproducing inequities in the

larger society. Schools should cease to sort and select students for future roles in society. Second, schools must concentrate on equalizing the day-to-day educational experiences for all students. This implies altering the structures and contents of schools that seem to accord greater benefits to some groups of students than to others.

Recommendations for Further Research

Research recommendations which follow are based upon the results of this study:

1. Future research should investigate why high school students are not learning math adequately, even after taking several years of high school math. The math skills of those students who have taken the required amount of high school math show major deficiencies. Even the students that have had at least three years of high school math do not have the fundamental skills to be successful in college. A large number of students in remedial math (83%) reported that they had several high school math courses but never learned the material. Studies in the literature also reported that most remedial students in college have had the required amount of high school math, yet still require remediation. These findings suggest that there is a serious educational problem within the high school math curriculum. The majority of students in remedial math reported "inadequate learning" rather than "never had" as their reason for taking remedial math. Because of the large number of students that had math but never learned it, and given the future trends in remedial education, further research is warranted.

2. Future research should focus upon the content and rigor of the high school math curriculum. Obviously, from this study and several others in the literature, requiring students to take three years of high school math does not ensure sufficient math skills to be successful in college. The teaching of math in high school should equip students to enroll in college math without needing remediation in fundamental skills. As was pointed out in the review of the literature, the math curriculum in high schools is undemanding and superfluous, and the course material does not prepare students for college level work. The high school math courses reflect "minimum competency" and

fall short of what is needed, as the "minimum" tends to become the "maximum", thus lowering educational standards for all. Also, due to the pressure on high schools to meet certain retention and persistence standards, much of the curriculum is watered-down to keep students in school. Thus, in addition to the required sequence of courses for graduation, new, equally demanding math curricula need to be developed and implemented in high school. Researchers need to conduct further research in this area.

3. Future research should examine the required competencies for college entrance. What criteria should colleges use to determine if students are competent enough to be successful in college? The review of the literature shows that one-fifth of all four-year colleges must accept every high school graduate regardless of program followed or grades, thereby serving notice to high school students that they can expect to attend college even if they do not follow a demanding course of study in high school or perform well. Even the more selective colleges reported that their general level of selectivity has declined, reducing the number of specific high school courses required for admission. College admission standards have been drastically reduced in order to accommodate the diversity of their entering students. Low-level fundamental courses were established to keep the "bottom half" from fleeing in panic. Colleges are sending out a message to high school students that they will be admitted, regardless of academic ability. If colleges are willing to remediate any deficiencies of entering students, then high schools realize they do not need to be accountable for their students' academic competencies. Have colleges compromised their academic standards and quality education in order to admit the vast number of under-prepared students? It appears that the required competencies for college entrance are ineffective in determining student

readiness for college level work. What is the current evaluation of these competencies? Should colleges establish a common criterion of assessment, such as ACT scores, institutional assessment scores, or high school grades? Should colleges set common standards for admission requirements? Should colleges reexamine their admission policies with regard to students who lack fundamental skills? If colleges tighten their admission requirements and refuse to accept students unable to exhibit fundamental skills and perform at the college level, then high schools would be forced to take responsibility for teaching students the basic skills needed for college. The literature revealed that some states are trying to pass legislation that would require public schools to reimburse colleges for the cost of remedial courses for their graduates. Further research is needed regarding accountability for remediation.

4. Future research should focus on how to develop more effective exit criteria for high school graduates. The state increased the math requirements for graduation to include Algebra I, II and Geometry but this did not solve the problem of students who are not academically prepared for college. Even with the increased math requirements for graduation, it is still sobering that nearly half of all new college freshmen entering from high school need remediation with fundamental math skills. This study shows that high school graduates still cannot do basic math, even after having three years of high school math. The literature shows that innumeracy among high school graduates is widespread and growing, causing remedial programs to saturate the college curriculum. High schools need to implement more effective assessment criteria for their graduates. The literature indicates that high school graduation requirements need to be strengthened and that all students pass competency tests in basic core subjects. The literature provides evidence

that high school course work in math is not consistent with the requirements demanded of college freshmen. NAEP analysts found that only 16 percent of high school seniors were proficient in math and two-fifths failed to reach even the basic math level. NAEP also reported that half of high school seniors could not do math involving decimals and fractions. NAEP concluded that less than half of high school seniors reached a seventh grade competency level in math and only five percent attained a level of performance characterized by the first year of Algebra. Other studies in the literature reported that only one-third of high school graduates can solve basic math problems. The literature makes it clear that further research is needed in regards to improving basic math competencies and skills and strengthening the math requirements for high school students. Researchers need to conduct further research regarding the following areas: 1) Are the standards required for high school graduation sufficient for college success? 2) Should high schools require students to pass competency tests at each grade level before being allowed to advance to the next grade? 3) Should high schools require seniors to pass a final competency exam before being allowed to graduate?

5. Future research should focus upon the quality of the math offered in high school, rather than the quantity of math required. This study focused heavily on the quantity of math required for high school students. There was not a significant relationship between the amount of math taken in high school and their reason for taking remedial math in college. Further research may well need to investigate "how" math is currently taught in high school and how the teaching/learning process can be improved. What needs to be emphasized is that it is not how much math students take but how well students learn the math they have taken. This study shows that most students take math

in high school but do not learn it. Additional research is needed to find out why students are not learning the math they have taken. The review of the literature points out that traditional methods of teaching high school math are not only ineffective but also seriously stunt the growth of students' mathematical reasoning and problem solving skills. The literature also shows that current high school instruction continues to be dominated by isolated lectures, skill maintenance drills, teacher-centered environments, didactive approaches, and content-driven outcomes. Research is needed in the area of more innovative forms of instruction that involve problem solving skills, critical thinking, interpretation, and application of math concepts. Alternative teaching approaches, such as small group activities, laboratory work, and special projects remain disappointingly rare in high school math classes. High school students exhibit serious gaps in their knowledge and are learning math concepts and skills at a superficial level. The increase in remedial college math programs and the large number of innumerate high school graduates make clear the need for the development of pedagogy and curricula with better teaching practices that promote better thinking skills among math students. In the literature, researchers acknowledge that the way math is currently taught in high school is inadequate and failing students in their quest for understanding math. Some researchers suggest shifting the emphasis in math education from rote computational facility and manipulation of symbols toward an understanding of the concepts of basic math which can be demonstrated through problem solving and critical thinking. According to the current research on math education, in order to teach math effectively, a pedagogy that centers on conjecture, conceptual explanation, and discursive exchange must combat a well-entrenched pedagogical practice that emphasizes rote memorization and

computational routine conveyed through lecture, demonstration, or textbook. The numerous calls for math education reform tend to converge around an alternative teaching method referred to as "constructivism." This theory emphasizes problem solving, interpretation, and application of concepts as the focus of math education for high school students. Additional research is needed regarding this new instructional approach.

6. Future research should investigate the relationship between "time away from math" and reason for taking remedial math in college. This study, along with others, revealed that many students enroll in remedial math because they have "forgotten the material." The older students who have been away from math for several years indicated that neither factor "never had" nor "inadequate learning" applied to them. It seems clear from this study that older non-traditional students who have not had math recently need special attention. This group of students was not addressed in this study. The older students claim that too much time elapsed between their last math course and entering college. Researchers need to conduct further research on how colleges can accommodate this group of older students.

7. This study uncovered a disturbing result that warrants further research. Some students reported that they had very little or no high school math, yet these students were recent high school graduates. The graduation requirements policy for math requiring all high school students to take three years of high school math has been in effect for 10 years. How can students who have graduated in the past few years have no high school math? How have these students fallen through the cracks? Why is the system failing these students and why are high schools not preparing them for college? The number of

recent high school graduates that have had no high school math is substantial enough to warrant further research.

8. Future research should investigate the demographic backgrounds of remedial math students. Do these students, who are placed in remedial programs, tend to be from specific groups or come from certain types of high schools? Understanding the academic, demographic and socio-economic characteristics of students who require remedial assistance in college can enhance early intervention efforts. The literature reveals that the remedial enrollment for African-Americans is substantially higher than for other groups. This has relevance since African-Americans make up nearly one-quarter of all undergraduates, a proportion which has risen rapidly in recent years and is expected to continue to climb due to the increase in the minority school age population. Researchers need to conduct further research on the characteristics and backgrounds of remedial students to see if there is a relationship between their high school preparation and math skills. This information will provide a better understanding of how effectively certain types of schools are equipping students for college.

9. Future research should focus upon "prevention" -- adequate pre-college preparation, rather than the "cure" -- post-secondary remediation of deficiencies. Most of the current research emphasizes improving remedial programs at the college level rather than reforming the high school curriculum. There seems to be a gap in the literature regarding the importance of the quality and standards of the K-12 curriculum. Researchers need to conduct further research regarding reform efforts of the high school math curriculum.

10. Future research should focus on why students do not achieve more in high school math classes. Research studies need to be conducted with high school students to determine what happens in their math classes and explore why they do not learn in their high school math classes.

11. Future research should focus on the causal link between the inequalities in school experiences and the differences in student achievement outcomes. Also researchers should investigate the relationship between classroom interactions experienced by the low-track students and the high levels of school deviance and drop out rates.

12. Future research should examine the tracking processes in high school math classes. Is the tracking or sorting of students responsible for low achievement levels in high school math classes? What are the student outcomes of students that have been separated into homogeneous ability or achievement groups in math classes?

13. Future researchers should investigate the possible link between student achievement levels and the social, cultural, and economic reproduction theories discussed in this study. The differential socialization process of schools and its impact on student achievement is clearly a subject for further inquiry.

REFERENCES

Adelman, Clifford. (June, 1999). Academic Intensity, Attendance Patterns, and Bachelor's Degree Attainment. Office of Educational Research and Improvement. United States Department of Education, ix.

Astin, A. W. (1982). Minorities in American Higher Education. San Francisco: Josey-Bass.

Astin, Alexander. (Summer, 1998). Remedial Education and Civic Responsibility. National Crosstalk, National Center for Public Policy and Higher Education.

Ball, D. L. (1993a). With an eye on the Mathematical Horizon: Dilemmas of Teaching Mathematics. Elementary School Journal, 93, (4), 373-397.

Ball, D. L. (1993b). Halves, Pieces, and Twoths: Constructing Representational Contexts in Teaching Fractions. In Carpenter, T. P., Fennema, E., & Romber, T. (Eds.), Rational Numbers: An Integration of Research, 157-196. Hillsdale, NJ: Lawrence Erlbaum Associates.

Barnett, C., Goldenstein, D., & Jackson, B. (1994). Mathematics Teaching Cases: Fractions, Decimals, Ratios, & Percents. Portsmouth, NH: Heinemann.

Battista, Michael T. (February, 1999). The Mathematical Miseducation of America's Youth. Bloomington: Phi Delta Kappan, 80, (6), 424-433.

Bell, J. E. (1983). Survey of Remedial Math Students. Northeastern State University, Tahlequah, OK.

Bernstein, B. (1977). Class, Codes, and Control. London: Routledge and Kegan Paul.

Bishop, A. J. (1988). Mathematical Enculturation: A Cultural Perspective on Mathematics Education. Dordrecht: Kluwer.

Borasi, R. (1992). Learning Mathematics Through Inquiry. Portsmouth, NH: Heinemann.

Bowles S. and Gintis H. (1976). Schooling in Capitalist America. New York: Basic Books.

Boyd, P. C. (1994, March/April). Professional School Reform and Public School Renewal: Portrait of a Partnership. Journal of Teacher Education, 45, (2), 132-139.

Budros, Kathleen & Kangas, Jon. (1992). Success, Competency, and Persistence of New College Students in Math 310 at SJCC by Method of Instruction. (ERIC Digest, Research Report No. 126). San Jose, CA: ERIC Clearinghouse on Teaching Methods in Mathematics. (ERIC Document Reproduction Service No. ED 348099).

Carnegie Foundation for the Advancement of Teaching. (1976). Missions of the College Curriculum: A Contemporary Review with Suggestions. San Francisco: Josey-Bass.

Carpenter, T. P., Coburn, T. G., Reys, R. E., & Wilson, J. W. (1978). Results of the First Mathematics Assessment of the National Assessment of Educational Progress. Reston, VA: National Council of Teachers of Mathematics, Inc.

Carriuolo, Nancy. (April, 1994). Why Developmental Education in Such a Hot Potato. The Chronicle of Higher Education, B1-B2.

Chambers, Donald L. (March, 1994). The Right Algebra For All. Educational Leadership, 85-86.

Chang, Ping-Tung. (1983). College Developmental Mathematics. A National Survey. (ERIC Digest, Research Report No. 143, Conference Paper No. 150). A paper presented at the Annual Convention of the Mathematical Association of America, Southeastern Section, Charleston, SC, April 15-16, 1983 and the National Convention of the American Mathematical Association of Two-Year Colleges, Orlando FL, November 10-13, 1983. ERIC Clearinghouse on Teaching Methods in Mathematics. (ERIC Document Reproduction Service No. ED 234841).

Clement, John. (January, 1982). Algebra Word Problem Solutions: Thought Processes Underlying a Common Misconception. Journal for Research in Mathematics Education, 13, (1), 16-30.

Cohen, D. K. (1988). Teaching Practice. In Jackson, P. W., (Ed.), Contributing to Educational Change: Perspectives on Research and Practice, 27-84. Berkeley, CA: McCutchan.

Coleman, William T. & Selby, Cecily C. (October, 1982). Today's Problems, Tomorrow's Crises. A Report of the National Science board Commission on Precollege Education in Mathematics, Science, and Technology. National Science Board, National Science Foundation, Washington, D. C.

College Board, The (1983). Academic Preparation for College: What Students Need to Know and be able to do. New York, NY: College Board.

Conrad, C.F. & Haworth, J.G. (1990). Curriculum in Transition: Perspectives on the Undergraduate Experience. Needham Heights, MA: Ginn.

Countryman, J. (1992). Writing to Learn Mathematics: Strategies That Work. Portsmouth, NH: Heinemann.

Darkenwald, Gordon G. & Merrian, Sharan B. (1982). Adult Education: Foundations of Practice. New York, NY: Harper and Row.

Davis, R. B. (1984). Learning Mathematics: The Cognitive Science Approach to Mathematics Education. Norwood, NJ: Ablex.

Eldersveld, Paul J. (1983). Factors Related To Success and Failure in Developmental Mathematics in the Community College. Washington, D.C.: Community/Junior College Quarterly, 7, (2), 161-174.

Elliott, Emerson J. (1993). A Preliminary Report of National Estimates From the National Assessment of Educational Progress, 1992 Mathematics Assessment. Princeton, N.J.: 1993, p. 9. (ERIC Document Reproduction Service No. ED 351397).

Everhart, R. B. (1983). Reading, Writing and Resistance. Boston: Routledge and Kegan Paul.

Fennema, L., Carpenter, T. P., Franke, M. L., & Carey, D. A. (1993). Using Children's Mathematical Knowledge in Instruction. American Educational Research Journal, 30, (3), 555-495.

Fey, J. T., Albers, D. J., & Fleming, W. T., assisted by Lindquist, C. B. (1981). Undergraduate Mathematical Sciences in Mathematics, Four-year Colleges, and Two-year Colleges, 1980-1981. Report of the survey committee, Conference Board of the Mathematical Sciences, 6. Washington, D. C.: CBMS.

Finn, C. E. Jr. (1988, October). Consumers Need a 'No-Frills University' to Turn the Higher Education Marketplace Upside Down. Chronicle of Higher Education, 35, Issue 9, B1-B2.

Fosnot, Catherine Twomey. (1989). Inquiring Teachers, Inquiring Learners: A Constructivist Approach for Teaching. New York: Teachers College Press.

Frankenstein, M. (1981). A Different Third "R": Radical Math. Radical Teacher, 20, 14-18.

Fredrick, Dennis, Mishler, Carol, and Hogan, Thomas P. (1984). College Freshmen Mathematics Abilities: Adults vs. Younger Students. School Science and Mathematics, 84, 334-335.

Gibbons, A. (1994, November). A Time of Trials and Tribulations: Campus Innovations: Overview. Science, 266, (4), 844-851.

Ginsburg, H. (1977). Children's Arithmetic: The Learning Process. New York, NY: Van Nostrand.

Ginsburg, H. (1986). Children's Arithmetic: How They Learn it and How we Teach it. Austin, TX: Pro-Ed.

Graph, B.T. (1993, September). Higher Expectations Sought For State Curriculum. Source: Oklahoma State Regents for Higher Education. Tulsa World.

Grigoriu, Elizabeth C. (November, 1997). Qualitative Transformations Within the Student-Teacher Relationship. (ERIC Digest). Albuquerque, NM: Paper presented at the Annual Meeting of the Association for the Study of Higher Education, ASHE Annual Meeting. (ERIC Document Reproduction Service No. 415806).

Hiebert, James. (1986). Conceptual and Procedural Knowledge: The Case of Mathematics. Hillsdale, NJ: Lawrence Erlbaum Associates.

Hiebert, James. (January, 1999). Relationships Between Research and the NCTM Standards. University of Delaware: Journal for Research in Mathematics Education, 30, (1), 3-19.

Kamii, C. (1985). Young Children Reinvent Arithmetic: Implications of Piaget's Theory. New York, NY: Teachers College Press.

Kansky, Bob and Olson, Melfried. (1981). Career Choice: Do Students' Pre-collegiate Mathematics Programs Deny It? School Science and Mathematics, 81, 656-664.

Kelley, J. (1989, May). Colleges Shouldn't Waste Their Resources on Students Who Aren't Qualified to be There in the First Place. The Chronicle of Higher Education, B2-B3.

Kennedy, M. M. (1991). An Agenda for Research on Teacher Learning. East Lansing: Michigan State University, National Center for Research on Teacher Learning, Special Report.

Labinowicz, E. (1980). The Piaget Primer: Thinking, Learning, Teaching. Menlo Park, CA: Addison-Wesley.

Lampert, M. (1988). The Teacher's Role in Reinventing the Meaning of Mathematics Knowing in the Classroom. In Behr, M. J., Lacampagne, C. B., & Wheeler, M. M., (Eds.), Proceedings of the Tenth Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, 433-480. DeKalb: Northern Illinois University.

Lampert, M. (March, 1989). Arithmetic as Problem Solving. Arithmetic Teacher, 34-36.

Lang, W. S. (1992). Analysis of the Effects of the Computer Enhanced Classroom on the Achievement of Remedial High School Math Students. (ERIC Digest/Research Report No. 142). Washington, DC: ERIC Clearinghouse on Teaching Methods in Mathematics. (ERIC Document Reproduction Service No. ED 301600).

Lappan, Glenda & Phillips, Elizabeth. (January, 1984). The Mathematical Preparation of Entering College Freshmen. NASSP Bulletin, 68, (468), 79-84.

Leitzel, J. R. (1983). Improving School-University Articulation in Ohio. Mathematics Teacher, 76, 610-617.

Leo, J. (1994, August). A University's Sad Decline. U.S. News and World Report, 20.

Lester, F. K. & Garofalo, J. (March, 1982). Metacognitive Aspects of Performance on Arithmetic Tests. Paper presented at AERA.

Lively, Kit. (June, 1995). Growth of Admissions Exemptions Prompts Concern in Massachusetts. Los Angeles, CA: The Chronicle of Higher Education, A23.

Lively, Kit. (March, 1995). Ready or Not. California Aims to Reduce the Need for Remedial Instruction at four-year Colleges. The Chronicle of Higher Education, A23-A25.

Lochhead, J. (Autumn, 1980). Faculty Interpretations of Simple Algebraic Statements: The Professor's Side of the Equation. The Journal of Mathematics Behavior, 3, (1).

Manno, Bruno V. (May/June, 1995). Remedial Education: Replacing the Double Standard With Real Standards. Change, 47-49.

Marzano, R. J. (1988). Dimensions of Thinking: A Framework for Curriculum and Instruction. Alexandria, VA: ASCD.

Mathematical Association of America. (1991). A Call for Change: Recommendations for the Mathematical Preparation of Teachers. Washington, D. C.: Author.

Maxwell, Martha. (1975). Remedial Education at Berkeley: Why Do We Still Require it? ERIC. University of California, Berkeley: ERIC Clearinghouse on Remedial Education: No. CS002994. (ERIC Document Reproduction Service No. ED 130249).

McKenna, B. (1994, October). K-12 Standards Meet Higher Education. The Education Digest, 8-10.

Michigan Council of Teachers of Mathematics. (1983). High School Mathematics Preparation in Michigan: Assets and Liabilities. Guidelines for Quality Mathematics Teaching. ERIC. (ERIC Document Reproduction Service No. ED 228052).

Mikusa, Michael G. & Lewellen, Hester. (February, 1999). Now Here is That Authority on Mathematics Reform, Dr. Constructivist! Mathematics Teacher, 92, (6), 158.

Mitchell, C. E. (1984). The Importance of Three Years of High School Mathematics. Mathematics Teacher, 77, 510-513.

Mullis, Ina V.S., et al. (1991). The State of Mathematics Achievement. Washington, D.C.: U.S. Department of Education, 1991, p. 80.

Myers, Michael M. (1983). Remedial Education in College: The Problem of Underprepared Students. Issues in Higher Education, Southern Regional Education Board, No. 20. 1340 Spring Street, N. W. Atlanta, Georgia.

Narode, Ronald. (August, 1989). A Constructivist Program for College Remedial Mathematics at the University of Massachusetts, Amherst. (ERIC Digest). Palm Springs, CA: ERIC Clearinghouse on Constructivism and Metacognition. (ERIC Document Reproduction Service No. ED 309988).

National Center For Education Statistics (NCES). (October 1996). Remedial Education at Higher Education Institutions in Fall 1995: Statistical Analysis Report. NCES 97-584, Indicator 29, Section 3, C, 1999-02. (nces.ed.gov/pubs/997584.html.).

National Council of Teachers of Mathematics. (1989). Curriculum and Evaluation Standards for School Mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics. (1991). Professional Standards for Teaching Mathematics. Reston, VA: Author.

National Research Council. (1989). Everybody Counts: A Report to the Nation on the Future of Mathematics Education. Washington, D. C.: National Academy Press.

National Research Council. (1990). Reshaping School Mathematics: A Framework for Curriculum. Washington, D. C.: National Academy Press.

Oakes, Jeannie. (1985). Keeping Track: How Schools Structure Inequality. New Haven and London: Yale University Press.

Oklahoma State Regents for Higher Education. (1994). State Regents' Fall Policy Seminar: System Policy Revisions. Oklahoma City: State Regents Central Services.

O'Loughlin, Michael. (June, 1989). The Influence of Teachers' Beliefs about Knowledge, Teaching, and Learning on Their Pedagogy: A Constructivist Reconceptualization and Research Agenda for Teacher Education. (ERIC Digest). Philadelphia, PA: Paper presented at the Annual Symposium of Jean Piaget Society. (ERIC Document Reproduction Service No. ED 339679).

Owens, Kay; Perry, Bob; Conroy, John; Howe, Peter; Geoghegan, Noel. (February, 1998). Responsiveness and Affective Processes in the Interactive Construction of Understanding in Mathematics. Educational Studies in Mathematics, 35, (2), 105-127.

Paulos, J. A. (1988). Innumeracy: Mathematical Illiteracy and its Consequences. New York, NY: Hill and Wang.

Piaget, J. (1972). Psychology and Epistemology: Towards a Theory of Knowledge. Harmondsworth, England: Penguin Books.

Piaget, J. (1977). The Principles of Genetic Epistemology. London: Routledge and Kegan Paul.

Reich, Robert. (1991). The Work of Nations: Preparing Ourselves for 21st Century Capitalism. New York: Vintage Books.

Resnick, L. B. (1987). Education and Learning to Think. Washington, D. C.: National Academy Press.

Robinson, Patricia W. (1990). A Study of the Self-Paced Math Lab Approach to Developmental Algebra Compared to the Traditional Lecture Method at Brenau. Learning and Theory Applications. (ERIC Digest, Research Report No. 143). Gainesville, GA: ERIC Clearinghouse on Teaching Methods in Mathematics. (ERIC Document Reproduction Service No. ED 328452).

Rudolph, F. (1962). The American College and University: A History. New York: Random House, Inc.

Schifter, Deborah & Fosnot, Catherine. (1993). Reconstructing Mathematics Education: Stories of Teachers Meeting the Challenge of Reform. New York, NY: Teachers College, Columbia University, New York and London: Teachers College Press.

Selingo, Jeffrey. (August, 2000). Cal State Puts Remediation on an "Or Else" Basis: University System Combines a Tough Approach With Efforts to Help High School Students Prepare. The Chronicle of Higher Education, A27-A33.

Sells, L. W. (1978). Mathematics -- A Critical Filter. The Science Teacher, 45, 29.

Silver, Edward A. (1985). Research on Teaching Mathematical Problem Solving. Some Underrepresented Themes and Needed Directions. In Silver, E. A., Teaching and Learning Mathematical Problem Solving: Multiple Research Perspectives, 247-266. Hillsdale, NJ: Lawrence Erlbaum Associates.

Simon, Martin & Schifter, Deborah. (August, 1991). Towards a Constructivist Perspective: An Intervention Study of Mathematics Teacher Development. Educational Studies in Mathematics, 22, (4), 309-331.

Steen, L. A. (1986, Summer). Stress Points in School and College Mathematics. College Board Review, 140, 6-9, 35-36.

Steffe, L. P., Cobb, P., & von Glasersfeld, E. (1988). Construction of Arithmetical Meanings and Strategies. New York, NY: Springer-Verlag.

Student Remediation Study Report. (1993, May). Oklahoma State Regents for Higher Education. State Capitol Complex, Oklahoma City, 1-5.

Sykes, C. J. (1988). Profscam: Professors and the Demise of Higher Education. New York: St. Martin's Press.

Taylor, Peter C. S. (April, 1990). The Influence of Teacher Beliefs on Constructivist Teaching Practices. (ERIC Digest). Boston, MA: Paper presented at the Annual Meeting of the American Educational Research Association. (ERIC Document Reproduction Service No. ED 320883).

Usiskin, Z. (1985). We Need Another Revolution in Secondary School Mathematics. In An Agenda For Action, 1-21. Reston, VA: National Council of Teachers of Mathematics, Inc.

Usiskin, Z. (1985). We Need Another Revolution in Secondary School Mathematics. The Secondary School Mathematics Curriculum: 1985 Yearbook. Eds. C. R. Hirsch and M. J. Zweng. Reston, VA: National Council of Teachers in Mathematics.

von Glasersfeld, Ernst. (1983). Learning as a Constructive Activity. In Bergeron, J. C. & Herscovics, N. (Eds.), Proceedings of the Fifth Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, 41-69. Montreal: Universite de Montreal, Faculte de Science de l'Education.

von Glasersfeld, Ernst. (1988). Cognition, Construction of Knowledge, and Teaching. Paper presented in Syntheses, Special Issue on Philosophy of Science and Education.

von Glasersfeld, Ernst. (1990). An Exposition on Constructivism: Why Some Like it Radical. In Davis, R. B., Maher, C. A., & Noddings, N. (Eds.). Constructivist Views on the Teaching and Learning of Mathematics. Journal for Research in Mathematics Education, Monograph No. 4, 19-30. Reston, VA: National Council of Teachers of Mathematics.

von Glasersfeld, Ernst. (1991). Radical Constructivism in Mathematics Education. Mathematical Education Library Series, Volume 7. Norwell, MA: Kluwer Academic Publishers.

Waida, John D. (January/February, 1999). Eliminating Remediation Has High Costs. AGB Publications, 5.

Weingartner, R. H. (1993). Undergraduate Education: Goals and Means. Phoenix: ACE and Onyx Press.

West, Edwin G. (August, 1983). Are American Schools Working? Disturbing Cost and Quality Trends. Policy Analysis, 26, 1-2.

Whitesitt, J. (1982). Mathematics for the Average College-Bound Student. Mathematics Teacher, 75, 105-108.

Wilcox, S., Lanier, P., Schram, P., & Lappan, G. (1992). Influencing Beginning Teachers' Practice in Mathematics Education: Confronting Constraints of Knowledge, Beliefs, and Context, Research Report 92-1. East Lansing: Michigan State University, National Center for Research on Teacher Learning.

Willis, P. (1977). Learning to Labour: How Working Class Kids Get Working Class Jobs. Lexington, Mass.: D. C. Heath.

APPENDIXES

APPENDIX A

MATH BACKGROUND QUESTIONNAIRE

Math Background Questionnaire

The demand for math courses at this level has increased recently and we are doing a study to find out why. Thank you for helping us with this study.

1. Please indicate your:

Age _____ 21 or under

_____ 22-30

_____ 31 or over

Sex _____ Male

_____ Female

Major or intended major _____

Classification _____

Year you graduated from high school or completed GED _____

2. Indicate your math background by checking each of the following courses you successfully completed in high school:

_____ General Math or Consumer Math or Business Math

_____ Algebra I

_____ Geometry

_____ Algebra II

_____ Math Analysis or Advanced Math or Pre-Calculus or Trigonometry

_____ Other high school or college math courses you have completed

3. Date of completion of you most recent math course:

_____ 1999 - 2000

_____ 1997 - 1998

_____ 1995 - 1996

_____ Earlier than 1995

4. Below are two reasons which may explain your need to take this course instead of a higher level math course. Rate each reason according to your personal situation.

Reason 1: I never had this material in high school, so I need this course instead of a higher level math course

_____ This is a very important reason for me taking this course

_____ This is a somewhat important reason for me taking this course

_____ This is not an important reason for me taking this course

Reason 2: I had this material in high school but never learned it very well, so I need this course instead of a higher level math course

_____ This is a very important reason for me taking this course

_____ This is a somewhat important reason for me taking this course

_____ This is not an important reason for me taking this course

5. Which do you consider is the most important reason that you are taking this course?

_____ Never had this material in high school

_____ Had this material in high school but never learned it very well

As part of this study we are also looking at the relationship between students' math backgrounds and their ACT scores. Please give us permission to access your ACT scores by supplying your social security number and signing your name below. This information will be kept confidential and will not be linked with your name. It will be used only to compile group data.

Social Security Number_____

Signature _____

APPENDIX B

FACULTY COVER LETTER

FOR MATH BACKGROUND QUESTIONNAIRE

Rachelle D. Duncan
General Studies/Business Technologies
Oklahoma State University
Okmulgee, OK 74447-3901

Dear Faculty Member:

My name is Rachelle Duncan and I am a graduate student at Oklahoma State University, completing my doctoral degree in Higher Education and Educational Administration. I am requesting that you participate in my dissertation project. My topic is an analysis of "The relationship Between Math Preparation in High School and Math Skills of Entering College Students at Selected Oklahoma Institutions."

_____ has graciously given permission for your institution to participate in this dissertation project. However, she did indicate that each individual faculty member has the right to make their own decision as to their level of participation.

The enclosed questionnaire contains five questions related to remedial students' math background in high school. The questions ask for information regarding the amount of math and the type of math classes that students have taken in high school. The questionnaire should take no longer than five minutes to complete. Because you, as a faculty of remedial mathematics, play such a critical role in this analysis, you can understand how much I need your participation to make this study a success.

The results of this study will be reported to the participating institutions. However, information from this project will only be compiled in aggregate form and institutions will not be identified other than the institutions who participated in the study.

Thank you very much for your cooperation and consideration in this project. Your participation will greatly be appreciated. Please respond to your division as soon as possible, regarding your decision to participate in this project.

Respectfully,

Rachelle D. Duncan

APPENDIX C

STUDENT COVER LETTER

FOR MATH BACKGROUND QUESTIONNAIRE

Rachelle D. Duncan
General Studies/Business Technologies
Oklahoma State University
Okmulgee, OK 74447-3901

Dear Student:

My name is Rachelle Duncan and I am a graduate student at Oklahoma State University, completing my doctoral degree in Higher Education and Educational Administration. I am requesting that you participate in my dissertation project. My topic is an analysis of "The relationship Between Math Preparation in High School and Math Skills of Entering College Students at Selected Oklahoma Institutions."

_____ has graciously given permission for your institution to participate in this dissertation project. However, he/she did indicate that each individual student has the right to make their own decision as to their level of participation.

The enclosed questionnaire contains five questions related to your math background in high school. The questions ask for information regarding the amount of math and the type of math classes that you have taken in high school. The questionnaire should take no longer than five minutes to complete. Because you, as an entering college student enrolled in mathematics, play such a critical role in the analysis, you can understand how much I need your participation to make this study a success.

As part of this study I am also looking at the relationship between students' math backgrounds and their ACT scores. Please give us permission to access your ACT scores by supplying your social security number. This information will be kept confidential and will not be linked with your name, it will be used only to compile group data.

The results of this study will be reported to the participating institutions. However, information from this project will only be compiled in aggregate form and institutions will not be identified other than the institutions who participated in the study.

By returning the questionnaire, please be aware that you are implying your consent to participate in the project.

Thank you very much for your cooperation and consideration in this project.

Respectfully,

Rachelle D. Duncan

APPENDIX D

IRB REVIEW FORM

Oklahoma State University
Institutional Review Board

Protocol Expires: 10/30/2001

Date : Tuesday, October 31, 2000 IRB Application No: ED0150

Proposal Title: THE RELATIONSHIP BETWEEN MATH PREPARATION IN HIGH SCHOOL AND MATH SKILLS OF ENTERING COLLEGE STUDENTS AT SELECTED OKLAHOMA INSTITUTIONS

Principal Investigator(s) :

Rachelle Deawn Duncan
1540 E 67 Place
Tulsa, OK 74136

Deke Johnson
310 Willard
Stillwater, OK 74078

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s) : Approved

Signature :

Carol Olson, Director of University Research Compliance

Tuesday, October 31, 2000
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

VITA

Rachelle Deawn Duncan

Candidate for the Degree of

Doctor of Education

Thesis: THE RELATIONSHIP BETWEEN MATH PREPARATION IN HIGH SCHOOL AND MATH SKILLS OF ENTERING COLLEGE STUDETNS AT SELECTED OKLAHOMA INSTITUTIONS

Major Field: Educational Administration

Education: Graduated from Will Rogers High School, Tulsa, Oklahoma in May 1978; received Bachelor of Science degree in Mathematics from Northeastern State University, Tahlequah, Oklahoma in May 1984; received Master of Science degree in College Teaching from Northeaster State University, Tahlequah, Oklahoma in December 1989; completed requirements for the Doctor of Education degree with a major in Educational Administration at Oklahoma State University, Stillwater, Oklahoma in December, 2000.

Professional Experience: Faculty Assistant/Mathematic Tutor for Math and Science Department at Oklahoma State University, Stillwater, Oklahoma, 1982-83; Mathematics Instructor/Assistant Tennis Coach for Northeastern State University, Tahlequah, Oklahoma, 1986-87; Mathematics Instructor/Health and Physical Education Instructor for Tulsa Junior College, Tulsa, Oklahoma, 1983-91; Mathematics Teacher/Soccer Coach/Tennis Coach for Washington High School, Tulsa, Oklahoma, 1984-91; Mathematics and Science Instructor for Oklahoma State University, Okmulgee, Oklahoma, 1991 to present.

Professional Memberships: Alpha Lamba Delta, Rho Theta Sigma, Kappa Mu Epsilon, Kappa Delta Phi, National Beta Club, Math/Science Honors Club, National Honor Society, National Golden Key Honor Society, Residence Halls Honor Society, Who's Who.