DOCUMENT RESUME

ED 191 699 SE 031 917

TITLE Salient Issues in Mathematics Education Research for Minorities. Proceedings from an NIE Sponsored Meeting (Seattle, Washington, April 18, 1980).

SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.

PUB DATE Apr 80

NOTE 42p.: Not available in hard copy due to marginal legibility of original document.

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.

DESCRIPTORS American Indian Education: *Bilingual Education: *Chinese Americans: Hispanic Americans: *Mathematics Curriculum: *Mathematics Education: Mathematics Instruction: Research

IDENTIFIERS *Mathematics Education Research

ABSTRACT

The six brief papers in this document were prepared for an NIE-sponsored meeting in April 1980. Claudette Bradley poses questions (but no answers) on factors affecting American Indians. Alberta Castaneda stresses the need to ascertain how young children learn mathematical ideas. Tony Alfredo Gallegos notes inadequacies of Spanish bilingual programs. Dora Serna advocates the use of students' vernacular language in instruction. Hilda Serna also comments on bilingual concerns. Sau-Lim Tsang presents a review of research studies with Chinese American students, covering the topics of mathematical achievement, testing, Piagetian tasks, and curriculum. (MS)

# SALIENT ISSUES IN MATHEMATICS EDUCATION RESEARCH FOR MINORITIES

## PROCEEDINGS FROM AN NIE SPONSORED MEETING

APRIL 18, 1980
SEATTLE, WASHINGTON

## Introduction

The bulk of the mathematics education research literature during the last two decades (1960-1980) has largely stayed away from addressing concerns related to the mathematics education of minorities. In the interim there been some sporadic activities in this area but not enough to shed light on issues such as cognition and mathematics learning among minorities, or the problem-solving processes of these student populations, to name just a couple.

A set of subpopulations of minority students whose mathematics education needs have received even less attention are the bilingual students. Mathematics education research involving these students is virtually non-existent.

However, there are hopeful signs indicating that both of these situations may be improving.

In April 1980, the Mathematics Studies Team of the Learning and Development unit in the Teaching and Learning Program at the National Institute of Education (NIE) organized a meeting in Seattle, Washington, to discuss the "Salient Issues In Mathematics Education Research for Minorities." The meeting focused on the linguistically and culturally different students of Asian American, Chicano, and American Indian background.

Six mathematics educators from outside of NIE attended the meeting and each was asked to write a paper in preparation for the meeting. Such essays served as the basis for the discussion that took place. Those six papers constitute this volume.

Taken together the papers cover topics in bilingual education, curriculum, teaching and teacher training, ethnography, testing, and basic research.

Claudette Bradley poses a series of questions spanning the areas of curriculum, mathematics learning, cognitive styles, and cultural factors specific to American Indians. The document does not attempt to answer the questions posed, and thus it can be seen as a kernel for future research activities in this area.

The essay by Alberta Castañeda advocates longitudinal studies with children investigating the skills that may be precursors to mathematical concepts and mathematical thinking. She is also of the opinion that the traditional first-grade mathematics curriculum is not developmentally appropriate for children and does not provide sufficient time for stable learning to occur. Another need that she sees is the development of preservice courses for prospective preschool and elementary school teachers which include mathematics content, mathematics teaching methods, and information about the learning characteristics of children.

Tony Alfredo Gallegos claims that there does not exist at the present time a complete, coherent, and comprehensive bilingual elementary school mathematics program. He outlines a minimum set of topics that such a program should include. Gallegos also points out that teachers who teach mathematics to bilingual students should be well versed in the technical language of mathematics in the particular language medium involved (Spanish, Chinese, etc.). His comments also touch on teacher training needs, the need for bilingual math specialists, and other topics.

Dora Serna expresses ideas similar to those of Gallegos but she does not cover as much ground nor does she include as much details. Although she advocates the use of the students' vernacular language in instruction, she makes it clear that what matters is to teach the mathematics concepts whether by means of English or the vernacular. She is also of the opinion that mathematics is the school subject most independent from language and culture.

The last paper is that of Hilda Serna. Hilda's comments, although somewhat brief, cover curriculum and instruction, and testing topics. One comment that stands out advocates the need to develop bilingual instructional materials which emphasize mathematics learning by seeing, doing, and other types of student active participation. She also suggests the development of local norms as more realistic indicators of student achievement levels, particularly in mathematics.

In closing, the issues covered in these essays seem to cast a large shadow over the mathematics achievement of bilingual students. It is hoped that this collection of papers will bring light to the dark corners of mathematics education in the United States.

Luis Ortiz Franco
NIE Associate
Mathematics Studies Team in the
Learning and Development Unit of the
Teaching and Learning Program

To: Language and Culture in the Mathematics Curriculum of the 1980's- seminar
Himmelman Room, Washington Plaza Hotel, Seattle, Washington, April 18, 1980

From: Ms. Claudette Bradley, Ed. D. Candidate, Harvard Graduate School of Education

Re: Issues in Mathematics Education Research for Minorities

I. Is mathematics a Culture-free discipline?

A. To what extent is mathematics a universal among all cultures? i. e., Counting, navigation, etc.

B. To what extent culturally biased? ie, Logic, number concepts, etc.

C. Are math teachers responsible for the notion that mathematics is a European-Arabic derived body of Knowledge? To what extent does this effect an Indian child, who discovers to be smart he must continually relate to non-Indian ways?

II. Can we design Mathematics programs based on culture and environment?

A. What is the value of connecting mathematics to a student's ancestral past, his/her present environment, and his/her possible future?

B. How can an ethnographic study of a mathematics classroom and/or relevant community facillitate a culturally relevant mathematics program? ie, communication codes, cultural referents and the environemt.

C. Can we balance anxiety and boredom, thereby creating a flow experience in the mathematics classroom for Indian children?

D. Is individualized instruction appropriate for Indian children?

E. Would viewing teaching as sharing knowledge be more appropriate for Indian students?

III. What is the learning process in the study of Mathematics?

A. Does learning arithmetic require convergent thinking? Does learning higher mathematics require divergent thinking? How does the learning arithmetic effect learning of higher mathematics?

B. What effect does culture have on a students learning style? Are Indian children in general reflexive observers? If so, how would this effect there learning experience in the mathmatics classroom?

C. In what ways do Indian students like to compete?

D. Is the teacher dominated classroom appropriate for Indian students?

E. How important is aesthetics in the mathematics classroom?

Brief Resume

Ms. Claudette Bradley April 18, 1980

**Teaching Experience:**

Guam - 1 year
Hawaii - 1 year
Sanfrancisco - 3 years
Boston Indian Council - 4 years

**Education:**

BS in Mathematics - University of Connecticut
MS in Mathematics - University of Connecticut
Ed.D. candidate - Harvard Graduate School of Education

**Community Service:**

Tribal Council member, Schaghticoke Indians in Connecticut
President, Board of Directors, Boston Indian Council

**Paper:**

Working paper at Logo - Artificial Intelligence Laboratory at MIT, 1975
Native American Loom Beadwork Can Teach Mathematics

**Tribal Affiliation:**

Schaghticoke of Connecticut

# RESEARCH QUESTIONS IN MATHEMATICS LEARNING
# BY MINORITY GROUP CHILDREN

Presented By:

ALBERTA M. CASTANEDA, Ph.D.
Department of Curriculum and Instruction
University of Texas at Austin
April 1980

Mathematics is a sequential discipline. The ability to do each new level of mathematics is dependent upon the understanding and skill the learner brings from the last level. The whole structure rests upon the base formed when the learner is in preschool and early primary grades. Most mathematics programs for young children begin with the association of spoken name to written symbol, the forming of written symbols, or the memorization of a sequence of number names, as in naming (not reading) and forming (not writing) numerals and in counting. Although we would not expect children to name and form words for which they have no meaning, we regularly ask children to name and form mathematical symbols for which they have no meaning, and even more, we expect them to manipulate the symbols themselves. Almost never is attention paid to ensure children's developing of the concepts for which the written mathematics symbols and names stand.

When concepts are not formed, when the child is asked to name and form mathematics symbols before they have meaning for him, he* comes to see mathematics as an irrational activity, neither verifiable in his own experience nor reconcilable with what he already knows. Unable to understand what he is asked to do, he resorts to rote memory, at best, or at worst, to a dependence upon manipulatives to find answers and to checking the teacher's reaction to see if he is right or wrong.

Anyone who has been in primary or intermediate classrooms recently has seen many children so dependent upon their fingers or upon other manipulatives that they resort to them to solve the simplest equation. They have seen children who cannot solve 3 + 2 = [] without a number line or counters who are doing pages of examples such as $\begin{array}{r}3,255\\ +\underline{2,123}\end{array}$; children who search for "key words" in "word" problems to decide which operation to use; who write 411 as the sum of 39 and 12 without discomfort; who count seven objects, then eight objects, then recount fifteen objects to solve 7 + 8 = []. Many elementary school aged children do not understand what they are asked to do in arithmetic. Uncomprehending, they participate by employing procedures with counters and they must be taught a new procedure for each new type of computation.

Ironically, elementary school mathematics is an area in which every child can succeed. It is too easy to determine what a child knows and what he can do in arithmetic for us to allow failure to continue. There is need in mathematics education as a whole to seek out the route

---

* The pronoun "he" is used to indicate a child, pupil, or student. No gender is indicated, none is intended.

of successful mathematics learning. The search should begin before children are asked to count, name or form numerals, add, or subtract. A basic question should be: What is there that can be done with young children prior to the introduction of mathematical symbols that will allow them to meet and to use those symbols and engage in mathematical thinking successfully? This need exists in mathematics instruction for all children. Perhaps it exists more strongly in mathematics instruction for minority children whose achievement, as a group, in many areas is not a source of pride or comfort for them, their families, or their teachers.

Mathematics instruction could easily become the centerpiece of any program for children for whom school success is not predicted. Mathematical symbols stand for the same concepts regardless of the language or dialect to which the symbols are associated and regardless of the words used to describe the analogous real-world action and setting. Mathematics is a rational, verifiable set of concepts and skills that can be reconciled, surely, with what a child knows. Mathematics has no ethnic tinge; it is inexpensive to teach; it does not require field trips nor expensive sets of materials.

The confidence and involvement and the predisposition to use their own rational power that can be fostered in children by a good mathematics program can be an asset in all endeavors - academic, social, creative, motoric. It can have its maximum value if begun with young, preschool children.

Jerome Bruner (1965, p. 1009) wrote:

> The more 'elementary' a course and the younger its students, the more serious must be its pedagogical aim

> of forming the intellectual power of those whom it serves. It is as important to justify a good mathematics course by the intellectual discipline it provides or the honesty it promotes as by the mathematics it transmits. Indeed, neither can be accomplished without the other.

An important need is information about the pre-mathematics understandings, concepts, skills that may be precursors to mathematical concepts and skills and to mathematical thinking. Is it true that children who understand the concept and easily use the language "more than" ("fewer than") later easily acquire the concept and the associated language "greater than" ("less than")? Does the concept "as many as" carry over to the concept "is equal to"? Does knowing that we can tell how many things there are in any set of objects, that we can communicate number, in terms of equivalent sets and left-overs, have any carry-over to a later study of the base property of our numeration system? Does knowing that if you have three objects and get two more, you have five objects, facilitate the learning of "three plus two is equal to five"? Does the ability and predisposition to find patterns in physical arrangements of objects or in designs contribute to the ability to find and the predisposition to use patterns in the addition facts? And does the ability to find and the predisposition to use patterns in addition facts result in easier or faster learning of the facts or in the ability to use patterns in the multiplication facts? Generally, what pre-mathematical concepts, skills, and predisposition are associated with success and pleasure in early mathematics learning?

The question can be answered only with longitudinal studies. The payoff to a fine premathematics program with four- and five-year olds may not come when they are six years old. And the potential payoff of a fine premathematics program for four- and five-year olds may be blunted by their participation, when they are six or seven years old, in an arithmetic program that is developmentally inappropriate or mathematically unsound.

The first-grade mathematics curriculum traditionally (1) includes arithmetic that is not developmentally appropriate for many children; and (2) provides insufficient time for stable learning. For example, most first-grade mathematics text books introduce the numerals and the written and spoken names for the numbers zero through ten, or through five, with both addition and subtraction with sums to five, within a span of fewer than twenty days. Piagetian developmental theory, almost any learning theory, and information processing theory suggest that that's too much in quantity and abstraction for six-year olds.

When minority group six-year olds are faced with tasks that no first-grade child should be expected to perform, it is not surprising that they resort to their fingers, come to believe that mathematics is difficult and threatening, and begin to expect failure. With that as a beginning it is not surprising that many of our children do not build the concepts, skills, and attitudes necessary to continue in mathematics with the result that many professional and occupational fields are closed to them. Attention must be paid to early childhood mathematics programs if we wish to make any real progress in improved mathematics learning.

Another important area of research is concerned not with children but with teachers. Many elementary, probably particularly primary and preschool teachers, are insecure in mathematics. They see it as a set of isolated, memorized facts and they teach it that way. We should investigate the possibility of changing teachers' attitudes toward mathematics and toward mathematics teaching as well as changing their methods of teaching mathematics through a carefully planned in-service or pre-service course which included mathematics content, information about the learning characteristics of young children, and methods of mathematics teaching. The section of the course related to mathematics would be predicated upon the need for teachers clearly to understand some very basic mathematics content and upon a need for them to see mathematics as having a game-like quality, the interest of a puzzle, and the possibility of being taught in a playful way. It would de-emphasize mathematics as a "rote" subject and emphasize its "meaningfulness," in Brownell's words. The section of the course related to how young children learn would emphasize their dependence upon perceptual information, their need to learn through acting upon materials, the importance of oral language development and the child's ability to use oral language to express his own ideas; and the section related to mathematics (more properly, pre-mathematics) instruction for young children would help the teachers (1) combine what they know about mathematics with what they know about how young children learn; and (2) acquire the predispositions and skills necessary to choose mathematics content and instruction that honor both the young child's natural modes of learning and the mathematics content this early learning would point toward.

Mathematics is a language and early mathematics learning is language learning - .ot word learning, language learning - and the language teachers model is very important. So is the kind of thinking they model through their language. Teaching young children is not an undertaking that can be carried out successfully by people who are not intelligent enough or sufficiently well-educated or well-trained to teach older children. We cannot persist in ignoring the intellectual capacity and mathematical understanding of the teachers of our young children. Ethnicity is not enough and loving is not enough.

To prejudge a child's ability or proclivities by his ethnicity or racial identity out of love for or identification with him may be very little better than to do so out of ignorance or bigotry. We cannot let ethnic or racial awareness blind us to the need to identify the best teachers for young minority children who will provide instruction appropriate to each child.

***

## Reference

Bruner, J. S. The growth of mind. American Psychologist, 1965, 20, 1007-1017.

# LANGUAGE AND CULTURE IN THE MATHEMATICS CURRICULUM OF THE 1980's

## ISSUES AFFECTING SPANISH BILINGUAL STUDENTS

BY
DR. TONY ALFREDO GALLEGOS
ASSOCIATE PROFESSOR OF EDUCATION
NEW MEXICO HIGHLANDS UNIVERSITY

LAS VEGAS, NEW MEXICO 87701

Much has been written and much will continue to be written with respect to bilingual elementary education. Much more has been written and much more will continue to be written with respect to elementary education.

Mathematics being one of the major components under the elementary school curriculum has always enjoyed and will continue to enjoy a fairly clear role in the regular elementary school curriculum.

However, from a brief review of the bilingual mathematics education literature available, one is not quite sure that bilingual educators have a clear perspective of the place and role of mathematics in the bilingual elementary school curriculum. Given the enormous volumes of bilingual education literature available in social studies, language arts, reading, culture, etc., and the relatively small amount availabe with respect to mathematics and the bilingual student, one is not quite sure that this issue has been or is being adequately addressed and researched.

On the basis of a significant number of years as a mathematics educator, mathematics consultant, and amateur mathematician, this panelist would like to pose the following questions for serious consideration:

(1) How serious is the language problem in teaching and learning of mathematics respecting bilingual students?

(2) What are the general characteristics/components currently and what should be the characteristcs/components of a bilingual elementary school mathematics curriculum?

(3) What is needed in bilingual elementary school mathematics teacher-training? What do inservice and preservice future teachers of bilingual elementary school mathematics need? How well are teachers now being prepared to teach bilingual elementary school mathematics?

(4) Would a serious analysis and response to the above questions begin to indicate a need for bilingal elementary school mathematics specialists?

Let us briefly and at best superficially address the four questions raised above.

(a) How serious is the language problem in teaching and learning mathematics as respects the bilingual student?

First of all, let us refer to the bilingual elementary school teacher who is to teach mathematics in Spanish. A necessary condition for the teaching of mathematics in Spanish is obviously that the teacher have an adequate command of the Spanish language as well as an adequate command of the technical mathematics vocabulary. This is only a necessary condition. This, however, is not a sufficient condition.

The teacher needs sound preparation in the concepts of elementary school mathematics. He-she needs to participate in and experience the learning of mathemaitcs on the level of an elementary school child. She-he needs to see and hear the teaching of elementary school mathematics totally in Spanish. The teacher-trainee needs to be exposed to and participate in the development of bilingual mathematics materials, models, kits and laboratory activities. He-she needs to internalize and articulate the purposes for and applications of concepts learned in mathematics. Thus teaching bilingual elementary school mathematics is more than learning to teach arithmetic in Spanish.

If the above is not done deliberately and conscientiously as an integral part of bilingual education, then anything short of it is unacceptable. Workshops, seminars, and other short, intensive types of sessions are okay for up-dating and for being made aware of innovations. But these types of training neither were nor are intended to provide the depth and breadth needed for the sound preparation of bilingual elementary school mathematics teachers.

Number two, let us briefly focus on the elementary child who is to learn mathematics but does not understand the English language well enough to learn in it. Then clearly we must begin to teach him in the language he understands--his first or native tongue. However, let us not assume that because we are teaching him in his mother tongue, he is going to learn mathematics.

Again, a necessary condition for teaching him mathematics is that we begin in his native language. However, this is not a sufficient condition for his learning mathematics. The learner must actively participate in the learning process, but more important yet, the teacher teaching in Spanish <u>must teach some mathematics</u>. This statement then implies that the teacher himself must be sufficiently versed in the subject matter itself as well as the child's language.

With respect to the issue of language, culture, and the learning and teaching of mathematics, this speaker would like to make the following assertion: There is a very substantial portion of elementary school mathematics which is either language and culture free or in which the effect of these variables my be reduced to a minimal. For example, in the areas of teaching algorithms as processes for doing a significant portion of arithmetic concepts and in presenting challenging problem-solving activities, language can be reduced to a minimum and yet mathematical processes and mathematical thinking can be maximized.

Mathematics is perhaps the major subject matter area in the elementary school in which a majority of students can experience success independent of native language and culture.

Question number 2: What are the characteristcs/components currently and what should be the characteristics/components of a bilingual elementary school mathematics curriculum? First of all, this speaker wants it understood that he is not taking about remedial bilingual elementary school mathematics nor does he at this time express an interest in such.

Regarding the current characteristics of a bilingual elementary school mathematics curriculum, a review of the literature will reveal that at the elementary level there are no complete, coherent, comprehensive bilingual elementary school mathematics programs. There are smatterings here and there of suggestions, examples, and commendable attempts, but nothing resembling, say, something of the magnitude of the Nuffield Project. There are no comprehensive curricula incorporating the major recommendations of the most influential national mathematics education groups regarding appropriate topics and their grade placement.

Let us briefly deal with the second part of question number two: What should be the main components of a bilingual elementary school mathematics curriculum?

First of all, let us say that a bilingual elementary school mathematics curriculum is not simply teaching arithmetic in Spanish. This speaker wants to unequivocally demand that the bilingual elementary school mathematics curriculum parallel a regular but strong or outstanding up-to-date elementary school mathematics curriculum or program.

The basic bilingual elementary school mathematics program must have as a minimum the following basic components:

1. Traditional Number Concepts and Operations
   - (a) sets
   - (b) whole numbers
   - (c) integers

(d) rational numbers

(e) real numbers

2. Number Theory

(a) figurate numbers and number patterns

(b) factors, divisors, LCM,GCD

(c) primes, composites

3. Probability and Statistics

(a) simple measures of central tendency and dispersion

(b) collecting and graphing data

(c) prediction from empirical data

4. Informal and Formal Geometry

(a) topological notions

(b) relations

(c) 1-2-3-dimensional geometry

(1) perimeter, area, volume

(2) straight-edge and compass constructions

5. Metric and English Measurement Systems

6. Problem-Solving and Applications to Permeate the Entire Program

(a) random trial and error methods

(b) systematic trial and error methods

(c) systematic problem solving strategies

If one reflects with seriousness and understanding on the above components of an elementary school mathematics program and the innumerable possibilities for teaching processes, algorithms, and skills, one can clearly see that language and culture need not be an insurmountable barrier in the teaching of mathematics to the bilingual elementary school student.

Let us consider the third class of questions: What is needed in bilingual elementary school mathematics teacher-training? What do in-service and pre-service, future teachers of elementary school bilingual mathematics need? How well are teachers prepared?

This panel participant would want to think that no one would quibble with the statement that the following are critical needs in elementary school bilingual mathematics teacher-training:

(1) There must be adequate preparation in mathematical concepts and skills to be able to comfortably and efficiently teacher the curriculum outlined above. The idea of workshops and seminars is okay for certain limited purposes, but they cannot provide the breadth and depth needed. Only strong teacher-training programs will provide such breadth and depth.

(2) Beyond the acquisition of concepts and skills, the bilingual elementary school mathematics teacher needs adeuqate preparation in the use of the language of mathematics. Thus to communicate clearly and accurately mathematical concepts, one must possess the technical language of mathematics.

(3) Many mathematics concepts must initially be presented at the concrete and semi-concrete levels before going to the abstract level. Hence the teacher must be given extensive experience in the preparation and use of homemade teaching materials.

(4) The teachers in the elementary school must have firsthand experience in problem-solving activities and in applications of mathematical concepts to be able to meaningfully present them in the classroom.

(5) Furthermore the teacher-training program must prepare the elementary school teacher to be able to develop mathematics laboratories and mathematics interest centers and implement interesting, exciting, and meaningful laboratory activities.

Briefly summarized, then the adequate preparation of teachers of bilingual elementary school mathematics programs becomes a very serious, multifacted endeavor. Bilingual elementary school mathematics teaching is a very serious business and it must be recognized and treated accordinly. It cannot be left to the uninformed or untrained in mathematics education.

A bilingual elementary school mathematics curriculum is not a haphazard collection of rote activities, fun and games, and concepts. It must be coherent, organized, sequenced. It must be as good or better than the regular elementary school mathematics curricula. Anything less than this is unacceptable to this participant as a dedicated, conscientious mathematics educator.

Regarding the state of bilingual elementary school mathematics teacher-training, and the bilingual elementary school mathematics curriculum, the most obvious conclusion is that one is logically obligated to as for nothing short of preparing bilingual elementary school mathematics specialists. THANK YOU

# ISSUES AFFECTING BILINGUAL EDUCATION

# IN ELEMENTARY EDUCATION

BY

DORA A SERNA

LAREDO, TEXAS

Issues Affecting Bilingual Education
in Elementary Education

Do language and culture affect the learning of mathematics? Is bilingual education really necessary to teach mathematics to children who speak two languages or who speak only one language other than English? There are many conflicting opionions in reference to these two questions. However, I believe, most agree that mathematics is the subject area that is most independent from language and culture. Many students believe that mathematics is a hard subject whether they are bilingual or not which brings us to believe that the problem in learning mathematics is not the language but the subject itself or the way it is taught. Mathematics need not be a hard subject because it is not. The problem, I believe, is that when children at kindergarten and the elementary grades are taught mathematics they are not taught by mathematics specialists. Generally they are taught by teachers who teach all subject areas. This, I think, is wrong. I do not see how anyone could be an expert in all subject areas. Many teachers themselves do not like mathematics, or do not feel comfortable teaching it, and this feeling is transmitted to the student. Mathematics has a vocabulary of its own and unless the teacher is proficient and well versed in it, he or she will not be able to teach the vocabulary and the concepts of mathematics. It is very important that children be taught the concepts at an early age. It is not right to make them memorize things. They should understand the concepts and it takes a mathematics specialist to be able to do this.

When a child comes to school speaking only his or her mother language, let us say Spanish, and speaks no English at all, then it is necessary that he/she be taught bilingually. But, I believe, this is necessary only until he/she has begun to speak the English language which should not take too long. Mathematics, as I have said before, has a language of its own and if the child is taught mathematics only in English, it should not be too difficult. He or she may get more confused if the teacher tries to teach mathematics to him/her in the two languages. It would be easier if he/she masters the mathematics concepts and skills using one language (English) only. The important thing is that he/she masters the concepts.

If a school system decides to teach mathematics bilingually, the teacher doing it should be one who is proficient in the Spanish language as well as being a mathematics specialist. I do not think that a teacher should be hired to teach mathematics in a bilingual program only because he/she speaks Spanish fluently. The most important thing is that he/she is a mathematics specialist.

One big problem in teaching mathematics in a bilingual program is that there are no complete, comprehensive bilingual materials. The teacher must do the best he/she can with the very few materials available. This is one area where research should be made. Why are there no materials? The teacher usually has to translate his/her own materials to be able to teach in a bilingual setting. This should not be. It takes too much of the teacher's time to do the translating. Adequate materials should be provided so that the teacher can spend his/her time and efforts in teaching.

# SALIENT ISSUES IN MATHEMATICS EDUCATION RESEARCH AFFECTING MINORITIES

by
HILDA SERNA

LAREDO, TEXAS

Salient Issues in Mathematics Education
Research Affecting Minorities

The planning and the implementation of the mathematics curriculum should offer success with a realistic measure of challenge and positively affect self-concepts of children. The awareness of the need for change and improvement in the education of our non-English speaking children has caused educators to develop the approach of instruction of bilingual education. There are, however, many complex issues in bilingual education that need extensive study and research. The following are salient issues in mathematics education affecting minorities in the United States.

There is the lack of sufficient quality instructional materials needed to attain goals and objectives of school programs. The construction of the curriculum material should be based on structure, situation and interest. The evaluation, selection, and adaption of instructional materials suitable for local use is a challenging and large undertaking for teachers and local school administration. A vast and cooperative effort is necessary to develop criteria and to create quality materials.

Minorities tend to score higher on performance tests of computational ability. Bilingual instructional materials emphasizing learning by seeing, doing, and participating should be explored.

Abstract reasoning in mathematics requiring knowledge and comprehension of the English language hinder the non-English speading children's performance. Standardized tests in English do not give an accurate measure of the achievement of bilingual children. The development of measuring instruments (standardized achievement tests) with linguistic and cultural differences should be explored to measure the achievement of minority populations.

The nation expects the school districts to make adjustments and reshape themselves to fit standardized test norms. The possibility of altering the norms to fit every local school district should be considered.

# A CRITICAL REVIEW OF RESEARCH ON MATHEMATICS EDUCATION OF CHINESE AMERICAN STUDENTS

Sau-Lim Tsang
Asian American Bilingual Center

Presented at the
National Council of Teachers of Mathematics
58th Annual Meeting
Seattle, Washington
April, 1980

A CRITICAL REVIEW OF RESEARCH ON MATHEMATICS EDUCATION OF CHINESE AMERICAN STUDENTS

## INTRODUCTION

According to data collected by the National Center of Education Statistics, there were 578,000 Chinese living in the United States in 1976. Two-thirds of them were born overseas and ninety percent of these foreign-born Chinese lived in households where Chinese was the dominant language (Bulletin, 1979). The number of Chinese is continuously increasing at a rate of at least 20,000 per year, which is the number of immigrants allowed into the United States per country of origin. This, together with the recent influx of ethnic Chinese refugees from Vietnam, will probably bring the 1980 census count of Chinese in the United States to three-quarters of a million.

The Chinese population in the United States historically has been an urban one, and in 1976, over ninety percent of that population lived in urban areas (Gee, 76). The large number of Chinese students in schools poses a tremendous challenge for educators. The linguistic and cultural backgrounds of Chinese students have influenced their acquired knowledge, concepts, and methods of learning. In addition, immigrant students have been influenced by the curricula, teaching methods, and other pedagogical practices of their native countries. Because of these unique backgrounds, Chinese students very likely have special educational needs. However, the lack of research on the educational concerns of Chinese American students has left educational practitioners with no guidance. Consequently, more and more problems with Chinese in the public schools have surfaced (Sung, 1979).

This paper will summarize the few research studies related to the mathematics education of Chinese students in the United States. It will further suggest priorities for future research. The contents of the paper, though specific to Chinese Americans, could have some significance to other ethnic minority groups in the United States.

## MATHEMATICAL ACHIEVEMENT

Chinese students are usually described by educators as high mathematics achievers. Several studies tested the validity of this assumption. Mayeske et al. (1973) reanalyzed data collected for the Coleman Report (1966) and compared the achievement levels of different ethnic groups. A group consisting mainly of Japanese, Chinese, and Filipinos, labeled "Oriental,"[1] represented one percent of the total sample. This group scored slightly lower (0.1 S.D.) than whites in mathematics achievement. In 1960, another large-scale study, Project Talent, collected achievement data on 400,000 students in grades 9 through 12, a four to five percent national sample. Information on ethnicity was collected in the five-year follow-up study through mailed questionnaires. Using a selected sub-sample of the upper-middle and lower-middle SES students, Backman (1972) found that the Orientals' mathematics achievement was at the same level as Jewish whites but higher than both non-Jewish whites and blacks. Lesser, Fifer, and Clark (1965) studied the mental ability patterns of four ethnic groups in New York City--Chinese, Jewish, black and Puerto Rican. A test battery consisting of four scales was administered to the children. Two of the scales measured the students' numerical ability and their space conceptualization. Results showed that, on both scales, the Chinese students performed at the same level as the Jewish students, and these two groups performed significantly better than the black and Puerto Rican groups. Stodolsky and Lesser (1967) replicated the study with first grade Chinese, black, and Irish

1. "Oriental" is a vague term used in the questionnaire of the Coleman study. The term has since became unacceptable and has been replaced by the term <u>Asian American</u>.

students in Boston. The Chinese and Blacks showed levels and patterns of ability similar to those in the original study. Tsang (1976) administered a computational scale from the National Longitudinal Study of Mathematics Achievement (NLSMA) test battery to a group of 323 seventh and eighth grade Chinese students in three California cities. The Chinese students scored a mean of 14.69 on this twenty-item scale, compared to the national mean of 11.28 registered by the seventh and eighth graders in the NLSMA study.

Data collected from the two national studies (Mayeske et al., 1973; Backman, 1972) showed that Chinese students were achieving the same level as whites in mathematics. The Lesser et al. study and its replication by Stodolsky et al. indicated that Chinese students were achieving at the same level as Jewish students. Tsang's study showed that Chinese students scored above the national norm on a computational scale.

One must be careful when interpreting these results. First, the four studies, except for the study by Tsang (1976), were based on data collected before or immediately after the passage of the Immigration and Naturalization Act of 1965. This new immigration act now allows 20,000 immigrants per country of origin per year into the United States. A comparison of the 1960 and 1970 census showed that the Chinese population in the United States had grown by 84%. The majority of the increase were immigrants who came to the United States between 1965 and 1970 (Gee, 1976). Data collected before 1965 might not be valid for the current interpretation, since the makeup of the Chinese population has undergone immense change. Second, the two national studies (Mayeske et al., 1973; Backman, 1972) used "Orientals" as a comparison group. The term "Oriental" applies to many ethnic groups and these groups differ from each other in many aspects (Kitano, 1980). The data might not be an accurate indication of the Chinese students' achievement. The third problem is the failure of all these studies to provide a more comprehensive picture of mathematics achievement by dividing it into pertinent components, e.g., computation, comprehension, application, problem solving, etc. The studies reviewed reported a single score either on mathematics achievement or on computation. It is possible that Chinese students are better than other students in computation but not in other levels of mathematics achievement.

To obtain a clearer understanding of the mathematics achievement of Chinese students, further research in this area is needed. A convenient way to accomplish this would be to collect detailed information on the ethnicity of the students participating in the National Assessment of Educational Progress (NAEP) and to compare the achievement of different ethnic groups. The items on ethnicity on the 1980 census could serve as a model for such an effort.

## TESTING

Educators have studied the validity of standardized testing on minority children. Standardized tests were found to be heavily loaded with verbal and cultural-based items. Children whose home language is other than English or whose home culture is not in the cultural mainstream are usually handicapped when taking these tests.

Tsang (1976) studied the effects of the language and cultural contents of standardized mathematics tests on Chinese students. Twenty word problems which were determined to be culturally biased were selected from several standardized mathematics achievement tests. Four different versions of a test were constructed using the twenty word problems--one using the original items in English; one with items written in both English and Chinese; one in English with its content modified to adjust for the cultural biases; and one with the modified items written in both English and Chinese. The four versions were randomly distributed and administered to 323 Chinese seventh and eighth grade students in California. All four versions registered a high coefficient of reliability. Results showed that students who had lived in the United States for fewer than three years, i.e., recent immigrants, scored better on the bilingual versions of the test. When the immigrant group was divided into high and low achievers, only the low groups scored better on the modified items than on the original items. The high immigrant group performed at the same level on both versions. For those who had resided in the United States for more than three years, no significant effects were found.

Wu and Slakter (1978) compared the risk-taking and test-wiseness of Chinese American students with those of Euro-American students. Chinese American students had the same mean risk score as the Euro-American students and were consistently lower in mean test-wiseness scores than the Euro-Americans. This study, however, did not examine the cultural background variable of the Chinese students; the immigrant Chinese students might score differently than those who were born and raised in the United States.

Educators have also studies the effectivenes s of minority students test-taking strategy. Bernal (1971) and Ginther (1978) found that this technique increased Chicano students' performance on tests of unusual format or tests that require non-standard test-taking strategy. Tsang (1976) administered a Word Association test to a group of Chinese immigrant students and a group of Euro-American students in California. In this test, the students were given a set of stimulus words, and for each word, the students were asked to write down in one minuite as many words as they could think of which were related to the stimulus word. The Euro-American students encountered no difficulties in this task while over fifty percent of the Chinese immigrant students did not write down any response. The study was redesigned by Ng and Tsang (1980). In this study, examples and exercises were given to the Chinese students on how to complete the task of the Word Association Test. The Chinese students consequently showed no difficulties in completing the actual test.

These studies suggested that mathematics tests should be written in bilingual format when administered to immigrant students. The cultural content of the achievement tests, although controversial, did not seem to have a large effect on mathematics tests. This is especially true for the high achievers, who seem to be able to ignore the cultural content of the word problems and directly confront the mathematical problems they contain. When a test is written in an unusual format or requires special test-taking strategy, pretraining should be given to the student to familiarize them with the format and the task.

The results of the study on test-wiseness is interesting. However, more research in this area is needed before conclusions could be drawn. Future studies should especially examine the problem-solving strategies of Chinese students when doing routine and non-routine problems.

## PIAGETIAN TASKS

Piaget's theory of the growth of human knowledge has been widely studied in a cross-cultural context. With few exceptions, children from different cultures respond to the various conservation tasks according to the stages described by Piaget. However, the mean age of the children at each stage varies depending on the culture--i.e., children from certain cultures acquire conservation earlier than others.

DeAvila (1978) administered the Cartoon Conservation Scale, a Piagetian-based measure consisting of five subscales measuring various conservation concepts, to a group of Chinese American students in California and two groups of Mexican Americans in Texas and California. The grade one Chinese American students were found to be less advanced than the Mexican American students in conservation tasks, while the results for the third grade students were reversed.

The application of Piaget's theory of cognitive development in mathematics education is limited because of the wide range of students in different stages of conservation in any classroom. This prevents the teachers from tailoring the mathematics curriculum to a specific stage of conservation.

Despite this difficulty, the clinical approach employed by Piaget should be applauded. Similar methodologies should be used to study how Chinese children acquire basic mathematical concepts--addition, subtraction, equality, cardinal and ordinal values, etc. The linguistic and cultural backgrounds of the Chinese children might have a relationship to the development of their basic mathematical concepts, which might differ from that of children whose native language is English.

CURRICULUM

In order to maximize a student's learning, mathematics curriculum must be designed to meet the needs of the student. The curriculum should reinforce what has been learned previously and introduce new concepts based on previous knowledge. In a typical classroom, the teacher, guided by a curriculum framework, school records and personal contact, knows the student's educational background and the type of curriculum to which s/he has been introduced. In the case of the Chinese students, the large number of immigrants complicates the situation. Immigrant students come from different cultures and are products of the educational system of their respective countries. Teachers do not know about their educational background and the curriculum to which they were introduced. With mathematics curriculum, the problem is apparent. The curriculum revision effort of the last two decades in the United States has led to significant differences between the mathematics curriculum of the United States and those of many other countries. The immigrant students' knowledge of mathematics might be very different from that of students educated in the United States. However, with no research findings to guide their pedagogy, teachers usually let the immigrant students enroll in the regular mathematics classes and assume their needs are identical to that of the regular students.

Tsang (1977) conducted an exploratory study on student mathematical cognitive structure, a set of relationships between concepts that exist in a student's memory after instruction. He compared the mathematics cognitive structure of junior high school students educated in the United States with those of students recently arrived from Hong Kong. A Word Association test, which used eighteen mathematical concepts selected from textbook series of the United States and Hong Kong, was administered to the students after a practice example had been demonstrated. The results showed group differences involving concepts in geometry, in the four basic operations, and in the concept of fractions. However, several factors--access to only a small sample consisting of two intact classes, the inexplicably large attrition in the immigrant group, the use of a single analytical technique and of descriptive methods when comparing results--prevent the study from generating any useful conclusions.

Another study was designed by Ng and Tsang (1980) to further the investigation. Three groups of students were involved in this study--Euro-Americans, Chinese Americans, and Chinese in Hong Kong. A battery of ability tests, together with the Word Association test and the Sorting test, were administered to the students. Twenty mathematical concepts selected from text series in the United States and Hong Kong were used in the Word Association test and the Sorting test. Results showed that all three groups of students viewed the mathematical concepts in three clusters--geometric, set theory, and number theory clusters. The Word Association results also showed that the Hong Kong students were similar to the United States students in their conception of the four basic operations and the set theory concepts. However, geometric and rational number concepts were more closely associated by United States students than by Hong Kong students. Results of the Sorting test reported similar findings.

These two studies indicated that students in Hong Kong and immigrant students from Hong Kong have a different perception of mathematics concepts than do native United States students. However, the results are general. Further studies investigating specific differences are warranted before the results can be applied to classroom instruction and curriculum development. Research in this area should include comparative study of text series, comparative study of patterns of errors committed by immigrant students and United States students, and ethnographic study of immigrant students' problem-solving processes.

## CONCLUSION

The obvious conclusion is that there is a lack of research on mathematics education of Chinese American students. This phenomenon, in fact, is not unique to Chinese Americans. The number of research studies on mathematics education of other Asian American groups is also extremely small. This scarcity of research in mathematics education is even true for Hispanic Americans, the second largest minority group in the United States. This lack of research might be due to 1) the insensitivity of mathematics educators to ethnic minority students, 2) the small number of mathematics educators from the different ethnic minority groups, and 3) the indifference of the federal government and other research support agencies toward the mathematics education of ethnic minority students. Mathematics educators, professional organizations, and federal agencies should divert their research interests and efforts towards this area by generating and supporting more research on the mathematics education of minority students.

The first priority, specifically for the Chinese-American students, is to meet the special needs of the large and ever increasing number of immigrant students. Research should address how these students' mathematics knowledge and problem-solving strategies differ from those of students educated in the United States, and whether the differences are due to the curricula of their native country, instructional practices of teachers, their cultural background, or a combination of the above factors. When adequate information on these differences is gathered, instructional intervention methods, both in terms of teacher practices and curriculum materials, can be devised to guide them gradually into the regular mathematics curriculum of the United States.

## REFERENCES


Backman, M.E. Patterns of mental abilities: ethnic, socioeconomic and sex differences. American Educational Research Journal, 1972, 9, 1-12.

Bernal, E.M., Jr. Concept learning among Anglo, Black, and Mexican-American children using facilitation strategies and bilingual techniques. Unpublished doctoral dissertation, University of Texas at Austin, 1971.

_____________. Bulletin, 79, 144. Washington, D.C.: National Center for Education Statistics.

Coleman, J.S., et al. Equality of educational opportunity. Washington, D.C.: U.S. Government Printing Office, 1973.

De Avila, E.A. Research on cognitive styles with language minority children: Summary of pilot study design and data analysis. Reprot presented at the Seventh Annual Conference of the National Association for Bilingual Education, San Juan, Puerto Rico, April, 1978,

Gee, E. (Ed.) Counterpoint. Los Angeles: Asian American Studies Center, University of California, 1976.

Ginther, J.F. Pretraining Chicano students before administration of a mathematics predictor test. Journal for Research in Mathematics Education, 1978, 9, 118-125.

Kitano, M.K. Early education for Asian American children. Young Children, 1980, 35, 13-26.

Lesser, G.S., G. Fifer, and D.H. Clark Mental abilities of children from different social-class and cultural groups. Monographs of Society for Research in Child Development, 1965, 30.

Mayeske, G.W., T. Okada, A.E. Beaton Jr., W.M. Cohen, and C.E. Wisler A study of the achievement of our nation's students. Washington, D.C.: U.S. Government Printing Office, 1973.

Ng, K.M., and S.L. Tsang Mathematical cognitive structures of Chinese American, Euro-American, and Hong Kong Chinese students. Paper presented at the American Educational Research Annual Conference, Boston, Massachusetts, April, 1980.

Stodolsky S.S., and G.S. Lesser Learngin patterns in the disadvantaged. Harvard Educational Review, 1967, 37, 546-593.

Tsang, S.L. The effects of the language factor and the cultural content factor of mathematics achievment tests on Chinese and Chicano students. Unpublished doctoral dissertation, Stanford University, 1976, Tsang, S. L. Mathematical cognitive structures of junior high students educated in the United States and of those recently arrived from Hong Kong: An exploratory study. Berkeley, CA: Asian American Bilingual Center, 1977.

Wu, T.H., and M.J. Slakter Risk taking and test wiseness of Chinese students by grade level and resident area. The journal of Educational Reseach, 1978, 71, 167-170.