AN ABSTRACT OF THE THESIS OF

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Title: THE EFFECTS OF AN IMMERSION BILINGUAL MATHEMATICS INSTITUTE ON THE ACHIEVEMENT OF SEVENTH GRADE MEXICAN-AMERICAN STUDENTS

Abstract approved: Gene F. Craven
Gene F. Craven

The purpose of this study was to determine the extent to which an Immersion Bilingual Mathematics Institute (IBMI) can affect the mathematics achievement of entering seventh grade students of Mexican-American heritage. Mathematics achievement was defined as mathematics skills measured by the Mathematics Computation and Mathematics Concepts and Applications tests of the Comprehensive Test of Basic Skills (CTBS) battery.

A four-week, 80-hour supplementary mathematics institute was designed to increase computation skills in addition, subtraction, multiplication, and division of fractions, decimals and mixed numbers and in solving word problems requiring these skills. The IBMI curriculum included lessons requiring the use of manipulative materials such as measuring instruments to solve

mathematics problems perceived to be relevant to the students. Bilingual mathematics teachers rotated daily among three subgroups of 8 to 12 students classified according to English language ability. Instruction was characterized by teacher direction, high energy instruction, positive reinforcement and rapid drill sessions.

A modified Pretest-Posttest Control Group design was used. Incoming Mexican-American seventh grade volunteers from five Orange, California schools were blocked by sex and CTBS reading scores and randomly assigned into 30-student treatment and control groups. A second control consisted of 40 similar seventh grade Anglo-American students. One level of the CTBS battery was administered as a pretest in May, 1981. A higher level of the CTBS served as posttests in late August at the end of the IBMI and again six months later. The Institute was conducted in El Modena High School mathematics classrooms in August, 1981.

Significant ($p \leq .05$) gains in mathematics achievement were made by the treatment group on tests administered at the end of the IBMI. These gains were positive, but non-significant when compared to the two control groups six months later. Data obtained for the study confirmed a mathematics achievement disparity between Mexican-American and Anglo-American students in

Orange schools comparable to data reported for other regions of the Southwest.

The researcher concludes that an IBMI designed to meet the linguistic and cultural preferences of Mexican-American students has a short-term effect in significantly increasing their mathematics skills and in reducing the mathematics achievement disparity, but that these gains are not significant six months later.

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The Effects of an Immersion Bilingual Mathematics Institute on the Achievement of Seventh Grade Mexican-American Students

by

C. Steven Ebert

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APPROVED:

Gene F. Craven

Associate Professor of Science Education in charge of major

Thomas P. Evans

Chairman of Department of Science Education

John C Ringle

Dean of Graduate School

Date thesis is presented November 5, 1984

Typed by Christina Washington O'Bryan for C. Steven Ebert

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TABLE OF CONTENTS

TABLE OF CONTENTS

(continued)

LIST OF FIGURES

LIST OF TABLES

THE EFFECTS OF AN IMMERSION BILINGUAL MATHEMATICS INSTITUTE ON THE ACHIEVEMENT OF SEVENTH GRADE MEXICAN-AMERICAN STUDENTS

I. INTRODUCTION

Spanish-speaking children with little or no command of English are in a no-win situation in public schools in which English is the medium of instruction. They often come from homes in which Spanish is the only language spoken, yet when they enter school, they are expected not only to learn a new language, but to keep up in other subjects as well. By the time they have learned enough English to overcome the effects of the home-school language switch, they are often so far behind in other subjects that it is almost impossible for them to catch up.

This problem is especially apparent in the southwestern United States where there is a high proportion of Mexican-Americans in the public schools. When we look at mathematics achievement, we find a great disparity in achievement levels between Mexican-American and Anglo-American students. As mathematics study becomes more advanced, the disparity in achievement continues to increase. By the end of the sixth grade, Mexican-Americans are typically more than one year behind grade level. At the college level, their participation in mathematics study is less than twenty-five percent of what one expects based on their percentage of the population.

Immigration of Mexicans - Unique

Many Mexican-American educational problems stem from the nature of the Mexican immigration. The present wave of Mexican immigrants into the Southwest began with the industrialization of American agriculture in the 1930s. Population pressure and a chronically depressed Mexican economy combined to promote a steady influx of migrant laborers willing to do hard work for low wages. Unlike recent immigrants from Southeast Asia, the Mexicans come from their country's lowest socio-economic strata. Typically, they have been semi-literate, rural people without traditions of scholarly values.

Unlike European immigrants, who more or less rapidly assimilated into the "melting pot" of American society, Mexican-Americans have not integrated so successfully. They tend to remain in ethnic neighborhoods or barrios where their own language and culture dominate. The reasons for the residential segregation of Hispanic-Americans in the Southwest result partly from their own ethnic preferences as well as from the ethnic prejudices of Anglo-Americans (U.S. Commission on Civil Rights, 1971). The condition is also demographic in that the language and culture are continually reinforced by the arrival of new immigrants.

The public school system in the Southwest has not succeeded in educating students from the Spanish-speaking barrios to achieve, on an average, as well as their English-speaking counterparts on basic skills tests or in most school subjects. This achievement disparity is not confined to Anglo-dominated school districts. Mexican-American academic achievement remains low even in school districts dominated by Hispanic teachers and administrators.

Government Programs

During the 1960s, the mathematics achievement disparity for Mexican-Americans was studied as part of the broader issue of their failures in public schooling in general. Politicization of the problem during the late sixties brought about passage of legislation which became known as Title VII of the Bilingual Education Act of 1968.

The intention of bilingual education was to enable Spanish-speaking students to study non-English related subjects such as science and mathematics in Spanish as they continued to learn English. Unfortunately, bilingual education has not become the panacea once imagined. Since languages cannot rationally be mixed, bilingual instruction really meant teaching a lesson first in one language, then reteaching it in another. In actual practice, classes containing a mixture of Spanish- and English-speaking students are instructed first in English, then the students are separated and bilingual aides repeat the lesson in Spanish for the Spanish-speaking children. Meanwhile, the English-speaking students have this time available for mastery of the lesson with the regular teacher. Consequently, bilingual instruction is almost by definition less efficient than monolingual instruction. Despite the massive outlay of federal dollars for bilingual education since 1968, the achievement disparity in mathematics has persisted.

Title VII bilingual education programs are not providing the educational opportunities needed by Hispanics to compete on an equal footing in mathematics and science. Most of the seventh grade Mexican-American students who were the subjects of this study had participated in a Title VII program. As a group, however, their mathematics achievement level averaged 1.8 Grade Equivalents below the Anglo-American control group. Given the intractable nature of the problem, the researcher is convinced that the best hope for eliminating the mathematics achievement disparity for

Mexican-Americans is by supplementing their regular school curriculum.

Alternative Versus Supplemental

Bilingual programs, as presently implemented by autonomous school districts throughout the Southwest, represent an ALTERNATIVE rather than a SUPPLEMENT to traditional English-only instruction. This statement is self-evident since Title VII programs neither increase the length of the academic day nor prolong the instructional semester.

Today, the majority of Mexican-Americans live in metropolitan areas where they must compete for technical jobs requiring significant preparation in mathematics and science. Their opportunities for productive careers depend on the quality of education provided by public schools. If the alternative bilingual programs presently funded under Title VII cannot provide equal educational opportunities for Hispanics, then the only viable option is to supplement the regular curriculum. To that end, the purpose of this study is to design and test a supplemental mathematics curriculum.

Statement of the Problem

The purpose of this study was to determine the extent to which a supplemental Immersion Bilingual Mathematics Institute (IBMI) can affect the mathematics achievement of seventh grade students of Mexican-American heritage.

Hypotheses

Hypotheses to be tested concern the short- and long-term effects of an IBMI on a treatment group of Mexican-American subjects relative to non-participating Mexican-American and Anglo-American controls. Stated in null form, the hypotheses are:

H_1: There is no difference in gain scores in mathematics computation achievement between a Mexican-American treatment group at the end of a four-week IBMI and a non-participating Mexican-American control group.

H_2: There is no difference in gain scores in mathematics concepts and applications achievement between a Mexican-American treatment group at the end of a four-week IBMI and a non-participating Mexican-American control group.

H_3: There is no difference in gain scores in combined mathematics computation and concepts and applications achievement between a Mexican-American treatment group at the end of a four-week IBMI and a non-participating Mexican-American control group.

H_4: There is no difference in mathematics computation achievement between a Mexican-American treatment group at the end of a four-week IBMI and a non-participating Anglo-American control group.

H_5: There is no difference in mathematics concepts and applications achievement between a Mexican-American treatment group at the end of a four-week IBMI and a non-participating Anglo-American control group.

H_6: There is no difference in combined mathematics computation and concepts and applications achievement between a Mexican-American treatment group at the end of a four-week IBMI and a non-participating Anglo-American control group.

H_7: There is no difference in gain scores in mathematics computation achievement between a Mexican-American treatment group six months after completion of an IBMI and a non-participating Mexican-American control group.

H_8: There is no difference in gain scores in mathematics concepts and applications achievement between a Mexican-American treatment group six months after completion of an IBMI and a non-participating Mexican-American control group.

H_9: There is no difference in gain scores in combined mathematics computation and concepts and applications achievement between a Mexican-American treatment group six months after completion of an IBMI and a non-participating Mexican-American control group.

H_{10}: There is no difference in mathematics computation achievement between a Mexican-American treatment group six months after completion of an IBMI and a non-participating Anglo-American control group.

H_{11}: There is no difference in mathematics concepts and applications achievement between a Mexican-American treatment group six months after completion of an IBMI and a non-participating Anglo-American control group.

H_{12}: There is no difference in combined mathematics computation and concepts and applications achievement between a Mexican-American treatment group six months after completion of an IBMI and a non-participating Anglo-American control group.

Basic Assumptions

In this study, it was assumed that:

1. Students of Mexican-American heritage are capable of the same level of academic achievement as their Anglo-American counterparts.
2. A mathematics achievement disparity does exist between Anglo-American and Mexican-American students in the southwestern United States.
3. Supplementation of the public schools mathematics curriculum can reduce the mathematics achievement disparity between Anglo-American and Mexican-American students.
4. The Mathematics Computation and Mathematics Concepts and Applications tests of the Comprehensive Test of Basic Skills (CTBS) battery constitute valid and reliable instruments for measuring mathematics achievement of Mexican-American and Anglo-American students.
5. The random blocking technique used to select the subjects of this study resulted in equivalent samples of Mexican-American subjects in the treatment and control groups.
6. The pre-experimental communications sent to parents of the Mexican-American children attending the five

elementary schools did not cause a bias in the selection procedure.

7. The personal data obtained from the student directories of the five elementary schools and used to solicit volunteers was accurate and complete.
8. There was no differential mortality between the treatment and control groups resulting from interactions with the IBMI.
9. No differential changes such as "history" or "maturation" occurred between the Mexican-American and Anglo-American control groups during the ten month course of the study which would have caused them to become less comparable to each other.

Delimitation of the Study

The study was delimited as follows:

1. Mexican-American treatment and control groups consisted of seventh grade students selected from five elementary schools in the Orange Unified School District (OUSD) whose parents completed and returned a bilingual application form to participate in the IBMI.
2. The Anglo-American control group consisted of seventh grade students selected from three participating OUSD schools that had the largest Mexican-American enrollments.
3. The IBMI was four weeks (80 hours) long and focused on mathematics computation skills.

Limitations

The study was limited by

1. the fact that 33% of the parents or guardians of the Mexican-American students solicited by mail to participate in the IBMI did not return the bilingual application forms;
2. the level of motivation, the mathematics teaching ability and the bilingual teaching skills of the three IBMI instructors; and
3. the skill of the researcher in designing learning activities and in training the teachers to use those learning activities to raise the mathematics computation skills of students in the treatment group.

Definition of Terms

A number of terms are used in reporting this study that readers may interpret differently. The list of definitions that follows is provided to clarify the meaning of these terms:

1. Activity learning - a mathematics learning process in which the participant learns through active participation.
2. Anglo-American - a Caucasian person of non-Mexican heritage residing in the southwestern United States.
3. Barrio - an ethnic enclave or neighborhood populated mainly by Hispanic residents.
4. Bilingual-bicultural - persons who are the products of two distinct cultures who speak and understand two languages.
5. Cognitive style - learning behaviors of both individuals and populations classified as field-dependent or field-independent.
6. Field-dependency - a global mode of perception in which the organization of the field as a whole dominates the perception of its parts.
7. Field-independency - a mode of perception characterized by analysis without regard to the prevailing stimulus field.

8. Hispanic - a term referring to Spanish-speaking peoples regardless of nationality.

9. Inductive teaching - a teaching style distinguished by the example-followed-by-rule rather than rule-followed-by-example paradigm.

10. Immersion training - a short, intense course providing small groups of learners with several hours of daily instruction to master specific skills.

11. Mathematics achievement - mathematics skill as measured by the Mathematics Computation and Mathematics Concepts and Applications tests of the CTBS.

12. Rapid drill session - an intense, oral learning session directed by the instructor and intended to promote rote memorization.

13. Mexican-American - a person of Mexican heritage residing in the southwestern United States.

14. Traditional classroom structure - a teacher-directed lecture and discussion mode of instruction.

Importance of the Study

The importance of this study rests on two assumptions. One assumption is that the disparity in mathematics achievement between Mexican-American students and their Anglo-American counterparts can be reduced by supplemental instruction. The other is that training which focuses on specific basic skills using methods that meet the language and cultural preferences of Mexican-Americans is most likely to raise the mathematics achievement level of these students.

If mathematics achievement for Mexican-American students can be raised prior to the start of the school year, and at the end of the school year still exceeds the levels of comparable students who have not received immersion training in mathematics, then supplementary instruction will be shown to be one way to decrease the mathematics achievment disparity. Supplemental instruction during the summer recess is both feasible and economical for most school districts, since school facilities are not used and regular bilingual teachers are available to serve as instructors.

Teaching methodologies employed in "successful" IBMIs may also be incorporated into the regular instruction of the participating teachers, thereby further enhancing the mathematics achievement level of their Mexican-American students.

II. REVIEW OF THE RELATED LITERATURE

Academic Achievement for Mexican Americans

This study is directed to the lack of achievement and non-participation in mathematics by children of Mexican-American heritage in public school systems of the southwestern United States. A review of the literature indicates that these children generally achieve far below what is thought to be their intellectual potential. According to data compiled in 1978 by the National Center for Educational Statistics and based on results of a nationwide assessment test, Hispanics were found to be below national norms in all mathematics assessment categories. The following table shows the percentage differences from the national norms by age in three categories, "mathematical knowledge and

Table 2.1 Percentage Differences from National Norms for Hispanic Students (State-of-the-Art, 1980).

Age Category	Mathematical Knowledge and Skills	Mathematical Understanding	Mathematical Applications
9-yr-olds	-7.9%	-12.0%	-12.0%
13-yr-olds	-8.2%	-11.8%	-13.8%
17-yr-olds	-8.2%	-10.5%	-12.1%

skills," "mathematical understanding" and "mathematical applications."

The school drop-out rate among Mexican-American pupils is also high. Norma Hernandez (1972) reports that, among five southwestern states, the median number of school years attended by this ethnic group are: Arizona, 8.2; California, 9.2; Colorado, 8.7; New Mexico, 8.8; and Texas, 6.7, as compared to a nation-wide median of 12.1 for the general population. The results of the 1980 U.S. Census (The World Almanac, 1981) indicate that 42.8% of Hispanic-Americans completed less than four years of high school, compared to 20.6% for the Anglo-American population.

In an increasingly technological society, the lack of achievement and participation in higher education severely limits the career opportunities for Hispanics in scientific and technical fields. Again, the 1980 U.S. Census (Ibid.) indicates that only 2.4% of Hispanic peoples had completed four years or more of college education versus 7.4% for the Anglo-American population. The National Institute of Education (State-of-the-Art, 1980) reported that, of 15,816 Bachelor's degrees awarded in mathematics in 1976, only 1.6% were awarded to Hispanics who, according to the 1980 Census (Ibid.), constitute over 6.5% of the general population, not including illegal aliens. In general, the more technically specialized the curriculum becomes, the less likely one is to encounter Hispanic-American participants.

Intellectual Potential for Hispanics

As far back as 1936, Garth et al. had shown that a non-language based intelligence test administered to Mexican-Americans resulted in relatively normal IQ scores. A normal intelligence was also supported by the subsequent findings of Holland (1960) and Johnson (1962), both of whom measured performance of Mexican-Americans on nonverbal scales. A more recent study of the performance of Mexican-American children on intelligence tests (Gerken, 1978) is consistent with the earlier studies. Gerken compared the performance of twenty-five (n=25) Mexican-American children on a nonverbal scale, the Leiter International Performance Scale (LIPS), and a verbal scale, the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). She found that the children performed significantly ($p < .05$) better on the nonverbal scale and that the mean performance on the nonverbal intelligence test was within the average range.

Gerken also reported that language dominance was related significantly ($p < .10$) to IQ scores in that children who were dominant in the Spanish language achieved lower IQ scores on the verbal scales as shown in the following table.

Table 2.2 Comparison of LIPS (nonverbal) and WPPSI (verbal) Test Scores of Mexican-American Children. (Gerken, 1978)

Type of Test	n	$\bar{X}$	S.D.
LIPS (nonverbal)	25	102.44	19.35
WPPSI (verbal)	25	78.40	19.04

Language and Cultural Effects

Language

Spanish language usage is an important characteristic that differentiates the Mexican-American family from other ethnic groups. Spanish has historically been the most persistent foreign language spoken in the southwestern United States. The duality of language and culture has been widely credited for the intellectual achievement disparity for Hispanics in this region (Hernandez, 1972).

Holland (1960) demonstrated the contribution of the language factor to verbal IQ by means of an English and bilingual administration of the *Wechsler Intelligence Scale for Children* (*WISC*). The tests were administered to a sample of thirty-six (n=36) Mexican-American children native to Tucson, Arizona. The IQ point difference between the scores on the English and bilingual versions was taken by Holland to represent the individual language barrier:

Language Barrier = Bilingual Verbal IQ - English Verbal IQ

The average language barrier for the sample of Mexican-American children was computed to be 4.6 IQ points per student (S.D. = 4.05). From his study, Holland concluded that about 40% of the students sampled faced learning problems which could be expected to arise from a language handicap.

Carlson and Henderson (1950) reported that language-based intelligence tests administered to one hundred and fifteen (n=115) Mexican-American children at the first grade level already showed measurable differences when compared to a similar Anglo-American control group. These differences become increasingly apparent at higher grade levels due primarily to a drop in the verbal IQ test scores of the Mexican-American children.

The fact that many Mexican-American children are busy learning a second language (English) could account for much of the measurable decline in verbal IQ scores during early schooling. Brown, Fournier and Moyer (1977) suggest that Mexican-American children are raised in a home environment where a distinct language and culture dominate. Then, suddenly, they are thrust into a foreign school environment where they are expected to function as efficiently as the monolingual child.

> Mexican American children entering school for the first time experience 'cultural shock'. They must bridge a gap of cultural values and patterns and immediately confront a new language, English. Since they must express themselves from the beginning in English, they are inarticulate. Often they fall further behind with time; this conditions them

> to failure and reinforces feelings of frustration. (Brown et al., 1977).

Hernandez (1972) contends that Hispanic children are not linguistically homogeneous. Although they may be dominant in the Spanish language or dominant in English, they are not as fluently communicative in either language as is a monolingual child. Sometimes a condition called "language interference" occurs (Ibid.) The condition refers to the effects that the knowledge of one language has on the learning of another. In language interference, a person attempting to function in one language substitutes elements of the phonology, semantics or syntax of another language. As a result, the bilingual individual predictably speaks a complex and substandard mixture of both language (Gerken, 1978).

Culture

Romney and Romney (1963) observed an almost total lack of aggression and competitiveness among the peoples of rural Mexican villages. Madsen (1964) has also described the cultural control of competition and reinforcement of cooperation among Mexican-Americans. However, a cultural tendency toward cooperation, as opposed to competition, is apparently not a uniform trait among Mexicans. Madsen (1967) found urban middle class Mexican children to be much more competitive than rural village children.

Kagan and Madsen (1971) studied the extent of individual cooperativeness versus competitiveness for samples of one hundred and twenty-eight (n=128) Anglo-American children, one hundred and twenty-eight (n=128) Mexican-American children and sixty-four (n=64) Mexican children. A board game measuring levels of cooperation versus competition was played by pairs of primary school children from within the various sample groups. Cooperative play allowed both players to receive rewards. Competitive play was irrational, allowing no subject to reach his/her goals. The number of moves required to reach goals indicated the extent of cooperation-competition. Among the experimental subjects, Mexicans were the most cooperative, Mexican-Americans next, and Anglo-Americans were the least cooperative ($p < .001$). The authors suggest that within large, rural Mexican families, aggression and competition are averted by parental controls in favor of cooperation. In contemporary Anglo-American society, competition is rewarded to such an extent that children generalize a competitive strategy even to situations where it is nonadaptive.

Effect of the Schools

The unresponsiveness of public schools to the unique bilingual-bicultural character of Mexican-Americans has been cited as a factor influencing their lack of academic achievement (Carter, 1970; Hernandez, 1972; and Holland, 1960). In an article written for the College Board Review (1970), Carter argues that the public schools of the Southwest have, more or less, benignly served to keep the Mexican-American in his place. Until recently, the Anglo-American-dominated society of the region had functioned best with an unskilled Mexican-American labor force to serve its agricultural requirements. Carter (Ibid.) explains,

> The school was and in many geographical areas still is 'successful' in equipping most Mexican-Americans with the knowledge and skills appropriate to a low status: minimum English language ability, rudimentary reading and figuring skills, and the values necessary to be a 'law abiding' although non-participating, powerless and essentially disenfranchised citizen.

Effects of Tracking

Tracking is the policy of grouping together students of similar abilities for various academic classes. In mathematics, the assignment is usually accomplished on the basis of standardized intelligence or achievement tests. Brown et al. (1978) report that the lower level tracks contain significantly higher proportions of minority students and are frequently taught by poorly prepared and less experienced teachers. In the State of California in 1977, 21% of the total student enrollment consisted of Blacks and Mexican-Americans. However, 52% of the students who had been tracked into EMR classes (educable mentally retarded) consisted of Blacks and Mexican-Americans (State-of-the-Art, 1980).

The U.S. Commission on Civil Rights (1974) investigated the policy of tracking in five southwestern states -- Arizona, California, New Mexico and Texas. Their survey showed that 63% of the elementary schools and 79% of the secondary schools in the region practiced some form of ability grouping. Brown et al. (1978), in recognizing that ability tracking is firmly entrenched in the American system of public education, have commented,

> ...concerned educators should make greater efforts to ensure minority students equal opportunities for coming in contact with a stimulating educational environment and placement in high ability groups, if tracking is practiced. If not the (school) becomes a self-fulfilling prophecy for the predictive validity of the predictive variable (test scores used in tracking).

Bilingual Education

The federal government tried to improve the academic achievement of Hispanic-Americans through enactment of the Bilingual Education Act, signed into law in 1968 as Title VII of the Elementary and Secondary Education Act. Title VII, as it came to be known, sought to effect its goals by assisting Hispanic children in mastery of the English language and improving their positive self-identity. Typically Title VII concentrated on kindergarten through the third grades by providing bilingual aides to strengthen the efforts of the regular English-speaking teacher. Ortiz (1979) surveyed 300 Title VII sites and observed that the aides generally performed by separating the Mexican-American children from the Anglo-American children subsequent to the regular English language lessons in order to repeat and reinforce the same lessons in Spanish.

Title VII became law as part of the "Great Society" reforms of the Lyndon Johnson administration. The lawmakers of that era were undoubtedly well-intentioned, but the bilingual legislation was not based on a strong foundation of experimentalism. This researcher could find no true experimental study to test the effects of bilingual education prior to the enactment of the legislation. Lovett (1980) further points out that the goals of bilingual education tend to be controversial, and that the methods of implementing bilingual programs are often varied and complex. In 1979, Ortiz reviewed the evaluation studies for Title VII programs and found their claims to be "contradictory".

If present Title VII bilingual education programs cannot provide the kinds of skills necessary for Mexican-American children to compete and succeed on the high school and college level, what are the remaining choices? A half century ago, the noted Mexican-American educator George Sanchez suggested that the problem be solved by diagnosing students' specific deficiencies and providing supplemental education to remedy those needs. In 1934, he wrote,

> The school has the responsibility of supplying those experiences to the child which will make the experiences sampled by standard measures as common to him as they were to those on whom the norms of the measures were based.

Field Dependence

General

Field-dependence-independence are extremes of cognitive styles which can be distinguished by the length of time required to locate embedded figures in a background. The field-dependent learner has the greatest difficulty locating the embedded figures. Field-dependent individuals generally exhibit a cognitive style dominated by a perception of the prevailing field as a whole, rather than by its component parts. Field-independent individuals perform tasks without regard to the prevailing field (Witkin et al., 1962).

Research over the past three decades has provided a theoretical base for field-dependence-independence and a substantial amount of information on its relationship to the learning of mathematics (McLeod et al., 1978). Witken et al. (1977) profiled field-independent learners as having greater personal autonomy and succeeding at higher levels of abstraction dominated by symbolic representations. Field-dependent learners, in contrast, were profiled as requiring higher levels of external guidance and tending toward lower levels of abstraction dominated by concrete representations.

Mexican-Americans

Mexican-American children tend to be more field-dependent as compared to Anglo-American children (Kagan and Zahn, 1975; Ramirez and Price-Williams, 1974). Ramirez and Price-Williams (1974) compared the cognitive styles of sixty (n=60) Mexican-American fourth grade subjects to an equal number of similar Anglo-American children. Half of the subjects in each ethnic group were male and half were female. There were also equal numbers of subjects in lower and middle socio-economic classes in each ethnic group. The authors used the Portable Rod and Frame Test (Witken et al., 1977) to measure cognitive style. Their findings revealed significant ($p < .001$) ethnic differences and, to a lesser extent, significant sex differences ($p < .01$) in cognitive styles. The results of the study are shown in Table 2.3.

Research performed by Kagan and Zahn (1975) on forty-one (n=41) Mexican-American primary school students and ninety-three (n=93) similar Anglo-American students related the extent of field-dependence-independence to mathematics achievement for the experimental subjects. These authors also used the Portable Rod and Frame Test to determine field-dependence-independence. Mathematics achievement was measured by

Table 2.3 Ethnic Group Means and Standard Deviations on PRFT as Measures of Field-Dependence (Ramirez and Price-Williams, 1974).

Ethnic Group	n	$\overline{X}$	S.D.
Mexican-American			
Female	30	17.26	6.80
Male	30	14.56	7.80
Anglo-American			
Female	30	9.56	7.50
Male	30	6.98	5.04

the Comprehensive Test of Basic Skills (CTBS). The use of regression analysis on the data supported the hypotheses that Mexican-American children are more field-dependent than Anglo-American children and that field-dependence was significantly ($p < .01$) related to mathematics achievement.

Activity Learning

In mathematics learning, the differences between field-dependent-independent cognitive styles have been linked to "activity learning" (Kieren, 1969; Schulman, 1970). Kieren (1969) defines "activity learning" as a process in which the learner develops mathematics concepts through active participation. The process favors a learning sequence in which an example preceeds the formulation of the rule. Activity learning may involve the use of measuring instruments, manipulatory devices, or learning games.

The implication is that field-dependent learners are more apt to succeed in mathematics if concrete, rather than abstract, representations are used in teaching. The lesson might begin with a manipulatory exercise to demonstrate the utility of a computation. This would be followed by presentation of the computation itself. By seeing the computation utilized, the field-dependent learner discovers that the computation can be a useful tool.

Teacher Guidance and Manipulative Materials

McLeod et al. (1978) combined various levels of teacher guidance and manipulative materials into four parallel treatments to test the effects of cognitive style on the learning of numerical concepts. The one hundred and twenty (n=120) subjects in the study came from four sections of a mathematics course for prospective elementary teachers. Within each section, subjects were assigned to one of four treatment groups. The four otherwise identical fifty minute treatments consisted of minimum guidance with manipulative materials, maximum guidance with manipulative materials, minimum guidance with symbolic representations and maximum guidance with symbolic representations. In two of the four tests of achievement in numerical concepts, there was a significant ($p < .05$) interaction between field-dependence-independence and levels of teacher guidance. In the other two tests, the graphs of the regressions tended to support the hypothesis, but the differences between the beta coefficients failed to reach significance. The evidence was less convincing for interaction between cognitive style and manipulative materials in that only one of the four tests reached significance.

The authors report their results as supportive of Wilkins' theoretical profiles for field-dependent-independent cognitive styles. Their results suggest that field-dependent learners can achieve better in mathematics when matched into classroom settings with high levels of teacher guidance and the use of manipulative materials.

Traditional Classroom Structure

In a somewhat similar study, Phipps (1977) investigated the effects of placing sixth grade social science students with selected cognitive styles into open versus traditional classroom environments. A sample of one hundred and forty (n=140) inner city children were administered the Group Embedded Figures Test (GEFT) and designated as field-dependent or field-independent. The students were then randomly assigned on the basis of GEFT scores and sex into one of two open classroom treatment sections or one of two traditional classroom sections. Students in the traditional sections were exposed to teacher-structured presentations under conditions of formal classroom discipline. Lessons used the lecture-discussion method with students following the directions of the teacher. Students in the open classroom settings chose their assignments from among nineteen assignments made available by the teacher. Six of the nineteen were required and contained the same material covered in the traditional treatment. Students in the open classrooms were permitted to move about freely and to use all the hardware and software available in the classrooms.

The social studies classes lasted three weeks, including one week of orientation. A locally constructed test measured levels of student achievement in the two environments. A 2 x 2 analysis of variance was used to determine the effects of cognitive style and classroom environment on student achievement. The effect of the classroom environment was found to be significant ($p < .001$), indicating that field-dependent learners performed better in the traditional classroom than they did in the open classroom. Interestingly, the field-independent learners also demonstrated higher levels of achievement in the traditional classroom structure.

Inductive Teaching

Horak (1977) studied the effectiveness of inductive and deductive teaching methods and the interaction between these teaching methods and the field-dependent-independent cognitive styles. The deductive teaching method followed the rule-example paradigm, while the inductive method followed the example-rule paradigm. The GEFT was used to measure the extent of field-dependence-independence. An achievement test served as the criterion measure for a two-week teaching unit in transformational geometry. The sample consisted of one hundred and eighteen (n=118) preservice elementary education teachers enrolled in two class sections taught by the researcher. Linear regression analysis was used in testing for interactions between cognitive styles and instructional procedures. An analysis of the data supported the existence of selected interaction effects. The author determined that, for overall best achievement, field-dependent students should be taught by an inductive teaching method ($p \leq .10$).

In general, these recent studies of cognitive styles suggest that greater learning efficiency can be attained by a matching of field-dependent-independent populations to specific learning environments and instructional methodologies. Hispanic-Americans, in particular, could be expected to learn more from inductive teaching methods in a traditional classroom setting.

Self Concept

Much has been written on the issue of whether Mexican-Americans exhibit an overall lower self concept than other students but the issue remains unresolved (Hernandez, 1972). The Coleman study (1966) reported that the self concept of Mexican-American children was significantly below that of Anglo-American children, and Palomares (1966) reported essentially the same result. But Carter (1968), and DeBlassie and Healy (1970), measured no significant differences with respect to the self concept variable between the two groups. Possibly a part of this ambiguity reflects the variety of instruments used to measure the variable "self concept" as well as the reliability problems inherent in any measurements within the affective domain.

Perhaps more meaningful in the present context, was the research of Anderson and Johnson (1971) who studied the variables "self concept of ability" as a predictor of mathematics achievement. The authors analyzed the data obtained from a questionnaire given to a sample of one hundred and sixty-three (n=163)

Mexican-American high school students relative to their respective grade point averages in mathematics. Analysis of beta coefficients from stepwise multiple linear regression analysis revealed that the student's own evaluation of his/her ability was, by far, the most important factor among those examined in predicting levels of achievement in mathematics. The possible inference from these findings was not lost on the authors.

> ...it may be possible to significantly improve the academic performance of many Mexican-American children by designing educational programs that directly attempt to improve the degree of confidence (which these) children have in their ability to succeed...

Anderson and Johnson (1971) further suggest that this variable "self concept of ability" may be affected by the high failure rates which Mexican-Americans experience in the lower grades.

In a similar vein, Thomas et al. (1979) list pessimistic attitudes and lack of vocational models as factors which deter many minority students from their original goals. Wages (1969) also reports that, among Mexican-American school dropouts in southern Texas, poor grades were one of the major reasons cited for the decision to leave school. Bruner (1975) has suggested that children who suffer from low self esteem are unlikely to involve themselves in any enterprise which does not result in immediate gratification. These studies imply a need for incorporation of more positive reinforcement into curricula aimed at Mexican-American learners. The basic need of children to have their best efforts reinforced was noted by philosopher John Locke in the seventeenth century.

> First children, earlier perhaps than we think, are very sensible to praise and commendation. They find pleasure in being esteemed and valued by those [upon] whom they depend... (Cahn, 1970)

Summary

In the southwestern United States, mathematics achievement among Mexican-Americans is lower than that of Anglo-Americans. The combination of low achievement and non-participation in mathematics severely limits career opportunities for Mexican-Americans in technical industries. Yet non-verbal measures of intelligence confirm that Mexican-Americans are as intellectually capable as the rest of the population.

Bilingual-bicultural traditions and a field-dependent learning style contribute to early schooling difficulties among Mexican-Americans. Public schools often fail to respond to the unique character of Hispanic students. Ability tracking in public schools is detrimental to Mexican-Americans and Title VII programs of the federal government have proven to be ineffective.

III. IMMERSION BILINGUAL MATHEMATICS INSTITUTE

Current research shows that Mexican-American children achieve below their Anglo-American counterparts in various academic skills, including mathematics. Research also shows that Mexican-Americans tend to be field-dependent learners who respond positively to activity learning that involves the use of measuring instruments and other manipulative devices. Field-dependent learners, like their field-independent counterparts, have been shown to perform best in a teacher-directed classroom using inductive teaching methods.

Mexican-Americans are also characterized by their unique linguistic and cultural traditions. Teaching methodologies such as bilingual instruction and the use of Hispanic teachers as role models have been recommended as appropriate for these traditions. These field-dependent and language-culture related teaching/learning methodologies were combined with immersion training to produce a four-week Immersion Bilingual Mathematics Institute (IBMI).

This institute, designed by the researcher, was used to determine the extent to which supplementary mathematics instruction can affect the mathematics achievement of incoming seventh grade students of Mexican-American heritage. Curriculum materials for the IBMI were tested in a pilot project during the summer of 1980. The effect of the formal IBMI on the mathematics achievement level of Mexican-American students was tested the following summer.

Immersion Training

Immersion training was developed by the U.S. Army during World War II as a means of accelerating foreign language learning by the military in preparation for the post-War occupation period. However, the method has been adapted to other types of instruction as well. In recent years, immersion training has been used for rapid technical instruction by the Foreign Service Institute and the U.S. Peace Corps.[1]

Immersion training can be described as the framework for a short course of study. The programs provide small groups of learners with several hours of daily instruction as they are rotated among a team of high energy teachers. Immersion training concentrates on a narrow range of objectives and the class sections are arranged to correspond with the learners' previous knowledge. Constant change of pace from rapid drills to role-playing is used to break up the tedium and positive reinforcement is used to stimulate individual motivation.

Immersion training was used in the IBMI because it appeared to the researcher to offer the best chance of achieving the learning objectives in a short period of

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[1] The researcher's familiarity with immersion training draws from personal experience acquired as an assistant program director at the Peace Corps language facility at Camp Radley, P.R. from 1968-69.

time. Peace Corps experience has shown that, even when volunteers had studied several years of college-level foreign language, the extent of oral proficiency was often negligible. In contrast, the level of proficiency attained through a typical twelve-week immersion program often exceeded that resulting from years of conventional instruction.

IBMI Objectives

The purpose of the IBMI was to raise the mathematics computation skills of a participating group of entering seventh grade students of Mexican-American heritage. An anticipated result was that, with higher computational skills, these students would experience more success in subsequent mathematics courses than a Mexcian-American control group. Also, that the mathematics disparity between the treatment group and an Anglo-American control group would be reduced.

Specific Learning Objectives

Specific learning objectives of the IBMI focused on four sets of computational skills that are desired learning outcomes of the Orange (California) Unified School District (OUSD) in which the subjects of this study were students. Stated in performance terms, the objectives of the IBMI were that the participants would be able to:

1. Solve computations involving the addition and subtraction of common fractions and mixed numbers; recognize word problems requiring these computations for their solution; and be able to apply the computation skills correctly.

2. Solve computations involving the multiplication and division of common fractions and mixed numbers; recognize word problems requiring these computations for their solution; and be able to apply the computational skills correctly.
3. Solve computations involving the multiplication and division of decimals; recognize word problems requiring these computations for their solution; and be able to apply the computational skills correctly.
4. Solve computations involving long division (two or more digits in the divisor); recognize word problems requiring this computation for their solution; and be able to apply the computational skill correctly.

IBMI Curriculum

Curriculum Model

A model of the IBMI curriculm, shown in Figure 3.1, depicts the pattern of linkages within the IBMI curriculum. The model is divided into two parts. One part consists of teaching methodologies recommended in the literature as appropriate for the Hispanic field-dependent learning style. These include methodologies related to activity learning (increased teacher guidance and the use of manipulative materials) and methodologies related to the classroom teaching mode (traditional classroom structure and inductive teaching).

The second part consists of teaching methodologies recommended as most appropriate for students of Hispanic language-culture. These include methodologies related specifically to language (language groupings and bilingual instruction) and methodologies related to Hispanic culture (cooperative environment and vocational role models).

Methodologies Related to Cognitive Style

Several teaching methodologies consistent with a field-dependent cognitive style have been tested. Phipps (1977) found that field-dependent learners func-

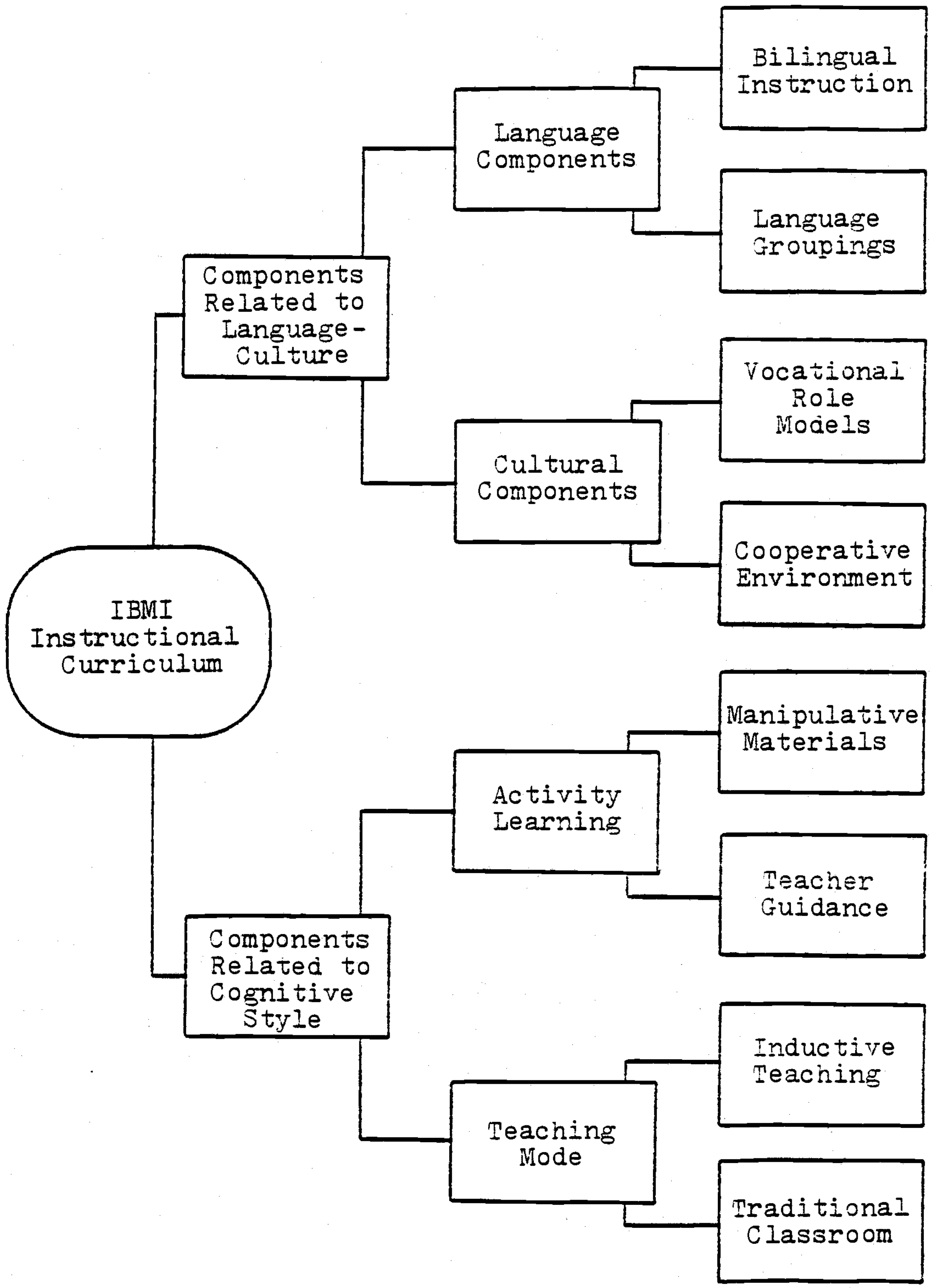

Figure 3.1. IBMI Instructional Curriculum Model.

tioned better in a traditional, structured classroom rather than in an open class where students work independently of each other. McLeod et al. (1978) related field-dependence to a strategy that combines greater teacher guidance and the use of visually manipulative materials. While Horak (1977) has reported that field-dependent learners tend to favor inductive teaching over deductive teaching methods.

In order to integrate these diverse methodologies into a single curriculum, the researcher implemented the activity learning model proposed by Kieren (1969). In activity learning, the student develops mathematics concepts inductively through active participation. The activities consisted of manipulative exercises requiring the use of a particular mathematics computation.

Activity Learning.

The IBMI activity exercises began with the instructor presenting manipulative materials to the class and explaining the objective of the activity. Computation skills needed to complete the activity were practiced until the students could complete the activity on their own. Generally, the entire activity was demonstrated by the instructor at least once.

A typical activity involved calculating the volume of a "Ditto" fluid can in cubic centimeters, using the volume formula, $V = l \cdot w \cdot h$ (Appendix I, Lesson No. 22). The goal here was to develop skill in multiplication of decimals. After the instructor had explained the use of the formula on the blackboard, the students practiced solving several simulated problems with data provided by the instructor. Then the students set out on their own to measure the dimensions of their "Ditto" can to the nearest tenth of a centimeter, and to compute its volume. Once the volume was computed, the computations were checked by the instructor. Then the students verified their own work by filling the can with water and pouring the contents into a large graduated cylinder.

Teaching Mode

The classroom teaching mode was a combination of two contrasting styles. One was the formal traditional mode used to explain the activity exercises. The other was the inductive mode used during the activity exercises. The key to the successful implementation of the contrasting styles, was keeping them separate from each other.

Typically, a class session began in a traditional classroom mode. Students were required to be in their seats and attentive during the initial lecture-discussion period. The instructor began by explaining the activity exercise, demonstrating the procedure and doing sample computations.

When the instructions were completed, the classroom environment switched to the inductive mode. Students left their seats, picked up materials, and began the activity exercises. During the activities, students were free to move about and communicate as long as they remained on task. Some students worked together in small groups. The instructor circulated among the students providing guidance and positive reinforcement.

Methodologies Related to Language-Culture

The dual language and culture characteristics of many Hispanic children in the Southwest give rise to a peculiar dilemma. On the one hand, the Hispanic child has a unique educational opportunity to experience the language and culture of two distinct societies. On the other hand, the bilingual child sacrifices learning efficiency in the school by not being as fluent in either language as a monolingual child (Hernandez, 1972).

The IBMI was designed to minimize the effects of learning problems related to language interference by tailoring the instructional language to the language of preference of the individual student. Accordingly, students who were predominantly Spanish-speaking received instruction in Spanish and students who were predominantly English-speaking received instruction in English. In all cases, however, instruction was given by bilinguists who were fluent in alternating between languages as the need arose.

The cultural component of the IBMI benefitted from the cross-cultural studies of Kagan and Madsen (1971). These authors showed that Mexican-American children exhibit a greater tendency toward cooperativeness -- as it compares with competitiveness -- than do Anglo-American children. Lack of competitiveness was cited as a factor detrimental to the success of Mexican-American students in the highly competitive environment of American public schools.

Language Components.

In order to reconcile the language heterogeneity of the treatment group which contained several non-English speaking children, the subjects were divided into three similarly sized class sections (n_1=8, n_2=11, n_3=10). The language sections, classified by English language dominance, were 1) fluent English, 2) limited English, and 3) very limited English.

Instruction for the three sections was, 1) English instruction, 2) bilingual instruction, and 3) Spanish instruction, respectively. Instructors were directed to use the language of student preference in the limited English section, but to emphasize the use of English as frequently as possible. In actual practice, English was used almost exclusively in this section.

Student placement into the three language sections was done initially on the basis of the <u>CTBS</u> Reading Totals (TL) test scores. Superimposed on this preliminary segregation were assessments of student language skills made by the instructors during the first few days of class. Readjustments of students into the appropriate language sections were made accordingly.

<u>Cultural Components</u>

The IBMI accommodated the cultural uniqueness of the Mexican-American participants in two respects. The first was by providing bilingual mathematics teachers as role models for the students to emulate. Securing the individuals was made easier because of increased teacher availability during the summer recess.

The second cultural accommodation of the IBMI was the emphasis on cooperation rather than competition. Successful activity exercises took on a game-like quality where the subjects tried to master the game rather than to compete with one another. Students were free to communicate and work together in small groups if they chose. There was no attempt to rank their work on a competitive grading scale.

IBMI Immersion Framework

Immersion Training Model

The structural framework within which the curriculum of the IBMI is fitted consists of immersion training techniques used by the Peace Corps for foreign language instruction. Eight major components were derived from (but not unique to) the immersion training process.

The immersion training model illustrated in Figure 3.2 shows the eight components and their linkages within the immersion framework design. Four of these components make up the first subunit of the Model, which is curriculum-centered. These components were built into the curriculum and required no active effort on the part of the instructors. They include: 1) several hours of daily instruction, 2) low student-teacher ratios, 3) a narrow range of instructional objectives, and 4) rotation of students among the team of instructors.

Four other components make up the second subunit of the Model, which is teacher-implemented, i.e., they require action on the part of the instructor. These include: 1) high energy instruction, 2) the use of positive reinforcement, 3) rapid drill session, and 4)

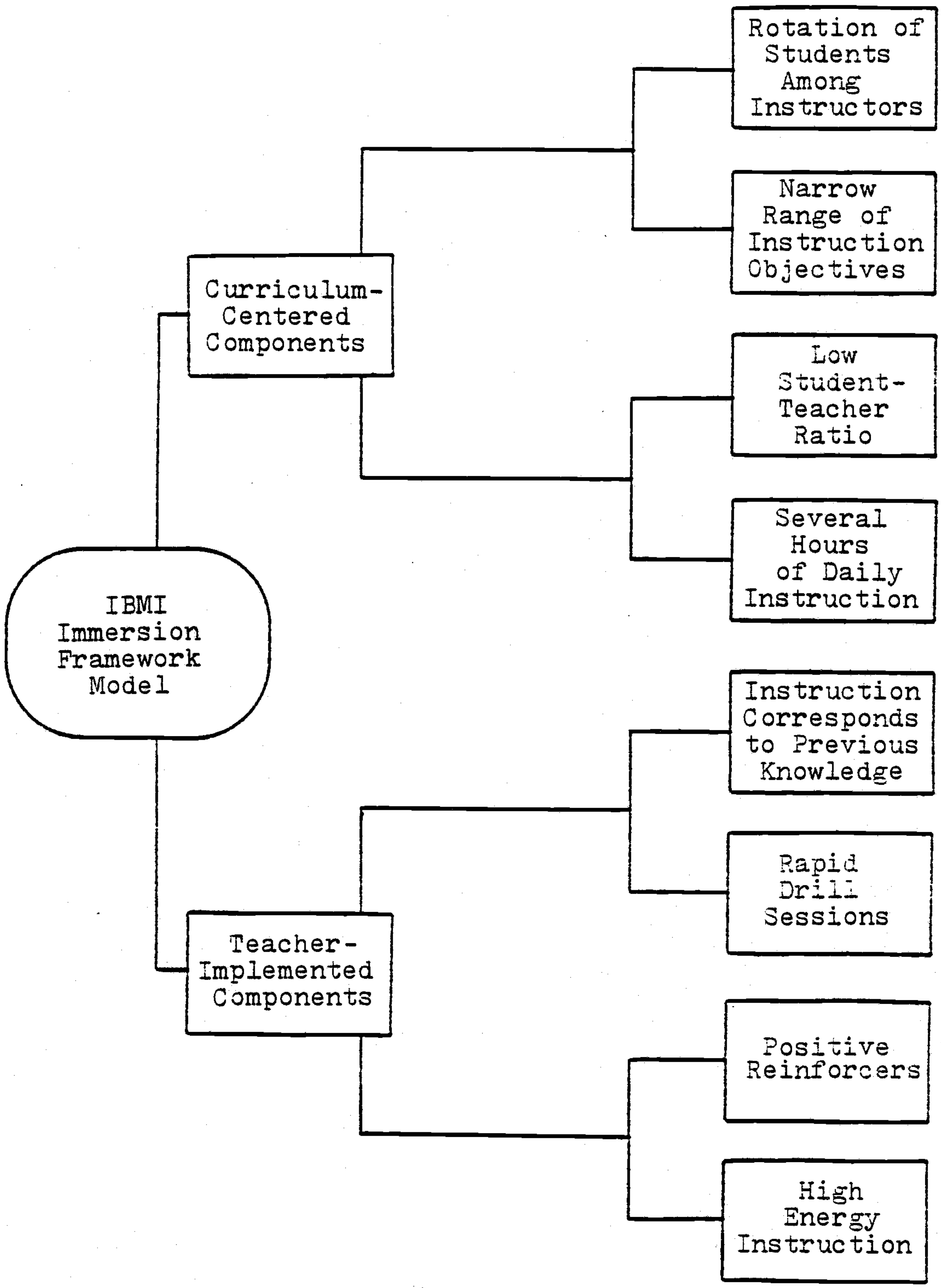

Figure 3.2. IBMI Immersion Framework Model

instruction that builds upon previous knowledge of the learner.

Teacher-Implemented Components

High Energy instruction.

Immersion training programs require a large measure of one-on-one interaction between teacher and pupil. Since the programs are necessarily fast-paced and intense, instructors are needed with the stamina necessary to adapt to these conditions (Calvert, 1963). Therefore, in addition to their bilinguality and mathematics teaching experience, the IBMI instructors were screened for their personal vigor and enthusiasm. These qualities were subjectively evaluated during interviews of the IBMI instructor applicants.

Positive Reinforcement

Positive reinforcers used in immersion training (Topping, 1965) are of two distinct types -- intrinsic and extrinsic. Intrinsic reinforcers arise from the learning itself. An example is reinforcement that results from successfully completing an activity exercise. Extrinsic reinforcers are superimposed on the learning by other people, such as teachers or classmates.

In the IBMI, intrinsic reinforcement was facilitated by the activity exercises. The strategy was to present the activity as a game to be played. Successful completion of the activity resulted in automatic reinforcement for most participants. Extrinsic reinforcers consisted primarily of verbal praise and facial expressions used by the teachers. Often, positive comments were placed on written assignments which could then be carried home by the participants. At the conclusion of the IBMI, each student received a printed certificate of participation.

Rapid Drill Sessions

The most unique aspect of the immersion training process adapted for use in the IBMI was the aural-oral rapid drill sessions (Calvert, 1963). Rapid drills are used in language training to enhance rote memorization. The sessions are generally brief and highly intense. Subjects were randomly asked to respond rapidly to teacher questions. The questions were kept short and related but not excessively repetitive. In order to increase the level of anticipation, a question was not directed to a specific individual until it was completed and followed by a short pause. Errors were immediately corrected and correct responses appropriately reinforced.

The daily IBMI rapid drill sessions were ten minutes in duration and scheduled with each of the three instructors at the end of the day. Generally, the drills covered the material from the previous activity lessons. For example, if the previous lesson involved fractions or decimals, the students might be called upon to convert common fractions into decimals or vice versa.

Instruction Corresponding to Previous Knowledge

In immersion language training, students are initially grouped according to previous knowledge of the foreign language (Calvert, 1963). Consequently, the more advanced students do not waste time re-learning what they already know. In the IBMI, there was less need for this type of grouping, since all the students were selected from the same grade level (entering seventh), and were relatively homogeneous with respect to their mathematics skills. However, during activity exercises, recognized high achievers were often assigned more demanding tasks to complete.

Curriculm Centered Components

Several Hours of Daily Instruction

One of the main benefits of immersion training is that the learners' efforts are not diluted by the interference of other course work. Immersion training is generally a full-time activity (Moore, 1957). However, in the IBMI, the age, motivation, and psychological maturity of the participants precluded the full daily schedule used in Peace Corps immersion language programs.

The researcher's experiences in a pilot IBMI pointed to a somewhat shortened daily schedule. In the pilot project, it was found that a maximum of four hours of daily instruction plus about one hour of assigned homework could be expected from the subjects without causing hardship.

Low Student-Teacher Ratio

Ideally, in immersion language programs, the student-teacher ratio is between five and nine to one (Horne, 1970). This ratio is particularly important in maintaining a high level of student alertness during the rapid drill sessions. However, considerations of economics as well as the level of maturity of the experimental subjects suggested the use of a somewhat higher student-teacher ratio. Based on the researcher's experience in the pilot project, a ratio of 8 to 12 students per section was settled upon.

Narrow Range of Instructional Objectives

In immersion training, the efforts of the learner are focused on a narrow range of instructional objectives. Once the objectives have been clearly identified, their mastery can be achieved more efficiently through exposure and repetition (Moore, 1957). By limiting the learners' efforts to a narrow range of objectives, the instructor wastes neither time nor energy attempting to teach material not directly related to the achievement of those objectives. In the IBMI, it was the responsibility of the researcher to make certain that each instructor knew both the overall objectives of the IBMI as well as the specific objectives of each planned lesson.

Rotation of Students Among Instructors

Rotation of students among the available team of instructors accomplishes two purposes in immersion training (Calvert, 1963). The first is to reduce monotony by varying the stimulus periodically. The second is to make the sections more homogeneous by diluting the impact that a given instructor might exert on an individual class section. In the IBMI, each section of students was rotated among the entire team of three teachers, twice during each instructional day, once for an activity exercise using manipulatives and once for the rapid drill session.

Additional Curricular Considerations

Rate of Learning

Since the experimental subjects were divided into sections based on English language competency rather than mathematics computational ability, there was some diversity in computational skills of students within each section. To accommodate this diversity, two adjustments were built into the IBMI. First, daily feedback from the instructors determined the rate of progress on the planned lesson. If an instructor reported that the time allotted for a particular lesson was insufficient, then the following day's lesson plan was adjusted accordingly. Second, if an instructor noticed that a student seemed to be falling behind other students in a section, the researcher was available to diagnose the learning problem and/or tutor the student.

Daily Lesson Plans

Mathematics learning tends to be sequential (Castaneda, 1980). The ability to do a given task depends on the knowledge and skills the learner brings from previous learning. The researcher took this aspect of mathematics learning into account in preparing the daily lesson plans by gradually building on the mathematics knowledge and skills of students in the treatment group.

However, it was often difficult for the researcher to anticipate the rate of progress of individual instructors. In order to adjust to variations in the rate of instruction, lesson plans were prepared by the researcher and provided to the instructors only one day in advance. The IBMI lesson plans are presented in Appendix I. Most of these lessons were tested by the researcher prior to use in the IBMI, either in the pilot study or in his own school teaching in the OUSD.

Facilities for the IBMI

Instructional Site

The instructional site for the IBMI was part of the mathematics department of El Modena High School in the OUSD. Three adjacent classrooms were used which were interconnected by means of inside doors. A sliding door connected the middle room to a rear office used by the researcher. The sliding door made it possible for the researcher to unobtrusively enter any of the classrooms.

El Modena High School was centrally located with respect to the Hispanic community and within easy walking distance for most of the participants. Those subjects living more distant from the site were transported from local elementary schools to El Modena by the IBMI instructors. All of the classrooms used in the IBMI were air-conditioned and had been designed for mathematics instruction.

Supplies and Equipment

A variety of reusable supplies was required for the IBMI activity exercises. Most of these items (Appendix II) were loaned to the researcher from a junior high school elsewhere in the district. A variety of non-reusable materials were also required. These items were either provided by the administration of El Modena High School or procured by the researcher.

Bilingual Instructors

Selection of the Instructors

Instructors for the IBMI were solicited by means of a notice published in the monthly OUSD News Bulletin. Candidates for employment were first contacted by telephone and arrangements made for a personal interview by the researcher. The interviewees were evaluated on the basis of five criteria:

1. A valid California teaching credential,
2. Either a major or minor (20 semester hours) in mathematics,
3. Fluency in both Spanish and English,
4. Experience in mathematics teaching,
5. Personal vigor and enthusiasm for the project.

In order to assess the degree of bilinguality of the candidates, part of the interview was conducted in Spanish.

General Profiles

Three IBMI instructors were chosen after personal interviews of over one dozen applicants from local school districts. All three had valid mathematics teaching certificates and were experienced instructors within the OUSD. Spanish was the native language of two of the three and the third, although not bilingual, was fluent in Spanish and carried a California Bilingual Credential. All had either majors or minors in mathematics and were experienced mathematics teachers. In addition, the instructors were relatively young and had expressed considerable enthusiasm for the project during the course of the personal interviews. All three were women. Their profiles are reported in Appendix III.

Training Session

The IBMI instructor training session consisted of a four-hour meeting at the instructional site on the Friday prior to the beginning of the IBMI. Each instructor had read the research proposal prior to the training session. Discussions centered on the instructional curriculum and the immersion framework. The researcher did not dwell on the bilingual-bicultural aspects of the curriculum since it was assumed that the backgrounds of the instructors would make it largely unnecessary. Each instructor was given her first daily lesson plan and was provided time to prepare her classroom for teaching.

Time Frame

Duration of the IBMI

The IBMI consisted of a total of eighty hours of planned instruction during a four-week period. It began during the last week of July and continued through the first three weeks of August, 1981. The program ran four hours per day, 8 a.m.

until noon, five days per week.

Daily Class Schedule

The IBMI instructional periods were fifty-five minutes long with a five minute break for passage between classes. Class sections spent one full period with each instructor, rotating between classrooms. Each instructor taught a distinct planned lesson emphasizing a specific computational skill. The third rotation was followed by a fifteen minute nutrition break. After the break, the remaining forty-five minutes were used for the rapid drill sessions. The rapid drills were ten minutes in duration, with the class sections again rotated among the three instructors.

Feedback Sessions

At the end of each instructional day, the instructors met individually with the researcher for a brief feedback session. At this session, each instructor returned the lesson plan card to the researcher. On the reverse side of these cards, the instructors had noted any problems or difficulties which had arisen in teaching the lesson. After these were discussed, each instructor received the following day's lesson plan along with a verbal explanation of the lesson to be taught. Classrooms were then set up for teaching the next day's lesson.

Role of the Researcher

Initially the researcher envisioned his role in the IBMI as something between that of a director and an unobtrusive data collector. However, as the Institute proceeded, the role of the researcher expanded to include a variety of duties that had not been envisioned at the outset. The researcher functioned as a counselor, disciplinarian, substitute teacher, attendance officer, and custodian.

The instructors were accustomed to letting their school administrators handle minor disciplinary infractions as well as logistical problems. These soon fell into the hands of the researcher. Parents had to be contacted about absences, students required counseling concerning disruptive behavior, and teachers needed assistance in classroom preparation and maintenance. The researcher also set out materials for the mid-morning nutrition break, and worked with students who needed special assistance.

In addition, it was necessary for the researcher to remain on call as a substitute teacher, since one of the instructors (being seven months pregnant) experienced occasional need to leave her classroom on short notice. Although these diverse activities were largely unanticipated, they had the beneficial effect of drawing the IBMI staff into a closer knit group.

Economics

The economics of the IBMI was a critical factor from the outset -- due not only to the limited resources available to the researcher, but also because the efficiency of any educational program must ultimately be measured in terms of benefits accrued per dollar invested. The instructional objectives of the IBMI were certainly not unique. Therefore, the IBMI was not only expected to achieve these objectives but to do so economically.

Advantages of the IBMI summer recess time frame were availability of instructional facilities and a pool of qualified bilingual mathematics instructors willing to work for comparatively small salaries. The IBMI instructors each received a modest stipend of $200.00 per week. All of the reusable materials were provided without charge by the OUSD. There was an additional outlay of less than $200.00 for refreshments provided for the experimental subjects during nutrition breaks. All expenditures were paid from personal resources of the researcher.

General Considerations

Support for the Study

This study required the cooperation and support of administrators of the OUSD as well as the parents or guardians of the children who were participants. Support from the school district was required in the form of permission to offer the Institute, provision of the classrooms, and supply of the equipment and materials used in the activity exercises. Parents of the Mexican-American students needed for the study were required to volunteer their children to participate in the study, and to see that they met their obligation of regular attendance.

Perceptions by the Educational Community

The success of the IBMI depended on the cooperation by both parents or guardians and school officials. A possibility existed that teachers and/or administrators might view the IBMI as a threat to, or to be in competition with their own efforts. In order to minimize these potential concerns, the study was conducted in the OUSD, where the researcher teaches. Lines of communication already existed between the researcher and key administrators within both the district office and the Orange Unified Educators Association.

The possibility also existed that parents or guardians of IBMI participants might perceive that their children were being used as experimental "guinea pigs" in private research. In order to allay this potential fear, the researcher's communications with the parents emphasized the educational benefits of the IBMI, rather than its experimental aspects.

Public Relations

Perception of the IBMI by the community at large was also an important concern. One spin-off of the pilot projects was that it gave the researcher a chance to do some public relations work for the formal IBMI. The Community Relations Director of the OUSD sent out a photographer to take pictures during the pilot Institute. Photographs and an accompanying article written by the researcher were later published in both the Orange News and the OUSD News Bulletin. As a consequence of the news articles, the researcher received queries from administrators within other Orange County school districts regarding the IBMI.

Pilot Institute

General Description

A two-week pilot IBMI was conducted by the researcher at El Modena High School during the summer of 1980. It was attended by twenty-three (n=23) seventh grade Mexican-American volunteers who had been solicited from nearby elementary schools. Activity exercises involving the use of manipulatory materials were used in helping the participants develop mathematics computational skills. Classes began at 8 A.M. and continued through until noon for a two-week total of forty hours of instruction. Students were provided with refreshments during a fifteen minute nutrition break at 10 A.M.

Because nearly half the pilot project participants did not speak English, teaching was in both Spanish and English. Typically, small amounts of instruction were given first in English and then repeated in Spanish. The necessity of constantly switching from one language to the other caused inefficiency in the teaching process. In the formal IBMI, that problem was corrected by creating separate Spanish and English language sections.

Parental Contact

Parents were informed of the pilot Institute by means of English-Spanish notes sent home with the Mexican-American children in early June. Next, copies of letters in English and Spanish were mailed to the homes of the children describing the Institute. The letters contained bilingual application forms and stamped, pre-addressed envelopes. Parents for whom telephone numbers were available were contacted by the researcher and encouraged to participate. This three-step method of parental contact worked well enough that it was used again the following summer in recruiting participants for the formal IBMI.

Results

At the conclusion of the pilot IBMI, the subjects were tested and found to have gained over one year of Grade Equivalency in mathematics achievement as measured by the CTBS. However, follow-up testing six months later revealed that the subjects had lost about half of their mathematics test score gains. This indicated to the researcher that the formal IBMI would have to be of greater duration with more attention paid to mastery of the instructional objectives. Accordingly, the time frame of the formal IBMI was doubled and the number of students per class section was reduced.

Parental support for the pilot IBMI was strong in the local Hispanic community. Several parents accompanied their children to the first class session and later assisted the researcher by preparing baked goods for the nutrition breaks. Other parents were helpful in preparing correct translations of printed materials.

Summary

The pilot IBMI was successful in that it provided evidence that supplemental bilingual instruction could raise the mathematics computation achievement of students of Mexican-American heritage in a relatively short two-week period. Also, it confirmed a positive response by members of the Hispanic community toward programs to raise the academic level of their children. The researcher was provided an opportunity to test curriculum materials and instructional strategies of the IBMI. Unanticipated problems that were encountered led to adjustments in the IBMI used to obtain the data reported in this study. Positive reactions to the pilot IBMI helped to assure school district support of the formal IBMI the following summer.

IV. EXPERIMENTAL DESIGN

Introduction

This study focuses on low achievement in mathematics among children of Mexican-American heritage. An Immersion Bilingual Mathematics Institute (IBMI) was conceived by the researcher as a supplemental program to increase mathematics achievement for Mexican-American students entering junior high school. The four-week Institute combined several independently tested teaching methodologies supported by recent research in bilingual education. These methodologies collectively constituted the experimental treatment (IBMI) -- the overall effect of which was measured.

The treatment group on which the IBMI was tested consisted of thirty-two (n=32) Mexican-American volunteers attending five Orange County California schools. Two controls were used. One control was composed of Mexican-American students selected from the same pool of volunteers as the treatment group. The other control consisted of similar Anglo-American subjects selected from the three participating schools which had the highest proportions of Mexican-Americans in attendance. This chapter describes the experimental design of the study, the selection procedure used to obtain the sample groups, and the testing instruments used to measure mathematics achievement levels.

Experimental Design

The experimental design used to test the hypotheses was a modification of the randomized "Pretest-Posttest Control Group." This design is described by Campbell and Stanley (1963) as the most strongly recommended of true experimental designs. It is particularly appropriate for controlling factors such as "history" and "maturation" (Ibid.) which threaten the internal validity of time-series experiments.

One modification of the standard randomized (R) "Pretest (O_1) - Posttest (O_2) Control Group" design was the addition of a second (Anglo-American) control group for reference purposes. A second modification was the addition of a time-series second posttest (O_3) administered six months after the first posttest. This second posttest was used to measure the endurance of the treatment effect (X) on the experimental subjects. The design model is shown symbolically as:

R	O_1	X	O_2	O_3	(M-A Treatment)
R	O_1		O_2	O_3	(M-A Control)
R	O_1		O_2	O_3	(A-A Control)

Population

General Description

The population from which the samples were drawn consisted of the 1981-1982 incoming seventh grade classes from five elementary schools in the Orange Unified School District (OUSD). Entering seventh graders were selected for the study because they represent a critical juncture where the incidence of Mexican-American dropout from public school begins to rise (State-of-the-Art, 1980). The five elementary schools were selected because they contained the highest proportions of Mexican-American enrollment in the predominantly Anglo-American school district. Mexican-American enrollment in these schools averaged 24% with a range from 21 to 41 percent. Blacks constituted less than 2% of the total enrollment in any of the five schools.

The Mexican-American population in the OUSD resides largely in a loosely defined "barrio" in the vicinity of the treatment site, El Modena High School. The barrio consists of older middle income housing units that have been given over to Mexican-American intrusion. This area also includes some low income rental units and is surrounded by moderately priced housing developments occupied mainly by Anglo-

Americans. Although there is a disparity in socio-economic levels between the two communities, there is a general upward mobility within the Mexican-American community and relations between both ethnic groups are good.

Ethnic Identification

Identification of ethnic groups within the OUSD was facilitated by means of a questionnaire filled out by parents at the time of pupil registration. The questionnaire requested parents to identify their ethnic background as:

1. Hispanic (Mexican-American)
2. White (Anglo-American)
3. Black
4. Asian
5. American Indian

This information, which is required for Federal Title VII funding, was coded next to each student's permanent registration number in the student directories and recorded on computer tapes at the District office. The researcher had unlimited access to both the directories and the tapes.

Method of Contact

The method of contacting parents was essentially the same as that used in the pilot study the previous summer. Mexican-American parents were first identified by means of student directories obtained from the feeder elementary schools. Student directories contained coded ethnic and sex designations as well as addresses, telephone numbers, grade levels and permanent identification numbers for each student. Information contained in the directories was updated for accuracy at the beginning of every semester. The three steps used in establishing parental contact were:

Note from School

A Spanish-English note was sent home from school with each Mexican-American student two weeks prior to the end of the spring semester. The note contained a brief description of the IBMI and the effective dates.

Letter to Home

A letter was mailed directly to the addresses of the Mexican-American students during the last week of the spring semester. The Spanish-English letter (Appendix IV) contained a more complete description of the IBMI and a bilingual application form. The letter also contained a preaddressed, stamped envelope for return of the application form.

Bilingual Telephone Call

Early in the summer recess, the researcher contacted, by telephone, all of the Mexican-American parents or guardians for whom current telephone numbers were available. The telephone conversation was in the language of preference of the parents which, in most cases, was Spanish. First, the researcher identified himself as a science-mathematics teacher in the OUSD in charge of a summer mathematics institute. Then the researcher determined if the parents had received the explanatory letter and form application in the mails. During the course of the brief (2-3 min.) conversations, the parents were cordially encouraged to enroll their children in the IBMI.

Parental Responses

Of the one hundred and twenty-five, subjects originally identified as Mexican-American from the student directories of the five feeder elementary schools, thirty-three of the addresses were discovered to be inaccurate since the letters were returned unopened by the postal service. A relatively large percentage of incorrect addresses had also been noted in the pilot study the previous summer. This was thought to be indicative of a high turnover rate in the Hispanic community. Sixty-one applications to participate in the IBMI were completed by the parents and returned by mail. These eventually became the Mexican-American treatment and control groups. The remaining thirty-one applications were unaccounted for.

From the one hundred and twenty-five original subjects identified from the directories, seventy-three were contacted by telephone. The remaining fifty-two subjects either had not reported telephone numbers, the number had been disconnected, or there had been no answer. Of the seventy-three contacts made by telephone, sixty-two were considered to be positive in that the parents or guardians expressed an intention to complete the application forms for participation in the IBMI. Eleven telephone contacts were considered to be negative -- due mainly to summer travel or moving plans.

Sample Selection

Mexican-Americans

From the pool of sixty-one applications received from the parents of the Mexican-American subjects, thirty-two (n=32) were blocked and randomized into a Mexican-American treatment group (R_1) and the remaining twenty-nine (n=29) subjects constituted the Mexican-American control group (R_2). The blocking of the Mexican-American subjects with respect to two factors -- sex and CTBS reading test score totals -- was done as follows:

1. A mid-point (median) reading total score was determined for the sixty-one subjects.
2. The subjects were divided into two groups by sex.
3. High (above median) and low (below median) subgroups were established for both males and females.
4. The Mexican-American treatment group (R_1) was selected by drawing at random (using a table of random numbers) eight students from each of four subgroups -- high male, high female, low male and low female.

5. The Mexican-American control group (R_2) consisted of the twenty-nine (n=29) students remaining in the four subgroups who had not been selected for the treatment group.

Anglo-Americans

The Anglo-American control (R_3) consisted of a blocked and randomly selected group of forty (n=40) entering seventh grade students. The Anglo-American subjects were selected from the end of sixth grade class of the three participating elementary schools with the highest percentages of Mexican-American students in attendance. From the pool of one hundred and twenty Anglo-American students, the Anglo-American control group of forty (n=40) subjects was selected as follows:

1. A mid-point (median) total reading score from the CTBS battery was determined.
2. Male and female subgroups were formed.
3. High (above median) and low (below median) subgroups were formed for both males and females.
4. The Anglo-American control group (R_3) was selected by drawing at random (random number

table), ten students from each of the four subgroups.

Informing the Parents Regarding Assignments

Mexican-American subjects for whom application forms had been received were assigned to either the treatment or control group by early July, 1981. At that time, two sets of letters were sent out to parents or guardians of the subjects. One set of letters congratulated the parents or guardians of the treatment subjects on the acceptance of the application of their child to participate in the IBMI. The letters also indicated the room at El Modena High School to which the students should report on the opening date of the Institute (Appendix V). The second set of letters politely informed the parents of subjects assigned to the control group that due to limited funding and a high number of applicants, their applications could not be accepted (Appendix VI).

Data Collection

CTBS Instrument

The CTBS form S (Expanded Edition) produced by McGraw-Hill was selected as the criterion instrument. The CTBS battery consists of timed, multiple-choice tests which have been used by the OUSD for annual parametric testing for over ten years.

In reviewing the CTBS for the Seventh Mental Measurements Yearbook, Ahmann (Buros, 1972) describes the superiority of the CTBS over then available measures of general academic achievement. He points to a reliability study comparing the CTBS to other achievement tests which yielded correlations as high as 0.92. Ahmann cites Kuder-Richardson 20 reliability coefficients in the 0.85 to 0.95 range for the entire CTBS battery.

Another reason for selecting the CTBS instruments was that they measured mathematics computation and application skills which the IBMI was designed to affect. Other determining factors were that the CTBS tests are nationally normed and have been used in related Hispanic educational studies (Kagan and Zahn, 1975).

Levels of the CTBS

Due to the ten month time span of the study, two separate levels of the CTBS battery were required. The pretest (O_1) employed CTBS Level 2, and the two post-tests (O_2, O_3) employed CTBS Level 3. The two levels and the overlapping grade ranges for which the CTBS has been standardized are shown below (McGraw-Hill, 1974):

Level 2	Grades 4.7 - 6.7	(O_1)
Level 3	Grades 6.7 - 8.7	(O_2, O_3)

Since two levels of the CTBS were employed in the study, it was necessary to transform the raw test scores (RS) to standard scores (Z) for comparative purposes. Standard scores form a single equal interval scale across all grade ranges for use with all levels of the CTBS. Transformation to standard scores required obtaining standard deviations (σ) and grade conditional means (μ) based on national norms for levels of the CTBS tests employed.

$$Z = \frac{RS - \mu}{\sigma}$$

This information was included in the CTBS form S Technical Bulletin No. 1 published by McGraw-Hill which was obtained from the publisher.

The grades used for standardization did not correspond exactly to the grades of the subjects at the time they were tested, but they were as close as could be achieved given that the means and standard deviations for CTBS Levels 2 and 3 were published only for grades (4.7, 5.7 and 6.7) and (6.7, 7.7 and 8.7), respectively. Raw score data from observation level O_1 were standardized at grade 6.7 on Level 2 and raw score data from observation level O_2 were standardized at grade 6.7 on Level 3. Finally, the raw score data from observation level O_3 were standardized at grade 7.7 on CTBS Level 3.

CTBS Test Battery

Pretest scores (O_1) are the Mathematics Computation (CM) and Mathematics Concepts and Applications (CNAP) tests of the CTBS battery, Level 2. Posttests (O_2, O_3) were Mathematics Computation and Mathematics Concepts and Applications test scores of CTBS battery, Level 3. Mathematics Totals (TL) scores are the sum of the Mathematics Computation and Mathematics Concepts and Applications test scores. TL scores were computed at each observational level.

The forty-five minute Mathematics Computation tests (Levels 2 and 3) each contained forty-eight items that measured skill in addition, subtraction, multiplication and division. The Mathematics Concepts and Applications tests (Levels 2 and 3) each contained fifty items consisting of word problems related to measurement, set theory, geometry, algebra, graphs and reasoning, and were forty minutes in duration. Scores on these tests are used in this study as measures of mathematics achievement.

Reading Comprehension and Reading Vocabulary pretest (O_1) scores were summed as Reading Totals. Reading Totals scores were used in assigning the Mexican-American subjects into class sections based on English language dominance and in the random blocking procedure used to obtain comparable treatment and control groups.

Administration of the CTBS

Pretest and posttest measurements O_1 and O_3 were made by OUSD personnel in early May, 1981 and late February, 1982, respectively, as part of the district's ongoing testing program. Administration of the complete CTBS battery to the entire student population was completed during three consecutive half-days of testing at the subjects' schools. Testing was conducted by teaching personnel under the supervision of counselors trained in CTBS testing procedures. Answer sheets were machine-scored and the scores were transferred to computer tapes at the OUSD data bank.

Treatment and control groups were tested independently of each other at the O_2 observation level in order to reduce the "halo effect" which might have resulted from testing all three groups together immediately following the IBMI. Measurement O_2, consisting of the CTBS mathematics battery only, was obtained for the Mexican-American treatment group on the last day of the IBMI. Treatment subjects were told that the purpose of the testing was to measure improvements in their mathematics achievement resulting from the Institute.

The Mexican-American and Anglo-American control groups were tested two to three weeks later during the first week of classes at their respective junior high schools. The control subjects were summoned to the closed libraries during a morning session for testing. The explanation given students in the control groups was that they had been selected by computer for testing in mathematics and that the test results would be important in planning for their future careers. All testing at the O_2 observation level was conducted and hand-scored by the researcher. Test scores from the three levels (O_1, O_2, and O_3) were subsequently transferred to individual student data cards for convenience of analysis.

Treatment of the Data

Subgroup Data

Since the sample groups used in the study were relatively small, a blocking technique was used to prevent disproportionate selection of high achievers into a given sample group. Subjects were first divided into four subgroups according to sex (M/F) and reading ability (H/L) and then randomly assigned from the subgroups into the sample treatment and control groups.

Variations within the four subgroups were monitored during the subsequent course of the experiment by computing means and variances for each of the subgroups. These data, along with surviving numbers of subjects in each subgroup, were reported for each sample group at observation levels O_1, O_2, and O_3.

Correlation Coefficients

In a search for internal relationships beyond the scope of the experimental design, linear correlations were computed between CM and CNAP test scores for the three sample groups at each obseration level. Since the CNAP test contained word problems requiring English language skills, there was an interest in determining how the correlations would compare among the sample groups and how the IBMI would affect them.

Regression Lines

The original statistical model for the study had been analysis of covariance with the pretest (O_1) serving as a covariate for each of the posttests (O_2 and O_3). However, non-parallelism and curvilinearity of the regression lines caused the covariance model to be dropped. Nevertheless, the resulting regression lines yielded some insights regarding subject-treatment interactions and were therefore reported in the study.

Hypotheses Testing

Graphic Displays

The first treatment of the data for hypotheses testing involved transforming the raw CTBS scores to standard scores. These formed a continuous equal interval scale across grades and levels of the CTBS. Means and standard deviations were computed for each set of CTBS test scores (CM, CNAP and TL) at the three observation levels. A set of sequential means for a single test were then displayed for each sample group as a continuous time-series plot on the same graph. The results were three separate time-series graphs, one for each CTBS test, analogous to the experimental design. These graphic displays told the story of the study and simplified interpretation of the hypotheses.

Comparisons of the Control Groups

One of the stated assumptions of this research was that a mathematics achievement disparity exists between Mexican-American and Anglo-American students. To confirm the validity of this assumption with regard to the sample groups, their CTBS mathematics scores were compared at the O_1 observation level.

A second stated assumption was that the Anglo-American and Mexican-American control groups remained comparable to each other at the three observation levels (parallelism). In effect, this was a check on the internal validity of the study to determine whether factors such as "history" or "maturation" had caused differences between the control groups during the ten month duration of the experiment. To establish parallelism, an analysis of variance (ANOVA) was done on the two sample groups at the three observation levels.

Comparisons of the Treatment Group

Once the assumptions had been confirmed, the researcher proceeded to test the first set of hypotheses. The differences between the gain scores (posttests minus pretests) for the Mexican-American treatment group and the Mexican-American control were tested for significance with a t test at the O_2-O_1 (short-term) and O_3-O_1 (long-term) observation levels. The comparisons were made for all three CTBS mathematics tests (CM, CNAP and TL), and constituted the testing of hypotheses H_1-H_3 and H_7-H_9.

For the second set of hypotheses, the differences between the mean scores of the Mexican-American treatment group and the Anglo-American control were compared at the O_2 (short-term) and O_3 (long-term) observation levels. These comparisons were also made by a t-test, and constituted the testing of hypotheses H_4-H_6 and H_{10}-H_{12}.

V. PRESENTATION AND ANALYSIS OF THE FINDINGS

Introduction

This study was undertaken to determine the extent to which a four-week supplemental Immersion Bilingual Mathematics Institute (IBMI) can affect the mathematics achievement of entering seventh grade children of Mexican-American heritage. Control groups consisted of a) Mexican-American children blocked by sex and reading ability from the same pool of subjects as the treatment group and b) Anglo-American children selected from the three participating schools with the highest percentage of Mexican-American children in attendance.

Data were obtained by multiple administration of tests from the CTBS test battery. Pretests (O_1) consisted of Level 2, form S, Reading Vocabulary, Reading Comprehension, Mathematics Computation, and Mathematics Concepts and Applications tests administered to sixth grade students in May 1981 as part of the regular testing program of the Orange Unified School District. Posttests (O_2) consisted of Level 3, form S of Mathematics Computation and Mathematics Concepts and Application tests of the CTBS battery. Posttesting of the treatment group occurred in late August, 1981, on the last day of the IBMI. Posttesting of members of the control groups occurred in two to three weeks later in the schools that they attend during the first week of the 1981-82 school year. A second posttesting (O_3) occurred in February 1982 as part of the regular testing program of the Orange Unified School District. Identical tests were used for both August/September and February posttesting.

Pretest and posttest data were tabulated on data cards by the researcher. Reading achievement test scores were used to randomly block the subjects by sex and reading ability into comparable treatment and control groups. Mathematics achievement test scores were used to determine the effect of the IBMI on the treatment group.

Linear correlations were computed between Mathematics Computation and Mathematics Concepts and Applications pretest scores for all sample groups at each observation level. Regression lines were computed for the mathematics pretest-posttest scores. Raw mathematics test scores were converted to standard scores for hypothesis testing employing the Student's t test. The null hypotheses under test are stated in Chapter 1 and will be reviewed in this chapter when tests of the hypotheses are considered.

Treatment and Control Groups

Reading Achievement

The entire pool of sixty-one children of Mexican-American heritage who were volunteered by their parents or guardians to participate in the IBMI were divided into equivalent treatment and control groups. The Anglo-American control group was randomly selected from the pool of Anglo-American students attending the participating schools.

A random blocking technique was used to minimize experimental error that could result by accidental assignment of disproportionate numbers of subjects of the same sex or reading ability into the treatment or control group. Both the Mexican-American and the Anglo-American subjects were subgrouped by sex (M/F) and reading ability (H/L). Treatment and control groups were formed by random selection from the four subgroups: high male, high female, low female, low male.

Table 5.1 shows the number of subjects, pretest raw score means and variances of the CTBS Reading Totals for each of the four subgroups of the treatment and control groups.

Table 5.1 Numbers of Subjects, Pretest Means and Variances of CTBS Reading Totals for Subgroups Blocked by Sex and Reading Ability.

	High M	High F	Low M	Low F	Totals
M-A Treatment	n=8 $\bar{x}$=72 s^2=30	n=8 $\bar{x}$=61 s^2=38	n=8 $\bar{x}$=34 s^2=140	(1) n=7 $\bar{x}$=39 s^2=140	n=31 $\bar{x}$=52 s^2=340
M-A Control	n=7 $\bar{x}$=63 s^2=65	n=7 $\bar{x}$=68 s^2=54	(1) n=7 $\bar{x}$=43 s^2=33	n=7 $\bar{x}$=39 s^2=85	n=28 $\bar{x}$=53 s^2=210
A-A Control	n=10 $\bar{x}$=76 s^2=17	n=10 $\bar{x}$=74 s^2=33	n=10 $\bar{x}$=55 s^2=160	n=10 $\bar{x}$=60 s^2=48	n=40 $\bar{x}$=66 s^2=140

Mathematics Achievement

In order to monitor changes in mathematics achievement of the groups and subgroups during the course of the experiment, numbers of subjects, Mathematics Totals (TL) means and variances were computed at the pretesting (O_1) and posttesting (O_2 and O_3) levels. Data shown in Table 5.2 are Mathematics Totals (TL) test scores defined as the sum of CTBS Mathematics

[1] Data do not include one subject whose reading scores were missing and who was arbitrarily assigned into the low subgroup.

Table 5.2. Numbers of Subjects, Means and Variances of CTBS Mathematics Totals (TL) for Subgroups at O_1, O_2 and O_3 Levels.

Group	Level	High M	High F	Low M	Low F	Total
M-A Treatment Group	O_1	n=8 $\bar{x}$=79 s^2=200	n=8 $\bar{x}$=68 s^2=170	n=8 $\bar{x}$=54 s^2=65	n=7 $\bar{x}$=59 s^2=97	n=31 $\bar{x}$=65
	O_2	n=5 $\bar{x}$=76 s^2=330	n=7 $\bar{x}$=59 s^2=390	n=8 $\bar{x}$=46 s^2=59	n=8 $\bar{x}$=39 s^2=91	n=28 $\bar{x}$=52
	O_3	n=5 $\bar{x}$=82 s^2=390	n=7 $\bar{x}$=57 s^2=450	n=7 $\bar{x}$=43 s^2=40	n=6 $\bar{x}$=38 s^2=34	n=25 $\bar{x}$=53
M-A Control Group	O_1	n=7 $\bar{x}$=65 s^2=250	n=7 $\bar{x}$=76 s^2=60	n=7 $\bar{x}$=61 s^2=165	n=7 $\bar{x}$=59 s^2=76	n=28 $\bar{x}$=65
	O_2	n=6 $\bar{x}$=37 s^2=120	n=6 $\bar{x}$=45 s^2=380	n=5 $\bar{x}$=26 s^2=34	n=6 $\bar{x}$=32 s^2=39	n=23 $\bar{x}$=36
	O_3	n=6 $\bar{x}$=53 s^2=500	n=6 $\bar{x}$=61 s^2=380	n=8 $\bar{x}$=38 s^2=210	n=6 $\bar{x}$=44 s^2=24	n=26 $\bar{x}$=48
A-A Control Group	O_1	n=10 $\bar{x}$=84 s^2=41	n=9 $\bar{x}$=86 s^2=91	n=10 $\bar{x}$=72 s^2=150	n=10 $\bar{x}$=70 s^2=86	n=39 $\bar{x}$=78
	O_2	n=10 $\bar{x}$=57 s^2=270	n=7 $\bar{x}$=57 s^2=300	n=8 $\bar{x}$=40 s^2=41	n=9 $\bar{x}$=42 s^2=95	n=34 $\bar{x}$=58
	O_3	n=10 $\bar{x}$=68 s^2=480	n=9 $\bar{x}$=78 s^2=250	n=8 $\bar{x}$=51 s^2=150	n=9 $\bar{x}$=64 s^2=170	n=36 $\bar{x}$=66

Computation and Mathematics Concepts and Applications raw test scores.

An examination of Table 5.2 shows that the number of subjects per subgroup varied during the ten month duration of the experiment. However, at no observation level did the number of subjects per subgroup drop to less than five. The greatest mortality occurred at the second (O_2) observation level. Subjects missing from the two control groups at the O_2 level may have been due to changes of residence during the summer recess or caused by absences during the first week of classes when the tests were administered. Three of the four subjects missing from the treatment group at the O_2 level were students who were enrolled by mail in the IBMI but who failed to show up and participate. The fourth subject was also enrolled but dropped out before the end of the term.

A further examination of Table 5.2 reveals that the subgroups identified as high achievers based on CTBS Reading Totals test scores had higher mean Mathematics Totals (TL) scores than did the low reading ability subgroups at each observation level. This indicates that a correlation existed between reading and mathematics achievement of both the Mexican-American and Anglo-American subjects.

With few exceptions, Mathematics Totals variances are disproportionately higher for both high male and high female subgroups than for their low subgroup counterparts. This suggests that a wider range of mathematics achievement existed among subjects in the subgroups identified as high reading achievers.

Mathematics Totals mean pretest scores were identical for the Mexican-American treatment and control groups, but lower than that for the Anglo-American control group. This is consistent with the findings of other studies cited in Chapter II that show a mathematics achievement disparity between students of Mexican-American heritage and their Anglo-American counterparts.

Correlation Coefficients

Presentation of Correlations

Pearson r correlation coefficients were computed between Mathematics Computation (CM) and Mathematics Concepts and Applications (CNAP) test scores for the treatment and control groups at each observational level. The correlation coefficients and corresponding p-values shown in Table 5.3 are based on raw test scores.

The expectation was that the CM and CNAP test scores would correlate positively since each is a measure of mathematics skill and knowledge. However, the CNAP test contains a relatively large number of items presented in English sentence form. Thus, subjects who were the least proficient in English were expected to perform less well on the CNAP test than on the CM test.

Analyses of Correlations

Table 5.3 shows that the individual correlations between the CM and CNAP scores were highly significant ($p \leq .01$) for the three sample groups at all observation levels. The pretest (O_1) correlations for the Mexican-American groups (.50 and .54) were predictably

Table 5.3 Pearson r Correlation Coefficients and Corresponding p-values Between CM and CNAP Test Scores for Sample Groups at All Observation Levels.

Observation Levels	Tests	M-A Treatment	M-A Control	A-A Control
O_1	CM/CNAP	r=+.54 p=.002	r=+.50 p=.007	r=+.70 p=.001
O_2	CM/CNAP	r=+.79 p=.001	r=+.66 p=.001	r=+.76 p=.001
O_3	CM/CNAP	r=+.86 p=.001	r=+.78 p=.001	r=+.74 p=.001

lower than the Anglo-American control (.70). But the correlations for the Mexican-American sample groups, particularly the treatment group, showed continual increases (.50-.86) from one observation level to the next, while the correlations for the Anglo-American control remained relatively constant (.70-.76).

In trying to interpret the increases in the correlations for the two Mexican-American sample groups, it is important to remember that the mean scores for these groups were low to begin with and that a more difficult Level 3, CTBS battery was employed at the O_2 and O_3 observation levels. The increased correlations for the Mexican-American sample groups may have been caused as much by the increased difficulty of the Level

3 tests as by an increase in language ability among these subjects.

Regression Lines

Presentation of Regressions

Analysis of covariance was the original statistical model proposed for testing the hypotheses of this study. The method reduces experimental error by basing hypothesis testing on two sets of data points instead of one and is the most highly recommended statistical procedure (Campbell and Stanley, 1963) for use with the Pretest-Posttest Control Group design. In this study, the pretest (O_1) was to have served as the covariate for each of the two posttests (O_2 and O_3).

In addition to normality of error and equality of variances, the appropriateness of the simple analysis of covariance model also depends on two additional factors. These are equality of slopes (parallelism) for the regression lines and linearity of the regression lines. The failure of these last two requirements precluded the use of analysis of covariance for its intended purpose. However, the resulting regression lines produced some insights concerning interactions between the subjects and the treatment effect.

In the representative display shown in Figure 5.1, the regression lines were computed from raw CTBS test scores. The Mathematics Computation scores from the pretest (CMO1) have been used as the independent vari-

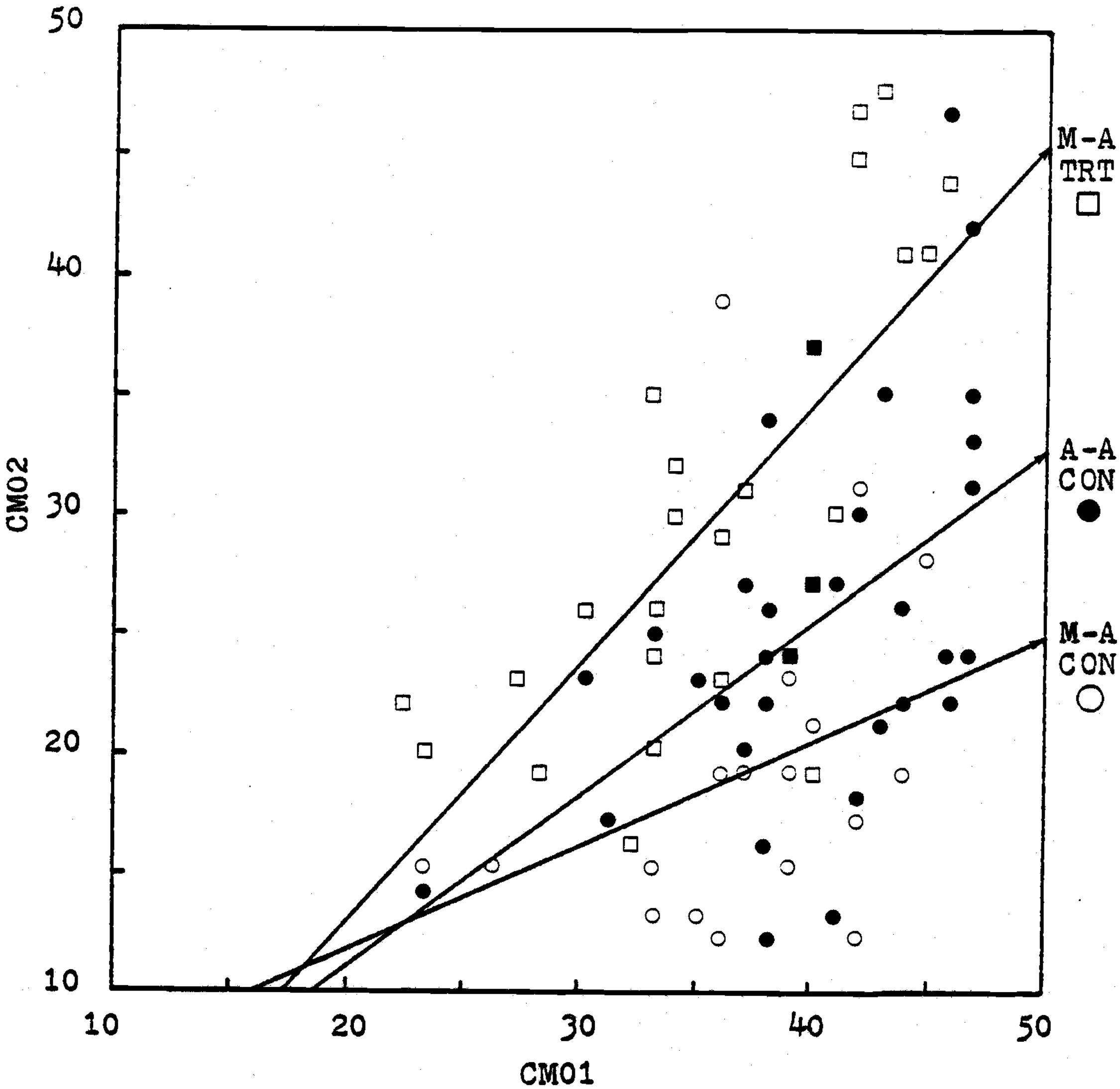

Figure 5.1. Regression Lines Based on CTBS Mathematics Computation Pretest (CMO1) and Posttest (CMO2) Raw Scores.

able and the posttest scores (CMO2) as the dependent variable for each of the three sample groups. The non-equality of the slopes of the regression lines is evident.

Analyses of Regressions

The lack of parallelism of the regression lines representing the Mexican-American and Anglo-American control groups was not totally unexpected. These are consistent with evidence cited in the literature review that the two control groups represent separate populations each with its own distinct cultural and linguistic identity (Hernandez, 1972; Brown et al., 1977). Non-parallelism also supports the researcher's view that the Anglo-American "control" should be regarded as a reference group rather than a true control since it is representative of a measurably distinct population.

The lack of parallelism between the regression lines for the Mexican-American treatment and control groups was not anticipated, although in retrospect it can be understood. Parallelism of regression lines for the two Mexican-American groups would have required that the treatment (IBMI) react equally on both ends of the independent variable (CMO1) distribution for the treatment group. But the more positive slope of the regression line for the treatment group indicates that the IBMI had a greater effect on students at the high end of the CM01 distribution. Evidently, the high ability students, despite any language handicaps, were already higher mathematics computation achievers, and succeeded in making greater gains as a result of their participation in the IBMI than the low achievers.

Since the non-parallelism and non-linearity of the regression lines precluded the use of analysis of covariance, the hypotheses concerning the Mexican-American treatment and the Mexican-American control were tested by computing pretest-posttest gain scores. A t test was then used to test the difference between the gain scores. Campbell and Stanley (1963) cite the use of gain scores as the most commonly used appropriate method of treating the Prettest-Posttest Control Group design.

The hypotheses concerning the Mexican-American treatment group and the Anglo-American control were based on mean scores since they related to the achievement disparity. A t test was also used to test the difference between the mean scores for these sample groups.

Initial Comparisons of the Sample Groups

Before beginning the hypotheses testing, it was possible to confirm a basic assumption of the study. The assumption was that there were initial differences in mathematics achievement between the Mexican-American and Anglo-American sample groups. This assumption was important because the study had been predicated on the existence of a widespread mathematics achievement disparity between these populations.

In order to confirm the mathematics disparity assumption, the raw CTBS data were first transformed to standard scores. Means and standard deviations were computed for each sample group at the pretest (O_1) observation level. The sample groups were then investigated two at a time and their variances checked for equality. When the variances were found to be not significantly different (a requirement for the t test), a pooled variance estimate t test was used to determine whether there were differences between the two groups with regard to their CTBS test scores. If the 2-tailed probability computed for the t test was found to be less than or equal to 5% ($p \leq .05$), then the means were considered to be different and the sample groups were confirmed to be not equivalent.

Table 5.4 shows the results of the significance testing between the Mexican-American and Anglo-American sample groups on the CM, CNAP and TL tests of the CTBS battery. The tests confirmed expectations that there were pretest differences in mathematics achievement between the Anglo-American and Mexican-American subjects selected for this study.

Table 5.4 Pretest (O_1) Differences Between Mexican-American and Anglo-American Sample Groups

Test	Group	n	$\bar{x}$	S.D.	t	df	prob	Assumption
CM	Mexican Treatment	32	.04	.72	-2.92	69	.01	confirmed
	Anglo Control	39	.48	.53				
CNAP	Mexican Treatment	31	-.40	1.10	-4.18	68	<.01	confirmed
	Anglo Control	39	.58	.86				
TL	Mexican Treatment	31	-.17	.73	-4.03	68	<.01	confirmed
	Anglo Control	39	.47	.58				
CM	Mexican Control	29	-.06	.81	-3.31	66	<.01	confirmed
	Anglo Control	39	.48	.53				
CNAP	Mexican Control	28	-.34	.92	-4.21	65	<.01	confirmed
	Anglo Control	39	.58	.86				
TL	Mexican Control	28	.65	.12	-4.13	65	<.01	confirmed
	Anglo Control	39	.58	.09				

Hypotheses Testing

Presentation of the Standardized Testing Data

Table 5.5 includes numbers of subjects, standardized test score means, and standard deviations of the three groups of subjects on the two criterion tests and the total (CM + CNAP) mathematics test scores at the pretest (O_1) and posttest (O_2 + O_3) observation levels. These data were transformed from raw scores to z-scores using national grade conditional means and standard deviations published by McGraw-Hill for both levels of the CTBS employed.

Graphic Displays

The graphics shown in Figures 5.2 through 5.4 were constructed analogous to the experimental design to make understanding the hypotheses testing easier. In interpreting the graphics, two points need to be kept in mind. First, since the data have been standardized across student grade levels for both levels of the CTBS tests employed; the zero mark at the three observation levels represents the adjusted national mean for each test. Second, since standardized testing for the OUSD has consistently measured above the national norms; the key comparisons to be made are between the sample

Table 5.5 Numbers of Subjects, Means and Standard Deviations for Sample Groups Based on Standardized CTBS Test Scores

Observation Level:		0_1			0_2			0_3		
Test	Sample	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.
	MA treatment	32	.04	.72	28	.56	1.00	25	.05	.99
CM	MA control	29	-.06	.81	23	-.53	.72	26	-.21	.81
	AA control	39	.48	.53	34	.25	.76	36	.58	.87

Observation Level:		0_1			0_2			0_3		
Test	Sample	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.
	MA treatment	31	-.40	1.10	28	-.12	1.19	25	-.21	1.26
CNAP	MA control	28	-.34	.92	23	-.84	.90	26	-.50	1.12
	AA control	39	.58	.86	34	-.14	1.03	36	.53	1.13

Observation Level:		0_1			0_2			0_3		
Test	Sample	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.
	MA treatment	31	-.17	.73	28	.24	.95	25	-.07	.98
TL	MA control	28	-.16	.65	23	-.63	.67	26	-.32	.82
	AA control	39	.47	.58	34	.07	.77	36	.50	.84

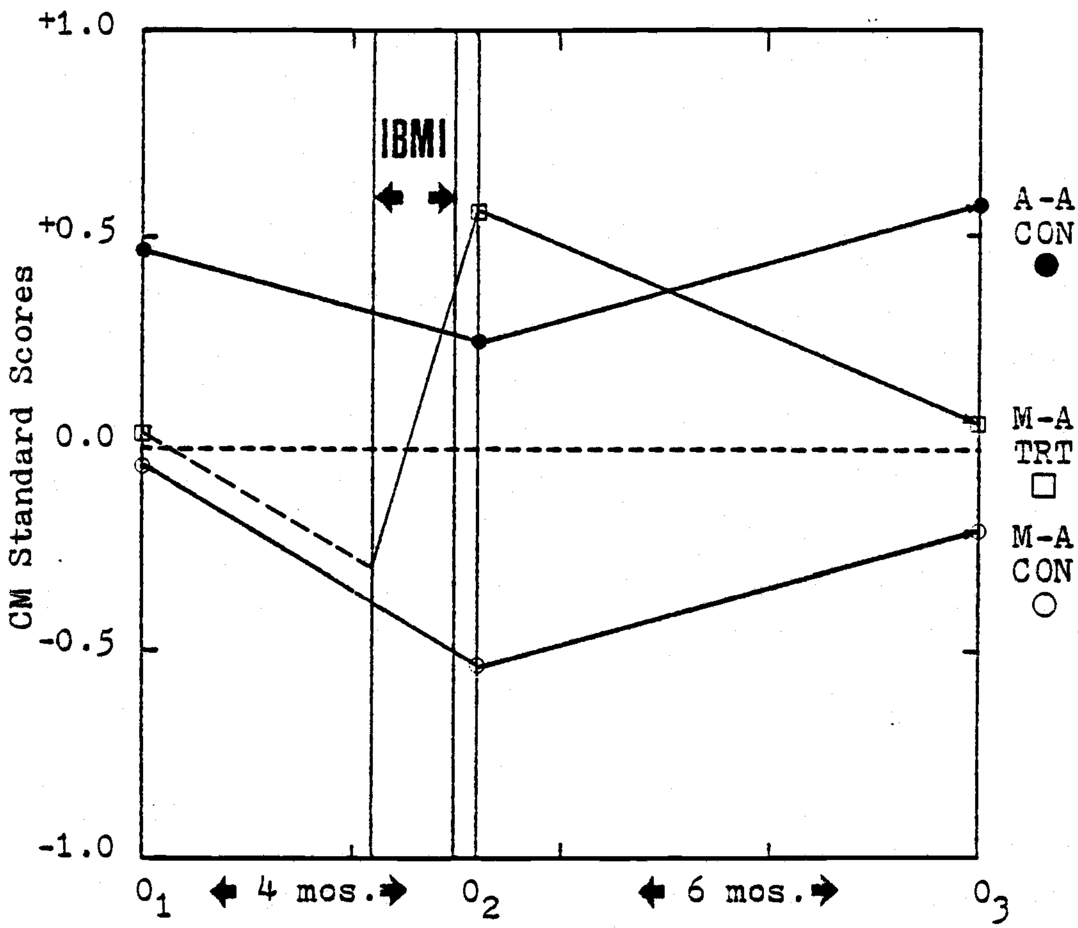

Figure 5.2. Mean Mathematics Computation (CM) Scores for Sample Groups at Observation Levels O_1, O_2 and O_3.

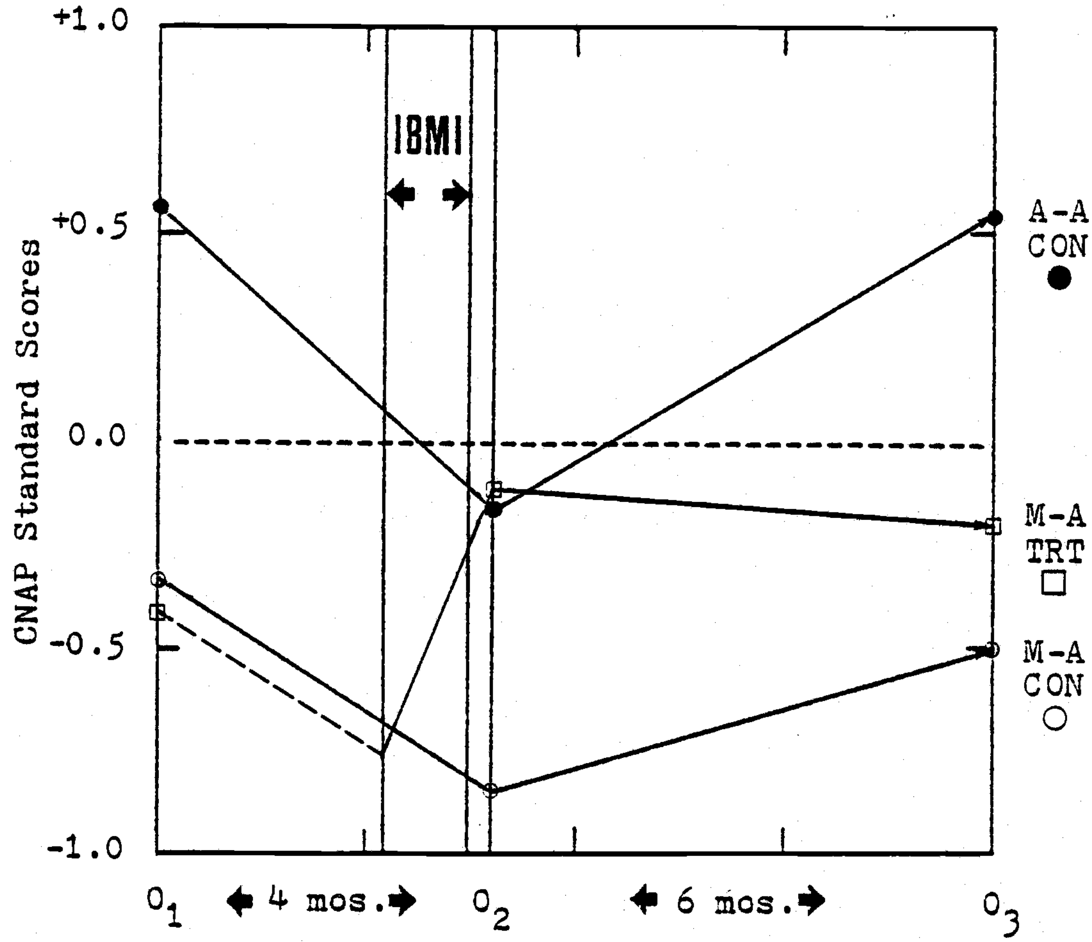

Figure 5.3. Mean Mathematics Concepts and Applications (CNAP) Scores for Sample Groups at Observation Levels O_1, O_2 and O_3.

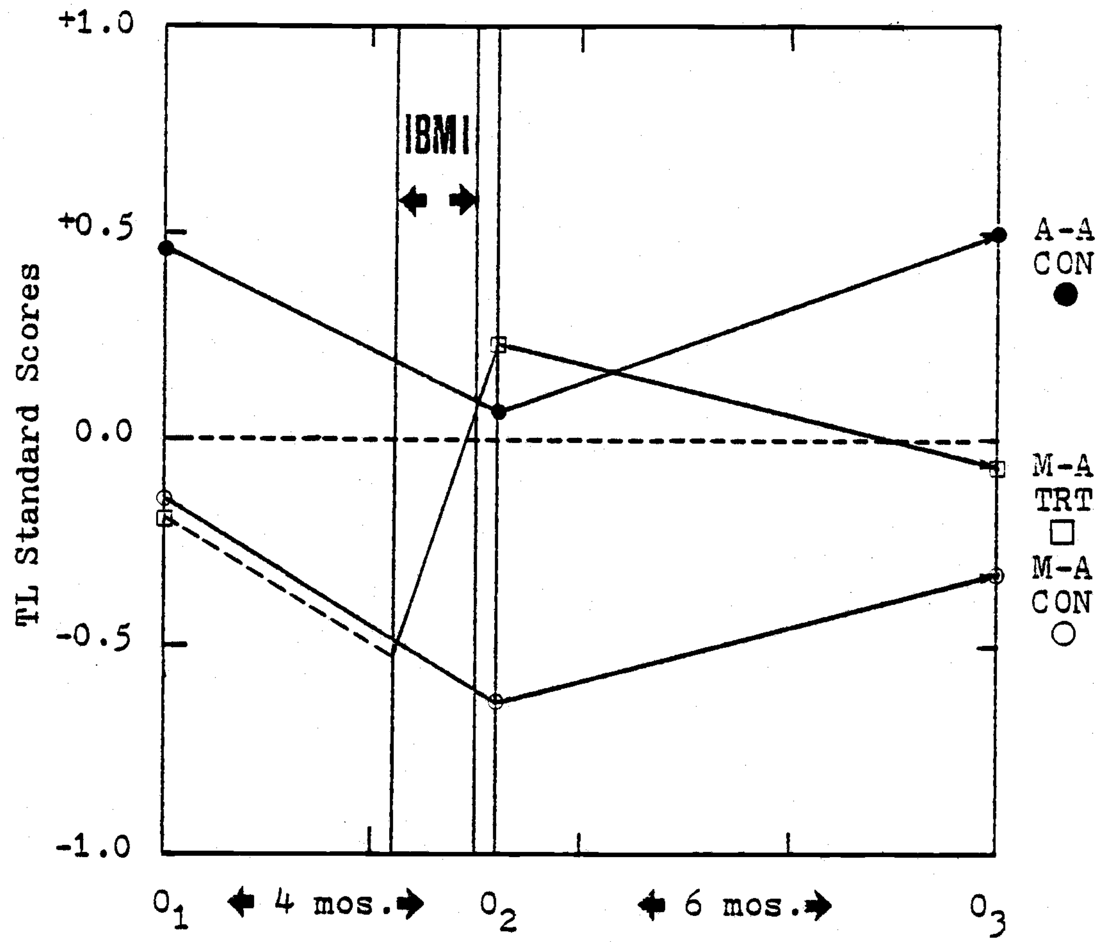

Figure 5.4. Mean Mathematics Totals (TL) Scores for Sample Groups at Observation Levels O_1, O_2 and O_3.

groups themselves and not between the sample groups and the national means (zero mark).

Differences between the gain scores shown in Figures 5.2 through 5.4 for the Mexican-American treatment group and the Mexican-American control at the O_2-O_1 and O_3-O_1 observation levels represent the differences tested for in hypotheses, H_1-H_3 and H_7-H_9, respectively. While the differences between the mean scores for the Mexican-American treatment group and the Anglo-American control at the O_2 and O_3 levels represent the differences tested for in hypotheses H_4-H_6 and H_{10}-H_{12}.

A comparison of pretest (O_1) scores of both Mexican-American groups on the Mathematics Computation (CM) and Mathematics Concepts and Applications (CNAP) tests reveals that the mathematics achievement levels of the two groups are comparable and below that of the Anglo-American control. A comparison of O_1 scores in Figures 5.2 and 5.3 shows that the Mexican-American students experienced greater difficulty in answering test items requiring language skills (CNAP) compared to items that required primarily mathematics computation (CM) skills. Figures 5.2 through 5.4 also reveal drops in mathematics achievement after the summer break by both control groups followed by gains during the subsequent school year. These graphics show a definite posttreatment gain by the treatment group followed by a mathematics achievement decline during the subsequent school year.

Testing the Gain Scores

In order to test the hypotheses regarding mathematics achievement test gain scores of the Mexican-American treatment and control groups, the raw CTBS test data were first transformed to standard scores. Gain scores (O_2-O_1 and O_3-O_1) were then computed for each subject, as well as mean gain scores and standard deviations for each group. The sample groups were then investigated two at a time and the variances of their gain scores checked for equality. When the variances were found to be not significantly different, a pooled variance estimate t test was used to retain or reject the hypotheses. If the 2-tailed probability computed for the t test was found to be less than or equal to 5% ($p \leq .05$), the null hypothesis was rejected. The results shown in Table 5.6 are divided into two sets corresponding to the hypotheses related to the short-term (O_2-O_1) and long-term (O_3-O_1) gains on the CM, CNAP, and TL tests, respectively.

Tests of the hypotheses confirmed the appearance shown by the graphics (Figures 5.2-5.4) that the short-

Table 5.6 Significance Testing of Gain Scores (O_2-O_1) and (O_3-O_1) for Mexican-American Treatment and Control Groups

Test/ Time	Group	n	$\bar{x}$	S.D.	t	d.f.	prob	Hypothesis:
CM Gain O_2-O_1	MA Treatment	28	.55	.63	-5.27	49	<.01	H_1 rejected
	MA Control	23	-.45	.73				
CNAP Gain O_2-O_1	MA Treatment	27	.36	.70	-3.48	47	<.01	H_2 rejected
	MA Control	22	-.41	.85				
TL Gain O_2-O_1	MA Treatment	27	.45	.48	-5.48	47	<.01	H_3 rejected
	MA Control	22	-.41	.62				
CM Gain O_3-O_1	MA Treatment	25	.04	.61	-1.23	49	.22	H_7 retained
	MA Control	26	-.21	.82				
CNAP Gain O_3-O_1	MA Treatment	24	.24	.81	-.85	47	.40	H_8 retained
	MA Control	25	.05	.82				
TL Gain O_3-O_1	MA Treatment	24	.14	.55	-1.51	47	.14	H_9 retained
	MA Control	25	-.11	.60				

term gains of the Mexican-American treatment group over the Mexican-American control were significant on all three CTBS test scores (CM, CNAP, and TL).[1] These findings resulted in rejection of hypotheses H_1, H_2, and H_3 that there would be no differences in criterion test score gains by the two groups. Also, the tests confirmed that the long-term gains (six months later) between the Mexican-American treatment group and the Mexican-American control were no longer significant on any of the CTBS tests. These findings resulted in retention of hypotheses H_7, H_8, and H_9.

An examination of Figures 5.2 through 5.4 shows that, while the long-term (O_3-O_1) gain score differences of the Mexican-American treatment and control groups were not statistically significant, they were positive in favor of the treatment group. Since the O_3-O_1 gain score differences approach the .05 level of significance (Table 5.6), they are considered by the researcher to have some educational significance.

Parallelism of the Controls

Before comparing the test scores of the Mexican-American treatment group to those of the Anglo-American

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[1] Discrepancies between Table 5.6 and Figures 5.2-5.4 result from experimental mortalities since gain scores required both pretest as well as posttest scores and could not be computed otherwise.

control at the O_2 and O_3 observation levels, it was first necessary to confirm another basic assumption of the study. The assumption was that no changes occurred to the Mexican-American and Anglo-American controls during the ten-month course of the study that would have made them less comparable to each other. This was done by demonstrating that the mean standard test score differences between the two control groups remained constant (parallel) at the three observation levels.

To demonstrate parallelism, the raw CTBS scores were transformed to standard scores and an analysis of variance (ANOVA) test was done on test data for the two control groups at the three observation levels. Observation level by sample group interactions would have indicated that the differences between the control groups were not the same at the three observation levels (i.e., non-parallel). However, the interactions were found to be not significant on the CM test ($p = .29$), the CNAP test ($p = .30$) or the TL test ($p = .70$), thereby confirming parallelism between the Mexican-American and Anglo-American controls on all three CTBS mathematics tests.

Comparisons to the Anglo-American Controls

In order to test the set of hypotheses comparing the Mexican-American treatment group to the Anglo-

American control, the raw CTBS data were first transformed to standard scores. Means and standard deviations were computed for both of the sample groups at the O_2 and O_3 observation levels. The sample groups were then investigated two at a time and their variances checked for equality. When the variances were found to be not significantly different, a pooled variance estimate t test was used to retain or reject the hypotheses. If the 2-tailed probability computed for the t test was found to be less than or equal to 5% ($p \leq .05$), then the means were considered to be different and the null hypothesis rejected. The results shown in Table 5.7 are divided into two sets corresponding to the hypotheses related to the short-term (O_2) and the long-term (O_3) differences between the sample groups on the CM, CNAP and TL tests, respectively.

Statistical tests of the hypotheses confirm the appearance of the graphics (Figures 5.2-5.4) in that the differences between the Mexican-American treatment group and the Anglo-American control at the O_2 level were not significant on any of the CTBS tests. These findings resulted in the retention of hypotheses H_4, H_5, and H_6. The data also confirmed that six months after completion of the IBMI (O_3), the differences

Table 5.7. Significance Testing of CTBS Scores at O_2 and O_3 Levels Between the Mexican-American Treatment Group and Anglo-American Control

Test/ Time	Group	n	$\overline{x}$	S.D.	t	df	prob	Hypothesis:
CM O_2	Mexican Treatment	28	.56	1.00	1.39	60	.17	H_4:retained
	Anglo Control	34	.25	.76				
CNAP O_2	Mexican Treatment	28	-.12	1.19	.06	60	.95	H_5:retained
	Anglo Control	34	-.14	1.03				
TL O_2	Mexican Treatment	28	.24	.95	.79	60	.44	H_6:retained
	Anglo Control	34	.07	.77				
CM O_3	Mexican Treatment	25	.05	.99	-2.25	59	.03	H_{10}:rejected
	Anglo Control	36	.58	.87				
CNAP O_3	Mexican Treatment	25	-.21	1.26	-2.39	59	.02	H_{11}:rejected
	Anglo Control	36	.53	1.13				
TL O_3	Mexican Treatment	25	-.07	.98	-2.44	59	.02	H_{12}:rejected
	Anglo Control	36	.50	.84				

between the Mexican-American treatment group and the Anglo-American control were once again significant on all three tests (CM, CNAP, and TL). These findings resulted in the rejection of hypotheses H_{10}, H_{11}, H_{12}. Thus, the alleviation of the mathematics achievement disparity by the IBMI was a temporary effect which did not endure six months after the treatment group subjects returned to their regular school curriculum.

Summary

Four subgroups resulting from the random blocking of the three sample groups by reading achievement (H/L) and sex (M/F) were monitored by mathematics achievement scores through three observation levels. These data show that the overall mortality peaked at the second observation level and that no extreme loss of subjects occurred within any of the subgroups during the ten month study.

Linear correlations between the CM and CNAP test scores of the CTBS battery were examined and found to be highly significant ($p \leq .01$) for all sample groups. The CNAP test contained word problems and thus required greater language skill than the CM test. Therefore, the pretest (O_1) correlation coefficients were understandably lower for the Mexican-American groups (.50 and .54) than for the Anglo-American control (.70). The correlations between CM and CNAP scores for the Anglo-American control were initially higher (.70), and remained in the same range (.70-.76) through subsequent observation levels. In contrast, the correlations for the Mexican-American treatment and control groups showed continual increases (.50-.86) through subsequent observation levels, with the treatment group showing the greatest overall increases.

Abandonment of the covariance model for hypotheses testing was caused by the lack of parallelism and linearity for the resulting regression lines. Nevertheless the regression lines themselves proved to be of interest and were retained in the study. The dissimilarity of the regression lines for the Mexican-American and Anglo-American control groups supported the researcher's contention that the Anglo-American control was really a reference group rather than a true control. The more positive slope of the regression line for the Mexican-American treatment group as compared to the Mexican-American control revealed that the Mexican-American subjects who were the high achievers on the pretest, benefitted more from their participation in the IBMI than did the low achievers.

A set of graphics was constructed for each of the CTBS mathematics tests to facilitate interpretation of the hypotheses testing between the sample groups. Significance testing at the pretest (O_1) level confirmed the assumption that the Anglo-American control group was significantly higher in mathematics achievement as measured by the CM, CNAP and TL tests than either the Mexican-American treatment group or the Mexican-American control.

Hypotheses testing based on gain score differences between the Mexican-American treatment group and the

Mexican-American control showed that the short-term gains for the treatment group were significant on the CM, CNAP and TL tests. Hypotheses testing also showed that the long-term gains (six months later) were no longer statistically significant; although they remained positive and approached significance on all three tests.

Analysis of variance was used to confirm the assumption that the differences between the Mexican-American and Anglo-American controls remained constant (parallel) during the course of the experiment. Parallelism established that the control groups remained comparable to each other during the course of the experiment. Thus, the Mexican-American treatment group could be compared to the Anglo-American control group just as it had been compared to the Mexican-American control.

Hypotheses tests of differences between the mean standard scores for the Mexican-American treatment group and the Anglo-American control showed that the short-term differences were not significant on the CM, CNAP or TL tests. The hypotheses testing also showed that the long-term differences were significant. Therefore, reduction of the mathematics achievement disparity between the Mexican-American treatment group and the Anglo-American control was a temporary effect and did not endure six months after the subjects returned to their regular school curricula.

VI. SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Summary

Rationale of the Story

The purpose of this study was to determine the extent to which an Immersion Bilingual Mathematics Institute (IBMI) can affect the mathematics achievement of entering seventh grade students of Mexican-American heritage. A large body of research supports the fact that, on average, the mathematics achievement of Mexican-Americans at all age levels is lower than that of their Anglo-American counterparts. A statistically significant disparity in mathematics achievement existed between the Mexican-American and Anglo-American subjects of this study.

This study was based on three underlying assumptions. First, that students of Mexican-American heritage are not inferior to their Anglo-American counterparts in their ability to succeed in mathematics. A second assumption was that supplemental training by participation in a short, intense Immersion Bilingual Mathematics Institute designed to accommodate Hispanic linguistic, cultural, and learning preferences would result in an increase in mathematics achievement of students in a Mexican-American treatment group.

Finally, it was assumed that, if the mathematics achievement level of the treatment group could be raised above that of a Mexican-American control group that this effect would endure after both groups returned to the classroom. If an enduring increase in the mathematics achievement of Mexican-American students could result from participation in a short, supplemental IBMI held during summer recess, the IBMI would have considerable potential for reducing the mathematics achievement disparity between Mexican-American and Anglo-American students in other schools in the southwestern United States.

The Immersion Bilingual Mathematics Institute

An IBMI was designed and administered by the researcher to test hypotheses relative to the effect of a supplemental IBMI on the mathematics achievement of incoming seventh grade students of Mexican-American heritage. Mathematics achievement was defined as Mathematics Computation and Mathematics Concepts and Applications as measured by tests with those titles from the CTBS battery. The mathematics skills focus of the Institute was on the addition, subtraction, multiplication, and division of fractions, decimals, and mixed numbers.

IBMI Curriculum Model

The IBMI curriculum combined several teaching methodologies recommended as appropriate for teaching students with Hispanic bilingual-bicultural traditions and/or field-dependent cognitive styles. Immersion training was used to achieve rapid improvements in mathematics learning. Methodologies related to the bilingual-bicultural traditions included the use of (a) language groupings, (b) bilingual instruction, (c) role models, and (d) a cooperative classroom environment. Methodologies consistent with the field-dependent cognitive style characteristic of Mexican-Americans were the use of (a) inductive teaching, (b) traditional classroom structure, (c) increased teacher guidance, and (d) manipulative materials.

Immersion training consisted of a series of curriculum-centered and teacher-implemented strategies developed by the Peace Corps for rapid training in foreign language. Among the curriculum-centered components were (a) several hours of daily instruction, (b) low student-teacher ratios, (c) a narrow range of objectives, and (d) rotation of the students among teachers. The teacher-implemented components included (a) high-energy instruction, (b) positive reinforcement, (c) rapid drill sessions, and (d) instruction that builds upon previous knowledge.

The Formal IBMI

The Immersion Bilingual Mathematics Institute (IBMI) was held at El Modena High School in the Orange Unified School District (OUSD) during the 1981 summer recess. Classes began at 8 A.M. and continued until 12 noon from the last week of July through the first three weeks of August for a total of eighty hours of instruction. The Mexican-American students who participated in the IBMI were divided into three class sections based on their English language skills and rotated among the three instructors. One section contained non-English-speaking students, and was instructed solely in Spanish. The other two sections classified by high and moderate levels of English skills, were instructed principally in English.

Three experienced mathematics teachers, who were also bilingual in Spanish and English, were trained to instruct the IBMI. Daily lesson plans that were prepared by the researcher, included activity exercises involving the use of measuring instruments such as balances, thermometers and graduated cylinders. The activity exercises required the use of computational skills focusing on the addition, subtraction, multiplication, and division of fractions, decimals and mixed numbers.

Experimental Design

The experimental design of the study was a Pretest-Postttest Control Group design with two modifications. One modification was a second (Anglo-American) control group used as a reference for the mathematics achievement disparity between the Mexican-American and Anglo-American students. The other was a second posttest used to measure the endurance of the treatment effect. Sample groups consisted of a Mexican-American treatment group (n=32), a Mexican-American control group (n=29), and an Anglo-American control (n=40). In order to reduce sampling error, the samples were each randomly selected from four subgroups obtained by blocking the pool of Mexican-American volunteers by sex (M/F) and reading ability (H/L).

Criterion tests were the Mathematics Computation (CM) and Mathematics Concepts and Applications (CNAP) tests of the CTBS battery. Mathematics Totals (TL) scores, consisting of the sum of the CM and CNAP test scores were used as an overall measure of mathematics achievement. CTBS tests were administered as part of the OUSD ongoing testing program at the O_1 (May, 1981) and O_3 (February/March, 1982) observation levels, and by the researcher at the O_2 (August/September, 1981) level.

Statistical treatment of the data included reading and mathematics achievement score analyses of the subgroups resulting from the random blocking used in sample selection. Regression lines computed from the pretest-posttest CM scores were also analyzed. Correlations between the CM and CNAP test scores were computed for the sample groups. Before the hypotheses were tested, raw score test data were transformed to standard scores, graphic displays were constructed, and some of the stated assumptions of the study were confirmed.

Hypotheses involving comparisons of mathematics achievement between the Mexican-American treatment group and the Mexican-American control were based on gain scores. Short-term and long-term differences between the two sample groups were tested for significance using a t test. Comparisons between the Mexican-American treatment group and the Anglo-American control were based on group mean scores. Short-term and long-term differences between those groups were also tested for significance with a t test.

Findings

Numbers of subjects, means and variances of the Mathematics Totals (TL) test scores were computed for the subgroups of each sample group and monitored from one observation level to the next. These data showed that there were no extreme losses of subjects from any of the subgroups during the ten-month period of the study.

Regression lines based on the pretest-posttest CM scores were computed for the three sample groups. Distinct differences in the slopes of the regression lines for the Mexican-American and Anglo-American control groups supported the contention that each was representative of a measurably distinct population. The more positive slope of the regression line for the Mexican-American treatment group as compared to the Mexican-American control indicated that the subjects who were the high achievers on the pretest benefitted the most from their participation in the IBMI.

Pretesting of the sample groups with the CTBS battery confirmed the assumption that significant differences in mathematics achievement existed between the Mexican-American and Anglo-American sample groups. The graphics also showed that these differences were greater using the CNAP test scores (involving language skills) than for the CM test scores (straight computations).

The first set of hypotheses (H_1-H_3 and H_7-H_9) comparing the effects of the IBMI on the Mexican-American treatment group relative to the Mexican-American control was based on gain scores. Short-term differences between the O_2-O_1 gain scores were shown by t test data analysis to be significant in favor of the treatment group on the CM, CNAP, and TL tests of the CTBS battery. This finding resulted in rejection of hypotheses H_1-H_3 that there is no difference in mathematics achievement gain scores between these two groups of subjects.

Long-term differences (O_3-O_1 gain scores) for the same sample groups were shown to not be significant six months later. Thus, hypotheses H_7-H_9 that there are no differences were retained. Although they were not significant, small differences in achievement did persist in favor of the treatment group on all three tests.

An analysis of variance test (ANOVA) comparing mathematics achievement of the Mexican-American and Anglo-American control groups at the three observation levels showed that the achievement differences between the two controls were constant (parallel). Parallelism confirmed the stated assumption that the control groups remained comparable to each other during the course of the study. The Mexican-American treatment group was then compared to the Anglo-American control in the same way it had been compared to the Mexican-American control.

The last set of hypotheses (H_4-H_6 and H_{10}-H_{12}), comparing the effects of the IBMI on the Mexican-American treatment group relative to the Anglo-American control, were made using group mean scores. Short-term differences between the O_2 mean scores for the two sample groups were demonstrated by t tests to be not significant on the CM, CNAP, or TL tests. Thus, hypotheses H_4-H_6 that there are no mathematics achievement differences between the Mexican-American treatment group and the Anglo-American control at the end of the IMBI were retained. However, the long-term differences between the O_3 mean scores obtained six months later were found, once again, to be statistically significant in favor of the Anglo-American control on all three <u>CTBS</u> mathematics tests. Thus, hypotheses H_{10}-H_{12} that there are no differences between the mathematics achievement of the Mexican-American treatment group and the Anglo-American control group six months after the end of the IBMI were rejected.

Conclusions

The following conclusions are drawn from the data obtained by this study:

1) A short supplemental Immersion Bilingual Mathematics Institute designed to accommodate Hispanic linguistic, cultural, and learning preferences of incoming seventh grade students of Mexican-American heritage can produce statistically significant short-term gains in mathematics achievement of the subjects as measured by the Mathematics Computation and the Mathematics Concepts and Applications tests of the CTBS test battery.
2) Significant gains in mathematics achievement of seventh grade Mexican-American students who have participated in an IBMI designed to accommodate their linguistic, cultural, and learning preferences are not statistically significant six months after they return to regular classroom instruction.
3) Mathematics achievement levels of Mexican-American seventh grade students attending Orange (California) Unified School District schools are significantly lower than those of their Anglo-American counterparts.

4) A supplementary IBMI is feasible for OUSD schools and can reduce the short-term mathematics achievement disparity between Mexican-American and Anglo-American seventh grade students.

Implications

The Language Factor

Correlation results, as well as pretest scores, support the contention (State-of-the-Art, 1980) that Mexican-American students, when compared to Anglo-American students, have more difficulty solving word problems (CNAP) than straight mathematics computations (CM). Comparisons of Figures 5.2 and 5.3 also show that the Mexican-American treatment group made greater O_2-O_1 gains on the CM test than on the CNAP test.

These findings are understandable since nearly one-third of the IBMI participants had poor English-speaking ability. Evidently, for these students, the symbolic language of mathematics computations was less problematic than the written language involved in solving word problems.

Regrettably, there was no way to determine whether the language problems resulted from interference in the actual learning process or whether they arose from the subjects' inabilities to comprehend the English language version of the CNAP test. It is even doubtful that a Spanish version of the CTBS would have resolved this question, since Spanish-speaking Mexican-American children are reported to be no more literate in the

Spanish language than in English (Palmer and Gaffney, 1972).

Endurance of the Treatment

When the experiment to measure the effects of the IBMI was being designed, the researcher was convinced that, since the IBMI was so short (four weeks) and intense, there might be some question concerning the endurance of its effects. Devine (1981) and others have contended that learning which results from cramming is more transitory than learning done over a longer period. Consequently, the second posttest (O_3) was added to measure the endurance of the treatment.

The researcher had presumed that, once the gains resulting from the IBMI were achieved, the follow-through provided by the regular OUSD mathematics curriculum would be sufficient to maintain these gains and would possibly even build on them. However, Figures 5.2-5.4 show that the O_3-O_2 gain scores for the Mexican-American treatment group were negative compared to the positive gain scores for the two control groups. Evidently, the highly intense instruction provided by the IBMI did not have the same endurance as conventional teaching. It is also possible that, because of the use of ability tracking, the follow-through instruction expected from the OUSD mathematics curriculum was insufficient to maintain the gains.

Effects of Tracking

One factor in the study that was beyond the researcher's control was the use of ability tracking in the OUSD. Follow-through teaching provided by the regular OUSD mathematics curriculum was considered to be important for maintaining the short-term gains measured at the conclusion of the IBMI. If knowledge gained is not properly reinforced, it tends to be lost with the passage of time (Vitale and Hebbler, 1978). Therefore, it was important that either IBMI participants not be tracked at all or that they be tracked into ability groups based on their newly acquired skills. Unfortunately, this could not be done.

Entering seventh grade students in the OUSD are tracked into five ability groups based on their sixth grade (O_1) CTBS mathematics scores. Consequently, the IBMI participants were tracked into the same lower ability groups as the Mexican-American control. What effect this had on the outcome of the testing at the O_3 observation level is not known; although it must certainly have been a disadvantage to the IBMI participants.

If tracking of the treatment subjects could have been based on posttest (O_2) scores and these subjects assigned into corresponding high level ability tracks, the tracking would have augmented the treatment effect. It can be argued that their assignment into the low level tracks was detrimental to the long-term effects of the IBMI.

In retrospect, it is apparent that tracking was an extension of the treatment effect (X) in the experimental design, which can be re-expressed symbolically as:

R	O_1	X	O_2	T_1	O_3	(M-A treatment)
R	O_1		O_2	T_1	O_3	(M-A control)
R	O_1		O_2	T_2	O_3	(A-A control)

where, for this study, T_1 represents the low ability tracks into which the Mexican-American subjects were placed based on their lower pretest (O_1) scores and T_2 represents the high ability tracks into which the Anglo-American subjects were tracked based on their higher pretest (O_1) scores.

Had the Mexican-American treatment subjects been placed into high level tracks (T_2) commensurate with their posttest (O_2) scores, it is probable that they would have been able to maintain more of the gains achieved via the IBMI.

Feasibility

The OUSD qualified for Title VII bilingual education funding over a decade ago, as did many other school districts throughout the southwestern United States. Over the years, nearly all of this federal money has been spent on alternative bilingual education programs at the elementary school level. Most of the Mexican-American students who were the subjects of this research had participated in the OUSD bilingual education program, yet a significant mathematics achievement disparity persisted for these students.

If current bilingual education programs cannot bridge the achievement gap for Mexican-Americans, perhaps supplementary programs can be developed to accomplish the task. This study has shown that a four-week supplementary Immersion Bilingual Mathematics Institute (IBMI) had a significant short-term effect on the mathematics achievement disparity for the participants.

The facilities, materials, and teaching personnel for an IBMI are already available in most school districts during summer recesses. With the evidence from this study at hand, an argument can be made for affirmative action funding to support a supplemental IBMI under existing Title VII legislation.

Recommendations

On the basis of the data presented in this study, the researcher recommends that consideration be given to:

1. Replication studies to determine whether or not the IBMI designed for this study has a significant short-term effect on the mathematics achievement of other groups of students of Mexican-American heritage.
2. Modified replication studies to determine whether or not the short-term gains achieved by the IBMI can become more permanent. Recommended modifications include
   a) increasing the length of the Institute from four weeks (80 hours) to six weeks (120 hours),
   b) eliminating ability tracking for future IBMI participants or basing tracking on post-IBMI test scores,
   c) providing periodic follow-through with IBMI-type lessons continuing into the regular school year.

d) use of a quasi-experimental time-series design (Campbell and Stanley, 1963) to eliminate the need in future studies for a Mexican-American control group.

3. Orange County school districts continuing to experiment with supplemental mathematics programs similar to the IBMI. This recommendation is supported by

   a) statistically significant short-term mathematics achievement gains of the Mexican-American treatment group in this study,

   b) higher, but not statistically significant mathematics achievement test scores of the Mexican-American treatment group compared to the Mexican-American control six months after completion of the IBMI,

   c) positive feedback from parents and guardians of the Mexican-American students in the treatment group,

   d) relatively low cost of the IBMI which resulted from employing facilities and materials otherwise unused during the summer recess.

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APPENDICES

APPENDIX I

Daily Lesson Plans

Lesson No. 1

Objective: To introduce the metric system of weights and measures.

Lesson: Present the meter, liter and gram. Pass a unit of each around for students to handle. Explain what they measure. Present metric prefixes: kilo- (x 1,000), hecto- (x 100), deka- (x 10), --, deci (x 1/10), centi- (x 1/100), milli- (x 1/1,000). Demonstrate metric units in common usage (e.g., milliliters of water, centimeters of ribbon and grams of brass weights.

Activity: Send students individually to locate and bring back specific metric quantities. Write the assignment on an index card to be returned with the quantity. For example, students can be asked to locate and bring back 130 ml of water in a beaker, 42 cm of ribbon from a spool or 78 g of brass weights. The instructor should check each measurement for accuracy before assigning the next task.

Materials: Class sets of 100 ml graduates, 250 beakers, brass weight sets (0.1-50 g), meter sticks and 1/4 inch ribbon spools. Also a a bucket of water.

Rapid Drill: Practice conversions within the metric system (e.g., the number of millimeters in a centimeter).

APPENDIX I

Lesson No. 2

Objective: To introduce volume as the product of length, width and height for cubical objects.

Lesson: Relate the linear centimeter to the square centimeter and then to the cubic centimeter. Discuss length, area and volume. Show the students what a cubic centimeter (plastic) looks like and pass them around. Stack several into a cubical construction and demonstrate that $V = l \cdot w \cdot h$. Demonstrate the formula again with a blackboard drawing. Show the students several cubical constructions made from stacks of plastic cubic centimeters and see if they can compute the volumes.

Activity: Assign each student to build a cubical construction of specific volume using the plastic cubic centimeters. Write each assignment on an index card to be placed next to the construction on the student's desk. The instructor should check each construction for accuracy before assigning another.

Materials: Class sets of bags of plastic or aluminum cubic centimeters.

Rapid Drill: Practice converting whole number products of length, width and height to areas and volumes using various units.

APPENDIX I

Lesson No. 3

Objective: To introduce the measurement of mass (weight), and practice the addition of decimals.

Lesson: Discuss the measurement of mass with a simple beam balance. Present a complete weight set (0.1 - 50.0 g) for the students to examine and handle. Practice summing decimal numbers. Write a series of simple decimal numbers scattered about on the blackboard. Have the students at their desks re-write the decimals in vertical columns properly aligning the decimals before summing.

Activity: Provide each student with a complete weight set. Write a mass between 0.0 and 100.0 grams on an index card for each student. The students should select the weights from the weight set needed to add up to the total mass and place them on the index card. The instructor should check each total for accuracy before assigning another. The weights should be handled with forceps and returned to the set between each assignment.

Materials: Class sets of weight sets (0.1 - 50.0 g)

Rapid Drill: Practice converting simple fractions such as tenth, quarters and halves to decimal numbers.

APPENDIX I

Lessons No. 4

Objective: To practice estimating the volume of water in a graduate, and to practice recognizing fractional calibrations.

Lesson: Present students with several different sized graduates (10 ml, 100 ml, 250 ml and 1.0 liter), and discuss estimating volumes of water by reading from the bottom of the miniscus. Demonstrate the technique for holding the graduate. Discuss at the blackboard the difference between calibrations in quarters, fifths and tenths. Practice estimating volumes with the various partially filled graduates by passing one around the class.

Activity: Give each student a graduate containing water and have him or her estimate the volume and write it on an index card. After the instructor has checked each student's work several times for accuracy, reverse the process by writing a specific volume on an index card and have the student fill the graduate to the mark.

Materials: Class sets of 10 ml, 100 ml, 250 ml, 500 ml (plastic) 1.0 liter (plastic) graduated cylinders, and 250 ml beakers. Also, several buckets (plastic) of water.

Rapid Drill: Practice identifying metric system abbreviations, (e.g., mm, cm, ml, etc.)

APPENDIX I

Lesson No. 5

Objective: To teach estimation of linear distance on meter sticks and non-metric rulers.

Lesson: Discuss calibrations on meters sticks and show students how to read a meter stick using a large diagram on the blackboard. Provide each student with a meter stick and call out measurements for the class to locate. When the class appears to have mastered the process, switch to non-metric rulers and repeat the lesson. For example,

> "Class: Mark with your pencil tip the position eight and five sixteenths inches on your ruler - [pause] - you are correct if your pencil tip is five marks to the right of the number eight."

Activity: Give each student a piece of ribbon and have him or her estimate the length in centimeters and inches. Write their estimations on an index card. After accuracy is achieved, reverse the process by writing down a length of ribbon to be cut to the nearest sixteenth of an inch or to the nearest tenth of a centimeter.

Materials: Class sets of ribbon spools, meter sticks, non-metric rulers and scissors.

Rapid Drill: Practice reducing fractions.

APPENDIX I

Lesson No. 6

Objective: To recognize decimal positions in metric measurements of length.

Lesson: Review the prefixes of the metric system. Write a number like 243.567 meters on the blackboard and be certain that the students know what metric unit each digit represents. Demonstrate by measuring the length of the blackboard as perhaps 6 meters plus 9 decimeters plus 4 centimeters, hence 6.94 meters.

Activity: Assign each student to estimate the length of some object over two meters in length to the nearest centimeter. The students should make the measurements along an edge and record them on an index card. Then students can be rotated so that another student checks the same measurement. If a large disagreement is found, the two students can repeat their estimations working together.

Materials: Class sets of meter sticks.

Rapid Drill: Practice converting units within the metric system (e.g., 6.00 m = 60.0 dcm = 600 cm).

APPENDIX I

Lesson No. 7

Objective: To recognize and be able to compute fractions and percentages of whole numbers.

Lesson: Review the computations involved in taking fractions and percentages of whole numbers. Use only problems which give whole number answers (e.g., What is 3/4 of 36? or what is 75% of 36?). Give students problems to solve at their desks and at the blackboard.

Activity: Provide students with a perfect square number of plastic cubic centimeters and have students arrange them as a perfect square on their desk tops. Then have students identify fractions or percentages of the whole square by separating them from the whole. Repeat the process using different perfect squares. Problems should be restricted to those giving whole number answers.

Materials: Class sets of bags of cubic centimeters (plastic).

Rapid Drill: Practice converting fractions to percentages.

APPENDIX I

Lesson No. 8

Objective: To use a simple balance to accurately weigh an object to the nearest tenth of a gram.

Lesson: Demonstrate to the students how to set the balance at equilibrium by adjusting the messengers. Insist that the balances be checked for equilibrium before each weighing. Discuss stationary equilibrium and moving equilibrium on the balance.

Activity: Assign each student to a specific balance (numbered) and weight set. Provide the students with objects such as large nuts and bolts to be weighed one at a time to the nearest tenth of a gram. The students can record the weighings on index cards and the weighings can be verified by the instructor at the front desk using a triple beam balance.

Materials: Class sets of simple balances, weight sets and assorted nuts and bolts. Also a triple beam balance.

Rapid Drill: Practice converting decimals to percentages and percentages to decimals.

APPENDIX I

Lesson No. 9

Objective: To practice multiplication and division of decimals and to convert kilograms to pounds.

Lesson: Practice decimal placement in multiplication and division of decimals. Explain the relationship between kilograms and pounds (1 kg = 2.2 lbs.). Demonstrate how weights can be converted from kilograms to pounds by multiplication of decimals and from pounds to kilograms by division.

Activity: Assign the students to weigh themselves on a clinical balance in kilograms to the nearest hundredth. They can then convert their weight to pounds on an index card and check for accuracy by re-weighing themselves on another clinical balance calibrated in pounds. If time permits, the entire activity can be reversed.

Materials: Two clinical balances, one calibrated in kilograms and the other in pounds.

Rapid Drill: Write a number on the blackboard and practice identifying which digit occupies which decimal place.

APPENDIX I

Lesson No. 10

Objective: To practice the subtraction of decimals and to determine whether equal volumes of alcohol and water have the same mass.

Lesson: Discuss tare weights of containers used in weighings. Practice subtracting tare weights. Give students some data orally and check to see whether they line up decimals properly for subtraction.

Activity: Instruct the students to obtain the tare weight of a 25 ml graduate and to write down the weight on an index card. The student can then fill the graduate to the 25 ml mark with water and re-weigh it. After the instructor checks the mass of the water for accuracy (25 g), the student can replace the water with alcohol to determine whether the alcohol has the same mass.

Materials: Class sets of simple balances, weight sets, 25 ml graduates, and 250 ml beakers. Also a bucket of water and a gallon of methyl alcohol (Ditto fluid).

Rapid Drill: Practice converting percentages to fractions.

APPENDIX I

Lesson No. 11

Objective: To practice drawing line segments in metric units.

Lesson: Define a line segment and review the metric system units for linear measurement. Explain the equivalence of 146 mm, 14.6 cm, 1.46 dcm and .146 m. Demonstrate to the students on the blackboard how to properly draw and label a line segment.

Activity: Assign each student to draw and label a line segment of specified length on an index card. The instructor should check each segment for accuracy before assigning another. Vary the units given to the students but keep the lengths short enough to fit on the index card.

Materials: Class sets of metric rulers.

Rapid Drill: Practice converting decimals to common fractions and percentages.

APPENDIX I

Lesson No. 12

Objective: To practice use of the balance and to review the division of decimals.

Lesson: Practice dividing whole numbers into decimals and rounding to specified decimal places. Assign different computations to each student to work at his or her seat or on the blackboard. Review the use of the balance.

Activity: Provide each student with a different number of pennies to weigh on the balance. The student should record the total mass on an index card and return it to the instructor for a check. Then the student can divide the total mass by the total number of pennies for the mass of a single penny. This value can be verified by the student on the balance.

Materials: Class sets of balances and weight sets. A large number of pennies.

Rapid Drill: Practice rounding decimal numbers to specified decimal places.

APPENDIX I

Lesson No. 13

Objective: To practice long division (2 or more digits in divisor) of decimal containing numbers.

Lesson: Review long division on the blackboard and permit students to practice with several simple examples. Round the quotients off to the thousandth place. Present students with the problem of how they might calculate the volume of a single drop of water. Explain that drops from the same dropper should have the same volume.

Activity: Assign students to calculate the volume of a single drop of water. The students should hold the dropper vertically over a 10 ml graduate and count the drops in 5.0 ml. The answer should be reported to the instructor on an index card to the thousandths place. If the computation is accurate, the students can repeat the measurements using a different volume of water to check whether or not the volume of a drop remains constant.

Materials: Class sets of medicine droppers, 10 ml graduates and 100 ml beakers. A bucket of water.

Rapid Drill: Practice identifying decimal positions occupied by digits in a precise number, e.g. 9,654.321087.

APPENDIX I

Lesson No. 14

Objective: To practice the addition and subtraction of fractions.

Lesson: Review finding the common denominator between fractions. Give students several examples of mixed numbers and fractions to add or subtract. Have the students alternate between solving the computations at their seats and on the blackboard.

Activity: Provide each student with a short strip of 1/4 inch ribbon. The students should estimate the length of the ribbon to the nearest sixteenth of an inch and record the value on an index card. When the students return the ribbons to the instructor, cut off a portion and give the rest back to them. They should be able to calculate the length of the ribbon retained by the instructor. The instructor should check the computation done on the index card before returning the missing section to the students. The students can then verify their own computations by measuring the piece of ribbon.

Materials: Class sets of non-metric rulers and spools of 1/4 inch ribbon.

Rapid Drill: Practice converting mixed numbers to improper fractions.

APPENDIX I

Lesson No. 15

Objective: To practice long division and to apply the algebraic formula for velocity.

Lesson: Discuss velocity (speed) and give the students some sample problems involving the formula for velocity ($v=d/t$). For example, if lightning strikes a tree 9,600 feet from your house and it takes the sound 8 seconds to reach you, what is the speed of sound (ft/sec)? Now, pose the question of the students' top speed. How fast could they run in feet per second?

Activity: Provide the students with the distance in feet around the outside of the building. Then give each pair of students a stopwatch and let them time themselves in seconds around the building. The students can then compute their speeds and round the values off to the nearest tenth of a foot per second.

Materials: Class set of stopwatches.

Rapid Drill: Practice converting improper fractions to mixed numbers.

APPENDIX I

Lesson No. 16

Objective: To practice the addition and subtraction of decimals.

Lesson: Present the students with the problem of summing a series of positive and negative decimal numbers written horizontally. Be sure that the net sum is positive. The students should be able to sum the positive and negative numbers separately and then to sum them together to get the net sum. Review tare weights.

Activity: Assign each student to weigh out a sample of rock salt on a watch glass. Specify the mass on an index card to the nearest tenth of a gram. The students should be able to figure out how to handle the tare weight of the watch glass on their own. The instructor can set a triple beam balance to the various assigned masses and check the samples for accuracy as they are turned in.

Materials: Class sets of simple balances, weight sets, watch glasses, spatulas and 100 ml beakers. A bag of rock salt.

Rapid Drill: Practice summing pairs of positive and negative single digit numbers where the sum may be negative.

APPENDIX I

Lesson No. 17

Objective: To familiarize the students with the dimensions of a circle and rectangle.

Lesson: Review at the blackboard the radius, diameter and circumference of a circle. Also review the length, width and perimeter of a rectangle. Students should be able to distinguish among each of these dimensions.

Activity: Provide each student with a cylinder at least ten centimeters in diameter (gallon cans work well). The students should measure and record on an index card the diameter (d), radius (r) and circumference (C) for the lid of the can in centimeters to the nearest tenth. Then provide the students with a stiff piece of cardboard. Students should likewise measure and record the length (l), the width (w), and the perimeter (P) of the cardboard.

Materials: Class sets of gallon cans, rectangular pieces of cardboard, metric rulers and metric tape measures.

Rapid Drill: Review the dimensions of circles and rectangles from blackboard diagrams.

APPENDIX I

Lesson No. 18

Objective: To practice multiplication of fractions and to calculate the surface area of a rectangular surface.

Lesson: Discuss the concept of surface area and the reason for measuring it in square units. Mention the kinds of good that are bought and sold in square units (e.g., carpeting and wallpaper). Present the formula for the area of a rectangle ($A=l \cdot w$). Demonstrate the computation of the surface area of a book cover in square inches.

Activity: Supply each student with a rectangular piece of cardboard. The students can measure the length and width and record them on an index card before computing the surface area. After the instructor has checked the computation for accuracy, the student may next be assigned to compute the surface area of a wall brick, floor tile or desk top.

Materials: Class sets of rectangular pieces of cardboard, and non-metric rulers.

Rapid Drill: Practice reducing fractions likely to be encountered using a non-metric ruler (e.g., sixteenths).

APPENDIX I

Lesson No. 19

Objective: To practice multiplying decimals and to practice computing the circumference of a circle.

Lesson: Practice multiplying decimals using large and small decimal values. Present the formula for the circumference of a circle ($C=\pi \cdot d$). Explain pi and discuss its numerical value. Practice solving at the blackboard for the circumference of a circle, given its diameter.

Activity: Assign students to calculate the circumference of a round object (e.g. trash can lid or round table) by measuring the diameter with a meter stick in centimeters to the nearest tenth and multiplying it by pi (3.14). The students can verify their own computations afterward with a metric tape measure.

Materials: Class sets of assorted round objects, meter sticks, and metric tape measures.

Rapid Drill: Practice squaring and cubing small whole numbers.

APPENDIX I

Lesson No. 20

Objective: To practice the division of decimals and to measure the volume of a rubber stopper by displacement of water.

Lesson: Discuss volume and review metric units for volume measurement (milliliters and cubic centimeters). Present spouted displacement cans to the students and explain how they work. Have the students practice division of decimals with whole number divisors.

Activity: Provide students with 6-10 identical solid rubber stoppers (Nos. 4-6). Instruct students to load the displacement cans with water until they begin to overflow. Next, the students should add the stoppers to the displacement can one by one, capturing and measuring the overflow. The total volume of the overflow is then divided by the number of stoppers to give the volume of a single stopper.

Materials: Class sets of displacement cans, 250 ml beakers, 100 ml beakers, 100 ml graduates, and solid rubber stoppers (Nos. 4-6). A bucket of water.

Rapid Drill: Practice raising the base ten to various exponential powers.

APPENDIX I

Lesson No. 21

Objective: To practice multiplication and division of decimals and to calculate the mass of a single piece of BB shot.

Lesson: Review multiplication and division of decimals. Give the students computations to solve at their desks and on the blackboard. Review how the volume of a single drop of water was calculated. Pose the question as to how one might accurately measure the mass of a single piece of BB shot. Discuss the method.

Activity: Provide the students with quantities of BB shot and paper weighing cups. Students can weigh their samples of shot first and count the pieces afterward. Remind them about subtracting the tare weight. The mass of a single BB shot is obtained by dividing the number of BBs into the mass.

Materials: Class sets of balances, weight sets, 100 ml beakers and weighing cups. A can of lead BB shot.

Rapid Drill: Practice taking simple percentages (10%, 25%, 50% of amounts of money (e.g., what is 10% of $8.50?).

APPENDIX I

Lesson No. 22

Objective: To practice the multiplication of decimals and to calculate the volume of a cubical container.

Lesson: Practice multiplying decimal numbers, rounding the products to the nearest whole number. Review the formula for the volume of a box ($V=l \cdot w \cdot h$). Define length, width and height. Demonstrate how to measure and compute the volume of a "Kleenex" box in cubic centimeters.

Activity: Provide each student with an empty gallon "Ditto" fluid can. The students are instructed to measure and record the length, width and height of the can in centimeters to the nearest tenth, then compute the volume on an index card, rounding the answer to the nearest cubic centimeter. The students can check their own computations by filling the can with water and pouring the contents into a 1.0 liter graduate.

Materials: Class sets of gallon "Ditto" fluid cans, meter sticks and 1.0 liter graduates. Access to an outside hose.

Rapid Drill: Practice rounding decimal numbers to various decimal places.

APPENDIX I

Lesson No. 23

Objective: To practice dividing decimals and to learn how to do averaging.

Lesson: Practice long division (two or more digits in the divisor) of decimal numbers. Permit students to work some practice computations at the blackboard as well as at their desks. Explain averaging and demonstrate by computing the average size of the students' families for the class.

Activity: Students can compute the average metric weight of the students in the class by weighing themselves on a metric clinical balance and recording their weights to the nearest hundredth of a kilogram in a column on the blackboard. The averaging process can be repeated in pounds to the nearest tenth using a non-metric clinical balance. As a final check of their computations, students can use the conversion factor (1 kg = 2.2 lbs.) to see if the two averages are the same.

Materials: A metric clinical balance and a non-metric clinical balance.

Rapid Drill: Review common metric units used in the measurement of length, mass, area and volume (e.g., What are cm^2 used to measure?).

APPENDIX I

Lesson No. 24

Objective: To practice the addition of mixed numbers and to practice averaging the heights of students.

Lesson: Practice finding the least common denominator among two or more common fractions. Also review the division of mixed numbers. Practice converting measurements in feet and inches to mixed numbers (e.g. five feet, three inches equals 5 1/4 feet).

Activity: Combine students into small groups of two or three. The students in each group should estimate their height in feet and inches using two yardsticks taped in tandem flush against the wall. The students in each group can then sum the heights of the members of their group and divide to find the average height of the group.

Materials: Class sets of yardsticks.

Rapid Drill: Practice finding the least common denominator among several fractions written on the blackboard.

APPENDIX I

Lesson No. 25

Objective: To practice dividing decimals and to measure the volume of a single BB shot by the displacement of water.

Lesson: Review long division with three or four digits in the divisor. Review the methods used in finding the volume of one drop of water and the mass of one BB shot. Present the problem of how to find the volume of a single BB shot.

Activity: The students can use a medicine dropper to place exactly 15.0 ml of water into a 25 ml graduate. Then the students should count the number of BB shots necessary to raise the volume to 25.0 ml. The volume of a single lead shot can be obtained by dividing the displaced volume by the number of shot, and rounding the quotient off to the nearest thousandth of a cubic centimeter.

Materials: Class sets of 25 ml graduates, medicine droppers and 100 ml beakers. A can of lead BB shot.

Rapid Drill: Practice taking the square roots and cube roots of perfect squares and cubes, respectively.

APPENDIX I

Lesson No. 26

Objective: To practice finding the sums of mixed numbers and decimal numbers and to review the measurement of mass and volume.

Lesson: Review the conversion of common fractions to decimals by division. Practice summing mixed numbers and decimal numbers (e.g. 2 1/4 + 3.85 = ?). Express answers as decimals rounded to the nearest hundredth.

Activity: Provide each student with a different number of pennies. The students are assigned to measure and record the total mass of the pennies on a balance and the total volume of the pennies by the displacement of water. The instructor can then determine the accuracy of the students' measurements by checking the individual ratios of mass to volume (density) as the students turn in their assignments.

Materials: Class sets of pennies, balances, weight sets, displacement cans, 100 ml beakers, 250 ml beakers, and 100 ml graduates. A bucket of water.

Rapid Drill: Practice converting percentages to common fractions.

APPENDIX I

Lesson No. 27

Objective: To review long division and to identify an unknown metal from its calculated density.

Lesson: Practice varieties of long division problems. Present the concept of density as the ratio of mass to volume measured in grams per cubic centimeter. Practice using the density formula (D=m/V) at the blackboard. Present a list of densities for common substances (e.g., water, iron, magnesium, copper, aluminum and lead).

Activity: Provide each student with a cubical metal bar made of an unknown metal. The students should be able to calculate the mass and volume of the metal bar. The volume can best be computed by measuring the dimensions of the metal bar (length, width and height) in centimeters to the nearest tenth, and applying the volume formula for a cubical object (V=l•w•h). Then the density can be computed from the ratio of mass to volume in order to identify the metal.

Materials: Class sets of density bars (commercial product), balances, and metric rulers.

Rapid Drill: Present different metric units to the students and determine what the units measure (e.g., cm^3, g/cm^3, ml, mm, m/sec., and m^2).

APPENDIX I

Lesson No. 28

Objective: To practice long division and to calculate the decimal value of pi.

Lesson: Review the dimensions of a circle (area, circumference, radius and diameter). Present the formula for the circumference of a circle ($C=\pi \cdot d$) and rearrange the formula for pi ($\pi=C/d$). Ask the students to estimate how many times greater the circumference of any circle is than its own diameter.

Activity: Send the students out onto campus to find a large circle (lunch table, garbage can lid, flower garden) and to measure its circumference and diameter in centimeters with a metric tape measure. After the students have computed the ratio on an index card, they can check the value of pi given in a dictionary and see how close they have come to the accepted value.

Materials: Class sets of metric tape measures.

Rapid Drill: Take sequential integers beginning with two and see to how many exponential powers students can raise them without using a pencil.

APPENDIX I

Lesson No. 29

Objective: To practice the use of parentheses in mathematics computations and to calculate the area of a circle.

Lesson: Present a variety of simple numerical expressions involving parentheses and demonstrate the order in which the computations must be done (e.g., $4(5-2)+1=?$). Allow students to practice with several similar problems. Review the dimensions of a circle (area, circumference, diameter and radius). Present the formula for the area of a circle ($A=\pi \cdot r^2$) and practice solving for the areas of circles on the blackboard using sample data.

Activity: Provide each student with a one gallon cylindrical tin can. The students can measure the diameter of the can in centimeters to the nearest tenth and divide this value by two to obtain the radius. Insist that they write out the formula for the area of a circle and place the value for the radius in parentheses before squaring. The computation of the area of the circle should be done on an index card and checked by the instructor.

Materials: Class set of one gallon tin cans and metric rulers.

Rapid Drill: Practice simple problems involving the use of parentheses (e.g., What is the quantity five minus two, squared?).

APPENDIX I

Lesson No. 30

Objective: To construct a Cartesian plane and to practice locating coordinates on the plane.

Lesson: Construct a Cartesian plane on the blackboard. Label and calibrate it completely. Demonstrate the signs of coordinates within each of the four quadrants. Have the students come to the blackboard and locate specific coordinates.

Activity: Provide each student with a metric ruler and a piece of metric graph paper for the purpose of constructing a Cartesian plane. Direct the students to construct their axes in order to make them all identical. The students can then be given a series of coordinates (x,y) in centimeters to the nearest tenth to plot on their planes. The accuracy of the plotting can be checked by superimposing the teacher's master copy with hole-punched coordinates over the students' assignments.

Materials: Class sets of metric graph paper (centimeters to millimeters), and metric rulers.

Rapid Drill: Practice the addition of positive and negative numbers that may give negative sums.

APPENDIX I

Lesson No. 31

Objective: To calculate the volume of a cylinder using the formula.

Lesson: Review the concept of volume and the metric units used to measure it. Explain how the volume of a box can be thought of as the product of the surface area of its top times its height ($V=A \cdot h$). Apply this concept to the volume of a cylinder. The students should be able to deduce the specific formula for the volume of a cylinder on their own. Write the formula for the volume of a cylinder ($V=\pi \cdot r^2 \cdot h$) on the blackboard and practice using it.

Activity: Provide each student with a one-gallon cylindrical tin can. The students should accurately measure its dimensions (height and diameter) in centimeters to the nearest tenths. The formula can then be used to calculate the volume in cubic centimeters. After the instructor has checked the computations, the students can verify their work by filling the cans with water and pouring the contents into a large graduate cylinder.

Materials: Class sets of gallon cans, metric rulers, 1.0 liter graduates and buckets of water.

Rapid Drill: Practice rounding decimal numbers to specified decimal places.

APPENDIX I

Lesson No. 32

Objective: To practice converting common fractions into decimals and percentages, and to calculate the probability arising from coin tosses.

Lesson: Practice converting common fractions into decimals by division, then converting the decimals into percentages. Round the decimals off to the nearest hundredth. Toss a coin and ask the students what the probability is that it will come up heads. What if two coins were tossed? What is the probability that both will come up heads?

Activity: Students should work in pairs but each must keep separate data cards in this activity. Each students will need a coin and an index card. The card is divided into three columns, HH, HT or TH, and TT. The students proceed to flip the coins for fifteen minutes and match their results with pencil marks into the three columns. At the end of the time period, each student counts up the marks and computes the fraction and percentage of tosses in each column. The instructor can average the results on the blackboard from all the students to obtain the usual 25%:50%:25% ratio.

Materials: Class sets of coins.

Rapid Drill: Practice converting common fractions (halves, quarters, thirds, fifths and tenths) into decimals and percentages.

APPENDIX I

Lesson No. 33

Objective: To convert degrees Celsius to degrees Fahrenheit using the conversion formula and to practice measuring temperatures with a thermometer.

Lesson: Discuss the measurement of temperature with a Celsius thermometer. Present to the student the formula for converting from degrees Celsius to degrees Fahrenheit ($F = 9/5\ C+32$). Practice at the blackboard converting several temperatures. When the students begin to practice the conversions, be sure they use the complete series of steps including writing the original equation and then re-writing the equation with the Celsius temperature in parenthesis.

Activity: Provide each student with a Celsius thermometer. Direct the students to measure three temperatures and convert them one at a time to degrees Fahrenheit. The temperatures should include a boiling pot of water, a beaker of ice water, and their own body temperatures (under arm).

Materials: Class sets of Celsius thermometers and 250 ml beakers. A hot plate and a bag of crushed ice.

Rapid Drill: Practice multiplying and dividing positive and negative numbers.

APPENDIX I

Lesson No. 34

Objective: To practice solving word problems requiring the multiplication and division of fractions and to practice using a feeler gauge.

Lesson: Present division of fractions problems to students orally as word problems. For example,

(1) If two-thirds of a pizza is split equally among four students, what fraction of a whole pizza would each receive?

(2) If a dollar and a half is split equally among six friends, how much does each receive?

Discuss and demonstrate the use of feeler gauge to measure the gap of a spark plug.

Activity: Provide each student with a feeler gauge calibrated in decimal fractions of an inch. Instruct students to measure the gap of at least six labeled spark plugs and to record the measurements as both fractions and decimals on an index card.

Materials: Class sets of non-metric feeler gauges. A box of used spark plugs with numbered labels.

Rapid Drill: Practice squaring and cubing proper fractions.

APPENDIX I

Lesson No. 35

Objective: To construct the floor plan of a house and to compute its surface area and cost from the floor plan.

Lesson: Review the measurement of surface area in metric and non-metric units. Review rounding to various decimal point placements. Demonstrate how to draw a floor plan for a house on metric graph paper.

Activity: Provide students with metric graph paper and instruct them to draw the floor plan for the house of their dreams. Students should draw their lines parallel to the axes of the graph paper using a sharp pencil and a straight edge. The students can assume each centimeter to be equivalent to an actual meter in order to compute and label the floor area of each room. They can also assume a cost of $275.00 per square meter in order to compute and label the cost of each room. Finally, the total floor area and total cost of the house can be computed.

Materials: Class sets of metric graph paper and metric rulers.

Rapid Drill: Practice identifying the next number in a variety of sequences (e.g., 1,4,9,16, _?_).

APPENDIX I

Lesson No. 36

Objective: To practice adding and subtracting mixed numbers and to compute the length of a missing piece of ribbon.

Lesson: Review the addition and subtraction of mixed numbers. Present students with a series of three or four positive and negative mixed numbers to sum. Review reducing of fractions and conversion of improper fractions to mixed numbers.

Activity: Direct the students to cut off a short piece of ribbon and measure its length to the nearest sixteenth of an inch before returning the ribbon to the instructor. The instructor then cuts the ribbon into four unequal lengths and gives three of the lengths one at a time to the student to measure and return again. The objective is for the student to determine the length of the last piece of ribbon retained by the instructor. Therefore, the student must sum the lengths of the first three pieces of ribbon and subtract the sum from the total length. The students can verify their own results afterwards by actually measuring the last piece of ribbon.

Materials: Class sets of non-metric rulers. A roll of 1/4 inch ribbon.

Rapid Drill: Practice reducing fractions and mixed numbers.

APPENDIX II

List of Reusable Materials*

[*CS represents "class set"]

CS 100 ml beakers
CS 250 ml beakers
CS 10 ml graduated cylinders
CS 25 ml graduated cylinders
CS 100 ml graduated cylinders
2 250 ml graduated cylinders (plastic)
2 500 ml graduated cylinders (plastic)
2 1.0 liter graduate cylinders (plastic)
CS brass weight sets (0.1-50.0 g) with forceps
CS simple balances
CS meter sticks
CS yard sticks
CS plastic buckets
500 plastic or aluminum cubic centimeters
CS metric rulers
CS non-metric rulers
1 triple beam balance
1 metric clinical balance
1 non-metric clinical balance
50 medicine droppers
CS stop watches
CS 4 inch diameter watch glasses
CS spatulas
CS scissors
CS 200 ml spouted displacement cans
3 lbs. solid rubber stoppers (Nos. 4-6)
CS assorted metal density bars
CS Celsius thermometers (-10° - 150°C)
CS non-metric feeler gauges

APPENDIX II

List of Non-Reusable Materials

CS spools of 1/4 inch ribbon
2 gallon can of "Ditto" fluid (methyl alcohol)
1 5-lb. bag of rock salt
CS empty gallon "Ditto" fluid cans
CS rectangular pieces of cardboard
100 paper weighing cups
500 5 x 9 inch index cards
5 lbs. lead BB shot (No. 177)
CS cylindrical gallon tin cans
200 pieces of metric graph paper
CS used spark plugs
50 assorted large nuts and bolts

APPENDIX III

Personal Profiles of IBMI Instructors

INSTRUCTOR A

Age: 35 Sex: F Race: Negro
Spanish Competency: Native Speaker
Place of Birth: Panama City, Panama
Education: B.A. Mills College, Oakland, CA
M.A. Pennsylvania State University
University Park, PA
Brief Description:

Instructor A was an excellent teacher. She was somewhat less flexible than the other teachers, but she maintained excellent control in the classroom. Instructor A has a minor in mathematics and ten years of experience in teaching.

INSTRUCTOR B

Age: 25 Sex: F Race: Anglo
Spanish Competency: Moderately fluent
Place of Birth: Los Angeles, CA
Education: B.A. Chapman College, Orange, CA
Brief Description:

Instructor B was the weakest of the three teachers in Spanish-speaking ability, but had the most charismatic personality. She was energetic and adapted well to the IBMI curriculum. Instructor B has minors in both mathematics and general science.

INSTRUCTOR C

Age: 30 Sex: F Race: Hispanic
Spanish Competency: Native Speaker
Place of Birth: Albuquerque, NM
Education: B.A. University of New Mexico, Albuquerque, NM
M.A. University of New Mexico, Albuquerque, NM
Brief Description:

Instructor C was the most competent mathematics instructor of the three teachers. She had an M.A. in mathematics and had taught at the junior high school level for five years. She did an outstanding job of teaching in spite of having to cope with some of the difficulties of being seven months pregnant.

APPENDIX IV

Bilingual Letter

English version

Dear Parents,

During the late summer of 1981, an intensive short course in mathematics instruction is proposed for children of Hispanic heritage in the Orange Unified School District. The purpose of the course will be to demonstrate that rapid and significant improvement in mathematical skills is possible for these students through a bilingual mode of instruction. The course of instruction will emphasize a wide variety of laboratory oriented activities which require the use of basic mathematical skills. Instruction for the program will be carried out by bilingual professionals specifically selected and trained for this project.

The 4 week instructional course will consist of a 4 hour daily program each morning beginning on July 27 and continuing through Aug. 21, 1981. The instructional site will be El Modena High School. El Modena is within walking distance of Jordan, Esplanade and Prospect Elementary Schools. Transportation will be arranged for those students previously attending Cambridge and West Orange Schools. This project is supported by the Orange Unified School District and the Dept. of Science Education at Oregon State University.

Parents are advised that participation for their children is strictly voluntary and will be limited to a maximum of 36 pupils. Student participants will be randomly selected from among those students whose parents return the enclosed application form. Applicants who are selected for participation in this program will be advised by mail in mid-July. Additional information concerning the Bilingual Summer Mathematics Institute may be obtained from the project director, Mr. C. Steven Ebert, Science Dept., Cerro Villa Jr. High, 17852 Serrano Blvd., Villa Park, CA. 92667. (tele. 998-9730).

Cordially,

APPENDIX IV

Bilingual Letter

Spanish Version

Note importante a los padres:

Al final del verano de 1981 un curso intensivo de matemáticas ha sido propuesto para los niños de descendencia hispanoamericana en el Distrito Educativo de Orange. El propósito de dicho curso es demostrar que es posible mejorar rapidamente las habilidades matemáticas para dichos estudiantes a traves del modo bilingüe de instrucción. Este curso comprenderá una variedad de actividades de laboratorio que requieren el uso básico de ciertas habilidades matemáticas. Las instrucciones para este curso serán dadas por profesionales bilingües especialmente entrenados para este proyecto.

Este curso de 4 semanas consistirá en un programa de 4 horas diarias, comenzando en Julio 27 hasta Agosto 21 de 1981. El lugar de instrucción va a ser la escuela secundaria „El Modena High School". Estudiantes de las escuelas elementarias „Jordan", „Esplanade" y „Prospect" pueden llegar a pie. El transporte será arreglado por los alumnos de las escuelas „West Orange" y „Cambridge". Este proyecto esta sostenido por el Distrito Educativo de Orange y el Departamento de Ciencias de „Oregon State University".

Por este medio se les avisa a los padres de familia que la participación de sus hijos es voluntaria y estará limitada a 36 alumnos. Los estudiantes serán elegidos por las aplicaciones incluidas que los padres deberán llenar. A los estudiantes se les avisará por correo a mediados de Julio si son aceptados al programa. Para mas informaciones a este respecto se pueden dirigir al Director Señor C. Esteban Ebert, Departamento de Ciencias, Cerro Villa Jr. High, 17852 Serrano Blvd., Villa Park, CA. 92667. (tele. 998-9730).

Sinceramente,

Prof. C. S. Ebert

APPENDIX V

IBMI Acceptance Letter

English Version

C. Steven Ebert/Science Dept.
Cerro Villa Jr. High
17852 Serano Blvd.
Villa Park, CA. 92667.
tele. 998-9730

Dear Parents,

It is with great pleasure that we inform you that your child has been selected to participate in the 1981 Summer Mathematics Institute. The institute will begin on July 27 and continue through August 21 at El Modena High School. The classes will start promptly at 8:00 A.M. and continue with refreshment breaks through to 12:00 noon. Parents are reminded that, because of the intensive nature of the 4 week course, a single day's absence will be equivalent to a week's absence from a regular course. The mathematics instructors will include Ms. Socorro McGerty (McPherson), Ms. Shiela Osborne (Prospect), Ms. Jennifer Gaudet (Jordan), and Mr. Steven Ebert (Cerro Villa). Students should report to Rm. 321 of El Modena High School with a notebook and pencil at 8:00 A.M. on Monday, July 27.

*** Students coming from the vicinity of West Orange and Cambridge Schools should report to these schools. Transportation will be provided by the instructors from in front of these schools at exactly 7:30 A.M. Students will be returned to the same sites at 12:30 P.M.

Sincerely,

C. Steven Ebert

APPENDIX V

IBMI Acceptance Letter

Spanish Version

C. Steven Ebert/Science Dept.
Cerro Villa Jr. High
17852 Serano Blvd.
Villa Park, CA. 92667.
tele. 998-9730

Aviso Importante a los Padres:

Es para nosotros motivo de gran satisfaccion informarle a Ud. que su hijo ha sido seleccionado para participar en el Instituto de Verano de Matemáticas. Los cursos comenzarán el 27 de Julio en „El Modena High School" y continuarán hasta Agosto 21. Las clases empezarán a las 8:00 A.M. en punto y continuarán con sus descansos regulares hasta las 12:00 del día. Se les recuerda a los padres que debido a lo intensivo del curso, una simple ausencia equivaldrá a una semana completa de ausencia de un curso regular. Los instructores del curso de matemáticas serán Prof. Socorro McGerty (McPherson), Prof. Shiela Osborne (Prospect), Prof. Jennifer Gaudet (Jordan) and Prof. Steven Ebert (Cerro Villa). Los alumnos se deberán reportar al salón número 321 de „El Modena High School" con cuaderno y lápiz a las 8:00 A.M. en punto el lunes Julio 27.

*** Los estudiantes que viven cerca de las escuelas „West Orange" and „Cambridge" vendrán a estas escuelas. El transporte será proveído por los instructores en el frente de estas escuelas exactamente a las 7:30 A.M. de la mañana. Los estudiantes retornáran al mismo lugar a las 12:30 P.M. de la tarde.

Cordialmente,

C. Steven Ebert

APPENDIX VI

IBMI Rejection Letter

English Version

C. Steven Ebert/Science Dept.
Cerro Villa Jr. High
17852 Serano Blvd.
Villa Park, CA. 92667.
tele. 998-9730

Dear Parents,

Due to severe limitations of funding and personnel, the 1981 Summer Mathematics Institute is limited to a maximum of 36 students. Since over twice that number of applications were received, a completely random selection of student participants was drawn from among the applications submitted. Unfortunately your child was not among those selected for this summer's program. However, preference will be given to those students whose parents submitted applications for this summer's program in selection procedures for future programs. We hope that you will appreciate the difficulty in obtaining the necessary funding from independent sources needed to facilitate even a limited experimental program in these times. And we thank you most sincerely for your interest and offered participation in this project.

Cordially,

C. Steven Ebert

APPENDIX VI

IBMI Rejection Letter

Spanish Version

C. Steven Ebert/Science Dept.
Cerro Villa Jr. High
17852 Serano Blvd.
Villa Park, CA. 92667.
tele. 998-9730

Aviso Importante a los Padres:

Debido a las severas limitaciones de fondos monetarios y personal, El Instituto de Matemáticas de Verano será limitado a un máximo de 36 alumnos. Como recibimos más de el doble de solicitudes que pueden participar, tuvimos que sortear las solicitudes para acomodar los 36 lugares disponibles. Desafortunadamente su niño no estuvo en el grupo seleccionado para este verano. De todas maneras se les dará preferencia a aquellos estudiantes cuyos padres enviaron las solicitudes, para los programas futuros. Nosotros esperamos que Uds. se den cuenta de las dificultades en obtener los fondos monetarios necesarios para estos programas. Queremos darles las más sinceras gracias por su participación e interés en estos programas.

Sinceramente,

Prof. C. Steven Ebert

APPENDIX VII

IBMI Application Form-Bilingual

Application Form for Bilingual Summer Mathematics Institute

Requirements - The Bilingual Summer Mathematics Institute is tuition-free and open to students of Hispanic heritage entering the 7th grade in the Orange Unived School District during the 1981-82 school year. Citizenship is not a requirement.

Name of Student ______________________ Age ____ Sex ____

Name of Parents or Guardians ___________________________

Address __________________________________ Tele ________

School Attended Last Year ______________________________

Aplicaciones para el Instituto Bilingue de Matematicas

Requisitos - El Instituto Bilingue de Matematicas es gratis y esta abierto para los estudiantes de descendencia hispanoamericana que entran en el 7º grado del ano escolar 1981-82 en el Distrito Educativo de Orange. Ser ciudadano norteamericano no es necesario.

Nombre del Estudiante ________________ Edad ____ Sexo___

Nombre de los Padres _________________________________

Direccion ____________________________ Tele ____________

Escuela del ano pasado _________________________________