THE EFFECTS OF ENGLISH IMMERSION MATHEMATICS CLASSES
ON THE MATHEMATICS ACHIEVEMENT AND ASPIRATIONS
OF EIGHTH-GRADE SPANISH-SPEAKING
LEP STUDENTS

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Beverly Thornhill Hunt, B.A., M.A.
Denton, Texas
December, 1996
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This research grew from concerns relative to the mathematical performance of Spanish-speaking limited English proficient (LEP) public school students. This investigation studied the effects of the sheltered mathematics class on eighth-grade Spanish-speaking LEP students with regard to mathematical achievement, attitudes toward mathematics, the dropout rate, and the number of math credits earned in high school. The enrollment of a sheltered mathematics class was limited to LEP students.

The purpose was to compare Spanish-speaking LEP students enrolled in sheltered mathematics classes with Spanish-speaking LEP students enrolled in regular mathematics classes. The research hypotheses were that achievement, mathematical attitudes, the dropout rate, and high school math credits earned would favor enrollment in sheltered mathematics classes.

The data for achievement, dropout information, and mathematics course work completed were drawn from student records in the school district data bank. A mathematics
attitude survey was given to a sample from the 1995-96 eighth-grade advanced level Spanish-speaking LEP students.

The research hypotheses were not accepted. All of the populations did show an academic deficit. However, they did have more positive attitudes than negative attitudes toward mathematics.

To improve achievement, staying in school, and a higher rate of inclusion in mathematics related careers the following recommendations were made:

1. Research should be done to write standardized mathematics tests that would be accurate and fair for Spanish-speaking LEP students.

2. Further research should be done into teaching strategies and classroom management particularly suited to Spanish-speaking LEP students.

3. Attitude measures should be used as pretest and posttest to study the effect of sheltered mathematics classes on LEP students in relation to attitudes toward mathematics and motivation to continue schooling.

4. Recruit and train qualified mathematics teachers to teach English as a second language (ESL) mathematics.
ACKNOWLEDGMENTS

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CHAPTER 1

INTRODUCTION

Since the late 1970s waves of Asian and Central American immigrants have increased pressure on schools to provide quality English-as-a-second-language (ESL) instruction for children who have minimal exposure to English outside the classroom ("Language Acquisition," 1987). These non-English-speaking students enter public schools at all grade levels.

This pressure overlaps the national concern for Hispanic at-risk students. The NAEP (National Assessment of Educational Progress) mathematics assessment has shown performance improvement for these students from 1978 to 1986. Increased enrollment in high school mathematics courses has also been shown. The gap between white and Hispanic students is narrowing. However, the participation in high school mathematics courses beyond general and business mathematics courses actually dropped between 1982 and 1986 (Carpenter & Lindquist, 1989).

In working to provide equity, sheltered mathematics classes are a present reality in some places. They certainly can be more widely available without major curricular, personnel, or facilities changes. Sheltered
mathematics classes are a present help that deserves study for validation and information for improvement.

Statement of the Problem

This investigation was concerned with the effects of sheltered mathematics classes on eighth-grade Spanish-speaking, limited-English proficient students with regard to (a) mathematics achievement, (b) attitudes toward mathematics, (c) the dropout rate, and (d) the number of math credits earned in high school.

Purposes of the Study

The purposes of this study was to compare Spanish-speaking, limited-English proficient (LEP) students in sheltered mathematics classes (immersion) with Spanish-speaking, limited-English proficient (LEP) students in regular mathematics classes (submersion) to determine if the immersion students (a) demonstrate significantly higher mathematics achievement, (b) have a more positive attitude toward mathematics, (c) drop out at a lower rate, and (d) demonstrate a significantly greater tendency to complete mathematics courses in high school.

Hypotheses

The hypotheses for this study are as follows:

1. Spanish-speaking LEP students enrolled in immersion mathematics classes will have significantly higher
achievement in mathematics than Spanish-speaking LEP students enrolled in submersion classes as measured by nationally-normed tests, ITBS or NAPT.

2. The attitude toward mathematics, as measured by the Thornhill-Hunt Mathematics Survey, will be significantly more positive for the 1995-96 eighth-grade Spanish-speaking LEP immersion sample populations than for 1995-96 eighth-grade Spanish-speaking LEP submersion sample populations.

3. The drop out rate, as averaged from the withdrawn students for each year, 1991-92, 1992-93, 1993-94, and 1994-95, will be lower for immersion populations than for submersion populations.

4. The number of mathematics credits earned in high school will be significantly higher for the 1996 graduating students from the 1991-92 eighth-grade LEP immersion population than for the 1996 graduating students from the 1991-92 eighth-grade submersion population.

Significance of the Study

Western society is moving out of the industrial age. Whatever history finally names this age, it is built on technology and technology's tools for mankind's work and play and relationships. Mathematics is the language of technology. English is the lingua franca of mathematics research exchange and the publishing of scholarly mathematical work (Bauersfield, 1992). Sowder (1989) tells
us that information is the capital and raw material. The ability to communicate is the means of production. One must be literate and numerate to fully participate. Secada (1990) reminds us that the research to meet this need should help develop curriculum and practices that involve a diverse population of students so that engagement with and learning of mathematics is the healthy reaction.

The proposed study will focus on achievement, attitudes, remaining in school, and higher level participation in mathematics by Hispanic public school students. Given the geographical proximity and economic pressures in the countries south of the United States, it is not surprising that Hispanic students are a growing segment of the educational picture. One has only to tune in to the daily news to be apprised of the phenomenon. Thus, studying bilingual students has applied importance. There are important questions in the context of a program designed to accommodate the linguistic needs and heterogeneity of ethnolinguistic minority students (DeAvila, 1988).

The second mathematics assessment of the National Assessment of Educational Progress (NAEP) first identified a Hispanic minority (Carpenter, Coburn, Reys, & Wilson, 1978). Later NAEP studies reported that progress is beginning to be evident. However, achievement and participation do not show the full range at rates equal to the rates of the highest ranking subset of students (Johnson, 1989). Though Hispanic
high school completions are up 50%, this is still 30% below the white population. The SAT scores lag by 100 points (Huelskamp, 1993).

The language barrier is a factor in poor mathematics performance which results in Hispanics being underrepresented in careers that are technical and mathematics related ("Math Language," 1989). Frustration contributes to lack of involvement in learning and dropping out of the system. Failure to acquire adequate mathematical skills closes the door of opportunity for full participation in a technological society.

Demographic projections for the United States delineate a growing responsibility. These projections give mathematical "learning and engagement" a particular urgency. Huelskamp (1993), a Sandia researcher, warns that this country can expect five million children of immigrants in the traditional K-12 education system in the 1990s. Because mastering the mathematical linguistic register and moving over mathematics' technical threshold take time and guidance, expecting students to "absorb" this submerged in a math class is to encourage the failure these students already experience (Spanos, Rhodes, Dale, & Crandall, 1986). The response needs to be one of action, not prolonged consideration or protracted study.

For secondary LEP students, immersion for mathematics is feasible, immediately available, and effective. There is
a pool of mathematics teachers from whom instructors could be recruited. The recruits could be enabled to instruct immersion classes with a minimal amount of training.

In this study the researcher looked at current administrative reality. If the study found positive correlations, it would encourage improvement of current sheltered classes and perhaps the expansion of the program. This is important in the light of the demographic projections.

Definition of Terms

Definition of terms for this study are as follows:

ESL: English as a second language.

Immersion class: a class in which the target language, which is English in this case, is used as the medium of instruction and the instructional text (Teschner, 1990).

ITBS: Iowa Test of Basic Skills.

LEP: limited English proficient. At enrollment the student whose first language is not English is placed in the ESL program. The student’s placement is determined by the results of a Language Assessment Survey (LAS) test. If the student’s English is limited, he is placed accordingly into a LEP level. In grades 4 through 8 the three levels (beginner, intermediate, and advanced) are one-year programs. Students who have exited these levels are monitored academically as transitional students.
NAPT: Norm-Referenced Assessment Program for Texas.

Population: Dallas Independent School District students who fit the following criteria: (a) enrolled for the indicated year in the eighth grade, and (b) classified as Spanish-speaking, advanced level, LEP students.

Sample: Identified subjects of the indicated population.

Sheltered class: a class in which the complexity and abstractness of ideas in English are reduced or enhanced for the LEP student (Teschner, 1990). In the Dallas Independent School District beginner, intermediate, and advanced level LEP students are scheduled into sheltered mathematics classes where the number of these students is sufficient to form a class. Each sheltered class can be made up of any combination of the three levels according to scheduling conditions.

Submersion class: a class in which the subject matter is taught in a language native to the class members with at least one class member for whom the class language is not native. Some LEP students are scheduled into one of these classes when a sheltered class is unavailable. Crawford (1989) refers to this situation as submersion in a mainstream class.

Thornhill-Hunt Mathematics Attitude Survey: a survey written for this study to assess the students' attitudes toward mathematics.
Limitations

The limitations for this study are as follows:

1. Population selection. The expectation for the study was to sample the population for both the experimental group and the control group from the DISD eighth-grade LEP students who were at the advanced level as naturally scheduled into sheltered and regular math classes.

2. Population mortality. The populations were limited to those students who had seventh- and eighth-grade scores.

3. Interaction effects. Teacher qualifications for a sheltered math teaching assignment were not controlled except for the certification to teach math in the middle school. The qualifications were not controlled for (a) elementary versus secondary certification, (b) volunteer for versus assignment to sheltered math classes, and (c) ESL or bilingual certification.

Basic Assumptions

The basic assumptions for this study were as follows:

1. It was assumed that the ITBS and NAPT tests were valid and reliable with regard to the content of mathematics courses.

2. The Dallas Independent School District had guidelines for the security and uniformity of the administration of ITBS and NAPT test materials. It was
assumed that the test administrators complied with these conditions.

3. It was assumed that the district's regular eighth-grade math curriculum was the guideline for LEP mathematics instruction.

4. Teacher training was similar.

5. The population of eighth-grade LEP mathematics classes was drawn from the three-year basic program of English for speakers of other languages.
CHAPTER 2

REVIEW OF RELATED LITERATURE

Historical Growth of Concern for the Language Minority Student

The United States Office of Education's century-old charge to measure the nation's educational progress in mathematics was answered in the early 1970s. The First Mathematics Assessment of the National Assessment of Educational Progress (NAEP) was taken in the 1972-1973 school year (Carpenter et al., 1978). This first assessment gave a mixed picture of strengths and weaknesses. In the 1960s the emphasis on understanding mathematical processes, nicknamed "new math," did not hurt computational skills, but neither did it help higher order thinking skills. The first assessment report listed skills in numeration, practical measurement, one-step word problems, and basic geometry as strong or reasonably so. The same report revealed that skills in percents, fractions, two-step word problems, measurement tasks, and geometric understandings were weak (Carpenter et al., 1978).

The Second International Mathematics Study (SIMS) reported that, from the late 1970s to the early 1980s, the typical eighth-grade mathematics program was dominated by arithmetic. Even with this emphasis, achievement was only
at the international average. The data revealed that the
typical eighth-grade curriculum treated many mathematical
topics in a "low intensity" manner; that is, for just a
lesson or two. This contrasts with some other countries.
Japan, for example, teaches mathematics with a more
"intense" approach (Crosswhite, 1985).

The Hispanic minority was identified in the second NAEP
assessment. The performance trend was downward and was
below the national average (Corbitt, Carpenter, Kepner,
Lindquist, & Reys, 1981). The ensuing downward trend in
mathematics for Hispanic 13-year-olds leveled out by the
fourth assessment, 1982-1985. However, students did not
display adequate knowledge of underlying concepts (Carpenter
& Lindquist, 1989). Johnson (1989) related that the small
gains Hispanic students made measured over assessments two
through four were with computational skills, the least
complex level tested.

Kaufman (1992) examined Hispanic students in a
longitudinal study from 1988 to 1990. These students from
low SES were more likely to lack basic skills and to drop
out than other students.

In 1978 criticism from bilingual experts surfaced when
the American Institute of Research (AIR) evaluated federally
funded bilingual education programs. This large study drew
data from 7,000 LEP children in 150 schools. The evaluation
found that structural immersion and ESL worked in some
settings. This pointed up a need for demonstration programs of structural immersion. The study, coupled with an evaluation by the U. S. Education Department in 1981, drew criticism from bilingual educators. Rudolf C. Troike, then director of the National Clearinghouse for Bilingual Education, noted the scarcity of evidence for English-only programs and pointed to the large methodological base for ESL. He added that there was no research to compare ESL-only with bilingual education ("Debate Over Effectiveness," 1987).

The decade of the 1980s began with the appointment of the National Commission on Excellence in Education (NCEE) by Secretary of Education, Terrel H. Bell. The NCEE report, titled A Nation at Risk, stirred political, educational, and corporate responses. Bell (1993) gave a concise summary of the decade after A Nation at Risk. He was surprised at the vehemence of the accusation of increasing mediocrity by the NCEE. His warnings were ignored when the declining SAT and ACT scores were published. These scores were the sole nationwide common indicators and were thus of limited use regarding academic achievement. According to Bell, the press and many educators demonstrated the national pastime of jumping to conclusions with this information.

Wirth (1993) stated that in the 1980s the alarm over educational productivity problems exerted pressure for reform. Many reacted by insisting on expert-designed,
centrally monitored instruction and testing, but imposing regulations from the top down on the same educational structure has not worked. The 1990s restructuring of education is driven by local school autonomy and public schools of choice. Out of this comes an emphasis on strategies such as cooperative learning and problem solving. Wirth (1993) sees the aim of education to be that of educating a population with symbolic analysis skills, ecological awareness, and a commitment to democratic values and traditions.

Public, Political, and Corporate Responses

The public response to A Nation at Risk has been astonishing. Among these responses have been state-legislated top down initiatives, judicial equity measures, and accusations of ineptitude aimed at teachers. These responses have been ineffective, but education has become a major, high-priority concern of political and corporate America (Bell, 1993).

Horvath (1987), in reporting the results of the Second International Mathematics Study (SIMS), found the pattern of improvement for Japan and the United States to be the same. Achievement in computation showed the largest gain. Comprehension and analysis achievement were essentially the same, whereas application achievement showed a decline. The decline in the performance of American students was more
pronounced than that of Japanese students. In both the first and second study, the Japanese scored an average of 18 points higher than students in the United States.

The situation may not be as bleak as pictured. The often-quoted Japanese comparison is usually negative. However, when Mayer, Stanley, and Tajika (1991) compared U. S. and Japanese students, the Japanese students, who spend more time on mathematics, excelled in achievement. The American students, on the other hand, excelled in mathematical problem solving. American educators bemoan the achievement scores, whereas Japanese educators bemoan the pressure to conform, which limits student creativity.

Huelskamp (1993), one of the Sandia Report authors, responded to the public outcry about declining scores and negative international comparisons. Huelskamp assured the public that the operation of the U. S. educational system has been steady or improving slightly for the past 20 years. Hispanic high school graduations have risen to 50%, and their SAT scores are better than they were 15 years ago. However, the rate of high school completions for Hispanics is 30% below that of whites, and SAT scores lag by 100 points. Huelskamp also made pertinent demographic predictions. More than 5 million children of immigrants will enter kindergarten through grade 12 in the 1990s. More than 150 languages are represented in schools nationwide, with nearly this number occurring in single large districts.
The *Sandia Report* authors (Carson, Huelskamp, & Woodall, 1993) have broken down the stable Hispanic dropout rate to give some interesting observations. Although the high school completion rate for the Hispanic population has remained near 60% for 2 decades, the rate for the recently immigrated youth is less than 30%. The authors stated, "We believe that the recent immigration of youth who do not have the background to succeed in our high schools is inflating dropout statistics for the Hispanic population" (p. 265).

Okagaki, Frensch, and Gordon (1995) gave questionnaires to parents of high-achieving and low-achieving Mexican-American students. All the parents felt that education is important. The difference was in the minimum amount of education that they would allow their children to have. The parents of high-achieving students maintained a higher minimum than the parents of low-achieving students. With low-achieving students there was a lack of stigma attached to being a poor student. Okagaki et al. (1995) felt that this may be a resistance to the barriers to educational opportunities. They also felt that Mexican-American parents may have been unaware that their children were not doing well in elementary school.

Stedman (1994) dichotomized the current educational debate. He labeled the two ends of the continuum as "school critics" and "revisionists." The critics began with the publication of *A Nation at Risk* in the early 1980s. The
revisionists based their responses to the crisis refrain largely on the Sandia Report. The critics accuse the revisionists of complacency, whereas the revisionists accuse the critics of exaggerating the crisis and neglecting the poor and urban areas. Stedman (1994) concluded:

In broad outlines, their [the Sandia authors] perspective is right—performance has been stable over the past 2 decades, there have been improvements in some areas, the United States is a world leader in high school and college graduation, and ethnic and racial groups need to be targeted for assistance because they continue to lag behind. (p. 144)

Bracy (1992) contradicted the "politically correct" naysayers by making positive statements about U. S. schools in general. According to Bracy, schools are doing a good job with students who are ready to learn. Schools are continuing to perform better than ever in spite of declines in other social institutions, and U. S. students are performing about the same although the tests have been changed so that the student "must run faster to stay in the same place" (p. 107).

Public ratings are affected by naysayers and by negative comparisons with other countries. Although the public ratings have remained fairly stable since 1972, it is a majority of those respondents with less education and lower income who rate schools as average or below. However, 84% of the non-white (not black) respondents favored increasing the coursework, counseling, and school activities
to help race relations in the local schools (Elam, Rose, & Gallup, 1992).

Owen (1991) summarized data from the National Assessment of Educational Progress (NAEP) for 1970-1990. In general, almost all 13-year-olds could perform simple arithmetic facts and demonstrate proficiency with beginning skills and understandings. During this period, the same age group improved its performance in numerical operations and problem solving, from 65% to 75%. The students' proficiency remained stable in moderately complex procedures and reasoning (18% to 17%). Almost no 13-year-olds could succeed with multi-step problem solving and algebra. Broken down by populations, the white 13-year-olds remained the same from 1973 to 1990 (54.8% to 55.2%). The Hispanic 13-year-olds showed significant gains during this period (47.8% to 51%). The white students in 1990 still had a higher average mathematics proficiency than Hispanic students.

The decade of the 1980s was one of reform. It began with A Nation At Risk, progressed through national educational goals from the 50 governors and the president, and increased business involvement, including the Business Round Table, the National Alliance for Business, the U. S. Chamber of Commerce, and individual efforts such as the I Have a Dream Foundation (Pipho, 1992).
Researching Achievement and Attitude

The Research Advisory Committee of the National Council of Teachers of Mathematics (1992) has put forth standards of evidence. Four ideas encompass these standards: intention of research, role of evidence, underlying educational theory, and interpretations. Evidence can be potential, veridical, and "so-and-so's." The most desirable situation would be veridical, the situation with potential evidence, true hypotheses, and an explanatory connection between them.

Any research into mathematics should describe its parameters. Sierpinska et al. (1993) delineated several characteristics, objective aim, question results, and criteria. Immersion versus submersion for Spanish-speaking LEP students is a situation from current practice with results from this special situation available to test validity and relevance.

White (1982) reviewed nearly 200 studies to establish the relation between socioeconomic status (SES) and achievement. The relationship between typically used measures of SES—Income, education, and occupation—and achievement is weaker than has been assumed. Also, the relationship lessens as the student becomes older. The causal effect is more relevant to individual students than to groups.

Reynolds and Walberg (1992) revealed interesting relationships between achievement and attitude. Both are
strongly affected by prior measures. Achievement is also influenced by motivation, outside reading, peer environment, instructional quality, and home environment. Attitude and achievement have a reciprocal relationship. Not only does attitude affect achievement positively, but learning increases motivation.

Because of this researcher's concern with the effect of immersion and submersion on achievement and attitude, Shiow-Ling and Walberg's (1983) study of the relationship between achievement and attitude is of interest. They analyzed the 1977-78 National Assessment of Educational Progress (NAEP) data for the relationship between the productivity constructs of achievement, attitude, parent education, and outside reading. Each of these constructs was significantly related to the others. With regard to the relationship between achievement and attitude, the researchers felt that causality may be reciprocal, each factor influencing the other.

In this atmosphere of concern about achievement and how to pursue improvement, the National Council of Teachers of Mathematics stated the following:

It is the mathematics educators themselves, trained in content and methods of teaching mathematics, who must assume leadership roles in conceptualizing, communicating, and implementing research related to mathematics instruction. (NCTM Goals, 1990, p. 16)
English for Speakers of Other Languages

Bilingual education and English-as-a-second-language (ESL) are teaching strategies for non-English-speaking students. Bilingual education has been a part of U.S. history since colonial days, whereas ESL was developed in the 1930s for diplomats and university students ("Bilingual Education," 1987). Much controversy exists over the superiority of bilingual, ESL, immersion, or submersion ("Debate over effectiveness," 1987). Medrano (1988) studied Spanish-speaking seventh- and eighth-graders who had bilingual instruction in the primary years. This study found significant positive program impact on mathematics achievement. Shapson and Kaufman (1978) found that in Canada 10th-grade Anglophone students who had French immersion mathematics had a greater knowledge of French technical vocabulary than Anglophone students who took mathematics in their native English and French as a separate high school class. Though this program may have valuable information for immersion, teaching the results cannot be extrapolated to the Hispanic situation in the United States. The Canadian experience concerns language-majority students while the United States situation concerns language-minority students ("Debate over effectiveness," 1987).

Learning English is only one step toward learning mathematics in English. Cuevas (1989) observed that students must master a special mathematics language in order
for teachers to be able to communicate mathematics. Further, teachers must be sensitive to both the needs and feelings of these culturally different students.

Two decades of research have not defined the relationship between language and mathematical achievement. Research has not provided a reason to assume any inborn differences to account for achievement differences. Organismic variables such as development and environment warrant attention to determine conceptual foundations. The basic assumptions of language and learning mathematics should be reexamined to meet the challenges of educational quality and equity (Cocking & Chipman, 1988).

Spanos, Rhodes, Dale, and Crandall (1988) noted that LEP students have traditionally been mainstreamed with the mistaken assumption that mathematics is "language independent." They combine CALP (cognitive academic language proficiency) and CAMP (cognitive academic mathematics proficiency) in a discussion of a technical threshold. The former takes from 5 to 7 years to develop in a second language, and the latter implies a mastery of features expressed in the unique linguistic register of mathematics. The authors warned that to expect students to "pick up" the language in the course of mathematics class work is to encourage the kind of failure that language-minority students are experiencing.
Hispanics are seriously underrepresented in careers and professions that require mathematical skills. Math performance is affected by the language barrier. Hispanic students experience difficulty in academic and technical tasks even when they possess oral fluency. This points to a technical threshold that reflects the cognitive and linguistic requirements for mathematical fields ("Math Language Equation," 1989).

Mathematics and linguistic experts should collaborate to help students effectively use the vocabulary and syntactic components of the mathematics language register. Non-native speakers have particular problems with comparative structures, the passive voice, and prepositional phrases. The experts should develop both a linguistic approach and the materials to help students master and use the mathematics register ("Math Language Equation," 1989).

The process of learning a second language resembles that of learning the first one. Older students, although they learn a second language faster than younger students, need more formal assistance with language. The acquisition of mathematical ability necessitates effective communication between student and teacher. The importance of this is pointed up by the fact that it takes longer to develop CALP than language for social situations (Cuevas, 1984).

The mathematics register has grammatical patterns, styles of presentation, and arguments that are alien to
informal conversation. True mathematical language is nonredundant and unambiguous. The mathematics register reinterprets natural language words such as even, uses locutions such as square on the hypotenuse, combines natural language words such as output, and incorporates Greek and Latin elements in such words as denominator. Thus, students must have considerable language proficiency to cope with mathematical language (Cuevas, 1984).

Traditional assessment of mathematical achievement is impacted by language proficiency, which should be considered in an interpretation of an LEP student’s mathematics achievement tests. There is little research relating language and mathematics, and the same is true for the role of language in mathematical assessment (Cuevas, 1984).

Historically, language study has been considered important to academic training. Discipline, historical perspective, and access to knowledge have been the guiding rationales. Access continues to be a part of the debate over the role of language in learning, and it has been the driving force for a great deal of legislation (Cocking & Mestre, 1988).

National educational statistics have fostered the assumption that low English language proficiency is related to Hispanic underachievement. The familiar terms equal access and bilingual education provision have come from the legislative legacy of bills such as the Civil Rights
Mathematics appears to have a large language-related component, although it is not well understood. Both mathematics and language are symbolic processes. The consensus among experts from the fields of cognitive development, education, language studies, and mathematics is that the cognitive processes of learning, comprehension, and symbolic thinking are all involved in learning mathematics (Cocking & Mestre, 1988).

Educational research should ask whether mathematics is "culture free" as well as "language free." It should answer how language proficiency affects the learning of mathematics. The scope of the effect of culture and language is overwhelming, and there is a need for the education community to study, hypothesize, and research the conflicts and problems language minority students face (Cuevas, 1989).

In response to the stresses of a growing multiethnic phenomenon there are those who argue for meaningful change for minority groups. Clark (1993) brought together several opinions related to educational difficulties. She declared that, after completing an education, one should have the necessary tools to share in the fruits as well as the decision-making power of society. In the process, it is a questionable assumption to think that all children in a
multicultural society can learn equally well from the same teaching material. Underachievement as experienced by subordinate groups (Clark’s term) is complex. Within this complexity is the difference in any one minority between immigrant and non-immigrant members of the subordinate group. The subordinate group’s actions must be considered in the process of education. Poor school performance is related to different frames of reference and coping strategies.

Clarkson (1992) found that, for a person learning a second language, competence built in one language builds competence in the other. For example, gaining insights into working with patterns is transferable between languages in a straightforward manner. It is significant that competence brought to the mathematics class in another language helps the student in learning both mathematics and English. Conversely, competence in mathematics in English carries over to competence in mathematics in the first language.

Dawe (1983) studied the ability of bilingual students in England between the ages of 11 and 13 to reason deductively in mathematics. He reported that the general underperformance of ethnic minority students is related to the students’ level of English competence, knowledge of English logical connectives, native language competence, the sociolinguistic distance between English and the student’s native language, and cultural factors such as parental
involvement and sex role differences. He affirmed that the knowledge of logical connectives seems to be highly important and that there is a need to work on this skill within the registers of mathematics and science.

Stephen Krashen (1983), a leading linguistic theorist, discussed several key ideas necessary for good language learning. He asserted that language acquisition (fluency) happens when the student has comprehensible input in a meaningful context when the affective filter (anxiety level) is down. According to Krashen, language is acquired when the situation has imbedded meaning at a level slightly beyond the student's proficiency. Related to the affective filter ideas, Ecker and Lester (1991) found in their analysis of older teen-aged students who were performing poorly in mathematics that attitudes toward mathematics correlated stronger to performance than did locus of control. These ideas fit the concepts of the sheltered math class, a setting that can be paced and adapted to the added language learning needs.

Spanish Language Minority Populations

With the identification of the Hispanic population as a minority of concern and the resulting educational ranking, there exist a number of ways to respond to the mathematics achievement gap. School systems offer some combination of ESL classes, bilingual classes, immersion classes, and/or
submersion classes. As noted earlier, the gap is narrowing, and more Hispanic students are staying in secondary school. The Research Advisory Committee of the National Council of Teachers of Mathematics (1989) stated, however, that there is a lack of emphasis for implementing better instructional procedures for mathematics.

Johnson (1989) wrote that Hispanics have made substantial gains in enrollment in advanced level high school courses although the comparative performance is negative. The language barrier is a major factor in poor Hispanic mathematics performance. One problem is that the cognitive and linguistic demands require a successful passage over a technical language threshold ("Math Language," 1989).

Sosa (1993) has provided a number of characteristics of the Hispanic school population.

1. Hispanic students account for 64% of the school-age population from a non-English background.

2. The Hispanic population is the fastest growing ethnic group.

3. Mexican-Americans make up 62% of the Hispanic population.

4. The 1988 Hispanic dropout rate was 36%.

5. The high school completion rate for Hispanics has not improved since 1970.
6. Thirty-two percent of Spanish-speaking Hispanic students are 2 or more years behind grade level in school.

7. Students who attend urban schools are at higher risk of dropout. Of Hispanics, 88% are urban dwellers.

8. Seventy-eight percent of Texas Hispanic students are in a school that is predominantly minority students.

9. Some recent Hispanic immigrants lack prior experience with schooling. They are unaware of school expectations and school culture.

10. Some Hispanic students are weak in Spanish and English. They began learning English before there was a good conceptual basis for abstraction in Spanish.

Sosa (1993) discussed obstacles to educational equity. These obstacles include low expectations for Hispanic students, school system reliance on testing, a scarcity of minority teachers, tracking, educators' disregard for language and culture, inadequate financing, and the misjudging of students who lack the proper language to show respect.

Sosa (1993) listed the factors involved where success has been documented. Students experience peer acceptance, a liking for school, the approval of school personnel, recognition, good counseling, personal feedback, a flexible curriculum, interdisciplinary school work, a willingness to learn, and opportunities for comprehensible language input.
Bradby et al. (1992) studied Asian and Hispanic eighth-grade students' differences and similarities, emphasizing their language skills. Asian and Hispanic language-minority students are similar with respect to language skills. Seventy-three percent of Asian eighth graders are language minority. Similarly, 77% of Hispanic eighth graders are language minority. Concerning proficiency, 66% of Asian eighth graders and 64% of Hispanic eighth graders reported having high English proficiency. The percentages reported for both were similar with respect to moderate and low proficiency levels. The percentages were different, however, in relation to mathematics achievement. The middle and high socioeconomic status (SES) students from these minorities show Asian students with a lower failure rate than Hispanic students in the same SES category. Asian and Hispanic eighth-grade students plan to enroll in academic high school programs at a 38% to 22% ratio. In reference to planning to go to college, the ratio is 77% to 55% (Bradby et al., 1992). Educators need to take educational intervention seriously to rectify a situation in which two student groups with no obvious benefits for one respond so differently to schooling.

Rakow and Bermudez (1993) listed more than 10 factors that contribute to the underrepresentation of Hispanic Americans in scientific, mathematical, and technological careers. These factors include testing, learner
characteristics, classroom experiences, counseling experiences, low English proficiency, tracking, lack of continuity, cultural values against choosing science, peer pressure not to study, mislabeling LEP students as retarded, inadequate preparation in science and mathematics, lack of role models, and a home environment that does not value education.

Further consideration should be given to teachers and counselors who misread their students. There is a need for dissemination of information about teachers who have successfully encouraged Hispanic students. Unfortunately, most information about this success is anecdotal, not systematic (Rakow & Bermudez, 1993).

Valverde (1984) discussed five factors that contribute to the underachievement of Hispanics in mathematics: language, curricular materials, instructional method, teacher quality, and cognitive learning style. According to Valverde, concepts should be presented in the student's own language. The curriculum may present mathematics as culture free, but it takes place in a cultural context. Teachers should be aware of the Hispanic student's mode of learning, and educators must learn to present mathematics in the field-dependent learning style, which is more typical of the Hispanic student.

Ramírez (1993) examined Hispanics in education from 1979-1993. Students whose home language was not English
increased by 41%, whereas the overall public school population decreased by 4%. The population of Hispanic students is growing, and it experiences frustration, faces financial stress, and drops out of school in large numbers. Contrary to the trend, some Hispanic students are taking more academic courses in high school.

During the period Ramirez (1993) studied, students for whom English is language 2 increased by 41%. The overall increase was 4%. Hispanics were twice as likely to be in remedial math classes and to work full-time outside of school. The Hispanic dropout percentage remained in the mid-30s, whereas the white dropout rate went from 12.3% to 8.9%. The dropout rate for Hispanic students who were not born in the United States was 43%. On a positive note, Hispanic high school graduates increased the percentage of academic subjects from 61.9% to 66.7%, whereas the white percentage decreased by 9% (Ramirez, 1993).

Lopez (1995) gave a questionnaire to 100 Mexican-American undergraduate college students. The questionnaire sought information about challenges and resources in Mexican-American students' experiences. The challenges differed along gender lines. Females had greater challenges with financial matters, domestic responsibilities, and gender discrimination. Males experienced more academic discouragement and racial discrimination. Clearly, it is
important to understand cultural factors that affect these students’ attrition and retention in the academic sphere.

The cultural differences that Hispanic LEP students bring to class can create misunderstandings. Teacher-student communication, seating, concepts of time, nonverbal cues, activities, and mathematical notation are some areas that may be expressed differently in different cultures. The student may have experienced only teacher-to-student dissemination of information. The student may not be used to individual seating. Being on time may be a problem if tardiness is good manners in the student’s culture, and close scheduling of events within a limited time frame may be strange to the student. Respect may be the issue when, for example, the student does not look the teacher in the eye. Commas may be used as decimals in the student’s culture. To teach effectively, the teacher must be sensitive to cultural differences in order to understand and teach students from other cultures (Callahan, 1994).

Immigrant students are dependent on the school curriculum for educational growth when their parents are not English speakers; therefore, recent immigrants would be helped by curricular intervention since they depend on school course work to gain mathematical knowledge (Duran & Weffer, 1992).

Solutions to the problem of undereducated Hispanic high school students are a priority in educational research and
related fields. Current research indicates that motivation can overcome educational deficits. In the past, Hispanic underachievement has been attributed to language, low income, and low parental education. However, more recent studies have found that value variables have a larger effect than socioeconomic ones. Particularly important are valuing hard work and the expectation of going to college by parents or students (Duran & Weffer, 1992).

Duran and Weffer (1992) found that the quality of learning prior to high school made the greatest difference in high school mathematics achievement. Basic skills developed before high school were important determinants of academic success in high school. Pre-high school achievement was strongly related to taking advanced mathematics courses in high school. More course work in mathematics equalled higher achievement.

The National Council of Teachers of Mathematics spoke against the social injustice of minority underrepresentation in mathematics careers in the standards for mathematical reform. This important council reminds the nation that mathematics is a critical filter for full participation in the society (NCTM, 1989).
The LEP Classroom for Spanish-Speaking Students

The nation's concern with mathematical reform is expressed in the standards for school mathematics from the National Council for Teachers of Mathematics (NCTM). This publication discussed basic mathematical curricular concerns under 13 standards: problem solving, communication, reasoning, connections, estimation, number theory, number concepts, computation, geometry, measurement, statistics, fractions, and patterns (National Council of Teachers of Mathematics, 1989).

At present the Zeitgeist favors a cognitive learning theory. Recent research gives attention to cognitive learning theory and affective issues. This is reflected in research into teaching higher order thinking skills and nonroutine problem solving (Sowder, 1989). The current work is promising. Language proficiency and the technical threshold figure largely in cognition and positive attitudes. The literature has information to guide classroom practice.

In reviewing the National Council of Teachers of Mathematics Research Agenda Project (RAP), Fisher (1990) revealed mathematics' basic dichotomy. Mathematical knowledge is either external or internal; that is, it is either objective or subjective. The particular viewpoint affects planning for learning, assessment, and research. The applicable learning theory drives the planning. When
mathematical knowledge is viewed as external, or objective, it is as if it were always there to be discovered and made generally accessible. The internal view is that mathematics is subjective, having been created by social groups. Neither view is right or wrong. Alternate conceptualizations of mathematical knowledge fit different contexts.

This dichotomy stretches from computational procedures to active social construction, and from teacher as teller to teacher as coach. Assessment would go from the familiar objective measures to more complex performance measures (Fisher, 1990).

Research and practice reflect the dichotomy. Objective research and practice generate knowledge and the ensuing implementation. The subjective viewpoint is difficult to identify. The usual agenda pays more attention to the practice of mathematics education than to knowledge per se (Fisher, 1990).

Although neither approach is right or wrong, the current attention is on the subjective end of the continuum. These cognitive issues have received much support through time, and each time around, there seem to be more and better experiences.

Davis, Maher, and Noddings (1990) explained constructivist views as it relates to mathematics. The shift from behaviorism to cognitivism during the 1960s and
1970s brought exciting philosophical changes that affect the teaching of mathematics. Cognitivism assumes that human beings are knowing subjects who construct knowledge.

Stigler (1989) reviewed the idea that mathematics is a cultural phenomenon built through universal activities such as counting, measuring, locating, designing, playing, and explaining. These activities give rise to different mathematical technologies serving the adapted goals of the varied cultures of the world.

Students beliefs about mathematics form the bases for interest and participation. Kloosterman and Cougan (1994) interviewed elementary students to learn about their beliefs concerning mathematics. The following are the results of the study.

1. Students who liked mathematics had confidence in their mathematical abilities.

2. High achieving and moderate achieving students had confidence in their mathematical abilities.

3. No consistent relationship was found between students' reports of parental concern and achievement.

4. The report about liking school and mathematics fell into three categories: (a) the majority, who liked school and mathematics; (b) a few who liked school more than mathematics; and (c) almost none who liked mathematics more than school. These conclusions should provide hypotheses about student beliefs for future studies.
In a study on problem solving, Mestre (1988) reported on a new field of study, problem processing, and relates its significance to language-minority students. This field of study attempts to integrate problem solving and text-processing models to encourage better word problem solutions. Problem processing examines the effects of language proficiency on the speed of comprehension, the technical language threshold, the perception of language structure, and the comprehension of the symbolic language of mathematics. Brisk (1991) wrote that teachers of speakers of other languages should be encouraged and trained to encourage strategies that will ensure the active involvement of these students.

Willoughby (1990) pointed out the obvious when he noted that students learn problem solving by solving many problems. Some problem categories are games, story problems, and projects. Good problems are difficult to create, and teachers should be encouraged to create problems to fit their own students.

Callahan (1994) recommended cooperative learning as good classroom learning strategy. It enhances self-esteem, combats isolation, and helps students make friends, as well as being a good learning strategy. The teacher should take care to give individual attention, and he or she also must be aware of how to phrase instructional language and explain concepts.
LEP students meet a different culture in school, which can cause them to be misunderstood and misjudged academically. Reduced interactive instruction interferes with language mastery and the acquisition of academic content. Under a social constructivist (cognitive) view of learning, instructional conversation (IC) is a promising strategy (Dalton & Sison, 1995).

To reach the intended outcome, IC encourages conversation and interaction based on the students' personal experiences. Such a strategy emphasizes concept-development activity, self-concept, and skill in conversation. Teachers must be responsive, guiding, and helpful (Dalton & Sison, 1995).

Dalton and Sison (1995) used IC in four geometry lessons with seventh-grade Spanish-language minority students with a teacher who spoke only English. The level of student talk was higher than the level of teacher talk in each lesson. The times in which the students used content lexicon went from 6 in the first lesson to 48 in the fourth lesson. The students' inappropriate utterances went from 12% to 4% from lesson 1 to lesson 4. These measures suggest that the students were using language for its sociocultural, role defining, and conceptual functions.

Reys, Reys, and Penafiel (1991) identified three general cognitive processes in estimating. The studying of aspects of estimation, reformulation, translation, and
compensation shows promise for pedagogical improvement related to this important concern. The study brings insight to estimation related to the general student population as well as to the considerable number of Spanish-language minority students from Mexico.

Sowell (1989) used meta-analysis of 60 studies to study the effects of manipulative materials on the achievement and attitudes of students from kindergarten to college. The manipulatives included both pictorial material and concrete material. Comparisons were among concrete instruction, abstract instruction, and pictorial instruction.

For concrete instruction versus abstract instruction, the length of treatment was found to be related positively to achievement. The results of shorter treatments were not statistically significant, and no significant effects were found for pictorial instruction versus abstract instruction. Thus, the significant finding was the effectiveness of manipulative materials instruction in long-term use. However, the analysis could not answer questions relative to matching which situation to which manipulative, and no definitive conclusions were found concerning attitudes (Sowell, 1989).

Reform in education necessitates a good relationship between instruction and assessment. Assessment should accompany mathematics instruction. Alternative assessment
must incorporate validity and equity. Inadequacies in assessment procedures are barriers to good reformation.

The assessment problem is exacerbated by widespread publication of test scores. Reform is defeated when educators are held accountable for standardized test scores. The solution is to align assessment with instruction.

In Sowell’s (1989) study, a composite of performance assessments correlated at 0.60. Anglo and Hispanic students approached the hands-on problems in the same way; however, Anglo students scored higher than Hispanic students. Performance assessments are costly and time consuming, so this approach to instruction needs to be studied relative to equity and consequential validity (Baxter, Shavelson, Herman, Brown, & Valadez, 1993).

Meisels and Fong-Ruey (1993) studied retention, using the data from the National Education Longitudinal Study of 1988 (NELS:88). The following five conclusions are from the study:

1. Boys, minorities, and students from lower socioeconomic (SES) are more likely to be retained.
2. Retention does not raise the performance level of retained students to that of nonretained students.
3. Retention increases the probability of dropping out of school.
4. Some students are retained for reasons other than academic achievement.
5. Retained students are more likely to exhibit negative behaviors.

The National Education Longitudinal Study of 1988 (NELS:88), the National Association of Elementary School Principals (NAESP), and the National Academy of Education agree that using retention as a treatment produces more negative than positive results (Meisels & Fong-Ruey, 1993).

Willoughby (1990) attacks the focus on current educational fads with common sense. The list is long and familiar: new math, back to basics, critical thinking, cooperative learning, and mastery learning, among others. He points out the foolishness of thinking that a student who understands a concept will remember it and use it without practice. According to the author, better mathematics education involves doing mathematics from reality, knowing the power of abstract thought, practicing, and applying mathematics to something from the students' interests.

The classroom situation encompasses content presentation and assessment practices in a learning theory milieu. Literature about problem solving, cognitive strategies, and manipulative information occurs more frequently than other topics. All the standards must be studied and research done with respect to LEP content delivery and counterproductive practices with LEPs such as retention, tracking, and inadequate assessment.
Teschner (1990) defined immersion as the use of the target language for instruction and text material. He observed that leaders in the field of linguistics have noted that there are virtually no research statistics for the results of monolingual immersion of minority students. Thus, there is a need for information about this educational strategy.
CHAPTER 3

METHODOLOGY

Method of Research

The research design for this study was a nonequivalent control-group design. Borg and Gall (1983) remind us that in education this is a widely used quasi-experimental design. The populations were the eighth-grade level 3 Spanish-speaking LEP students from the Dallas Public Schools for five years: 1991-92, 1992-93, 1993-94, 1994-95, and 1995-96. Data for achievement, dropout, and math credit comparisons were drawn from the school system data records. The experimental treatment was the assignment to sheltered mathematics classes. The control variable was assignment to regular (non-sheltered) mathematics classes.

Instruments

The achievement measures were taken from the ITBS, Form J and NAPT tests. The Mental Measurements Yearbook 11 (Buros Institute of Mental Measurement, 1993) reports

The ITBS are widely used standardized achievement tests that measure general cognitive skills. Form J was developed based on sound measurement practices and meets high standards of technical quality. (Item 184)

The NAPT was a standardized achievement test based on the ITBS test. It was distributed throughout Texas by the
Texas Education Agency to measure general cognitive skills (Texas Education Agency, 1992).

Limiting the populations to the advanced ESL level generated populations that had an ITBS or NAPT test score from the end of the seventh grade, a pretest score. The ITBS or NAPT scores from the end of the eighth grade were the posttest score. The seventh- and eighth-grade scores as measured by ITBS or NAPT were the source of achievement measures. The samples were drawn from five years of data, 1991-92, 1992-93, 1993-94, 1994-95, and 1995-96. Achievement comparisons were made within each school year.

Attitude measures were taken from a sample of the 1995-96 eighth-grade population. Comparisons were made between the immersion and submersion groups.

The Thornhill-Hunt Attitude Survey was designed with 50 questions, each with either a yes/no or a true/untrue response continuum (see Appendix). Each item was written in both English and Spanish. The survey was first written in English. The first Spanish translation was done by a person who had experience with sheltered math classes. This translator was a graduate of a teacher college in Cuba. The International Translating and Typesetting Company of Dallas, Texas, reviewed and formatted the document.

The validity was established from regular mathematics classes and ESL classes. Reliability was tested with
transitional ESL classes (LEP students who had completed the three year ESL program).

To establish validity and reliability, the survey was first given to regular eighth-grade math students, seventh-grade and eighth-grade transitional LEP students, and a seventh-eighth grade combination class of beginning level Spanish-speaking LEP students.

Three math teachers were asked to give the survey to 10 students, 5 who had a positive attitude about math and 5 who had a negative attitude about it. Two ESL teachers each gave the survey to one class two times, with an interval of at least six weeks between administrations. These students indicated whether or not they had had sheltered math. The final category was beginning level students. One ESL teacher gave the survey to a class of beginning level LEP students. The students indicated whether or not they had had sheltered math. The results are shown in Tables 1 and 2.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Positive Attitude (mean)</th>
<th>Negative Attitude* (mean)</th>
<th>Total Population (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>87.9%</td>
<td>53.6%</td>
<td>70.73%</td>
</tr>
</tbody>
</table>

*As indicated by math teacher.
Table 2

Mathematics Attitudes of ESL Transitional Students

<table>
<thead>
<tr>
<th>Grade</th>
<th>Sheltered Math Experience (%)</th>
<th>No Sheltered Math Experience (%)</th>
<th>Total Class (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>74.0</td>
<td>58.75</td>
<td>66.38</td>
</tr>
<tr>
<td>8</td>
<td>78.0</td>
<td>63.75</td>
<td>65.93</td>
</tr>
<tr>
<td>Test 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>80.4</td>
<td>60.3</td>
<td>70.35</td>
</tr>
<tr>
<td>8</td>
<td>64.5</td>
<td>63.25</td>
<td>63.88</td>
</tr>
</tbody>
</table>

The validity measures were in the expected direction. The regular class students identified as having a positive attitude toward mathematics had a positive mean score 34% higher than the positive mean score for the students identified as having a negative attitude toward mathematics. The class mean positive scores for all classes tested, regular and ESL, had a narrow range, 63.88% to 73.1%.

The reliability was established by giving the same survey twice to the transitional ESL classes. The overall difference between the first administration and the second one was less than 2% for the positive mean scores.

In summary, the data for the study was from two sources, the school system student data or the responses to
the attitude survey. The achievement data was the seventh- and eighth-grade standardized test scores for the members of the populations. The aggregated differences between these scores was the data used for comparison of immersion and submersion populations. The attitude survey data was from the positive and negative response totals to the survey. The dropout information was recorded as student status (active, graduate, or withdrawn) in the student records. The math credit information was under the "Department Totals" item in student records.

Sample

The subjects of the study were advanced level eighth-grade Spanish-speaking LEP students enrolled in the Dallas Independent School District ESL program for the school years of 1991-92, 1992-93, 1993-94, 1994-95, and 1995-96. All level 3 LEP middle school students in the district must be enrolled in composition and literature course number 1160. The population for this study was the subset of these students who had both a seventh-grade and eighth-grade standardized math test score. From this subset the immersion and submersion populations were identified by the scheduled mathematics courses. Those students scheduled into sheltered mathematics classes (2525) were the immersion populations. The students scheduled into regular mathematics classes (2550) were the submersion populations.
The only exception was students from 1991-92. The achievement difference could not be calculated because there was no standardized test given in May of 1991.

The students who were scheduled into sheltered mathematics classes were the experimental group. The students who were scheduled into regular mathematics classes (nonsheltered) were the control group. The sheltered and regular mathematics classes had the same curricular expectations as defined by the school district for regular eighth-grade classes. Although the curriculum for sheltered and regular classes was the same, the sheltered classes could alter the pacing and procedures to explain and elaborate vocabulary and concepts.

Procedures

The data for achievement, dropout information, and mathematics course work completed were drawn from student records in the school district data bank. The attitude survey was given to a sample from the 1995-96 eighth-grade level 3 Spanish-speaking LEP students.

Treatment of Data

The achievement measures in the study were seventh- and eighth-grade standardized test scores (ITBS or NAPT) for each member of each group. The statistical procedure was analysis of covariance. The pretest scores (seventh-grade
scores) were the covariate. The data from student records were analyzed for each year in the study except 1991-92. The differences between seventh- and eighth-grade scores of eighth-grade Spanish-speaking LEP students were analyzed. The analysis of covariance (ANCOVA) was used as a procedure because it was statistical control of an extraneous variable, a covariate. Using ANCOVA increased the precision of the research by partitioning out the variation attributed to the seventh-grade scores which resulted in a smaller error variance. To use this statistic, the covariate must be unaffected by the eighth-grade math treatment. The effect of ANCOVA was to equalize the groups with respect to the variable.

The data bank produced grade equivalent scores for some of the years in the process of viewing the information. This adds information to the achievement data.

In May 1996, the 1995-96 eighth-grade sample took the Thornhill-Hunt Mathematics Attitude Survey by mail. The positive and negative scores were tabulated from the yes/no or true/untrue responses according to whether the response reflected a positive or negative attitude toward mathematics. The positive and negative responses for each member of the sample were used in the statistics.

The attitude survey was analyzed with four statistical procedures.
1. Wilcoxon Match-Pairs Signed-Ranks Test. Because the positive-negative responses were in effect repeated measures (nonparametric), this statistic pictures this relationship within one sample. The results were compared between the two populations.

2. The t-tests for paired samples. This statistic is parametric. It compared the means of the positive-negative tallies within one sample.

3. The Mann-Whitney U Test. This statistic compared the rank orders of the two groups to determine if there was a significant difference.

4. The t-tests for independent samples. This statistic compared the means of the positive responses between the groups.

Dropout information was based on the number of students classified as withdrawn for the years of 1991-92, 1992-93, 1993-94, and 1994-95. The significance of dropout comparisons was calculated using Chi square ($x^2$). This statistic was appropriate for nonparametric data (enrolled, not enrolled).

The number of mathematics credits earned were calculated for each graduate of the 1991-92 population remaining in the 12th grade. The means of the credits earned were compared for the experimental and control groups. The significance of the number of math credits for
the graduating students were calculated using a t-distribution with the t-test for significance between means for independent samples. The t-distribution was used because of the small samples.
CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

This study looked at mathematics with eighth-grade Spanish-speaking level 3 LEP students for the past five years in a large urban public school district (Dallas, Texas). The populations for the study were drawn from these students. These populations fell into two classifications: those students in a sheltered math course (course number 2525) and those in the regular eighth-grade math course (course number 2550). This information was taken from five sets of level 3 Spanish-speaking LEP students, 1991-92, 1992-93, 1993-94, 1994-95, and 1995-96. The study anticipated a larger regular math population than has emerged. However, data over time added to the value of the information. Population sizes are in Table 3.

The study was concerned with achievement changes, attitudes, drop out rates, and high school math credits accrued with populations based on eighth-grade Spanish-speaking level 3 LEP students. The question was whether these LEP students do better in sheltered math classes (immersion) than in regular math classes (submersion). The achievement measures were drawn from students within each year who have both seventh- and eighth-grade scores from the
Table 3

Population of Eighth-Grade Level 3 Spanish-Speaking LEP Students

<table>
<thead>
<tr>
<th>8th-Grade Mathematics Course</th>
<th>Total Number</th>
<th>Sheltered</th>
<th>Non-Sheltered</th>
<th>Percentage of Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991-92</td>
<td>104</td>
<td>78</td>
<td>26</td>
<td>Sheltered: 75% Non-Sheltered: 25%</td>
</tr>
<tr>
<td>1992-93</td>
<td>97</td>
<td>77</td>
<td>20</td>
<td>Sheltered: 79% Non-Sheltered: 21%</td>
</tr>
<tr>
<td>1993-94</td>
<td>129</td>
<td>92</td>
<td>37</td>
<td>Sheltered: 71% Non-Sheltered: 29%</td>
</tr>
<tr>
<td>1994-95</td>
<td>163</td>
<td>138</td>
<td>25</td>
<td>Sheltered: 85% Non-Sheltered: 15%</td>
</tr>
<tr>
<td>1995-96</td>
<td>220</td>
<td>182</td>
<td>38</td>
<td>Sheltered: 83% Non-Sheltered: 17%</td>
</tr>
</tbody>
</table>

The school district administered nationally normed tests. The attitude measure was a survey designed for the study. The drop out information was drawn from information about the status of the students indicated by "graduated," "active," or "withdrawn" in their records. The math credits accumulated were reported under "Department Totals" in the students' records.

The populations for the study were very uneven. The school district did an excellent job of providing intervention mathematics (sheltered mathematics) for LEP students. The relatively small number of LEP students in regular mathematics classes includes students whose families requested the placement and students moved to regular mathematics classes by teacher recommendation.
Achievement changes. The achievement information was not the same for all five years in question. The testing policies were not the same throughout the years of the study. Scheduling and policy decisions sometimes precluded a full testing of the population in question. The following tables indicate the information used for the analysis of covariance. None of the years indicated a significant difference in either direction in the achievement as treated with this statistic. One year, 1995-96, does not have data sufficient to calculate a grade equivalent score. The students were not given enough of the test battery to calculate this score. The 1991-92 year does not have an achievement comparison because the test was not given in the spring of 1991. Comparisons of mathematical information for eighth-grade level 3 Spanish-speaking LEP students scheduled into regular math 8 or sheltered math 8 classes are shown in Tables 4, 5, 6, 7, 8, and 9.

The regular mathematics LEP populations were all small compared to the sheltered LEP populations. Within these smaller numbers were members who requested this placement (possibly indicating a more positive attitude toward mathematics) and members who were placed in regular math classes by teacher recommendation (possibly indicating a higher level of achievement). These conditions did not cause the measures to be significantly different. Since
Table 4

**Score Change from Grade 7 to Grade 8 Scores, 1995-96**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Label</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire population</td>
<td></td>
<td></td>
<td>8.6344</td>
<td>3.7149</td>
<td>186</td>
</tr>
<tr>
<td>MATHGRP8</td>
<td>1.00</td>
<td>Regular Math 8</td>
<td>7.7692</td>
<td>4.5282</td>
<td>26</td>
</tr>
<tr>
<td>MATHGRP8</td>
<td>2.00</td>
<td>Sheltered Math 8</td>
<td>8.7750</td>
<td>3.5625</td>
<td>160</td>
</tr>
</tbody>
</table>

Note: The score change information was only available for the last year in the study (1995-96).

Table 5

**Analysis of Variance for the Significance of the Changes Between the Grade 7 and Grade 8 Scores, 1995-96**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>314.701</td>
<td>1</td>
<td>314.701</td>
<td>25.991</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Grade 7 scores</td>
<td>314.701</td>
<td>1</td>
<td>314.701</td>
<td>25.991</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Main effects</td>
<td>4.778</td>
<td>1</td>
<td>4.778</td>
<td>.395</td>
<td>.531</td>
</tr>
<tr>
<td>Explained</td>
<td>337.325</td>
<td>2</td>
<td>168.663</td>
<td>13.930</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Residual</td>
<td>2215.814</td>
<td>183</td>
<td>12.108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2553.140</td>
<td>185</td>
<td>13.801</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6

Analysis of Variance for the Significance of the Changes Between the Grade 7 and Grade 8 Scores, 1994-95

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>1.654</td>
<td>1</td>
<td>1.654</td>
<td>.044</td>
<td>.844</td>
</tr>
<tr>
<td>Grade 7 scores</td>
<td>1.654</td>
<td>1</td>
<td>1.654</td>
<td>.044</td>
<td>.844</td>
</tr>
<tr>
<td>Main effects</td>
<td>4.158</td>
<td>1</td>
<td>4.158</td>
<td>.110</td>
<td>.757</td>
</tr>
<tr>
<td>Explained</td>
<td>4.702</td>
<td>2</td>
<td>2.351</td>
<td>.062</td>
<td>.941</td>
</tr>
<tr>
<td>Residual</td>
<td>151.013</td>
<td>4</td>
<td>37.753</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>155.714</td>
<td>6</td>
<td>25.952</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7

Analysis of Variance for the Significance of the Differences Between the Grade 7 and Grade 8 Percentiles, 1994-95

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>18.789</td>
<td>1</td>
<td>18.789</td>
<td>.070</td>
<td>.805</td>
</tr>
<tr>
<td>Grade 7 percentiles</td>
<td>18.789</td>
<td>1</td>
<td>18.789</td>
<td>.070</td>
<td>.805</td>
</tr>
<tr>
<td>Main effects</td>
<td>53.859</td>
<td>1</td>
<td>53.859</td>
<td>.200</td>
<td>.678</td>
</tr>
<tr>
<td>Explained</td>
<td>58.837</td>
<td>2</td>
<td>29.418</td>
<td>.109</td>
<td>.899</td>
</tr>
<tr>
<td>Residual</td>
<td>1074.878</td>
<td>4</td>
<td>268.719</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1133.714</td>
<td>6</td>
<td>188.952</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8

Analysis of Variance for the Significance of the Changes Between the Grade 7 and Grade 8 Scores, 1993-94

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>8.348</td>
<td>1</td>
<td>8.348</td>
<td>.661</td>
<td>.424</td>
</tr>
<tr>
<td>Grade 7 scores</td>
<td>8.348</td>
<td>1</td>
<td>8.348</td>
<td>.661</td>
<td>.424</td>
</tr>
<tr>
<td>Main effects</td>
<td>.483</td>
<td>1</td>
<td>.483</td>
<td>.038</td>
<td>.847</td>
</tr>
<tr>
<td>Explained</td>
<td>9.255</td>
<td>2</td>
<td>4.628</td>
<td>.366</td>
<td>.697</td>
</tr>
<tr>
<td>Residual</td>
<td>303.263</td>
<td>24</td>
<td>12.636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>312.519</td>
<td>26</td>
<td>12.020</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9

Analysis of Variance for the Significance of the Changes Between the Grade 7 and Grade 8 Scores, 1992-93

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>351.344</td>
<td>1</td>
<td>351.344</td>
<td>24.803</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Grade 7 scores</td>
<td>351.344</td>
<td>1</td>
<td>351.344</td>
<td>24.803</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Main effects</td>
<td>.050</td>
<td>1</td>
<td>.050</td>
<td>.004</td>
<td>.953</td>
</tr>
<tr>
<td>Explained</td>
<td>378.826</td>
<td>2</td>
<td>189.413</td>
<td>13.372</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Residual</td>
<td>1034.056</td>
<td>73</td>
<td>14.165</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1412.882</td>
<td>75</td>
<td>18.838</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
there were not larger numbers of LEP students who were placed in regular classes because of scheduling, it was probable that the sheltered populations contained a larger percentage of students who traditionally felt that 8 or 10 years of schooling was sufficient.

Since there is no significant difference in the measures, the research hypothesis number 1 was not accepted for any year in the study with achievement scores, 1992-93, 1993-94, 1994-95, and 1995-96. LEP students enrolled in immersion mathematics classes did not have significantly higher achievement than students enrolled in submersion classes. Conversely, it is not true that LEP students enrolled in submersion mathematics classes had significantly higher achievement than LEP students enrolled in immersion classes. There was no significant difference in any year with data.

The same data source yielded information about grade equivalencies. These important measures are shown in Table 10.

All grade equivalence measures were below grade level. The measures ranged from 1.3 years to 3.5 years below grade level. The differences between the populations within each year was less. The differences ranged from 1.4 years to .5 year. In the absence of the original data, the available information suggested little or no difference.
Table 10

Grade Equivalents for Nationally Normed Tests, Eighth-Grade Spanish-Speaking LEP Students

<table>
<thead>
<tr>
<th>Year</th>
<th>Sheltered Mathematics</th>
<th>Non-Sheltered Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases</td>
<td>GE Mean</td>
</tr>
<tr>
<td>1992-93</td>
<td>68</td>
<td>5.2868</td>
</tr>
<tr>
<td>1993-94</td>
<td>22</td>
<td>6.0591</td>
</tr>
<tr>
<td>1994-95</td>
<td>47</td>
<td>5.9660</td>
</tr>
<tr>
<td>1995-96</td>
<td>Not available</td>
<td></td>
</tr>
</tbody>
</table>

Attitude. The positive and negative responses to the attitude survey were tabulated for a sample of the 1995-96 population. The survey was given to eighth-grade level 3 Spanish-speaking LEP students from five middle schools. Further, 38 surveys were mailed to regular mathematics LEP students from the 1995-96 population list of which only 4 were returned. The survey takers fell into two categories: sheltered math classes (46 students) and regular math classes (10 students). The statistics gave rank order and rank order mean comparisons within and between the groups. Table 11 and Table 12 gives the results.
Table 11

**Attitude Measures Between Groups**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cases</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheltered Math</td>
<td>46</td>
<td>29.50</td>
<td>1357</td>
</tr>
<tr>
<td>Regular Math</td>
<td>10</td>
<td>23.90</td>
<td>239.0</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mann-Whitney U
Comparison of Rank Order

|| U  | W  | Z   | 2-tailed P |
|----|----|-----|-----------|
| 184.0| 239.0| -.9856| .3243     |

t-tests for Independent Samples
Comparison of Mean Ranks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cases</th>
<th>Mean</th>
<th>SD</th>
<th>SE of Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheltered Math</td>
<td>46</td>
<td>16.0217</td>
<td>8.304</td>
<td>1.224</td>
</tr>
<tr>
<td>Regular Math</td>
<td>10</td>
<td>12.8000</td>
<td>7.743</td>
<td>2.449</td>
</tr>
</tbody>
</table>

Mean Difference = 3.2217

Levene's Test for Equality of Variances:
F = .011  P = .918

t-test for Equality of Means

<table>
<thead>
<tr>
<th>Variances</th>
<th>t-value</th>
<th>df</th>
<th>2-Tail</th>
<th>SE of</th>
<th>95% CI for Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal</td>
<td>1.12</td>
<td>54</td>
<td>.266</td>
<td>2.866</td>
<td>(-2.524, 8.967)</td>
</tr>
<tr>
<td>Unequal</td>
<td>1.18</td>
<td>13.89</td>
<td>.259</td>
<td>2.738</td>
<td>(-2.654, 9.098)</td>
</tr>
</tbody>
</table>

Table 12
Attitude Measures Within Groups

<table>
<thead>
<tr>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.17</td>
<td>61.00</td>
<td>6 - Ranks (SUMPOS LT SUMNEG)</td>
</tr>
<tr>
<td>24.45</td>
<td>929.0</td>
<td>38 + Ranks (SUMPOS GT SUMNEG)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 0 Ties (SUMPOS EQ SUMNEG)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>46 Total</td>
</tr>
</tbody>
</table>

\[ z = -5.0674 \]

2-tailed \( P = < .001 \)

---

\[ \text{Paired Differences} \]

<table>
<thead>
<tr>
<th>Mean</th>
<th>SD</th>
<th>SE of Mean</th>
<th>t-value</th>
<th>df</th>
<th>2-tail Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>-17.9565</td>
<td>16.608</td>
<td>2.449</td>
<td>-7.33</td>
<td>45</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

95% CI (-22.888, -13.025)
Table 12--continued

### Wilcoxon Matched-Pairs Signed Ranks Test
Negative-Positive Comparison of Rank Order
Regular Math Group

<table>
<thead>
<tr>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>.00</td>
<td>.00</td>
<td>0 - Ranks (SUMPOS LT SUMNEG)</td>
</tr>
<tr>
<td>5.50</td>
<td>55.00</td>
<td>10 + Ranks (SUMPOS GT SUMNEG)</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0 Ties (SUMPOS EQ SUMNEG)</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Total</td>
</tr>
</tbody>
</table>

\[ z = -2.8214 \] 2-tailed \( P = .0048 \)

---

### t-tests for Paired Samples
Comparison of Positive-Negative Mean Scores for Regular Math

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Pairs</th>
<th>2-tail Corr</th>
<th>2-tail Sig</th>
<th>Mean</th>
<th>SD</th>
<th>SE of Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMNEG</td>
<td>10</td>
<td>-1.00</td>
<td>.000</td>
<td>12.8000</td>
<td>7.743</td>
<td>2.449</td>
</tr>
<tr>
<td>SUMPOS</td>
<td></td>
<td></td>
<td></td>
<td>37.2000</td>
<td>7.743</td>
<td>2.449</td>
</tr>
</tbody>
</table>

Paired Differences

<table>
<thead>
<tr>
<th>Mean</th>
<th>SD</th>
<th>SE of Mean</th>
<th>t-value</th>
<th>df</th>
<th>2-tail Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>-24.4000</td>
<td>15.486</td>
<td>4.897</td>
<td>-4.98</td>
<td>9</td>
<td>.001</td>
</tr>
</tbody>
</table>

95% CI (-35.478, -13.322)
Three statistical procedures were used to look at the attitude comparison between the immersion and submersion groups. Further statistical treatment of the data compared the positive responses with the negative responses within each group. Both the immersion group and the submersion group were significantly more positive than negative.

The Mann-Whitney U test compared the rank order of the items on the survey between the groups. The t-tests for equality compared group variances and mean scores. Each of these found no significant difference between the groups. The hypothesis that the immersion students would be more positive than submersion students (hypothesis number 2) was not accepted.

When looking at each item for the combined populations, six items dealt with the necessity of mathematics as an adult. Four of these items were answered positively by more than 80% of all 56 survey takers. The two items with percentages a little below 70 were written so that a double negative meant a positive response. This may have lowered the number of positive responses.

Most students responded positively to items related to future career and everyday life. Those items related mathematics as necessary, useful, and worthwhile. They wanted to do well and understood the utility of mathematics. The survey takers felt that they would need mathematics in the future (89%), that doing well in high school would help
adult life (87%), that math is useful in everyday life (87%), that they would like to make A's in math (86%), that learning mathematics is helpful for making a living (86%), and that mathematics is necessary and worthwhile (86%).

Over half of the survey takers reported some feelings of self-confidence. A majority of the students reported themselves as a "math person" (63%). The students felt capable of success with more difficult mathematics (53%), confident and self-reliant when working with mathematics (51%), and comfortable and calm with mathematics (53%).

More than 50% of the responding students had these negative attitudes toward mathematics. Studying mathematics does not bring success (66%). Some believe that they did not have the ability to do advanced mathematics (54%). Mathematics made some students nervous (54%). The student's own nervousness interferes with logical thinking (53%). Some students did as little math work as possible (53%). Math was not exciting for 51% of the survey takers.

**Dropout information.** The dropout rate is in the withdrawn statistics. It was estimated by categorizing the members of populations as active (enrolled) or withdrawn (not enrolled). The Chi square ($x^2$) statistic was used to determine the significance of the dropout rate. This statistic was used because the information was nonparametric (enrolled, not enrolled). The information summarized here is given in Table 13. The critical value for .05
significance for Chi square ($x^2$) is 3.84. The difference in the number of withdrawals was not significant for grades 9, 10, and 11. In contrast, the difference in grade 12 was significant at the .05 level of significance. The submersion group from 1991-92 had significantly less withdrawn students than the immersion group from 1991-92. The grade equivalence for the regular LEP students from the 1991-92 population was 7.5 (middle of seventh grade). Though this level was over a year below grade level, it was the closest to grade level (8.8) of any of the available measures for the populations. The hypothesis that immersion students would have a significantly lower dropout rate (hypothesis number 3) was not accepted for any year in the study.

The withdrawal percentages for the regular math LEP students were all in the three middle decades of percentages, 40s and 50s. The percentages for the sheltered math LEP students is more extreme, from 69% down to 19%. The sheltered math LEP students were more likely to stay in high school for two years before they withdrew in large percentages. The withdrawal percentage ratio for the 12th-grade sheltered and regular math students was 69% to 52%. Both of these withdrawal percentages are less than the 70% dropout rate for recently immigrated students reported by Carson et al. (1993). The final result of these percentages is in the percentage of graduations. The regular math class
sheltered math class LEP students, 48% to 23%. Table 13 contains these percentages. The actual frequencies were combined for the year 1991-92 (Graduated/Active) to facilitate Chi-square calculations.

Table 13

<table>
<thead>
<tr>
<th>Grade</th>
<th>Course</th>
<th>Pop.</th>
<th>Graduated</th>
<th>Active</th>
<th>Withdrawn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>No. %</td>
<td>No.</td>
<td>No. %</td>
</tr>
<tr>
<td>12</td>
<td>Sheltered-91/2</td>
<td>81</td>
<td>19  23</td>
<td>4</td>
<td>56  69</td>
</tr>
<tr>
<td></td>
<td>Regular-91/2</td>
<td>25</td>
<td>12  48</td>
<td>2</td>
<td>13  52</td>
</tr>
<tr>
<td></td>
<td>Sheltered-92/3</td>
<td>77</td>
<td>--  --</td>
<td>43</td>
<td>34  44</td>
</tr>
<tr>
<td></td>
<td>Regular-92/3</td>
<td>20</td>
<td>--  --</td>
<td>10</td>
<td>10  50</td>
</tr>
<tr>
<td></td>
<td>Sheltered-93/4</td>
<td>93</td>
<td>--  --</td>
<td>66</td>
<td>27  41</td>
</tr>
<tr>
<td></td>
<td>Regular-93/4</td>
<td>37</td>
<td>--  --</td>
<td>25</td>
<td>12  48</td>
</tr>
<tr>
<td>9</td>
<td>Sheltered-94/5</td>
<td>138</td>
<td>--  --</td>
<td>116</td>
<td>22  19</td>
</tr>
<tr>
<td></td>
<td>Regular-94/5</td>
<td>25</td>
<td>--  --</td>
<td>16</td>
<td>9   36</td>
</tr>
<tr>
<td>8</td>
<td>Sheltered-95/6</td>
<td>182</td>
<td>--  --</td>
<td>--</td>
<td>--  --</td>
</tr>
<tr>
<td></td>
<td>Regular-95/6</td>
<td>39</td>
<td>--  --</td>
<td>--</td>
<td>--  --</td>
</tr>
</tbody>
</table>

Note: The critical value for $x^2$ is 3.84 for significance at the 0.05 level (1 df).

High School Math Credits. The math credit information was from the records of the 1995-96 graduating students from the 1991-92 study population. The t-test for significance between means for small samples was used to determine the significance of the difference between the groups of graduates. The results are in Table 14. The difference was not significant. Research hypothesis number 4 was not accepted.
Table 14

Mathematics Credits Earned for High School Graduation 1996.

Eighth-Grade LEP Students 1991-92

<table>
<thead>
<tr>
<th>Category</th>
<th>Number Graduating</th>
<th>Percent of Population</th>
<th>Math Credits</th>
<th>SD</th>
<th>SE of Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheltered Math 8</td>
<td>19</td>
<td>24%</td>
<td>3.6842</td>
<td>.558</td>
<td>.128</td>
</tr>
<tr>
<td>Regular Math 8</td>
<td>12</td>
<td>46%</td>
<td>3.9167</td>
<td>.469</td>
<td>.135</td>
</tr>
</tbody>
</table>

Table 15

T-test for Equality of Means

Mean Difference = -.2325
Levene's Test for Equality of Variances: F = 2.458 P = .128

<table>
<thead>
<tr>
<th>Variances</th>
<th>t-value</th>
<th>df</th>
<th>2-Tail Sig</th>
<th>SE of Diff</th>
<th>CI for Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal</td>
<td>-1.20</td>
<td>29</td>
<td>.240</td>
<td>.194</td>
<td>(-.629, .164)</td>
</tr>
<tr>
<td>Unequal</td>
<td>-1.25</td>
<td>26.52</td>
<td>.233</td>
<td>.186</td>
<td>(-.615, .150)</td>
</tr>
</tbody>
</table>

Both categories of students averaged more math credits than were required for high school graduation. The averages were essentially even with regular math LEP students having an average of only .23 of a credit higher than the sheltered students. Eighth-grade Spanish-speaking LEP immersion students did not average more high school credits than eighth-grade Spanish-speaking LEP submersion students. However, the submersion students did not average
significantly more math credits than the immersion students. Both categories of students averaged more than 3 credits, the graduation requirement. The range of credits earned in high school for the regular LEP math students was 3.0 to 5.0. The range for the sheltered math LEP students was 3.0 to 5.0.
CHAPTER 5

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This study grew from years of involvement with mathematical learning for Spanish-speaking immigrant secondary students. This chapter is a discussion of the findings, the resultant conclusions, and recommendations in light of these conclusions tempered by experience and the writings of others respected in the field.

Summary

This study sought to gather information useful for improving mathematical proficiency with equity for Spanish-speaking LEP students. Measuring achievement and attitudes should form a basis for relating to the level of participation in mathematics courses and to graduation from high school.

To measure achievement the only possible population-wide measure was the administration of standardized tests. This was different through time because of district policy changes and student status changes. The population was identified through the level 3 English composition course (1160). District policy requires that all level 3 LEP students be enrolled in this course. From this population
the populations for the study were identified through the eighth-grade Spanish-speaking students enrolled in sheltered mathematics (2525) or regular mathematics (2550). The students enrolled in special education mathematics or advanced mathematics were excluded from the study.

The district data bank was the source of information about achievement, dropouts, mathematics credits, and graduation. The positive and negative responses to the survey were the source of quantifiable information about attitudes. Analysis of covariance was the statistic used to process achievement data. The Mann-Whitney U test, t-test for Independent Samples, t-test for Equality of Means, Wilcoxon Matched-Pairs Signed-Rank Test, and t-test for Paired Samples were used to test the data for the attitude survey. Chi square was used to treat the data related to dropouts. A t-test for Equality of Means was used to test high school math credits.

Findings

There was no significant difference in achievement for any year of the study between the immersion and submersion eighth-grade populations. Neither sheltered math placement nor regular math placement resulted in higher mathematical achievement. All populations from the five years were below grade level. The research hypothesis (hypothesis number 1)
was not accepted for achievement differences between sheltered and regular LEP mathematics students.

As with achievement measures, attitude measures were not more positive for the immersion population than the submersion populations of this study. The research hypothesis (hypothesis number 2) was not accepted. However, the statistics did find that both of the populations had significantly more positive responses than negative ones.

The research hypothesis for the dropout rate was not accepted for any year, 1991-92, 1992-93, 1993-94, or 1994-95. Hypothesis number 3 was not accepted. The opposite of the expectation for the dropout rate was true for the 1991-92 population. The dropout rate was significantly lower for regular math students. As part of this data the percentage of graduates was better for the regular mathematics students than for the sheltered students. The 1991-92 regular math group had a grade equivalence measure only 1.3 years behind grade level. Hence, they started with more mathematical knowledge.

The earned mathematics credits were not significantly different between graduating seniors from the 1991-92 eighth-grade sheltered and regular LEP mathematics students. Research hypothesis number 4 was not accepted.
Conclusions

The study did not show more achievement, better attitudes, better dropout rate, nor more credits earned by immersion students. The differences between the populations were not significant. The lack of achievement differences and the similarity of achievement and grade level measures indicated that the sheltered and regular math LEP students were not two populations.

The small number of LEP students in regular mathematics classes was unexpected. The small numbers were more indicative of personal preference and teacher placement than scheduling conflicts. The advantages that the regular LEP students may have had with respect to achievement were possibly offset by the at-risk students in the sheltered LEP classes. Though placement by request of family or math teacher would be expected to affect the achievement of the regular math population, it did not.

Additionally, there was an achievement deficit for all populations. Both groups in the four years for which there was data averaged more than 2-1/2 years below grade level. This agrees with the reported characteristics of Hispanic students. Sosa (1993) relates that 32% of Spanish-speaking Hispanic students are 2 or more years behind grade level. Interventions related to teaching strategies and learning styles show promise to encourage improvement for Spanish-speaking LEP students.
There are three important interacting factors with reference to how well LEP students achieve in mathematics: a threshold of cognitive academic language proficiency (CALP), cognitive academic mathematics proficiency (CAMP), and testing. CALP takes nearly seven years to develop (Spanos, Rhodes, Dale, & Crandall, 1988). These students are immigrant students in the third year of language training. They need help to get over the "threshold" of mathematical proficiency in the mathematical language register. CAMP involves proficiency with the language structured to express mathematical concepts and applications (Spanos et al., 1988). Thus, the concepts in CALP plus CAMP means the successful LEP mathematics student needs flexible pacing, adequate time, and language help to learn this mathematical language over and above the English language.

Assessment difficulties compound the mathematical learning challenge. Testing that is "one size fits all" is a recipe for disaster. Testing is listed throughout the literature as a problem because of lower measures for Hispanic mathematics achievement. The achievement results in this study are from tests that were the same for the entire school population. Various policy decisions that exempted various segments of the LEP population or removed parts of the tests from the batteries given to LEP students were in response to the felt need for differentiated assessment of the language-minority population.
Although Hispanic students are widely reported to have lower achievement, the picture may not be completely accurate. The literature calls for research in testing for Hispanic LEP students. The need exists for objective testing as well as subjective measures (performance assessment). Study about testing should cover general language minority assessment and emphasis on Hispanic assessment since the Hispanic population is so large and growing so fast.

Since the populations do not differ significantly with reference to the attitude survey, some considerations have value with reference to how the populations responded to the individual items. The amount of positive feelings needs to be encouraged. Educators should capitalize on the motivation potential.

About half of the students expressed frustration with mathematical effort leaving them with negative attitudes about ability resulting in less effort. Close to the same percentage expressed nervousness toward mathematical work. This negative response could be looked at in a positive way. A student must care about performance to feel nervousness toward it. Teacher awareness of frustration and nervousness is an important step toward altering content and strategies to diminish these feelings.

Surprisingly, a majority of the students responded positively to "I am a math person." About half of the
students expressed confidence in mathematical ability and felt self-reliant toward mathematical tasks. Math teachers may not be aware of this element of confidence in their LEP students. Armed with this knowledge, the teacher has a basis to build a positive mathematics learning climate in the classroom.

Most encouraging was the high percentage of students who value mathematics for adult life. The survey takers understood that high school mathematics preparation is key to using math as an adult. Since students are aware of the importance of mathematics and they are still underrepresented in mathematically related careers, educators must look at curriculum and teaching strategies to rectify this inequity.

The finding that the survey responses were significantly more positive than negative was encouraging. Though the groups did not differ significantly in how positively they responded to the survey, both groups were significantly more positive than negative toward mathematics.

These attitude findings are valuable when planning for better LEP achievement. Attitudes and values correlate positively with achievement (Reynolds & Walberg, 1992; Shiow-Ling & Walberg, 1983). Language learning has been successful when the anxiety level is down (Krashen, 1983). Educators must not overlook attitudes when planning for
better minority mathematics learning. Attitude surveys would be a source of attitude information for planning better Hispanic mathematical experiences. Expanded attitude surveys with pretreatment and posttreatment surveys would elicit more information related to student needs and motivations.

The withdrawal rate for the 1995-96 12th-grade students who were 1991-92 grade 8 level 3 Spanish-speaking LEP students was less than the dropout rate reported in the Sandia Report (Carson et al., 1993). This school system had a better rate than the national average. A better rate than the national average is not cause to be content. These rates are a function of mathematical success and good attitudes toward mathematics. If achievement and attitude improve, the dropout rate will go down.

Though there was no significant difference between the number of math credits completed by the sheltered and regular math graduates, both populations averaged more than the number of credits required for graduation. If immersion or submersion as present in this school system cannot be credited with the number of math credits completed, further study needs to be made to determine motives and circumstances that would differ from the students who did less or dropped out.

No research hypothesis in this study was accepted. The small number of level 3 LEP students in regular math classes
was not expected. The school system has successfully scheduled a high percentage of LEP students into sheltered math classes. Research into better sheltered mathematics classes would need to avoid placing LEP students into mathematics classes without language help. It would not be fair to schedule an LEP student into a math class that did not meet the programmatic remedy designed to meet a language need in mathematics.

The educational description that emerged fits the general description for urban school districts. The policies that have been implemented in this school district have provided the limited English proficient students with sheltered mathematics classes with calculators, computers, and manipulative materials. Changes need to be made in curriculum, teacher recruitment and training, and classroom strategies.

Curriculum should be studied to balance basic skills deficits and age-appropriate concept development. Students who have not mastered utility skills are capable of understanding mathematical concepts beyond elementary computational skill levels. Mathematically rich problem situations would address parallel skills and concepts. Problem solving situations lend themselves to strategies that incorporate field dependent activities. Planning problem-solving situations for the mathematics classroom is time consuming, but valuable since field dependent learning
is more typical of Hispanic students. The difficulty with teaching by problem solving situations comes in knowing that the students have encountered all the parts of a well-rounded math curriculum.

Learning theory is based on a continuum from technological sources, external stimuli, and objective measurements to cognitive sources, internal knowledge construction. The present emphasis is on cognitive learning theory. Such ideas as cooperative learning, locus of control, and field dependent learning fit this learning theory. Cooperative learning encourages internal locus of control and field dependent group learning. Encouraging an internal locus of control meets a need Hispanic students have. Immigrant Hispanic students often come to school in this country depending on the teacher for all directions for activity. Field dependent learning fits the cultural orientation of Hispanic students. Research is needed in classroom management and activities in a search to improve achievement and percentage of graduations.

Math teachers as a group have not given emphasis to language learning. Teaching LEP students mathematics is a blending of mathematics and language learning of both English and the mathematics register. Often the teacher for sheltered mathematics is a qualified mathematics teacher assigned to that course. Recruiting sheltered mathematics teachers from the qualified mathematics teacher pool would
add the element of commitment to an approach to mathematics teaching that is largely lacking now. These teachers would need ESL training and time together to plan classroom strategies.

Recommendations

In light of the findings and conclusions of this study of the current practice of sheltered mathematics classes for LEP Spanish-speaking middle school students these recommendations are made:

1. Research should be done to write standardized mathematics tests that will be accurate and fair for Spanish-speaking LEP students.

2. Further research should be done into teaching strategies and classroom management particularly suited to Spanish-speaking LEP students.

3. Attitude measures should be used as pretest and posttest to study the effect of sheltered mathematics classes on LEP students in relation to attitudes toward mathematics and motivation to continue schooling.

4. Recruit and train qualified mathematics teachers to teach ESL mathematics.
APPENDIX

THORNHILL-HUNT

MATHEMATICS ATTITUDE SURVEY
Thornhill-Hunt
Mathematics Attitude Survey
Assessment in English and Spanish

Date

Student No.

School

Grade
MATH ATTITUDE SURVEY
CUESTIONARIO DE SU ACTITUD EN MATEMÁTICAS

1. I am a math person. Say una persona a quien le gustan las matemáticas.
   • Yes/Sí
   • No/No

2. I enjoy math—it is exciting. Me gustan las matemáticas es exciante.
   • Yes/Sí
   • No/No

3. I would like to win an honor or a prize in mathematics. Me gustaría ganar un premio en matemáticas.
   • Yes/Sí
   • No/No

4. Doing well in high school math will help my adult life. Realizando un buen trabajo en matemáticas en “high school” me ayudará en mi futuro.
   • True/Cierto
   • Not true/No cierto

5. When I work on math I get nervous and can’t think logically. Cuando trabajo en matemáticas me pongo nervioso no puedo pensar con claridad.
   • True/Cierto
   • Not true/No cierto

6. If I cannot understand a math problem I stop working. Si no puedo comprender un problema de matemáticas lo abandono.
   • True/Cierto
   • Not true/No cierto

7. I know that I will use math in my everyday adult life. Sé que haré buen uso de las matemáticas en mi vida en el futuro.
   • Yes/Sí
   • No/No

8. I feel I will fail if I try hard math problems. Creo que yo fracasaré si trato de trabajar en problemas de matemáticas muy difíciles.
   • Yes/Sí
   • No/No

   • Yes/Sí
   • No/No

10. I do the math work that is assigned. Hago el trabajo de matemáticas que me es asignado.
    • Yes/Sí
    • No/No
11. I would feel excited if I won a prize in mathematics.  
*Yo me sentiría muy feliz si obtuviera un premio en matemáticas.*

12. I will need math in my future career.  
*Yo necesitaré de las matemáticas en mi carrera profesional.*

13. I could succeed with more difficult mathematics.  
*Yo podría tener éxito con problemas de matemáticas más difíciles.*

14. I study math but it is still hard for me.  
*Estudio matemáticas pero continúan siendo difíciles para mí.*

15. I do the smallest amount of math work possible to pass the course.  
*Hago solamente la menor cantidad posible de trabajo en matemáticas para aprobar la asignatura.*

16. I would like to make A's in math.  
*Me gustaría obtener “A” en matemáticas.*

17. I need to know math well for my work as an adult.  
*Necesito saber bien las matemáticas para mi trabajo como adulto.*

18. I do well in math whether or not I feel comfortable with other subjects.  
*Prescindiendo de las demás asignaturas, en matemáticas me defiendo bien.*

19. I like to solve mathematical problems.  
*Me gusta resolver problemas de matemáticas.*

20. I continue to think about unanswered questions in math.  
*Cuando tengo preguntas sin contestar en matemáticas no paro de pensar en esas preguntas.*
21. I would feel proud if I were the outstanding math student. . . .
Me sentiría muy orgulloso si yo fuera el más sobresaliente estudiante de matemáticas.

22. I do not expect to use mathematics when I am an adult. . . .
No espero usar las matemáticas cuando sea adulto.

23. I feel confident when I try to work on my math assignments. .
Me siento seguro cuando trato de hacer mis tareas de matemáticas.

24. I am afraid of mathematics. . . . . . . .
Las matemáticas me dan miedo.

25. I want to know mathematics so it will help me earn a living. .
Deseo saber matemáticas porque esto me ayudará a ganarme la vida cuando sea adulto.

26. I have the ability to get good grades in math. . . . .
Yo tengo facilidad para obtener buenas calificaciones en matemáticas.

27. Math puzzles are interesting. . . . . . . . .
Los rompecabezas de matemáticas son interesantes.

28. I stick to a problem until I get a solution even if I fail at first.
Yo trato de resolver un problema de matemáticas hasta que encuentre la solución a pesar de haber fallado la primera vez.

29. I would feel happy to be known as an excellent student in math.
Sería muy feliz de ser considerado como un estudiante excelente en matemáticas.

30. I do not believe mathematics is important to my work as an adult.
No creo que las matemáticas serán de importancia en mi trabajo cuando sea adulto.
31. I can get good grades in the math class I am in. □ Yes/Sí □ No/No
   *Yo puedo tener buenas calificaciones en la clase de matemáticas que estoy tomando.*

32. Mathematics is not pertinent to my life. □ True/Cierto □ Not true/No cierto
   *Las matemáticas no son importantes en mi vida.*

33. I feel comfortable with mathematics. □ True/Cierto □ Not true/No cierto
   *Yo me siento a gusto con las matemáticas.*

34. The reason to study math is its usefulness. □ True/Cierto □ Not true/No cierto
   *La razón de estudiar matemáticas es su utilidad.*

35. I cannot do mathematical school work. □ True/Cierto □ Not true/No cierto
   *Yo no puedo hacer mis tareas matemáticas escolares.*

36. I feel calm when I'm working on math work. □ True/Cierto □ Not true/No cierto
   *Me siento tranquilo cuando trabajo con las matemáticas.*

37. I want to solve difficult math problems for myself. □ True/Cierto □ Not true/No cierto
   *Yo deseo resolver problemas difíciles de matemáticas sin ayuda.*

38. I know mathematics is necessary and worthwhile. □ True/Cierto □ Not true/No cierto
   *Yo sé que las matemáticas son necesarias y de gran valor.*

39. I am glad when someone gives me the solution to a problem before I have worked it out. □ True/Cierto □ Not true/No cierto
   *Me alegro mucho cuando alguien me da la solución de un problema antes de que yo lo resuelva.*

40. I would feel uncomfortable with the attention I got if I won a prize in mathematics. □ True/Cierto □ Not true/No cierto
   *Me sentiría apenado si me dieran demasiada atención por haber ganado un premio en matemáticas.*
41. I feel comfortable with the work in math class.  
   *Yo me siento a gusto trabajando en la clase de matemáticas.*
   - True/Cierto
   - Not true/No cierto

42. I can understand how people enjoy spending a lot of time on math.  
   *Yo comprendo cómo hay personas que disfrutan empleando mucho tiempo en las matemáticas.*
   - Yes/Sí
   - No/No

43. I have the ability to do advanced mathematics.  
   *Tengo habilidad para trabajar en matemáticas avanzadas.*
   - Yes/Sí
   - No/No

44. I am not interested in working on math problems.  
   *A mi no me interesa trabajar con problemas de matemáticas.*
   - True/Cierto
   - Not true/No cierto

45. I know I can solve math problems most of the time.  
   *Yo sé que puedo resolver problemas de matemáticas la mayoría de las veces.*
   - Yes/Sí
   - No/No

46. Studying mathematics is a waste of time.  
   *Estudiar matemáticas es una pérdida de tiempo.*
   - True/Cierto
   - Not true/No cierto

47. I am scared of math tests.  
   *Los exámenes de matemáticas me dan miedo.*
   - True/Cierto
   - Not true/No cierto

48. I never feel nervous doing a math test.  
   *Cuando tomo un examen de matemáticas nunca me pongo nervioso.*
   - True/Cierto
   - Not true/No cierto

49. Math ranks at the bottom of my subjects.  
   *Las matemáticas ocupan el último lugar en la lista de mis asignaturas.*
   - Yes/Sí
   - No/No

50. I feel confused and uncomfortable with mathematics.  
   *Me siento incómodo y confuso con las matemáticas.*
   - True/Cierto
   - Not true/No cierto
REFERENCE LIST


Debate over effectiveness has shaped federal policy. (1987, April 1). *Education Week, 38*-39.


