1996

A content analysis study of Portable Assisted Study Sequence mathematics curricular materials for migrant students using the National Council of Teachers of Mathematics Standards

Karen I. Conger

A CONTENT ANALYSIS STUDY OF PORTABLE ASSISTED STUDY SEQUENCE MATHEMATICS CURRICULAR MATERIALS FOR MIGRANT STUDENTS USING THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS STANDARDS

A DISSERTATION SUBMITTED TO
THE FACULTY OF WALDEN UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

EDUCATION

BY

KAREN I. CONGER

August 1996

UMI Number: 9705725

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WALDEN UNIVERSITY
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ABSTRACT

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ABSTRACT

The need for change in the mathematics curricula in our public schools has been well documented (Kirwan, 1990; National Commission on Excellence in Education, 1983; National Research Council, 1989; Overby, 1993). Testing surveys show low overall performance at every age throughout the K-12 levels. The Curriculum and Evaluation Standards for School Mathematics, (Standards) issued by the National Council of Teachers of Mathematics (NCTM) in 1989 are designed to move mathematics curricula forward to meet the needs of students for the future. The analysis of new curricular materials is essential in order to produce materials that meet recommended standards.

Migrant students represent one segment of the student population with deficiencies in mathematics training at the K-12 level. The Portable Assisted Study Sequence (P.A.S.S.) Program serves migrant students in 165 schools in California, and must provide materials which comply with the Standards. This study analyzed and compared this compliance in two mathematics courses written in 1989 and 1995 for P.A.S.S. An evaluative instrument was designed to measure the extent to which reform ideas in the Standards are represented in the curricular materials. Content analysis procedures were used to analyze the curricula with the assistance of Nud*Ist software.

Research design for the instrument included procedures for content validation and interrater reliability. The results of this study showed the 1995 P.A.S.S. curricular materials measurably improve upon the 1989 curricular materials with respect to the Standards. The evaluative instrument was found to effectively and reliably measure the extent to which curricular materials meet the Standards.

This study provides guidance and direction for teachers, students, curriculum developers, and future researchers at local, state, and national levels. Standards are a major component of education, and this study represents a pioneering effort to quantify the changes that can hopefully help our society meet these goals. This process can be replicated in other disciplines, which increases the potential for social change. Significant curricular reform will have significant social impact.

Dedication

I dedicate this dissertation

to Rosebud, Patches, and Sapphire, who were always by my side,

but most of all to my 3 best friends--

my husband Thurston, my daughter Kaarstin, and my son-in-law Mike.

Your thoughtfulness, patience, love, and help sustained me throughout,

and I will always treasure the memories.

Acknowledgments

I wish to express sincere appreciation to my Doctoral Committee Chair and faculty advisor, Dr. Marilyn K. Simon, for her unfailing support, inspirational advice, and timely encouragement throughout this study. Her great wisdom and unique humor helped me, in chaotic terminology, to find order masquerading as randomness. I also wish to thank the other members of my Doctoral Committee, Dr. Paul A. Bloland and Dr. Barry Persky, for their willingness to serve on my committee, as well as their insights, expertise, and support throughout the Walden program.

To my validation panel, comprised of Dr. Jane D. Gawronski, Dr. Carol Fry Bohlin, and Dr. Roy M. Bohlin, and the mathematics department at my school, I express thanks for their guidance, assistance, expertise, and time which were invaluable to this study. To the administration at my school, I express profound gratitude for the encouragement and supportive working environment they have given me to pursue this dream.

To the assistant coders and computer programmer who assisted me in this study, I express my eternal gratitude for their help with coding, scanning, programming, typing, and computer maintenance. I am appreciative beyond measure for their devotion to this study and their sharing in the vision.

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CHAPTER 1

Introduction

> Up in the mountains, he knew, the ants changed with the season. Bees hovered and darted in a dynamical buzz. Clouds skidded across the sky. He could not work the old way any more.
>
> - J. Gleick (1987, p. 317)

The need for change in the mathematics curricula in our public schools is well documented (Kirwan, 1990; National Commission on Excellence in Education, 1983; National Research Council, 1989; Overby, 1993). The National Research Council's Committee for the Mathematical Sciences in the year 2000 released a final report in January 1991. The chairman of the committee, William Kirwan, reported that "too few people are learning mathematics at all levels of our educational system" (Kirwan, 1990, p. 23). Our attrition rate in mathematics from ninth grade on is about 50%. We fail to keep women and minorities in mathematics, and "mathematics has one of the poorest attrition rates of all the sciences for women from the bachelor's to the Ph.D" (p. 24). Children of migrant workers are reflected in these dismal statistics. Overby (1993) reports dropout rates for migrant students of 43%

as compared to Mexican-Americans of 35.8%. Many of the reasons for these failures point to deficiencies in mathematics training at the K-12 level. Testing surveys show low overall performance at every age throughout the K-12 levels. Even "the most able U.S. students--the top 1% in ability--scored the lowest in algebra and among the lowest in calculus" (Kirwan, 1990, p. 25) when compared to high school seniors from 13 countries. The Curriculum and Evaluation Standards for School Mathematics (the Standards) issued by the National Council of Teachers of Mathematics (NCTM) in 1989 are designed to move mathematics curriculum forward to meet the needs of students for the future. The NCTM News Bulletin (1995) cites a study by the Council of Chief State School Officers that indicates "that a majority of states are now involved in developing, revising, and implementing state frameworks in mathematics . . . [and] . . . that many mathematics frameworks agree with the thrust of the Standards" (p. 1).

The analysis of new curricular materials is essential in order to produce materials that meet recommended standards. Assessing the curriculum in relationship to the Standards is not an easy task. The Standards states this explicitly:

> A deep, thorough analysis is necessary to determine the extent to which a curriculum and its materials are compatible with the Standards. The Standards offer a framework for curriculum development but not a scope and sequence. Simply checking topics on a scope-and-sequence chart is insufficient to determine the extent to which a curriculum and its materials are compatible with the Standards. A comparative analysis must provide qualitative documentation of the degree of consistency between the Standards and the curriculum. Such results can then be used to make decisions about the adoption of materials and how the curriculum needs to be modified to be more consistent with the Standards. (pp. 241 - 242)

The migrant student population in California is served through the Portable Assisted Study Sequence (P.A.S.S.) Program. The students frequently relocate to other school districts in California and in other states throughout the school year. This creates a problem when transferring academic credits because generic descriptions such as "algebra" or "geometry" do not readily define the content in the student's mathematics experience. The P.A.S.S. Program meets the needs of migrant students by providing courses designed in units. Students carry the portable units with them to other school sites to continue the course of study. Each mathematics course is divided into 10 units, and each unit is self-contained with content clearly defined. A multiple-choice test is given upon completion of the unit and students must exhibit mastery at 70% before they can continue to the next unit. This process enables teachers and counselors to more easily determine credits for transferring students.

This study analyzed the content of a 1st-year mathematics course written for P.A.S.S. and compared it to the course it replaced with respect to the NCTM Standards. A major contribution of this process included the design of an evaluative instrument meeting the Standards that can be used for both development and assessment of further mathematical curriculum. The instrument was used in this study to analyze the P.A.S.S. curricular materials in relationship to NCTM Standards.

Statement of the Problem

Educating the migrant student population is one of the greatest challenges that the California educational system and the United States educational systems face today. Students from this population frequently relocate to other schools and to other states. The Portable Assisted Study Sequence (P.A.S.S.) Program serves 165 schools in California and was created to help assuage some of the difficulties that these students encounter. The P.A.S.S. Program must not only provide materials that will be appropriate for the migrant student, but must also comply with the National

Council of Teachers of Mathematics Standards for School Mathematics (NCTM Standards or Standards). Until now, no study has been conducted that has analyzed the P.A.S.S. mathematics curricular materials in relationship to the Standards. Furthermore, an evaluative instrument designed to measure the extent to which reform ideas in the Standards are represented in the curricular materials has been sorely needed, and to date, has not existed.

Background of the Problem

> Everyone depends on the success of mathematics education, everyone is hurt when it fails.
>
> \- National Research Council (1989, p. 7)

This study focuses on the content analysis of the mathematics curricular materials designed for the migrant student in relationship to National Council of Teachers of Mathematics (NCTM) reform Standards ideals. The development of curriculum aligned to reform standards is a complex process. Furthermore, developing curriculum for the migrant student requires an understanding of the issues surrounding that segment of the school population.

Curriculum and Reform Standards

Curriculum is "a plan, a set of directions whose chief purpose is to guide the work of the schools. That work is called teaching or instruction" (English, 1987, p. 9). Curriculum has a variety of forms such as textbooks, study guides, district, state, and board regulations and policies, and any supplementary materials which are used to make decisions pertaining to content or subject matter. The National Council of Teachers of Mathematics defines curriculum as

> an operational plan for instruction that details what mathematics students need to know, how students are to achieve the identified curricular goals, what teachers are to do to help students develop their mathematical knowledge, and the context in which learning and teaching occur. (Standards, 1989, p. 1)

The Commission on Standards for School Mathematics was established in 1986 by the Board of Directors of NCTM. This was in response to a need to improve school mathematics expressed in publications such as A Nation at Risk (National Commission on Excellence in Education, 1983). Many of the reform ideas in the Standards are supported by data found in publications such as Everybody Counts (National Research Council, 1989). One of the major recommendations made in this report involved the inclusion of all students in a core of broadly useful mathematics. Furthermore, "all students should study mathematics every year they are in school" (p. 50). The NCTM Standards were published in 1989 as a response to this need for mathematics reform.

A standard is a "statement about what is valued" (National Council of Teachers of Mathematics, 1989, p. 2) and ensures quality, indicates goals, and promotes change. The Standards assert that the educational system must meet new social goals. These are defined as providing for society mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate. Students must learn to value mathematics, become confident in their mathematical abilities, become mathematical problem solvers, learn to communicate mathematically, and learn to reason mathematically (p. 5).

The Standards emphasize the need to "do" rather than "know" (1989, p. 7). Interdisciplinary curriculum must be included to supplement and replace portions of traditional engineering and physical science applications. Technology must be included and updated to reflect the nature of mathematics. The curriculum must be available to all students if "they are to be productive citizens in the twenty-first century" (p. 9). Students must participate in activities that model genuine problems, and be encouraged to experiment, discuss, and discover ideas and concepts.

An important component in meeting Standards recommendations is determining the extent to which curriculum is aligned to the reform ideas. Assistance is given in A Guide for Reviewing School Mathematics Programs (NCTM, 1991). This publication provides guides for the K-12 mathematics program to "determine the level of implementation that currently exists. . . . Users should feel free to modify these outlines or develop new ones" (p. 1). The general guides for two curricular areas, Grades 5-8, and Grades 9-12, which were considered to be "the most useful for systematically analyzing textbooks or other materials that are being considered for adoption" (p. 3), were followed for this study. These guidelines were used in the design of an evaluative instrument meeting the Standards that can also be used in curriculum development.

The Migrant Student

The ethnic population of our public schools is rapidly changing. It is estimated that by the year 2010 more than one half of our children "under 18 years of age will be minorities: Hawaii (80%), New Mexico (77%), California (57%), Texas (57%), District of Columbia (93%)" (Klauke, 1989, p. 1). Projections to 2020 indicate an Hispanic population of over 47 million in the U.S., representing 15% of the total population (Bedard, Eschholz, & Gertz, 1994, p. 72). The U.S. Census Bureau reported nearly 13,000,000 Mexican-Americans living in the United States in 1989. Headden (1995) reports nearly three million students in the American educational system are designated as limited English proficient (LEP), and 45% of these students live in California. Most of the LEP students in California are Latino (p. 45), and many of these students are children of migratory workers.

The migrant student is a child defined by family mobility and type of labor. Migratory workers move from one state to another for the purpose of finding temporary or seasonal employment (U. S. Department of Education, 1985). Most are agricultural workers or migratory fishermen who move from one district to another during the regular school year (Cahape, 1993;

California Department of Education, Handbook, 1992). Cahape (1993) reports there are over half a million migrant children enrolled in public education in the 50 states, the District of Columbia, and Puerto Rico. Trotter (1992) argues that many migrant children are unidentified and claims "estimates of all those engaged in migrant labor range between 1.7 million and 6 million" (p. 16). The Migrant Education Program was authorized in 1965 through the Elementary and Secondary Education Act. Federal program regulations require state Departments of Education to identify and educate migratory children. The California Department of Education assumes responsibility for all statutory and regulatory requirements of the program including subgrantees. Funding is based on a "Full-time Equivalent (FTE) count of each individual child for each day of residence in the State. This count is based upon the entry of data into the Migrant Student Record Transfer System (MSRTS) for each State for each year" (California Department of Education, Handbook, 1992, p. 1-2). The California Portable Assisted Study Sequence (P.A.S.S.) program is based in part on a newer Federal Law, P. L. 100-297, which was passed in 1988, and California Assembly Bill No. 1382, which was passed in 1981. This program serves the migrant students in California and provides services throughout the U.S. to other migrant programs.

California Portable Assisted Study Sequence (P.A.S.S.) Program

The California Portable Assisted Study Sequence (P.A.S.S.) program serves migrant students throughout California. The P.A.S.S. Program's goals are described in the P.A.S.S. Handbook:

> Provide portable learning packages adapted for migrant students, enabling them to proceed at their own pace, provide competency-based credits for skills, interests, and educationally related-life experiences, supplement the regular instruction for targeted migrant students at secondary-level schools in California, and utilize existing counseling and tutorial support through regular migrant education personnel, and the California Mini-Corps to accomplish the goals of the P.A.S.S. Program. (p. 1)

The P.A.S.S. Program allows migrant students to accumulate credits that are transferable within the state and to many other states. The list of states include Arkansas, Arizona, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kansas, Michigan, Montana, Nevada, New York, North Dakota, Oregon, Texas, Utah, Washington, and Wisconsin. Ten units provide credits for two semesters. The portable units can be continued at new school sites throughout California "thanks to the coordination of services among the migrant staff at the school sites" (p. 2). The California P.A.S.S. Program is accredited through Fresno Unified School District, and the Western Association of Schools and Colleges.

Study Background

The investigator is a mathematics teacher at a secondary school in a small community of approximately 10,000 residents in California. The school's student population of approximately 1,100 is comprised largely of rural students with two thirds from Latino ethnic backgrounds, many of whom are migrant students from Mexico.

The P.A.S.S. Program offers four sequential 1-year mathematics courses to secondary migrant students. The 1989 general mathematics course General Math A and General Math B was the first course in the sequence until it was replaced with the 1995 P.A.S.S. integrated mathematics course Integrated Math A and Integrated Math B. The 1995 course was written to update the 1989 curriculum by emphasizing interdisciplinary connections and higher-order thinking skills in alignment with the California Framework

(California Department of Education, 1992). The NCTM Standards affirm and enhance the goals of the California Framework.

Purpose of the Study

This study was undertaken because no research has analyzed the Portable Assisted Study Sequence (P.A.S.S.) mathematics curricular materials in relationship to the NCTM Standards. Furthermore, an evaluative instrument designed to measure the extent to which reform ideas in the Standards are represented in the curricular materials did not exist. These are needed because it is becoming increasingly important to evaluate curriculum with respect to the Standards if we intend to radically change our mathematics curriculum.

Significance of the Study

This study has value at three levels: local, state, and national. The P.A.S.S. materials are used locally, throughout the state, and manually carried by students to many other states as part of the P.A.S.S. program. The P.A.S.S. Program offers four sequential 1-year mathematics courses to secondary migrant students. The 1989 general mathematics course is the first course in the sequence. The 1995 materials are intended to provide content and experiences in alignment with NCTM Standards to direct and guide teachers and students. This updated curriculum can be developed further as sequential courses are written. This will result in a new curriculum designed around the concepts and transitions inherent in the NCTM Standards. Analysis of this important first course (1995) is valuable for future course developers as they make decisions to continue developing the courses to meet NCTM Standards.

Mathematics teachers throughout the state and nation can benefit from this study. The flexibility and adaptability of curriculum to meet NCTM Standards require mathematics teachers to provide and evaluate supplementary material to determine its applicability to the Standards. The analysis of content in relationship to the Standards is complex and time-consuming. This study can help secondary mathematics educators interpret and select the supplementary materials they produce or provide in their own mathematics classroom. The instrument itself will provide guidance and direction in curriculum selection and development.

The process of content analysis of mathematics curricular materials in respect to their relationship to the NCTM Standards, and the evaluative instrument that was developed and used in this study will have value to further researchers. Content analysis was conducted to determine the best way to analyze the units. The NCTM Standards are replete with subjective goals. This study examined previous content analysis studies that have dealt with subjective text, as well as objective text. An instrument and methods for reliable and valid content analysis were also investigated and developed. The culminating research produced an evaluative instrument meeting NCTM Standards that can be used in curricular materials development, and which was used in this study.

Finally, this study can help mathematics educators at all levels identify problems that are encountered by the classroom teacher in the process of implementing NCTM Standards. The Standards reflect "a vision of appropriate mathematical goals for all students" (NCTM, 1995, p. 1). It assumes that all students are capable of learning mathematics, and that previous curriculum has "underestimated the mathematical capability of most students and perpetuated costly myths about students' ability and effort" (p. 1). The Standards were enacted to address this vision, and "many schools and teachers have responded enthusiastically . . . by changing both the mathematical content of their courses and the way in which the content is taught" (p. 3). This study can serve to simplify and demonstrate some of the problems faced in the distribution of the Standards' ideals to the mathematics curriculum.

Nature of the Study

This study utilized the methodology of content analysis to analyze the content of the 1989 and 1995 Portable Assisted Study Sequence (P.A.S.S.) mathematics curricular materials in relationship to the goals and spirit of the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics (1989). Narrative descriptions and comparisons, manual data collection and coding, and computer analyses using Nud*Ist qualitative data analysis software (Richards & Richards, 1995) have been performed. This combination of analyses has resulted in a concise and complete analysis of the curricular materials.

An evaluative instrument to measure the relationship between the curricular materials and the recommendations made in the NCTM Standards (1989) was also developed for this study. This process included content validation using an expert panel consisting of three educators who are familiar with, and experienced in, the vision of the NCTM Standards. Interrater reliability was established through a pilot study.

Theoretical Framework

Mathematics curriculum in the period from the 1970s to the 1980s has been influenced by two types of thought. One is the fixed, static view described by Dossey (1992) as external conceptions. This view establishes a body of knowledge that is available in curriculum materials. An extended version of this view allows adjustment of the curriculum, but still focuses on student mastery and applications of technology to mathematics instruction.

The second view is one of internal conception (Dossey, 1992; Polya, 1965; Romberg, 1988; Schoenfeld, 1988; Steffe, 1988; von Glasersfeld, 1988). There are three groups of thought in this second view. First, mathematics is a process and is the result of "experimenting, abstracting, generalizing, and specializing, . . . not a transmission of a well-formed communication" (Dossey, 1992, p. 45) This is the view of constructivists. The second group employs psychological models of cognitive procedures and schemata. The third group views mathematics as knowledge resulting from social interaction. Context is important and students must "participate aggressively in analyzing, conjecturing, structuring, and synthesizing numerical and spatial information in problem settings" (p. 45).

In mathematics education, Steffe and Kieren (1994) identify a "preconstructivist revolution in research . . . beginning in 1970 and proceeding on up to 1980" (p. 711). They consider the publication of von Glasersfeld's work in the early 1980s on radical constructivism as the beginning of the constructivist revolution that marks the "reform movement that is currently underway in school mathematics" (p. 711). Radical constructivism in mathematics education means "although there can be well-defined tasks or spaces for experience, there are no pregiven prescribed ends toward which this construction strives" (p. 721). This translates into "no optimal selection of the individual's actions or ideas by the environment, nor is some perfect internal representation or match against an external environment the test of the constructed 'reality' " (pp. 721 - 722).

The constructivist view is a strong component of many of the recommendations made in the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989). NCTM Standards are based upon the belief that all students should learn more (and different) content than is contained in traditional programs, and new teaching strategies need to be introduced. The thinking processes of problem solving, communication, reasoning, and connections are emphasized at all levels. Bridging the gap between constructivist theory and teaching practice is a major challenge for mathematics educators. Teachers must become "facilitators of learning rather than imparters of information" (NCTM, 1989, p. 41.)

The Commission on Standards for School Mathematics was established in 1986 by the Board of Directors of NCTM. This was in response to a need to improve school mathematics expressed in publications such as A Nation at Risk (National Commission on Excellence in Education, 1983). Many of the reform ideas in the Standards are supported by data found in publications such as Everybody Counts (National Research Council, 1989). One of the major recommendations made in this report involved the inclusion of all students in a core of broadly useful mathematics. Furthermore, "all students should study mathematics every year they are in school" (p. 50). The NCTM Standards were published in 1989 as a response to this need for mathematics reform. A comparative analysis of the P.A.S.S. courses required the researcher to thoroughly understand the recommendations made in the NCTM Standards for grades 5-8 and grades 9-12.

Educating our youth depends upon understanding the complexity of the changing world. Our universe is experiencing tremendous turmoil and disruption. Famine, plague, violence, poverty, overpopulation, environmental pollution, and geological disasters demand our attention at the same time that changing political systems are bringing new freedom as well as tyranny to nations of the world. Segments of our society enjoy health, wealth, and opportunity while other segments of our society experience despair. The societal forces that impact our students and our world are economic, psychological, environmental, ecological, biological, political, social, and moral. They are interrelated, as are the specific events or situations that result. For example, overpopulation may result in famine, plague, violence, poverty, and environmental pollution. Geological disasters may cause poverty, famine, plague, and environmental pollution. Moral attitudes may encourage overpopulation, disease, and violence. Economic inequities may produce poverty, poverty may produce violence. Biological discoveries may affect the environment and the economy. Political upheavals may affect the economy and the social structure. Psychology may affect ecology, and so on. Everybody Counts states the mathematical connection to these problems in this way:

> Our students need to know enough about chance to understand health and environmental risks, enough about change and variability to understand investments, enough about data and experiments to understand the grounds for scientific conclusions, enough about representation to interpret graphs, and enough about the nature of mathematics to be supportive parents to their children who will learn aspects of mathematics that their parents never studied. (National Research Council, 1989, p. 49).

Providing curriculum that is aligned to the Standards requires an understanding that

> the Standards offers a vision of, and a direction for, a mathematics curriculum but does not constitute a curriculum in itself. If a mathematics program is to be consistent with the Standards, its goals, objectives, mathematical content, and topic emphases should be

> compatible with the Standards' vision and intent. Likewise, the instructional approaches, materials, and activities specified in the curriculum should reflect the Standards' recommendations and be articulated across grade levels. In addition, the assessment methods and instruments should measure the student outcomes specified in the Standards. (NCTM, 1989, p.241)

Hypotheses and Research Questions

This study stated the following hypotheses and asked the following research questions:

Hypotheses:

1. The 1995 P.A.S.S. curricular materials are more likely than the 1989 P.A.S.S. curricular materials to reflect reform ideas expressed in the Standards.

2. There is no difference between coding performed by human coders and coding performed with a computer in relationship to the 1989 and 1995 P.A.S.S. curricula.

Research questions:

1. To what extent do the 1995 P.A.S.S. curricular materials improve upon the 1989 P.A.S.S. curricular materials with respect to the

Standards of mathematics education delineated by the National Council of Teachers of Mathematics?

2. Can a researcher-designed evaluative instrument measure the extent to which curricular materials meet the NCTM Standards ?

Limitations and Scope of Study

This study focused on specific material that is available to migrant students throughout California. The material that has been analyzed in this study is the 1995 1-year course in the Portable Assisted Study Sequence (P.A.S.S.) Program curricular materials entitled Integrated Math A and Integrated Math B. It was designed to replace the 1989 1-year course entitled General Math A and General Math B for migrant students in grades 9-12 that was also analyzed.

The content analysis findings cannot be generalized to other courses because the P.A.S.S. course is unique. The P.A.S.S. Program's goals are described in the P.A.S.S. Handbook:

Provide portable learning packages adapted for migrant students,

> enabling them to proceed at their own pace, provide competency-based credits for skills, interests, and educationally related-life experiences, supplement the regular instruction for targeted migrant students at secondary-level schools in California, and utilize existing counseling and tutorial support through regular migrant education personnel, and the California Mini-Corps to accomplish the goals of the P.A.S.S. Program. (p. 1)

The contact person on-site is responsible for providing instruction, grading the unit, and administering the unit tests. However, the tests are scored by the P.A.S.S. office. Two thirds of the final semester grade is based on the average of unit tests, and multiple choice tests must be used for the convenience of the scorers. Other assessment methods can be used within the unit as one third of the semester grade is based on the student's performance in the unit books. The semester grade, based upon completion of five unit books, must be at least 60% to receive credit, and students receive five academic units per semester.

The P.A.S.S. Program allows migrant students to accumulate credits that are transferable within the state and to many other states. The list of states include Arkansas, Arizona, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kansas, Michigan, Montana, Nevada, New York, North Dakota, Oregon, Texas, Utah, Washington, and Wisconsin. Ten units provide credits for two semesters. The portable units can be continued at new school sites throughout California "thanks to the coordination of services among the migrant staff at the school sites" (p. 2). The California P.A.S.S. Program is accredited through Fresno Unified School District, and the Western Association of Schools and Colleges.

The agreement with P.A.S.S. for the 1995 course entitled Integrated Math A and Integrated Math B was to provide materials aimed mainly at Latino students because they comprise the majority (99%) of the migrant population served by P.A.S.S. The course is therefore designed primarily for Latino migrant students in Grades 9-12, many of whom are academically below grade level 9. This study therefore developed and utilized an evaluative instrument geared to grade levels 5-8 and grade levels 9-12 to cover the scope of content in the 1989 and 1995 curricular materials. Specific instructions from P.A.S.S. for the 1995 curriculum also included instructions to use Latino surnames and problems that are relevant to Latino life experiences and ambitions. Content analysis of this material was therefore also performed from a multicultural perspective. This emphasis on the Latino migrant population and the broad range of academic grade levels represented in the curriculum also restrict the applicability of this study.

Content analysis methodology for this study required extensive coding and interpretation by the researcher. However, the researcher's in-depth knowledge of the material can be viewed as valuable to coding the materials, and ultimately the integrity of any researcher must also be considered.

CHAPTER 2

The Literature Review

> The mathematician does not study mathematics because it is useful, he studies it because he delights in it and he delights in it because it is beautiful.
>
> - Henri Poincar'e

Educational needs are determined by the society in which we live. We will first examine the changes in western society and the respective needs in mathematics education from an historical perspective. The professional response from the educational community and the specific issues surrounding migrant students will then be addressed. Finally, the methodology of content analysis will be discussed, and the studies which relate to content analysis of new curricula will be reviewed.

Societal Changes

To appreciate the changes that are needed in our mathematics curriculum requires an historical perspective of the changes in our society. Our western society has developed in three distinct stages or eras of change called waves (Toffler, 1980). Toffler describes the first era from 8000 B.C.

to A.D. 1650-1750 as the first wave of change. The population could easily be divided into two categories: primitive and civilized. The primitive population lived in small tribes. The civilized population farmed and produced their own goods and food. Villages were organized, labor was divided, and religious and governmental authority was established. Scientists and mathematicians such as Galileo Galilei, Johannes Kepler, and Rene Descartes lived in this time, but their contributions were not greatly appreciated until the second wave.

The second wave has lasted 300 years and has become known as the Industrial Revolution and the Age of Enlightenment (Toffler, 1980, Etzioni, 1968). A mechanistic viewpoint emerged as scientific discoveries and theories became known. The Age of Scientific Revolution began in the 16th century with "Nicolas Copernicus, who overthrew the geocentric view of Ptolemy and the Bible that had been accepted dogma for more than a thousand years" (Capra, 1982, p. 54). Descartes, a brilliant mathematician who is regarded as the founder of modern philosophy, "did not accept any traditional knowledge, but set out to build a whole new system of thought" (p. 56). The scientific method of deduction was born, and mathematics was an integral part of it. Mind was separate from matter, and the universe was a machine that man could learn to manipulate and control. Scientific theory became reductionist theory in the biological sciences allowing life organisms to be studied as mechanisms. Isaac Newton completed the vision. "Newton developed a complete mathematical formulation of the mechanistic view of nature, and thus accomplished a grand synthesis of the works of Copernicus and Kepler, Bacon, Galileo, and Descartes" (Capra, 1982, p. 63). His methodology combined the inductive, empirical method with the deductive, rational method, and is the method of scientific inquiry today.

Mechanistic elements are evident in the second wave civilization. A "half-dozen principles--standardization, specialization, synchronization, concentration, maximization, and centralization--were applied in both the capitalistic and socialist wings of industrial society" (Toffler, 1980, p. 76). Class structure becomes important in maintaining these relationships. A property class inherits rights of ownership, an acquisition class acquires their property and rights of ownership, and the social class determines the individual's rights, lifestyle, prestige, and power within the society. (Parsons, 1947). The second wave is evident in our western society, but it is becoming engulfed by the third wave.

Toffler (1980) describes the third wave as interrelated spheres: technosphere, biosphere, infosphere, sociosphere, and psychosphere. He sees the need for decentralized reorganization to meet the needs of the changing world. Third wavers are "a combination of consumers, environmentalists, scientists, and entrepreneurs in the leading-edge industries, along with their various allies" (p. 153). They are proficient at technology, which is distinguished as "new industries--computers and data processing, aerospace, sophisticated petrochemicals, semiconductors, advanced communications, and scores of others" (p. 155). This technology has already given us fiber optics, antinoise technology, neural networks, antisense technology and recombinant DNA technology; we are familiar with terms such as virtual reality and artificial intelligence (Simon, 1995). In the public arena, the newest computer program for personal computers was introduced with a 1-year advertising budget of 1 billion dollars: Windows 95 sells for $89 and "has moved stock markets worldwide . . . and has attracted the attention of Washington antitrust officials" (Murphy, 1995, p. D1). It is obvious that technology has impacted every area of our lives, and that second wave skills and knowledge are rapidly becoming extinct.

Educational Response

Educational practices can be seen to respond to these changes. In the first wave, formal education was reserved for the privileged few who assumed the powers of authority. Kilpatrick (1992) describes mathematics in the curriculum of liberal arts, and as providing the foundation for mechanics and the ensuing revolutions in science and technology. Textbooks included Socratic dialogue to deal with matters of proof, definition, and understanding. Students were given opportunities to discover rules by induction.

The second wave provided impetus for mathematical study and public education. The Industrial Revolution required skilled workers and mechanistic responses. The Age of Enlightenment inspired a desire for higher levels of education for the public. Mathematics did not develop as a field of study until the end of the 19th century in "response to the need for more and better prepared teachers" (Kilpatrick, 1992, p. 5). Teaching methodology began to emerge with concrete experience and educational aims influencing the teaching of mathematics in the U.S. throughout the entire public school system.

The establishment of standards became important. Kilpatrick (1992) discusses the use of testing to establish standards, which began in earnest in the U.S. with the published doctoral dissertation in 1908 of Cliff W. Stone. It provided data concerning the measured achievement of 3,000 sixth graders in 26 school systems. Stone recommended standards of achievement to make courses of study more uniform and to reduce the variability in average test scores.

Controversies arose over topics in elementary curricula. Another doctoral thesis published in 1919 described by Kilpatrick (1992) refers to the unnecessary inclusion of traditional processes in arithmetic at elementary grade level. This study analyzed the everyday use of arithmetic and found real-life problems to be concrete and business-oriented. This reductionist movement caused many reactions. Kilpatrick (1992) discusses the social value of arithmetic and the "informational, sociological, and psychological functions of arithmetic" (p. 18). Readiness theory came into being in the 1930s and 1940s with one researcher even claiming to have found the "minimum mental age at which each of the topics should be taught" (p. 19). Extreme proponents of readiness theory advocated the elimination of formal instruction in mathematics altogether, thereby allowing the child the freedom to discover mathematics by experience (p. 19).

Secondary education felt the effects of these controversies. Unified courses, also called integrated courses, were developed and tested from 1903 to 1923 by the University of Chicago; the resulting findings favored unified courses, but evidence was rather weak (Kilpatrick, 1992, p. 21). All students were required to study mathematics in secondary school in the 1920s and 1930s (Kilpatrick, 1992). This was seriously challenged and the National Council of Teachers of Mathematics (NCTM) was formed as a result of the crisis. Research was also undertaken at this time on such questions as ability grouping, and unified mathematics versus traditional separated courses. Many of the findings were published in NCTM yearbooks and journals.

Mathematics education was influenced primarily by psychological theory in the period from the 1930s to the 1960s. The ideas of Piaget, Bruner, humanistic psychology, Marxist psychology, and contemporary behaviorism flourished (Kilpatrick, 1992, p. 24). Mathematicians reentered the educational field in the 1960s in response to declining enrollments in university mathematics courses. The mathematics curricula had changed in the lower schools and students were unmotivated and unprepared for the traditional university curriculum.

Mathematics curricula in the period from the 1970s to the 1980s has been influenced by two types of thought. One is the fixed, static view described by Dossey (1992) as external conceptions. This view establishes a body of knowledge that is available in curriculum materials. An extended version of this view allows adjustment of the curriculum, but still focuses on student mastery and applications of technology to mathematics instruction. The second view is one of internal conception (Dossey, 1992; Polya, 1965; Romberg, 1988; Schoenfeld, 1988; Steffe, 1988; von Glasersfeld, 1988). There are three groups of thought in this second view. First, mathematics is a process and is the result of "experimenting, abstracting, generalizing, and specializing, . . . not a transmission of a well-formed communication" (Dossey, 1992, p. 45) This is the view of constructivists and is a strong component of many of the recommendations made in the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989). The second group employs psychological models of cognitive procedures and schemata. The third group views mathematics as knowledge resulting from social interaction. Context is important and students must "participate aggressively in analyzing, conjecturing, structuring, and synthesizing numerical and spatial information in problem settings" (Dossey, 1992, p. 45).

The National Council of Teachers of Mathematics (NCTM) has played a major role in curriculum reform since it was founded. It began publishing summaries and analyses of research as well as analyses of math textbooks. In 1950, NCTM became affiliated with the National Education Association (NEA). The Journal for Research in Mathematics Education was published in January 1970, and provided reports of research aimed at mathematics teachers (Kilpatrick, 1992, p. 26).

Curriculum and Standards

The third wave creates the demand that environmental, biological, sociological, and technological issues be confronted (Shane, 1990). Many educators believe integrated curriculum design is the only way to meet the challenge of holistic learning.

> An integrative curriculum is one which gives both knowledge of past systems and the desire and power to create new ones. . . . Students who experience opportunities to construct their own integrating structures must also possess the knowledge of structures common to

> their culture, so that they may take advantage of the collective wisdom of past generations. The common structures provide the tools to converse with others about the world they share, while their own new structures provide avenues for new ideas. (Harter & Gehrke, 1989, p. 13)

English defines curriculum as "a plan, a set of directions whose chief purpose is to guide the work of the schools. That work is called teaching or instruction" (English, 1987, p. 9). It has a variety of forms such as textbooks, study guides, district, state, and board regulations and policies, and any supplementary material that is used to make decisions pertaining to content or subject matter. English believes there are three types of curriculum: written, taught, and tested. They are interactive and work together in a tight relationship if they have a definite purpose.

Glatthorn (1987) proposes there are at least six types of curriculum: recommended, written, taught, supported, tested, and learned. The recommended curriculum is ideal and is recommended through state frameworks and national guidelines. The written curriculum is found in the district's scope and charts, site and board policies and goals, study booklets, and any "attempts to translate district policies and goals into documents that will enable teachers to implement those policies and meet those goals"

(Glatthorn, 1987, p. 3). The taught curriculum is what is occurring in the classroom. The supported curriculum is the staff, time, texts, space, training, and other essential resources that support the curriculum. The tested curriculum measures performance.

The learned curriculum is what the students actually learn. Pratt (1994) sees the curriculum as overt and hidden. The overt curriculum is "the blueprint for teaching and learning that is publicly planned and adopted" (Pratt, 1994, p. 29). The hidden curriculum "refers to conscious or unconscious intentions reflected in the structure of schools and classrooms and the actions of those who inhabit them" (p. 29). Curriculum development concerns itself mainly with the overt curriculum, but elements of the hidden curriculum should be considered.

Glatthorn (1987) believes a sound program of studies is goal oriented, balanced between knowledge and skills versus special interests, and is integrated and interdisciplinary. Interdisciplinary studies require an improvement in critical thinking across the curriculum. Glatthorn asserts "you may safely experiment with integrated courses as long as you keep your eyes on the basic skills" (p. 50). He also believes "interdisciplinary courses are as effective as separate-subject courses in teaching basic skills" (p. 50).

Forman and Steen (1995) discuss the need to prepare all students for the world of work. "Math at work is concrete. It is spreadsheets and perspective drawings, error analysis and combinatorics" (p. 6). It is estimating, exploring, classifying, optimizing, representation of relationships, process modeling, and anticipation of consequences. "Most people now recognize that doing mathematics (reasoning logically, solving problems) is more important that just knowing it (remembering formulas, memorizing algorithms)" (p. 7).

The Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) addresses the needs of the third wave. The Standards reflect the reform needed in mathematics. They define curriculum as the "intended curriculum" or the "plan for a curriculum."

> A curriculum is an operational plan for instruction that details what mathematics students need to know, how students are to achieve the identified curricular goals, what teachers are to do to help students develop their mathematical knowledge, and the context in which learning and teaching occur. (National Council of Teachers of Mathematics, 1989, p. 1)

A standard is a "statement about what is valued" (p. 2) and ensures quality, indicates goals, and promotes change. The Standards assert that the educational system must meet new social goals. These are defined as providing for society mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate. Students must learn to value mathematics, become confident in their mathematical abilities, become mathematical problem solvers, learn to communicate mathematically, and learn to reason mathematically (p. 5).

The Standards emphasize the need to "do" rather than "know" (1989, p. 7). Interdisciplinary curricula must be included to supplement and replace portions of traditional engineering and physical science applications. Technology must be included and updated to reflect the nature of mathematics. The curriculum must be available to all students if "they are to be productive citizens in the twenty-first century" (p. 9). Students must participate in activities that model genuine problems, and be encouraged to experiment, discuss, and discover ideas and concepts.

The NCTM Standards (1989) are based upon the belief that all students should learn more (and different) content than is contained in traditional programs, and new teaching strategies need to be introduced. "Cultural background and language must not be a barrier to full participation in the mathematics programs" (NCTM, 1995-1996, p. 20). The thinking processes of problem solving, communication, reasoning, and connections are emphasized at all levels . Content standards are separated into elementary, middle, and high school grades with specific topics and subtopics that should be addressed. Content in the elementary grades consists of estimation, number sense and numeration, whole number operations and computation, geometry and spatial sense, measurement, statistics and probability, fractions and decimals, and patterns and relationships. Content in the middle school grades consists of number and number relationships, number systems and number theory, computation and estimation, patterns and functions, algebra, statistics, probability, geometry, and measurement. Content in the high school grades consists of mathematical connections, algebra, functions, geometry from a synthetic perspective, geometry from an algebraic perspective, trigonometry, statistics, probability, discrete mathematics, conceptual underpinnings of calculus, and mathematical structure.

Mathematics curriculum within the classroom is defined largely by the textbook used for instruction (Flanders, 1994; Chandler & Brosnan, 1995). Dossey (1992) lists four textbook models: mechanistic, structuralist, empiricist, and the realistic or applied. The texts are used in three ways:

instrumental, subjective, or fundamental. Instrumental use is linear and rule-oriented; teachers follow the table of contents and the teacher guidelines. Subjective use is flexible; teachers use the text as a guide but employ their own experiences and constructive overview. Fundamental use is the development of curriculum from a constructivist viewpoint; teachers and students develop the curriculum as they learn together. In many classrooms, the prevailing model is mechanistic-instrumental. Modern reform documents such as the Standards advocate the use of a realistic-fundamental model (Dossey, 1992, p. 43).

The adequacy of the textbook is integral to the implementation of the Standards. A study of mathematics textbooks for grades 1-8 published after the Standards were implemented in 1989 found publishers have moved towards the Standards by adding "more material rather than making decisions of what to omit" (Chandler & Brosnan, 1994, p. 8). The mismatch of material was confirmed in a later study by the same researchers. "The content in the mathematics textbooks studied was disproportionate to the content of the proficiency test studied" (Chandler & Brosnan, 1995, p. 122) which is based on NCTM Standards. The researchers conclude that the major changes in textbooks are "superficial changes such as rewording headings and adding more pages" (p. 123).

Garet and Mills (1995) emphasize the lack of research "on the effects that the Standards document has had on practice" (p. 380). An interim survey was conducted in the Midwest in 1991 and will be completed in 1996. Department chairs were asked to reflect upon practices in 1st-year algebra between 1986 and 1991, and anticipated practices in 1996. Four areas were selected: curriculum content, technology, methods, and assessment. "The evidence indicates that in all four areas, change has occurred, at least in norms and beliefs, and that more change is anticipated by 1996" (Garet & Mills, 1995, p. 383). The use of technology reflected the greatest increase. However, the variation in school responses was substantial. The schools experienced consistent practices before 1986, but displayed inconsistencies of practice after 1986. "By 1996, schools in the major urban centers also anticipate practice more consistent with the Standards document than do the smaller cities and rural areas" (Garet & Mills, 1995, p. 383).

Webb (1995) discusses the political and marketing strategies used to provide textbooks, and claims "there is little evidence to suggest that classroom practice has changed much since the late 1970s" (p. 1).

> "The best teachers are not using textbooks very much anymore," says Harold Howe II, former U.S. Commissioner of Education. "Good teachers help kids to discover the sources of learning and create their own texts in the process." (Webb, 1995, p. 3).

Teaching Strategies

The NCTM Standards (1989) emphasize new teaching strategies are needed to help students at all levels develop new thinking processes of problem solving, communication, reasoning, and connections. Teaching strategies are part of curriculum development and may be experiential or systematic, or a combination of both:

> The experiential approach emphasizes creativity and encourages learners to choose their own curriculum, but does not teach basic skills. The systematic approach teaches basic skills, but does not encourage creativity and learner choice. (Nelson, 1990, p. 17).

Instructional strategies are important to successful adaptation of the Standards proposed by NCTM. Students must have access to manipulatives, calculators, computers, and other appropriate tools and techniques. Interactive, cooperative groupwork is essential, and students must work independently and collaboratively. Assessment must be varied, practical, fair, and meet new standards of quality. Students should be given time to master material and opportunities to improve the quality of their work. Projects and investigations should be large-scale, and reflect social issues that help connect mathematics to society. Students should learn to communicate their learning and ideas in mathematics through written, oral, and electronic reports.

Teachers must adapt their styles in the classroom to the new instructional strategies. Teachers must become "facilitators of learning rather than imparters of information" (NCTM, 1989, p. 41.) They must be conscious of their prejudices and overcome them in the classroom. They must provide equal learning opportunities for all students, and adapt curriculum to multicultural needs in the classroom. Teachers must become practicing mathematicians to provide role models for their students and thereby encourage an interest in mathematics. Teachers must encourage discussion and freedom for students to make errors, while exercising caution to fit their own teaching style. They must "produce a classroom climate that encourages students to take risks and venture incomplete thoughts, knowing that others will try to understand and will value the individual's thinking" (NCTM, 1989, p. 53).

Teachers' Experiences and Recommendations

Teachers have been involved in rewriting curricula on a regular basis since the Standards were published. There are numerous articles that itemize and categorize recommendations for implementation of the Standards. Schmalz (1994) proposes an exploration of themes at a leisurely pace. She divides the year's content into broad categories that contain subcategories traditionally taught in sequential order. Her recommendation is to integrate the material and provide richer learning experiences. Wiske and Levinson (1993) discuss the survey results from 50 teachers who reach consensus on the need to overcome barriers of incompatible texts and materials, inaccessible technology, inappropriate assessments, and inadequate professional knowledge. The motivation for these teachers to overcome the barriers is "the gratification they receive from seeing engaged, achieving students" (p. 10).

The successful implementation of NCTM Standards depends on the classroom teacher. Webb (1995) states there is "little evidence to suggest that classroom practice has changed much since the late 1970s" (p. 1). Many textbook publishers are not helping to implement the Standards. Webb cites observations from the Textbook Letter that claims "not nearly enough American textbook publishers are prepared to take on real world issues, and that with every passing year, with each passing textbook production cycle, the books get farther and farther from reality" (p. 3).

Classroom teachers must find and develop curricula to supplement their texts. They must also evaluate the degree of success to which they align their curricula to the Standards.

Immigration and The Migrant Student

The impact of immigrants upon our society is often touted in economic terms. Their contribution to our economic system is generally divided into skilled and unskilled labor. "Immigrants constitute the main workforce for firms that operate by informal labor subcontracting, and/or produce goods and services directed at the affluent or low-income sectors of the population" (Ziolniski, 1994, p. 2307). These firms use immigrants as the primary labor force for low-wage jobs in industries such as apparel, electronics, or footwear. In addition, immigrant workers work in unskilled jobs as subcontractors in janitorial, landscaping, construction, and restaurant industries. "Many Mexican immigrants have found . . . casual employment as home and street vending, house cleaning, baby-sitting, day labor, and recycling" (p. 2308). Many are migratory workers who move from one state to another for the purpose of finding temporary or seasonal employment (U. S. Department of Education, 1985). Most migratory workers are agricultural workers or migratory fishermen who move from one district to another during the regular school year (Cahape, 1993; California Department of Education, Handbook, 1992). Their children are deemed "migrant students" in our school system, and therefore, the migrant student is a child defined by family mobility and type of labor.

Many of these immigrants are illegal. Immigration arrests have rocketed from "1.6 million during the 1960s to 8.3 million in the 1970s" (p.86) and are continuing to rise dramatically. Federal legislation is constantly in a state of change to alleviate economic pressures on our system as "newcomers, both legal and illegal, are taking jobs from U.S. citizens and straining public assistance programs" (Idelson, 1996, p. 698).

California is presently struggling with the issue of illegal immigration due to the great influx of two to three million illegal residents (Schuck, 1995; O'Halloran, 1994). Proposition 187, approved by California voters in November 1994, is an anti-illegal immigrant initiative that has caused much controversy and alarm throughout the United States and even the world. It seeks to eliminate educational, medical, and welfare funding for illegal residents, with many Mexican-Americans supporting the proposition (Schuck, 1995). Support for the proposition is fueled by the illegal immigrant's fierce allegiance to Mexican nationalism and defiance of Americanization (assimilation, acculturation, and citizenship) (Aldama, 1995). The California "voters responded angrily to the vivid television images of Mexican officials denouncing the measure and to the marchers in Los Angeles waving Mexican flags and protesting its limits on welfare benefits" (Schuck, 1995, p. 90). Proposition 187 is being challenged in court by opponents who claim it violates federal and state guarantees of equal protection, of state and federal privacy rights, and of international law. The federal courts have temporarily blocked the amendment as many citizens favor continuance of benefits.

California laws specifically give its citizens "a right to a basic education and the Legislature has a constitutional duty to provide one" (O'Halloran, 1994, p. 370).

The migrant worker is in the midst of this battle. Agriculture is California's largest industry and it now produces "more than half the fruits, nuts, and vegetables consumed in the United States" (Schlosser, 1995, p. 80). Schlosser maintains from 30% to 60% of the migrant workers in California are illegal immigrants. "Illegal immigrants, widely reviled and depicted as welfare cheats, are in effect subsidizing the most important sector of the California economy" (p. 82). Illegal immigrants are so essential to the U.S. agricultural economy that legislators often find ways to provide temporary guest worker programs for states that are dependent upon them. "Skillful manipulation of an increasingly vulnerable administrative system" (Schuck, 1995, p. 92) provides that the legal status of aliens "who enter surreptitiously should be called 'undocumented' rather than 'illegal' because their legal status remains uncertain for months or years during which the aliens can usually obtain work permits" (p. 92).

The agricultural employment is a lifeline to the migrant families. The cheap wages in the U.S. are up to 10 times the wages earned by Mexican peasants in their native villages. It is at a cost to Mexico and the United States. Mexico loses its surplus workers and the United States increasingly pays higher costs as migrants marry and raise children within the U.S. The Immigration and Naturalization Service "has traditionally rounded up and deported illegal immigrants in California immediately after the harvest" (Schlosser, 1995, p. 99). The workers who are overlooked often become American citizens and eventually find less physically demanding and more financially rewarding kinds of work in factories and other skilled trades. "As a result, the whole system now depends on a steady supply of illegal immigrants to keep farm wages low and to replace migrants who have either retired to Mexico or found better jobs in California" (p. 99).

This is having a dramatic effect on the ethnic population in our schools. It is estimated that by the year 2010 more than one half of our children "under 18 years of age will be minorities: Hawaii (80%), New Mexico (77%), California (57%), Texas (57%), District of Columbia (93%)" (Klauke, 1989. p. 1). Projections to 2020 indicate a Latino population of over 47 million in the U.S., representing 15% of the total population (Bedard, Eschholz, & Gertz, 1994, p. 72). The U.S. Census Bureau reported nearly 13,000,000 Mexican-Americans living in the United States in 1989. Headden (1995) reports nearly three million students in the American educational system are designated as limited English proficient (LEP), and 45% of these students live in California. Most of the LEP students in California are Latino (p. 45), and many of these students are children of migratory workers.

Velazquez (1994) discusses the movement of migrant workers along three identifiable streams: Eastern, Mid-Continent, and Western. The Western stream is the largest, "extending from California and Arizona to Oregon and Washington" (p. 32). The migrant student is a child defined by family mobility and type of labor. Migratory workers move from one state to another for the purpose of finding temporary or seasonal employment (U. S. Department of Education, 1985). Most are agricultural workers or migratory fishermen who move from one district to another during the regular school year (Cahape, 1993; California Department of Education, Handbook, 1992). Cahape (1993) reports there are over half a million migrant children enrolled in public education in the 50 states, the District of Columbia, and Puerto Rico. Trotter (1992) argues that many migrant children are unidentified and "estimates of all those engaged in migrant labor range between 1.7 million and 6 million" (p. 16). Illegal immigration plays a major role in these statistics.

There is some disagreement on statistics relating to these farm workers. "The vast majority of aliens [foreigners] who enter illegally are more or less seasonal migrants" (Schuck, 1995, p. 90). Trotter (1992) estimates that 95% of illegal immigrants are farm workers, and 90% of these are Latino. Velazquez (1994) claims undocumented workers comprise only 15% of all migrants. Doyle (1990) cites studies that support this smaller number, and claims that many of the labeled migrant students maintain stable residences. O'Halloran (1994) claims more than two million of those enrolled in public institutions in the last decade were immigrant youth, and 70% reside in just five states, "the majority having settled in California" (p. 371). The Migrant Student Record Transfer System (MSRTS) is a computerized information network used by approximately 17,000 sites in the U. S. that regulates and transfers data on migratory students as they move from school site to school site. MSRTS figures for 1990 show there are approximately 600,000 migrant children in the U.S. with the following concentrations:

California (209,006), Texas (123,187), Florida (59,195), Washington (30,000), Arkansas (20,000), Oregon (20,000), New York (10,000), and the least, District of Columbia (190), and West Virginia (94).

Authorized recruiters for the migrant student programs identify these students, but many are not found. The 1993-1994 National Report for the California Portable Assisted Study Sequence (P.A.S.S.) Program, which serves migrant students in California, shows it served only 8,326 of the estimated 209,006 migrant students in California in 1993-1994. Nearly all of these students (8,243 or 99%) were Latino. The California Handbook for Identification and Recruitment (California Department of Education, 1992) discusses the difficulty of finding children in rural settings who may be living temporarily in abandoned buildings, orchards, and cars. The "culture of migrancy" (Velazquez, 1994, p. 32) contributes to the difficulty. Children assume adult roles in the fields, and "most migrant children drop out of school when they are able to work in the fields and earn money" (p. 33). MSRTS reports that the drop-out rate for migrant students is between 35% and 60%, and that most have dropped out by 10th grade. Overby (1993) reports dropout rates for migrant students of 43% as compared to Mexican-Americans of 35.8%. This reflects an improvement for migrant students over previous dropout rates as high as 90% in the 1970s, however (Cahape, 1993), and graduation rates have also increased. "Between 1984 and 1990, the number of migrant students enrolled in 12th grade climbed from 21,493 to 30,745--a 43% rise" (Trotter, 1992, p. 17). Trotter points out that most do not graduate however, and that student enrollment had actually increased by 13% during the same period. He reports only 13.8% of migrant students graduate, compared to 87.8% of the general population, and 67.6% of the Latino population.

Grade level retention rates are also a problem. Migrant students are retained at grade level at least 1 year twice as often as the general population, largely due to academic deficiencies that result from problems associated with their lifestyle. MSRTS reports "33% are one year below grade level and 17% are two years or more below grade level" (Cahape, 1993).

The types of problems faced by migrant students are varied. Prewitt-Diaz (1991) lists four factors affecting migrant children in school: ecological, educational, psychological, and economical. Many families are seeking refuge from tyranny in their native countries. Others seek a better lifestyle and job opportunities. Children move regularly from district to district, and experience absenteeism and falling behind in academic areas. Their self-image is affected as they struggle with their language and new relationships.

Cultural differences create problems of inclusion within the classroom. Children are contributors in their families and "are essential in the economy of the migrant family" (Prewitt-Diaz, 1991, p. 485). They have power and may control their parents as they become the interpreters between the school and the home. Romo (1993) lists similar problems, and adds that many secondary-age students have only attended grades 1-6 in Mexico. Velazquez (1994) describes their feeling of powerlessness combined with their respect for authority. Families have little formal education and trust the schools. They "feel that their questions about the appropriateness of their children's educational program will be construed as a challenge to the teacher's authority and prestige" (p. 33).

In a study conducted by Bedard, Eschholz, and Gertz (1994), the Latino community ranked its most important problems facing the community as:

Crime	21%
Gangs	17%
Drugs	18%
Unemployment	12%

Education	7%
Economy	5%
Racism	2%
Health care	1%
Not sure	10%
Other	7%

Furthermore, 49% of Latinos surveyed who were born in Mexico considered lack of parental involvement to be the major cause of Latino youth dropping out of school. The next highest ranking (19%) cause of dropping out of school was considered to be gangs and delinquency (Bedard, Eschholz, & Gertz, 1994, p. 77).

The federal government remains dedicated to its commitment to migrant children and families as demonstrated by the government's blocking of Proposition 187 and other legislation. The Migrant Education Program was authorized in 1965 through the Elementary and Secondary Education Act. Federal program regulations require state Departments of Education to identify and educate migratory children. The California Department of

Education assumes responsibility for all statutory and regulatory requirements of the program including subgrantees. Funding is based on a "Full-time Equivalent (FTE) count of each individual child for each day of residence in the State. This count is based upon the entry of data into the Migrant Student Record Transfer System (MSRTS) for each State for each year" (California Department of Education, Handbook, 1992, p. 1-2). The California Portable Assisted Study Sequence (P.A.S.S.) program is based in part on a newer Federal Law, P. L. 100-297, which was passed in 1988, and California Assembly Bill No. 1382, which was passed in 1981. This program serves the migrant students in California and provides services throughout the U.S. to other migrant programs.

California Portable Assisted Study Sequence (P.A.S.S.) Program

The California Portable Assisted Study Sequence (P.A.S.S.) program serves 165 schools in California and was created to help assuage some of the difficulties that migrant students encounter. The P.A.S.S. Program's goals are described in the P.A.S.S. Handbook:

Provide portable learning packages adapted for migrant students,

> enabling them to proceed at their own pace, provide competency-based credits for skills, interests, and educationally related-life experiences, supplement the regular instruction for targeted migrant students at secondary-level schools in California, and utilize existing counseling and tutorial support through regular migrant education personnel, and the California Mini-Corps to accomplish the goals of the P.A.S.S. Program. (p. 1)

The P.A.S.S. program allows migrant students to accumulate credits that are transferable within the state and to many other states. The list of states include Arkansas, Arizona, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kansas, Michigan, Montana, Nevada, New York, North Dakota, Oregon, Texas, Utah, Washington, and Wisconsin. Ten units provide credits for two semesters. The portable units can be continued at new school sites throughout California "thanks to the coordination of services among the migrant staff at the school sites" (p. 2).

The P.A.S.S. Program courses "have the same content as the regular high school courses" (p. 2). The mathematics courses are sequential. The first course in the program was General Math A and General Math B, which has now been replaced by Integrated Math A and Integrated Math B. Other math courses include Consumer Math, Pre-Algebra, and Algebra A and Algebra B. A fifth course, Geometry is planned for 1997. The Consumer

Math course is being rewritten for 1996-1997 as Consumer Education to integrate new reform ideas with career math into the program.

The California P.A.S.S. Program is accredited through Fresno Unified School District, and the Western Association of Schools and Colleges.

The Methodology of Content Analysis

Krippendorff (1980) discusses the historical growth of content analysis methodology. He finds it has been dated to the late 1600s in church-conducted research to assess nonreligious content in newspapers. Early content analysis, in fact, came to be called quantitative newspaper analysis. The emergence of social sciences and electronic media produced survey research and polling. Opinion research and attitude surveys appeared in the early 1900s. Propaganda analysis was conducted during World War II as an "instrument for identifying individuals as 'unethical' sources of influence" (Krippendorff, 1980, p. 16). It became useful in other areas as well.

> Among the most outstanding predictions actually made by British analysts was the date of deployment of the German V-weapon against Great Britain. Monitoring Goebbel's speeches, the analyst inferred interferences with the production of these weapons and extrapolated the launching date which was accurate within a few weeks. (p. 17)

Content analysis became useful in many disciplines after World War II. The methodology was used in television surveys, population trends, cultural indicators, and political surveys. Psychology found applications to discover motivational, psychological, and personality characteristics. Anthropologists analyzed myths, folktales, and riddles to determine kinship terminology. Historians added the methodology as another systemic tool to examine historical documents. Educational material was analyzed to "understand larger political, attitudinal, and value trends" (Krippendorff, 1980, p. 18). The first conference on content analysis, sponsored by the Social Science Research Council's Committee on Linguistics and Psychology, was held in 1955. Participants "came from such disciplines as psychology, political sciences, literature, history, anthropology, and linguistics" (Krippendorff, 1980, p. 19).

Computers began to be used in analysis at this time. Weber (1990) discusses two computer-aided studies conducted in the 1970s. One analyzed differences in narrative form in American black and white song lyrics, and the other studied differences in sex-role relationships. Frisbie (1986) used computer-aided analysis to establish its value in creating and coding survey category responses. Some contemporary studies that relate to textbook analysis are those conducted in mathematics, science, history, and health. Flanders (1994) analyzed the content of nonalgebra mathematics books and compared them to items on the Second International Mathematics Study (SIMS) test. Lumpe and Scharmann (1991) analyzed the content of lab activities in biology as they related to the Task Section of the Laboratory Structure and Task Analysis Inventory. Wolf (1992) analyzed eighth grade history books and compared them to multicultural content in the California History Social-Science Framework. Huetteman (1989) analyzed six college health textbooks to assess coverage of the Surgeon General's Report on Health Promotion and Disease Prevention. The four studies provide a broad perspective of the methodology as it is used in textbook content analysis.

Researchers offer varied definitions of content analysis. Berelson (1952) defines content analysis as "a research technique for the objective, systematic and quantitative description of the manifest content of communication" (p. 18). His definition implies structure and quantifiable content, and "manifest content means the apparent content, which means that content must be coded as it appears rather than as the content analyst feels it is intended" (Stempel & Westley, 1989, p. 125). Krippendorff (1980) believes "content analysis is a research technique for making replicable and valid inferences from data to their context" (p. 21). He states it must be specific about the data, context, and target, but it is an intuitive "method of inquiry into symbolic meaning of messages" (p. 22). Messages are interpreted by the researcher, and inferences are made. Weber (1990) states that "content analysis is a research method that uses a set of procedures to make valid inferences from text" (p. 9). He states there is "no simple right way to do content analysis. Instead, investigators must judge what methods are most appropriate for their substantive problems" (p. 13).

Weber (1990) describes content analysis as a process that involves selecting a unit of analysis, constructing category systems, selecting a sample of content, and providing reliable and valid coding. The unit of analysis may be a word, a phrase, a sentence, a paragraph, or a theme. Categories should be mutually exclusive to prevent interpretative errors. The categories may be narrowly defined or broad with many entries. Stempel and Westley (1989) say the categories should be pertinent to the objectives of the study, functional, and manageable. They believe 10 to 20 categories are adequate for most studies. Weber (1990) states "the best test of the clarity of category definitions is to code a small sample of the text. Testing not only reveals ambiguities in the rules, but also often leads to insights suggesting revisions of the classification scheme" (p. 23). Krippendorff (1980) discusses the sampling schemes that can be employed: random, stratified, systematic, clustered, or proportional. Multistage sampling uses one or more of these procedures at different time periods. The sample size can be limited to a cost-effective point "at which a further increase will not appreciably improve the generalizability of the findings" (Krippendorff, 1980, p. 69).

There is a large variety of computer software available to today's qualitative researcher (Kelle, 1996; Prein, Kelle, & Bird, 1995). Kelle (1996) discusses the software as first-, second-, and third-generation programs. First-generation programs are largely "word-processors and standard database management systems" (p. 34). Second-generation programs provide techniques for coding and retrieval and have "facilitated the mechanization of rather mundane mechanical tasks, namely the building of indexes, concordances and index card systems" (p. 34). Third-generation programs extend the capabilities of second-generation software and "require a coding of qualitative data that is much closer to that applied in classical content analysis" (p. 34). This includes building indexes, cross references, and decontextualization and comparison of text passages (cut-and-paste techniques). The advanced features of these programs allow coding linkages, network building, hypothesis testing, and theory building. The extended features "are only seldom used" (p. 34) and "offer fascinating new possibilities for analysts to 'play' with their data and thereby help to open up new perspectives and to stimulate new insights" (p. 59). He warns, however, that the "qualitative researcher runs the danger of reifying the codes and losing the investigated phenomenon by confusing two analysis strategies" (p. 59).

Finally, the reliability and validity of coding is imperative to assure a reputable study. Reliability of coding is "consistency of classification" (Stempel & Westley, 1989, p. 132). Coding can be performed manually or with computers. Frisbie (1986) found that computer programming output did not help participants create more reliable and valid category systems for the responses to open-ended survey questions, but did help participants to "more reliably and validly code the open-ended responses in terms of the category system (p. 32). Krippendorff (1980) proposes reliability should be established through the duplication of efforts. He distinguishes between three types: stability, reproducibility, and accuracy. Stability can be established by the repetition of coding by the same coder. Reproducibility requires more than one coder and is "a minimum standard for content analysis" (Weber, 1990, p. 17). Coders must work independently to prevent agreement through communication as the "lack of independence is likely to make data appear more reliable than they are" (Krippendorff, 1980, p. 132). Accuracy is the "strongest reliability test available" (p. 131).

Validity is the most important test, it is the assurance that the analytical results are true, predictive, and consistent with established knowledge. Content analysis is "valid to the extent its inferences are upheld in the face of independently obtained evidence" (Krippendorff, 1980, p. 155). Internal validity is synonymous with reliability. External validity "assesses the degree to which variations inside the process of analysis correspond to variations outside that process and whether findings represent the real phenomena in the context of data as claimed" (p. 156). Weber (1990) divides validity into themes of correspondence and generalization. Krippendorff (1980) provides five types. He differentiates between data-related validity (semantical validity and sampling validity), pragmatical or product-oriented validity (correlational validity and predictive validity), and process-oriented validity or construct validity. He states it is important to decide on standards of reliability and validity "before an analysis is conducted" (p. 175).

Content Analyses of Curriculum

Many of the ideas in the Standards are complex and subjective. It is difficult to evaluate subjective ideas, but it is essential for successful implementation of the Standards. Evaluation of curricula is integral to successful mathematics reform, and establishing criteria for content analysis is essential.

One useful breakdown comes from a study conducted in the early 1980s by the International Association for the Evaluation of Educational Achievement (IEA). The Second International Mathematics Study (SIMS) included an extensive curriculum analysis. It studied the mathematics curriculum at three levels: intended curriculum, implemented curriculum, and attained curriculum (Robitaille & Travers, 1992, p. 693). The intended curriculum is defined at the national or system level, the implemented curriculum is that which is taught by the teachers in the classroom, and the attained curriculum is what is learned by students and demonstrated through their achievement and attitudes.

Content analysis of textbooks should "concentrate on the characteristics of the textbook which emphasize the main objectives of the curriculum" (Dreyfus, 1992, p.8). The main objectives of the curriculum are stated in the intended curriculum. In this researcher's study, they are stated in the NCTM Standards. Subjective interpretation is necessary for many of the objectives. Other objectives are can be measured with descriptive statistics.

A combination of these was used in a study that compared American and Japanese mathematics textbooks (Robitaille & Travers, 1992). The researchers found that many topics were introduced 1 year later in American textbooks than in Japanese textbooks except for ratio and proportion, problem solving, fractions, and weight (p. 707). Material was spiraled or reviewed in American textbooks more often than in Japanese textbooks. More than 70% of the concepts were reviewed at least once, almost 25% were reviewed twice, and 10% were reviewed three times. Japanese textbooks reviewed

38% of the concepts once and only 6% more than once (p. 707). American texts were longer and less complicated than Japanese texts. Problems began simply in the Japanese texts but quickly became difficult. The process of mathematics was explained in detail in American textbooks; steps were omitted in Japanese textbooks. American mathematics texts were also longer than Japanese texts. American texts ranged from 400 to 856 pages with an average of 540 pages; Japanese texts averaged 178 pages with a maximum of 230 pages.

Content analysis of two secondary biology textbooks was carried out by Lumpe and Scharmann (1991). They used an instrument from a previous study that was "designed specifically for content analysis of written lab activities" (p. 232). Lumpe acted as one of two judges and worked independently to assess 10% of the lab activities with the instrument. Interrelater reliability was established and Lumpe then proceeded to judge the remaining activities from both texts.

Linguistic content analysis was used to measure science as a process of inquiry in a high school biology textbook series (Eltinge & Roberts, 1993, p. 65). The researchers used a scheme developed by a previous researcher, Tamir, for use on chapters of science textbooks. Sentences were classified as "rhetoric of conclusions" or "narrative of inquiry" (p. 67). The categorization scheme included 23 items that listed examples of what might appear in a narrative of inquiry. Eltinge and Roberts write that two general techniques of content analysis were used. The first involved the researcher's "subjective, impressionistic application of a classification scheme to the phenomena of interest" (p. 68). The second applied "computers in classifying words and phrases from texts of transcripts" (p. 68). They caution against the varying interpretations of subjective schemes, while also pointing out the limitations of computer-aided interpretations taken out of context.

Another approach to content analysis is the evaluation and analysis of two eighth grade history books with respect to the California History Social-Science Framework (Wolf, 1992). The author isolated multicultural perspectives and criteria for evaluating instructional materials from the Framework. He employed an instrument from previous studies that used "descriptive concepts and quantitative data (number of pages and pictures)" (p. 24). A narrative compared and contrasted the findings.

Krippendorff (1980) considers content analysis to be "fundamentally empirical in orientation, exploratory, concerned with real phenomena, and predictive in intent. . . . (It) enables the researcher to plan, to communicate, and to critically evaluate a research design independently of its results" (p. 9). Data must be unitized, separated, and identified. Recording and coding of data can be done manually or with computers, but it must be replicable. Finally, it must be understood that "although a good content analysis will answer some question, it is also expected to pose new ones. . . . The beginning and end of a content analysis mark but an arbitrary segment in time" (p. 169).

Summary

In summary, the changes in society have created a new need for mathematics reform in the 1990s. The issues are interrelated and require a flexible, holistic viewpoint, and complex problem-solving abilities. Students in today's educational system will need to solve these complex problems. The NCTM Standards (1989) address these needs, but purposely do not provide an easy checklist for curriculum developers (pp. 241-242). Mathematics teachers need assistance in aligning their curriculum to NCTM Standards (Chandler & Brosnan, 1995; Rivers, 1990). Subjective, interpretative analysis, as well as objective analysis, is needed to determine if new curricular materials are meeting many of the objectives. This researcher was unable to locate an adequate evaluative instrument based upon the NCTM Standards for textbook analysis. Therefore, the researcher developed an instrument that was used in this study to analyze the P.A.S.S. curricular materials with respect to the Standards.

CHAPTER 3

Methodology

> A considerable portion of my high school trigonometry course was devoted to the solution of oblique triangles. I pride myself on the fact that I was the best triangle solver my high school ever turned out. When I went to Princeton I found that I was up against very stiff competition. But whereas other freshmen might outdo me in many ways, I felt confident that I would shine when the time came to solve triangles. All through my undergraduate years I was waiting for that golden moment. Then I waited all through graduate school, through my work with Einstein, at Los Alamos, and while teaching and consulting for more than a dozen years. I have still not had an excuse for using my talents for solving oblique triangles.
>
> If a professional mathematician never uses these dull techniques in a highly varied career, why must all high school students devote several weeks to the subject?
>
> - John G. Kemeny
> (Schmalz, 1993, p. 260)

This lengthy quote succinctly expresses the vision behind the National Council of Teachers of Mathematics (NCTM) Standards. Mathematics curricula must reflect the needs of the society. The California Portable Assisted Study Sequence (P.A.S.S.) Program is a unique program that provides educational opportunities to students who are often underserved in the regular system. The P.A.S.S. mathematics curriculum is periodically rewritten to reflect changes in educational theory and instruction.

Educating the migrant student population is one of the greatest challenges that the California educational system and the United States educational systems face today. Students from this population frequently relocate to other schools and to other states. The P.A.S.S. Program serves 165 schools in California and was created to help assuage some of the difficulties that these students encounter. However, the P.A.S.S. Program must not only provide materials that will be appropriate for the migrant student, but must also comply with the National Council of Teachers of Mathematics Standards for School Mathematics (NCTM Standards or Standards). Until now, no study has been conducted that has analyzed the P.A.S.S. mathematics curricular materials in relationship to the Standards.

This study analyzed the 1-year secondary level courses entitled Integrated Math A and Integrated Math B written in 1995 and the 1989 course General Math A and General Math B. This analysis compared the curricula in relationship to the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics

(1989). An evaluative instrument was designed to measure the extent to which the curricular materials meet NCTM Standards and was used in this study to analyze the P.A.S.S. curricular materials.

Design of the Study

This study used content-analysis as the main methodology to analyze the text of the P.A.S.S. curricula for 1989 and 1995. The 1995 curricular materials entitled Integrated Math A and Integrated Math B replaced the 1989 curricular materials entitled General Math A and General Math B. Comparisons were made in reference to the NCTM Curriculum and Evaluation Standards for School Mathematics (1989).

Content analysis is a specialized technique in research that can provide important information. Krippendorff (1980) defines content analysis as "a research technique for making replicable and valid inferences from data to their context" (p. 21). Berelson (1952) defines it as "a research technique for the objective systematic and quantitative description of the manifest content of communication" (p. 18). Borg and Gall (1989) describe its use in education as being "aimed at answering questions directly relating to the material analyzed" (p. 520). They point out that "recent content-analysis studies consider not only content frequencies but also the interrelationships among several content variables, or the relationship between content variables and other research variables" (p. 521).

Content analysis methodology requires the research design to remain open and flexible during the study. Krippendorff (1980) considers the content analysis research design to be sequential. Outcomes from one step determine the next step, and "in sequential processing of information, errors are thus cumulative or multiplicative" (p. 50). Therefore, the design must allow room to compensate for any loss of information or an opportunity to recreate what was destroyed if results are to be trusted. With this caveat in mind, this study adhered to the following recommended procedures.

Procedures

Krippendorff (1980) lists the components or steps of content analysis as the process as (a) data making, which includes unitization, sampling, and recording, (b) data reduction, (c) inference, (d) analysis, (e) direct validation, (f) testing for correspondence with other methods, and (g) testing hypotheses regarding other data (p. 52). Kelle (1996) discusses classical content analysis as building indexes, including cross references, and "decontextualization and comparison of text passages" (p. 36) also known as "cut-and-paste." "The crucial point in the hermeneutic analysis of large amounts of textual data is that at any given point the analyst must be able to draw together all text passages, chunks of data and memos that relate to a certain topic" (p. 38).

This researcher utilized the third-generation qualitative data analysis software Nud*Ist (Richards & Richards, 1995). This qualitative data analysis software offers coding and retrieving functions, as well as exploration of the data. Kelle (1996) considers this type of program to be "a major methodological innovation" (p. 41). The use of this program required online documents to provide maximum indexing opportunities. The 1989 Portable Assisted Study Sequence (P.A.S.S.) curriculum materials General Math A and General Math B were scanned into the computer in the Fall of 1995. The 1995 P.A.S.S. curriculum Integrated Math A and Integrated Math B existed online in the researcher's computer because the researcher was a co-author.

The evaluative instrument, Mathematics Materials Analysis Instrument (MMAI) (see Appendix A), was designed in the fall of 1995 and given to the content validation panel in January 1996. (The content evaluation process for this study is described in detail on p. 80.) It was edited and panel approval was received in March 1996. The pilot study to establish interrater reliability using the validated instrument was conducted at that time. Interrater reliability in this study is defined as the extent to which similar ordinal values are assigned using the validated MMAI by various coders at separate locations.

Computer coding and indexing began in April and continued through June 1996. The most common analytic techniques in content analysis are "in terms of frequencies: absolute frequencies, such as the numbers of incidents found in the sample, or relative frequencies, such as the percentages of the sample size" (Krippendorff, 1989, p. 109). Nud*Ist (Richards & Richards, 1995) provided the capability for frequency counts and percentage statistics for text units. In addition, two assistants collected data manually over a three-month period. This consisted of counting types of problems, recording number of pages, determining percentages of text to graphics, and compiling thematic word lists from sorted word lists. Coding retrieval in Nud*Ist and subsequent data analysis were then performed.

Population

The population affected by this study are the California Portable Assisted Study Sequence (P.A.S.S.) 1989 and 1995 mathematics curricula titled respectively General Math A and General Math B, and Integrated Math A and Integrated Math B. The courses are themselves the units of analysis. "Regarding unitization, the general recommendation is to aim for the empirically most meaningful and productive units that are efficiently and reliably identifiable and that satisfy the requirements of available techniques" (Krippendorff, 1980, p. 64).

The appropriateness of the 1995 P.A.S.S. curriculum materials for migrant students has been attested to in a letter (see Appendix J) submitted by Dr. Rudy Miranda, an educational consultant and the Director of Counseling at the researcher's school site. Dr. Miranda is directly involved with Latino students and the P.A.S.S. program and reviewed the materials for this study.

Instrumentation

An evaluative instrument was designed for this study to quantify the relationship between mathematics materials and the recommendations in the

NCTM Standards. This instrument is entitled Mathematics Materials Analysis Instrument (MMAI) (see Appendix A) and is divided into two grade levels: grades 5-8 and grades 9-12. A Guide for Reviewing School Mathematics Programs (NCTM, 1991) provided guides for the K-12 mathematics program to "determine the level of implementation that currently exists. . . . Users should feel free to modify these outlines or develop new ones" (p. 1). The researcher and a validation panel modified guides from two curricular areas, Grades 5-8, and Grades 9-12. The materials chosen were considered to be "the most useful for systematically analyzing textbooks or other materials that are being considered for adoption" (p. 3). These modified materials were used to create MMAI that has been used in this study to analyze the P.A.S.S. curricular materials.

The evaluative instrument MMAI consists of eight categories for grades 5-8 and eight categories for grades 9-12. There are 3 to 12 subcategories for each category in grades 5-8 and 6 subcategories for each category in grades 9-12. The instrument includes an ordinal value scale that measures the extent to which material in the curricular materials meet NCTM Standards. The ordinal values assigned to each subcategory are "1-None, 2-Low, 3-Moderate, 4-High." These values measure the extent of alignment of content in the curricular materials to the content in the subcategories on MMAI that reflects the NCTM Standards. Supplementary attachments were included with MMAI to assist the coders in assigning values (see Appendixes B-E).

Content Validity. The content validity of the evaluative instrument was determined by a panel of three expert educators who are familiar with and experienced in the vision of the NCTM Standards. Dr. Jane D. Gawronski is co-author of the NCTM Assessment Standards, and is the Superintendent of Escondido Union High School District in Escondido, California. Dr. Carol Fry Bohlin is an Associate Professor of Mathematics Education at California State University, Fresno, and Director of the California Mathematics Project for the San Joaquin Valley. Dr. Roy M. Bohlin is an Associate Professor of Instructional Technology at California State University, Fresno, Principal Investigator for the California Mathematics Project for the San Joaquin Valley, and the Coordinator of Evaluation for the National Science Foundation (NSF) Project PROMPT (Professors Rethinking Options in Mathematics for Preservice Teachers). The California Mathematics Project is designed to update teacher knowledge in the California Framework (California Department of Education, 1992) and NCTM Standards.

The panel was approached in the fall of 1995, and agreed to review and edit the instrument. A draft copy of the evaluative instrument, various supplementary attachments, and a letter of instructions (see Appendix F) were submitted to the panel in January 1996. Several revisions to the instrument occurred over the next two months; the supplementary attachments were accepted with minor editing changes. The panel gave their approval of content to the final revision in March 1996 (see Appendix G). The final instrument was titled Mathematics Materials Analysis Instrument (MMAI) and included supplementary attachments (see Appendixes A-E).

The following changes were made to the original draft of the instrument based upon recommendations and suggestions from the panel.

1. Categories and subcategories: The weighting of items in categories was deemed reasonable for Grades 5-8, which contained eight categories with each category containing from 3 to 12 subcategories. This distribution was maintained in the final instrument. The distribution for Grades 9-12 was deemed unreasonable because there were six categories with each category containing from 4 to 22 subcategories. This distribution was changed

to eight categories with each category containing six subcategories.

2. The words *curriculum* and *curricula* were replaced with *curricular materials* and *materials* throughout much of the instrument. This was done to reflect the intent of use for the instrument to measure curricular materials rather than curriculum as a whole. The title of the instrument was also changed to reflect this emphasis, and the acronym MMAI was added.

3. Editing changes were made throughout the instrument to separate compound statements, to correct the improper use of terms such as *reference materials* instead of *source materials*, and other semantical errors.

4. The instrument worksheet was edited to provide more detail and consistency of wording to ensure ease of use.

5. Ordinal values originally included the subcategory "0 - Not Applicable." The panel recommended deleting this subcategory. This was done during the pilot study when participants found the subcategory to be confusing.

Interrater Reliability. Reproducibility requires more than one coder and is "a minimum standard for content analysis" (Weber, 1990, p. 17). Coders must work independently to prevent agreement through communication as the "lack of independence is likely to make data appear more reliable than they are" (Krippendorff, 1980, p. 132). Accuracy is the "strongest reliability test available" (p. 131).

Interrater reliability in using the evaluative instrument MMAI was established through a pilot test conducted with secondary mathematics teachers from the researcher's school site. A team of five secondary mathematics teachers presently teaching all levels of secondary mathematics from general mathematics to calculus participated in the study. Two of the teachers each have over 25 years of teaching experience; both have served or are serving as chairman of the mathematics department. Both teachers unabashedly subscribe to a traditional philosophy of mathematics teaching based upon their experience and training. The remaining three teachers have less extensive experience. The third team member has approximately 5 years teaching experience. The fourth and fifth team members are new to the profession: one is in her 2nd year of teaching, and the other is in his 3rd year. The newest members have been exposed to contemporary training in the Standards and updated teaching techniques in their college programs.

The five teachers were divided into two teams of three members, with one teacher participating on both teams. Teams were given the choice of two textbooks: Integrated Mathematics, (Rubenstein, Craine, & Butts, 1995) or Informal Geometry (Cummins, Kenney, & Kanold, 1988). The researcher chose these textbooks because their publishing dates suggested there might be recognizable philosophical differences in the curricula. The instrument could therefore be tested from two distinctly different viewpoints.

The two traditional teachers immediately selected Informal Geometry because they were interested in obtaining it as a replacement text in their geometry courses. Their comments included statements to the extent that the text was advertised as a transition text between traditional teaching and teaching strategies recommended by the Standards. The other team enthusiastically agreed to assess Integrated Mathematics and recognized it as the first published mathematics text advertised in California as meeting the Standards. The third team member also agreed to assess Informal Geometry.

The enthusiasm of the participants was important to the study because they were more likely to be thoughtful and careful while coding.

The Mathematics Materials Analysis Instrument (MMAI) and supplementary attachments (see Appendixes A-E) were distributed to each of the team members. Both teams were asked to objectively survey the texts based upon an item-by-item assignment of values using the instrument, and they agreed to be objective. The coding values were discussed, and it was decided the value "0 - Not Applicable" was confusing. Therefore, the teams were advised to eliminate this item from the coding. The team members were asked to read the supplementary attachments and to form their own interpretations from those materials. The two traditional teachers asked for a moment to discuss the Informal Geometry text together, but the researcher advised them that research procedures required them to work independently. Coders must work independently to prevent agreement through communication as the "lack of independence is likely to make data appear more reliable than they are" (Krippendorff, 1980, p. 132). All team members then moved to separate sections of the room and independently used the instrument and materials. They completed the process in approximately one hour and offered comments to the extent that they felt the instrument was straightforward and relatively easy to use.

Data Collection Methodology

Content analysis is "valid to the extent its inferences are upheld in the face of independently obtained evidence" (Krippendorff, 1980, p. 155). Triangulation refers to the use of multiple methods of data collection to ensure trustworthiness and enhance the validity of research (Kelle, 1995; Patton, 1990). The triangulation in this study consisted of (a) qualitative examination of the materials, (b) descriptive statistics compiled from manual counts and observations, and (c) computer analysis using Nud*Ist (Richards & Richards, 1995), a third-generation qualitative data analysis software. The materials examined were the California Portable Assisted Study Sequence (P.A.S.S.) mathematics curricula for 1989 and 1995 entitled respectively General Math A and General Math B, and Integrated Math A and Integrated Math B.

Qualitative data were compiled by the researcher from examinations of the 1989 and 1995 curricula. This included an examination of unit titles, tables of contents, introductory instructions, student directions, and other topics of interest. Descriptive statistics were accumulated with the use of a data collection worksheet (see Appendix H) given to two assistants who worked diligently and carefully to manually record the data from the 1989 and 1995 curricula. Krippendorff (1980) discusses the need to choose observers and coders not only "familiar with the nature of the material to be recorded but also capable of handling the categories and terms of the data language reliably" (p. 72). The assistants were chosen because they are mathematically inclined and data-oriented. One is a manager for a major engineering corporation and is an electrical engineer in computer design; he compiled the data on the data collection worksheet for the 1995 curriculum. The other is a secondary mathematics teacher with 2 years teaching experience and 6 years engineering experience as an intern in high school and during college. She has a mathematics degree from California State University, Bakersfield, CA., which included updated training in reform curriculum in mathematics. Her real-world experience, teaching experience, and updated training made her an ideal candidate for coding the 1989 and 1995 curriculum using the evaluative instrument Mathematics Materials

Analysis Instrument (MMAI). She also searched sorted word lists and compiled topical or categorical word lists for both years, and compiled data for the 1989 curriculum on the data collection worksheet.

The 1989 and 1995 curricula were then assigned quantitative coding values by the researcher and the secondary mathematics teacher previously described, using the validated Mathematics Materials Analysis Instrument (MMAI) and supplementary attachments (see Appendixes A-E). This provided two human coders (Coder 1 and Coder 2) as well as computer coding (Coder 3). "Classification by multiple human coders permits the quantitative assessment of achieved reliability. Classification by computer, however, leads to perfect coder reliability" (Weber, 1980, p. 15). The researcher then began the computerization process of coding.

Data Computerization Process

Classical content analysis consists of several basic steps. Weber (1990) lists these steps as (a) defining recording units, (b) defining the categories, (c) test coding on a sample of text, (d) assessing accuracy and reliability, (e) revising coding rules if necessary, (f) return to step d until reliability is achieved, (g) coding all the text, (h) assessing achieved reliability and accuracy, and reexamining subtle meanings.

The recording unit or "unit of analysis (for example, sentences or paragraphs) has to be determined and a precise coding strategy has to be constructed" (Seidel & Kelle, 1995, p. 53). Text units can be defined in several ways. Weber (1990) lists six commonly used options: word, word sense, sentence, theme, paragraph, and whole text.

The size of a single text unit for this study varied from a sentence to several paragraphs depending on theme or context. For example, the text unit was often an entire word problem including all questions pertaining to that word problem. Another text unit would often be an entire page of skill-and-drill exercises that required the same thought processes. A text unit would sometimes be a simple one-line definition or sentence that was dissimilar to surrounding text. The researcher's objective in determining text units was to isolate meaningful information while minimizing the amount of raw data. This is considered to be "condensing the information contained in the raw data to a minimum" (Seidel & Kelle, 1995, p. 53).

In classical content analysis, once the recording units are established the researcher then assigns codes to text units "in a systematic and consistent way . . . (that is) . . . inclusive and exhaustive. . . . A precise coding scheme is developed before coding starts" (Seidel & Kelle, 1995, p. 54). This is a deductive process, which fit nicely with this study.

The validated content in the Mathematics Materials Analysis Instrument (MMAI) had been established as a third-order hierarchy of items and categories. The first order applied to the grade levels of the instrument: grades 5-8 or grades 9-12. These were assigned nodes 1 and 2. The second order applied to eight categories A - H for each grade level. These were assigned nodes with spaces included: 1 1, 1 2, 1 3, 1 4, 1 5, 1 6, 1 7, 1 8, 2 1, 2 2, 2 3, 2 4, 2 5, 2 6, 2 7, and 2 8. For example, node 2 7 referred to grades 9-12, category G, node 1 4 referred to grades 5-8, category D. The third order applied to the specific items in each category: there were 3 to 12 items in the eight categories in grades 5-8, and 6 items in each of the eight categories in grades 9-12. An example of node assignment for this hierarchy level were nodes: 1 1 1, 1 1 2, 1 1 3, 1 1 4, 1 1 5, 1 1 6, 1 1 7, 1 1 8, 1 1 9, 1 1 10, 1 1 11, and 1 1 12 for category A in grades 5-8, and 2 1 1, 2 1 2, 2 1 3, 2 1 4, 2 1 5, and 2 1 6 for category A in grades 9-12.

The category system was then entered into the computer as nodes (see Appendix I) using Nud*Ist, the qualitative data analysis software chosen for this study (Richards & Richards, 1995). The same categorizing system was used for the 1989 and the 1995 curricula. The process required two separate coding projects for comparison purposes.

The 1989 and 1995 Portable Assisted Study Sequence (P.A.S.S.) curricular materials were directly introduced to Nud*Ist as on-line documents. The 1989 curriculum had previously been scanned into the computer, the 1995 curriculum existed online. This process involved the researcher's preparation of the documents for Nud*Ist that consisted of dividing the curriculum into smaller documents that could be processed by the program. Headings were attached to each document, and the text units were marked with carriage returns. Spiral review and practice exercises were eliminated from the text as they represented repetitions of core content. The spiral review and practice exercises were accounted for in other data collection procedures (see Appendix H). "While each additional unit in a sample adds to the costs of an analysis, there comes a point at which a further increase will not appreciably improve the generalizability of the findings. This is the point at which the sample size is most efficient" (Krippendorff, 1980, p. 69). The documents were then introduced to Nud*Ist.

The Nud*Ist program was then tested for accuracy and reliability. Test coding on sample text was performed by the researcher, and no errors were found. The researcher had previously participated in a 2-day training seminar in Portland, OR., with Lyn Richards, the co-author of Nud*Ist. This experience undoubtedly smoothed the process of using the program. Nud*Ist is also recognized as a reputable software for research (Prein, Kelle, & Bird, 1995; Kelle, 1996) and has eliminated many of the programming bugs.

Text units were then indexed to nodes. "The best practical strategy is to classify each word, word sense, or phrase in the category where it most clearly belongs . . . (and) . . . each investigator will have to find the resolution that makes the most sense in light of the goals of the analysis" (Weber, 1990, p. 36). The researcher looked at every text unit and compared them to every item on the Mathematics Materials Analysis Instrument (MMAI) (see Appendix A) for grades 5-8 and grades 9-12. The text units were then indexed to single or multiple nodes. This process lasted several months. It was performed on the 1989 and 1995 curricula, and coding reliability depended largely at this point on the researcher's own integrity and understanding of the materials.

It should be mentioned at this point that a sample of text units were selected and indexing was discussed with the other coder in this study prior to computer coding. Agreement was reached as to basic coding strategies, but there was not a prolonged pilot study. Kelle and Laurie (1995) discuss this type of coding as referential coding, which in many cases do "not represent specific, precisely defined facts or incidents, but generally, vaguely defined topics" (p. 25). Therefore, while consistency of coding is important, "a more sophisticated investigation of the reliability problem is needed" (p. 25). The researcher thus decided consistency would be maintained as much as humanly possible. This consistency would later be measured by checking interrater reliability between the two human coders who manually coded the curriculum using MMAI, and the data retrieved from this computer analysis. This is, in fact, in line with the strategies recommended by Weber (1990) and Krippendorff (1980). Weber lists the assessment of reliability and accuracy as the last step of the coding scheme. Krippendorff proposes reliability should be established through the duplication of efforts. He distinguishes between three types: stability, reproducibility, and accuracy. Stability can be established by the repetition of coding by the same coder. Reproducibility requires more than one coder and is "a minimum standard for content analysis" (Weber, 1990, p. 17). Coders must work independently to prevent agreement through communication as the "lack of independence is likely to make data appear more reliable than they are" (Krippendorff, 1980, p. 132). Accuracy is the "strongest reliability test available" (p. 131).

Data Analysis

Content data analysis involves "word-frequency counts, key-word-in-context listing, concordances, classification of words into content categories, content category counts, and retrievals based on content categories and co-occurrences" (Weber, 1990, p. 41). Krippendorff (1980) considers measurement in terms of frequencies to be the most "common form of representation of data" (p. 109).

Measurement in this study involved calculating percentages and proportions of text units, word counts, category topics, and other items. Nud*Ist and human coders provided frequency counts and calculated percentages. Excel spreadsheet software for Windows was used to calculate statistics from the ordinal data. Frequency counts were conducted for words assigned to topical categories.

> Each word classified in a particular category need not equally represent the category content. Nevertheless, counting each entry equally is desirable because we currently lack procedures that reliably and validly assign weights indicating the unequal representation of category content by different entries in a single category. (Weber, 1990, p. 72)

The process of assigning ordinal values to Nud*Ist's code retrieval data involved several steps. The researcher chose a conservative approach to minimize co-author bias in reference to coding the curricula. Coded retrievals in Nud*Ist provided statistical printouts for each node. For example, the retrieval for node 1 1 1 for the 1989 curriculum, Grades 5-8 was shown in its node retrieval report:

> Total number of text units retrieved = 185
> Retrievals in 12 out of 15 documents = 80%.
> The documents with retrievals have a total of 645 text units,
> so text units retrieved in these documents = 29%.
> All documents have a total of 796 text units,
> so text units found in these documents = 23%.

There were 61 nodes for grades 5-8, and 48 nodes for grades 9-12 for each of the 1989 and 1995 curriculum. Node retrieval reports were compiled for each of the nodes, and three distinct percentages were retrieved for each node report. The first percentage was deemed highly misleading since one text unit would automatically qualify as retrieval from a document. Therefore, the second and third percentages were deemed to be the most useful and were used in the calculations for the mean as a percentage for each row or item (see Table 1).

The weighted average was then calculated for each category for each grade level of MMAI. For example, category A for grades 5-8 contained 12 out of 61 items or a weighted average of 19.7%. The weighted averages were established for each category (see Table 1 and Appendix S). Grades 5-8 had 61 items in 8 categories with 3 to 12 items in each category; thus, weighted averages varied for each of those categories. Grades 9-12 had 6 out of 48 items in each of 8 categories so the weighted average was 12.5% for each of those 8 categories.

Table 1

Assignment of Ordinal Values to P.A.S.S. Curricula by Coder 3 (Nud*Ist) Using the Mathematics Materials Analysis Instrument (MMAI)

Node	X	Y	M[a]	Ordinal Value
1995 curriculum, grades 5-8				
1 1 1	62.0	59.0	60.5	4
1 1 2	20.0	11.0	15.5	2
1 1 3	54.0	51.0	52.5	4
1 1 4	63.0	56.0	59.5	4
1 1 5	31.0	15.0	23.0	3
1 1 6	19.0	1.5	10.3	2
1 1 7	68.0	47.0	57.5	4
1 1 8	49.0	46.0	47.5	4
1 1 9	44.0	38.0	41.0	4
1 1 10	74.0	58.0	66.0	4
1 1 11	44.0	39.0	41.5	4
1 1 12	46.0	38.0	42.0	4
1 2 1	73.0	73.0	73.0	4
1 2 2	39.0	36.0	37.5	4
1 2 3	15.0	6.6	10.8	2
1 2 4	26.0	16.0	21.0	3
1 2 5	50.0	23.0	36.5	4
1 2 6	31.0	17.0	24.0	3
1 2 7	25.0	18.0	21.5	3

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = (X + Y)/2. [a]The weighted average for node 1 1 is 19.7% and for node 1 2, 11.5%.

The third step in this process involved assigning the weighted averages to ordinal values on the instrument (MMAI). The evaluative instrument includes an ordinal value scale that measures the extent of alignment of content in the curricular materials to content reflecting the NCTM Standards in the subcategories. The ordinal values are assigned to each subcategory as follows: 1-None, 2-Low, 3-Moderate, 4-High. As mentioned, a conservative rating strategy was chosen to alleviate measurable researcher bias. The ordinal value 1 was assigned to weighted averages between 0% and 1%. The ordinal value 2 was assigned to weighted averages greater than 1% and less than the computed weighted average to the next greatest integer, e.g., 19.7% became 20%. The ordinal value 3 was assigned to the weighted averages exceeding the previously calculated upper boundary, e.g., 20%, and less than approximately twice this boundary, e.g., 40%. The ordinal value 4 was assigned to all weighted average percentages greater than the prior upper boundary, e.g., 40%. An example of this assignment follows for category A in grades 5-8 with a computed weighted average of 19.7%. Appendix S shows the assignment of ordinal values for Coder 3 using this ordinal scale for the mean percentages (M) for the 1989 and 1995 curricula.

Ordinal Value	Weighted Average A
1	$0\% < A \leq 1\%$
2	$1\% < A \leq 20\%$
3	$20\% < A \leq 40\%$
4	$A > 40\%$

The 1989 and 1995 curriculum had therefore been coded to MMAI by three coders. Two of the codings were completed manually by human coders (Coder 1 and Coder 2) and one was based upon Nud*Ist node reports (Coder 3). The data analyses for the hypotheses and research questions were now performed.

Hypotheses. There were two null hypotheses for this study.

$H_{(O)1}$: There is no statistically significant difference between the 1989 and 1995 P.A.S.S. curricula materials in relation to the NCTM Standards. $\mu_1 = \mu_2$.

$H_{(R)1}$: There is a statistically significant difference at the significance level .05 between the 1989 and the 1995 P.A.S.S. curricula in relation to the NCTM Standards. $\mu_1 \neq \mu_2$.

$H_{(O)2}$: There is no statistically significant difference between human coders and computer coding in relationship to the 1989 and 1995 P.A.S.S. curricula. $\mu_1 = \mu_2 = \mu_3$.

$H_{(R)2}$: There is a statistically significant difference at the .05 significance level between human coders and computer coding in relationship to the 1989 and 1995 P.A.S.S. curricula. $\mu_1 \neq \mu_2 \neq \mu_3$.

The evaluative instrument designed for this study, Mathematics Materials Analysis Instrument (MMAI) (see Appendix A), includes an ordinal value scale that measures the extent of alignment of content in the curricular materials to content reflecting the NCTM Standards in the subcategories. The ordinal values are assigned to each subcategory as follows: 1-None, 2-Low, 3-Moderate, 4-High. Supplementary attachments were included with MMAI to assist the coders in assigning values (see Appendixes B-E). Nonparametric statistical tests were used to test the data for these hypotheses.

The first hypothesis was tested with a nonparametric test designed for ordinal data. Chi-square analysis was used to determine if there were any significant differences between the frequencies of ordinal value coding and the 1989 and 1995 curricula.

The second hypothesis was tested with the nonparametric Kruskal-Wallis H-test for ordinal data. This test was used to determine interrater reliability between the two human coders and Nud*Ist computer coding. The mean of ordinal values for each category for each coder was computed for each grade level 5-8 and 9-12. This was done for the 1989 and 1995 curricula. The H-test was then used to test for significant differences between the rankings of the category means for each year.

Research Questions. There were two research questions for this study.

1. To what extent do the 1995 P.A.S.S. curricular materials improve upon the 1989 P.A.S.S. curricular materials with respect to the Standards of mathematics education delineated by the National Council of Teachers of Mathematics?

2. Can a researcher-designed evaluative instrument measure the extent to which curricular materials meet the NCTM Standards ?

The research questions were answered in multiple ways. Qualitative analysis allows the researcher to maintain flexibility while considering new findings and discoveries. Descriptive statistics and narrative descriptions were used to answer the first research question. This also completed the triangulation process of analysis for comparing the 1989 and 1995 curricula. The triangulation in this study consisted of (a) qualitative examination of the materials, (b) descriptive statistics compiled from manual counts and observations, and (c) computer analysis using Nud*Ist (Richards & Richards, 1995), a third-generation qualitative data analysis software.

The second research question involved multiple steps of analysis. The first step involved content validation of the evaluative instrument designed for this study. This was accomplished through the use of a validation panel. The second step involved interrater reliability of coding using the validated instrument. This was accomplished through a pilot study with different curriculum materials and different coders than were used in this study. This pilot study was evaluated through the use of the nonparametric Kruskal-Wallis statistical test at the .05 level of significance. The third step involved interrater reliability for three coders who used the validated instrument MMAI to code the 1989 and 1995 P.A.S.S. curricular materials. The three coders included two human coders (Coder 1 and Coder 2) and Nud*Ist computer coding (Coder 3). Hypothesis 2 refers to this portion of the analysis.

CHAPTER 4

Findings

> A content analyst is obligated to make everything transparent, . . . at least for those interested in using the findings, replicating the analysis, or further developing the techniques.
>
> - K. Krippendorff (1980, p. 180)

This study utilized the methodology of content analysis to analyze the content of the 1989 and 1995 Portable Assisted Study Sequence (P.A.S.S.) mathematics curricular materials in relationship to the goals and spirit of the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics (1989). Narrative descriptions and comparisons, manual data collection and coding, and computer analyses using Nud*Ist qualitative data analysis software (Richards & Richards, 1995) have been performed. This combination of analyses has resulted in a concise and complete analysis of the curricular materials.

An evaluative instrument, Mathematics Materials Analysis Instrument (MMAI) (see Appendix A), to measure the relationship between the curricular materials and the recommendations made in the NCTM Standards (1989) was designed for this study. This process included content validation by an expert panel familiar with and experienced in the vision of the NCTM Standards. Interrater reliability was established through a pilot study as well as for this study.

Ordinal data from the 1989 and 1995 curricula were obtained through coding using the evaluative instrument MMAI . Coding was performed by three coders (two human coders and Nud*Ist computer coding). These data were converted to statistical measures of dispersion for analysis.

Content data analysis involves "word-frequency counts, key-word-in-context listing, concordances, classification of words into content categories, content category counts, and retrievals based on content categories and co-occurrences" (Weber, 1990, p. 41). Krippendorff (1980) considers measurement in terms of frequencies to be the most "common form of representation of data" (p. 109). These types of data were collected through the use of a data collection worksheet (see Appendix H) and word sort lists containing frequency counts for each curriculum. These word lists were manually examined for key-word-in-context listings, classifications of words into content categories, content category counts, and retrievals based on content categories and co-occurrences.

The 1989 and 1995 curricula were also examined by comparing titles, subheadings, sections headings, student directions, and teacher guidelines. Discoveries made during this process led to further examination of classifications of words into content categories, content category counts, and other interpretative analyses.

This chapter is divided into five sections. The first two sections list the two hypotheses and discuss the findings for each. The next two sections list the two research questions and discuss the findings for each. The final section discusses other findings that were discovered in the process of this qualitative study.

Hypothesized Findings

Null Hypothesis 1

$H_{(O)1}$: There is no statistically significant difference between the 1989 and 1995 P.A.S.S. curricula materials in relation to the NCTM Standards.

$\mu_1 = \mu_2$.

$H_{(R)1}$: There is a statistically significant difference at the significance level .05 between the 1989 and the 1995 P.A.S.S. curricula in relation to the NCTM Standards. $\mu_1 \neq \mu_2$.

One of the most commonly used nonparametric methods for testing ordinal data is the chi-square test (Borg & Gall, 1989; Vaillant & Vaillant, 1985). Chi-square analysis was used in this study to determine if there were any significant differences between the frequencies of ordinal value coding using Mathematics Materials Analysis Instrument (MMAI) on the 1989 and 1995 curricula. Table 2 shows the data and findings for these computations. The coded values for each of the three coders were tallied for the 1989 and 1995 curricula for each grade level 5-8 and 9-12. The total frequencies for each coder were inserted in 4x2 contingency tables. Expected values were also calculated in 4x2 contingency tables. The null hypothesis was rejected at both grade levels. This was interpreted as there is a statistically significant difference between the 1989 and the 1995 P.A.S.S. curricula in relation to the NCTM Standards.

Table 2

Chi-square Analysis of Observed and Expected Coding Values Using Mathematics Materials Analysis Instrument (MMAI) on P.A.S.S. Curricula

Coding Value	Observed 1989	Observed 1995	Expected 1989	Expected 1995
Grades 5-8				
1	63	2	32.5	32.5
2	65	35	50.0	50.0
3	40	77	58.5	58.5
4	15	69	42.0	42.0

$X^2 = 112.66$ $\alpha = .05$ $df = 3$

Coding Value	Observed 1989	Observed 1995	Expected 1989	Expected 1995
Grades 9-12				
1	73	17	45	45
2	42	25	33.5	33.5
3	20	56	38	38
4	9	46	27.5	27.5

$X^2 = 81.1$ $\alpha = .05$ $df = 3$

Null Hypothesis 2

$H_{(O)2}$: There is no statistically significant difference between human coders and computer coding in relationship to the 1989 and 1995 P.A.S.S. curricula. $\mu_1 = \mu_2 = \mu_3$.

$H_{(R)2}$: There is a statistically significant difference at the .05 significance level between human coders and computer coding in relationship to the 1989 and 1995 P.A.S.S. curricula. $\mu_1 \neq \mu_2 \neq \mu_3$.

Interrater reliability in this study was defined as the extent to which similar ordinal values were assigned by various coders at separate locations using the evaluative instrument Mathematics Materials Analysis Instrument (MMAI) (see Appendix A). This involved testing to see if there were significant differences in the coding assigned by two human coders (Coder 1 and Coder 2) and Nud*Ist computer coding (Coder 3) using Mathematics Materials Analysis Instrument (MMAI) on the 1989 and 1995 P.A.S.S. curricula. The nonparametric Kruskal-Wallis H-test was chosen to test for these differences. The means of ordinal values assigned by each coder were computed and ranked for the 1989 and 1995 curricula at each grade level 5-8 and 9-12. The H-test was then performed for each curriculum at each grade level, and no significant differences were found in any of the tests. Therefore, the null hypotheses were retained for both years and both grade levels. This was interpreted to establish interrater reliability between the coders using MMAI on the P.A.S.S. curricula in this study. These computations are shown in Tables 3-4.

Unhypothesized Findings

Research Question 1

> To what extent do the 1995 P.A.S.S. curricular materials improve upon the 1989 P.A.S.S. curricular materials with respect to the Standards of mathematics education delineated by the National Council of Teachers of Mathematics?

NCTM Standards are based upon the belief that all students should learn more (and different) content than is contained in traditional programs, and new teaching strategies need to be introduced. The thinking processes of problem solving, communication, reasoning, and connections are emphasized at all levels. The Standards assert that the educational system must meet new social goals. These are defined as providing for society mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate. Students must learn to value mathematics, become confident in their mathematical abilities, become mathematical problem solvers, learn to communicate mathematically, and learn to reason mathematically (p. 5). The Standards emphasize the need to "do" rather than "know" (1989, p. 7). Interdisciplinary curriculum must be included to supplement and replace portions of traditional engineering and physical science applications. Technology must be included and updated to reflect the nature of mathematics. The curriculum must be available to all students if "they are to be productive citizens in the twenty-first century" (p. 9). Students must participate in activities that model genuine problems, and be encouraged to experiment, discuss, and discover ideas and concepts.

The researcher began the analysis for this question with an examination of unit titles, which offered a cursory overview of contents in the 1989 and 1995 curricula. Table 5 lists the unit titles for each curriculum. Tables of

Table 3

Kruskal-Wallis H-test to Establish Interrater Reliability Between Coders Using the Mathematics Materials Analysis Instrument (MMAI) on 1989 Curriculum

MMAI Category	Coder 1	Rank	Coder 2	Rank	Coder 3	Rank
Grades 5-8						
A	2.08	11.5	2.08	11.5	2.17	13.0
B	1.71	4.5	1.86	6.5	1.86	6.5
C	2.25	16.0	2.25	16.0	2.25	16.0
D	2.44	20.0	2.22	14.0	2.56	21.0
E	2.40	19.0	2.60	22.5	2.60	22.5
F	1.71	4.5	2.00	9.0	2.29	18.0
G	1.00	2.0	1.00	2.0	1.00	2.0
H	2.00	9.0	2.00	9.0	3.33	24.0
	$N_1 = 8$		$N_2 = 8$		$N_3 = 8$	
		$R_{sum} = 86.5$		$R_{sum} = 90.5$		$R_{sum} = 123$

H = 2.004 $\alpha = .05$

table continued

MMAI Category	Coder 1	Rank	Coder 2	Rank	Coder 3	Rank
Grades 9-12						
A	1.83	13.0	2.17	22.0	2.33	24.0
B	1.67	9.0	2.00	18.0	1.83	13.0
C	2.00	18.0	2.00	18.0	1.50	6.5
D	1.83	13.0	1.83	13.0	2.17	22.0
E	1.33	5.0	1.17	4.0	1.50	6.5
F	1.67	9.0	1.83	13.0	2.17	22.0
G	1.00	2.0	1.00	2.0	1.00	2.0
H	2.00	18.0	1.67	9.0	2.00	18.0
	$N_1 = 8$		$N_2 = 8$		$N_3 = 8$	
		$R_{sum} = 87$		$R_{sum} = 99$		$R_{sum} = 114$

$H = 0.915$ $\alpha = .05$

Table 4

Kruskal-Wallis H-test to Establish Interrater Reliability Between Coders Using the Mathematics Materials Analysis Instrument (MMAI) on 1995 Curriculum

Category	Coder 1	Rank	Coder 2	Rank	Coder 3	Rank
Grades 5-8						
A	3.42	17.0	3.25	11.5	3.58	22.0
B	3.14	8.5	3.57	20.0	3.29	13.0
C	3.75	23.0	3.25	11.5	3.50	19.0
D	2.78	4.0	2.44	2.0	2.56	3.0
E	3.40	16.0	3.20	10.0	3.30	14.0
F	3.43	18.0	3.14	8.5	3.57	20.5
G	2.22	1.0	3.00	6.5	2.89	5.0
H	3.33	15.0	3.00	6.5	4.00	24.0
	$N_1 = 8$	$R_{sum} = 102.5$	$N_2 = 8$	$R_{sum} = 77$	$N_3 = 8$	$R_{sum} = 120.5$
$H = 2.389$	$\alpha = .05$					

Grades 9-12

Category	Coder 1	Rank	Coder 2	Rank	Coder 3	Rank
A	3.17	21.0	3.00	17.0	3.83	24.0
B	3.00	17.0	3.00	17.0	3.00	17.0
C	2.33	1.5	2.50	3.5	2.83	10.5
D	2.83	10.5	3.00	17.0	3.00	17.0
E	3.50	22.0	2.50	3.5	3.67	23.0
F	2.33	1.5	2.67	6.0	2.67	6.0
G	2.83	10.5	2.83	10.5	3.00	17.0
H	2.83	10.5	2.67	6.0	2.83	10.5
	$N_1 = 8$	$R_{sum} = 94.5$	$N_2 = 8$	$R_{sum} = 80.5$	$N_3 = 8$	$R_{sum} = 125$
$H = 2.589$	$\alpha = .05$					

contents for each unit were also examined (see Appendixes M-N). The 1995 curriculum titles clearly indicate a broader range of content and an implied potential for greater opportunities to engage higher-level thinking skills than are represented by the 1989 curriculum titles. The titles for the 1995 curriculum are, in fact, 10 of the curriculum standards (NCTM, 1989, pp. 65, 123) The 13 curriculum standards for grades 5-8 are problem solving, communication, reasoning, mathematical connections, number and number relationships, number systems and number theory, computation and estimation, patterns and functions, algebra, statistics, probability, geometry, and measurement. The 14 curriculum standards for grades 9-12 are problem solving, communication, reasoning, mathematical connections, algebra, functions, geometry from a synthetic perspective, geometry from an algebraic perspective, trigonometry, statistics, probability, discrete mathematics, conceptual underpinnings of calculus, and mathematical structure.

The tables of contents for all units in both courses were also examined. This examination further supported the researcher's viewpoint that the 1995 curriculum was more aligned to the Standards than the 1989 curriculum (see Appendixes M-N).

Descriptive statistics were used to explore the curricula in more detail. Data were obtained from data collection worksheets (see Appendix H) and from coding values obtained in the use of the evaluative instrument designed for this study, Mathematics Materials Analysis Instrument (MMAI) (see Appendix A). This instrument includes an ordinal value scale that measures the extent of alignment of content in the curricular materials to content reflecting the NCTM Standards in the subcategories. The ordinal values are assigned to each subcategory as follows: 1-None, 2-Low, 3-Moderate, 4-High. Three coders assigned values on MMAI to the 1989 and 1995 P.A.S.S. curricula. This included two human coders (Coder 1 and Coder 2) and the Nud*Ist computer coding (Coder 3). Supplementary attachments were included with MMAI to assist the coders in assigning values (see Appendixes B-E).

Krippendorff (1980) states "the most common form of representing data is in terms of relations between variables" (p. 111). The mean of ordinal values, group mean, and standard deviation for each category for each coder

Table 5

Unit Titles of P.A.S.S. Curricula

Course	Unit	Titles
1989		
General Math A	I	Numeration Systems and Place Value
	II	Addition and Subtraction
	III	Multiplication
	IV	Division
	V	Application
General Math B	VI	Fractions
	VII	Decimals
	VIII	Percent
	IX	Measurement
	X	Metrics
1995		
Integrated Math A	I	Number and Number Relationships
	II	Number Systems and Number Theory
	III	Computation and Estimation
	IV	Patterns, Functions, and Mathematical Connections
	V	Measurement
Integrated Math B	VI	Statistics and Probability
	VII	Algebra
	VIII	Geometry
	IX	Problem Solving
	X	Mathematics as Communication

were computed for grade levels 5-8 and 9-12. This was done for the 1989 and 1995 curricula. The median, mean, group mean, and standard deviation were also computed for each coder. Tables 6-7 present the central measures of tendency for the assigned coding values for the 1989 and 1995 curricula. The 1989 data in Table 6 clearly show the mean and median measures centering around or below 2.0 with small standard deviations (with one exception). This indicates the coders agreed that the 1989 curriculum represented low levels of content relating to the NCTM Standards. Category H in grades 5-8 has an exceptionally high standard deviation of 0.77 compared to the other categories. Closer examination shows a higher rating by Nud*Ist that clearly affected this standard deviation. This proved to be true for most categories in both grade levels. This is not surprising because the computer does not forget data and the assignment of ordinal values depended upon memory. Human coders are more likely to forget specific details and therefore assign lower ordinal values on MMAI. At any rate, the group standard deviation remained small showing agreement between the three coders.

The 1995 data in Table 7 clearly show the mean and median measures centering around or above 3.0 with small standard deviations (with several exceptions). This indicates the coders agreed that the 1995 curriculum represented moderate levels of content relating to the NCTM Standards. Categories G and H in grades 5-8 have standard deviations of 0.42 and 0.51, and categories A and E have standard deviations of 0.44 and 0.63. These measurements are a little higher than the other standard deviations. Closer examination again shows a higher rating by Nud*Ist that clearly affected these standard deviations. Again, this seems to indicate the computer coding isolated more applicable text units than the human coders were able to observe and remember.

Figures 1-2 demonstrate the distributions of the group means data in Tables 6-7. The scatterplot in Figure 1 compares the distributions of the group means for grade level 5-8 for the 1989 and the 1995 curricula. The scatterplot in Figure 2 compares the distributions for grade level 9-12 for the 1989 and the 1995 curricula. The graphs confirm the interpretations made from the dispersion measurements. The distributions are fairly consistent and the scatterplots depict the higher ratings for the 1995 curriculum in grades 5-8 and 9-12.

Content analysis involves "word-frequency counts, key-word-in-context listing, concordances, classification of words into content categories, content category counts, and retrievals based on content categories and co-occurrences" (Weber, 1990, p. 41). Krippendorff (1980) considers measurement in terms of frequencies to be the most "common form of representation of data" (p. 109).

The completed data collection worksheets (see Appendix H) provided frequency counts for various categories. Three major categories chosen for analysis in this study were word problems, skill and drill problems, and projects and investigations. The category for skill and drill problems was chosen as highly representative of problems found in traditional mathematics courses. The category for word problems was chosen as representative of problems found in both traditional and integrated courses. The category for projects and investigations was chosen as indicative of problems requiring the higher order thinking processes envisioned in the NCTM Standards. Projects and investigations were combined into one category because they

Table 6

Measures of Dispersion for Coding Values on MMAI for 1989 P.A.S.S. Curriculum

MMAI Category	Coder 1 Mean	Coder 2 Mean	Coder 3 Mean	Group Mean	Standard Deviation
Grades 5-8					
A	2.08	2.08	2.17	2.11	0.05
B	1.71	1.86	1.86	1.81	0.09
C	2.25	2.25	2.25	2.25	0.00
D	2.44	2.22	2.56	2.41	0.17
E	2.40	2.60	2.60	2.53	0.12
F	1.71	2.00	2.29	2.00	0.29
G	1.00	1.00	1.00	1.00	0.00
H	2.00	2.00	3.33	2.44	0.77
Median	2.08	2.08	2.25	2.11	
Mean	1.95	2.00	2.26	2.07	0.17
Standard Deviation	0.47	0.46	0.67	0.50	

MMAI Category	Coder 1 Mean	Coder 2 Mean	Coder 3 Mean	Group Mean	Standard Deviation
Grades 9-12					
A	1.83	2.17	2.33	2.11	0.26
B	1.67	2.00	1.83	1.83	0.17
C	2.00	2.00	1.5	1.83	0.29
D	1.83	1.83	2.17	1.94	0.20
E	1.33	1.17	1.5	1.33	0.17
F	1.67	1.83	2.17	1.89	0.26
G	1.00	1.00	1.00	1.00	0.00
H	2.00	1.67	2.00	1.89	0.19
Median	1.67	1.83	1.83	1.83	
Mean	1.67	1.71	1.81	1.73	0.08
Standard Deviation	0.35	0.42	0.45	0.37	

Table 7

Measures of Dispersion for Coding Values on MMAI for 1995 P.A.S.S. Curriculum

MMAI Category	Coder 1 Mean	Coder 2 Mean	Coder 3 Mean	Group Mean	Standard Deviation
Grades 5-8					
A	3.42	3.25	3.58	3.42	0.17
B	3.14	3.57	3.29	3.33	0.22
C	3.75	3.25	3.50	3.50	0.25
D	2.78	2.44	2.56	2.59	0.17
E	3.40	3.20	3.30	3.30	0.10
F	3.43	3.14	3.57	3.38	0.22
G	2.22	3.00	2.89	2.70	0.42
H	3.33	3.00	4.00	3.44	0.51
Median	3.37	3.17	3.40	3.36	
Mean	3.15	3.09	3.30	3.18	0.11
Standard Deviation	0.51	0.34	0.47	0.37	

table continued

	Coder 1	Coder 2	Coder 3		
MMAI Category	Mean	Mean	Mean	Group Mean	Standard Deviation
Grades 9-12					
A	3.17	3.00	3.83	3.33	0.44
B	3.00	3.00	3.00	3.00	0.00
C	2.33	2.50	2.83	2.55	0.25
D	2.83	3.00	3.00	2.94	0.10
E	3.50	2.50	3.67	3.22	0.63
F	2.33	2.67	2.67	2.56	0.20
G	2.83	2.83	3.00	2.89	0.10
H	2.83	2.67	2.83	2.78	0.09
Median	2.83	2.75	3.00	2.92	
Mean	2.81	2.74	3.00	2.85	0.14
Standard Deviation	0.40	0.21	0.32	0.24	

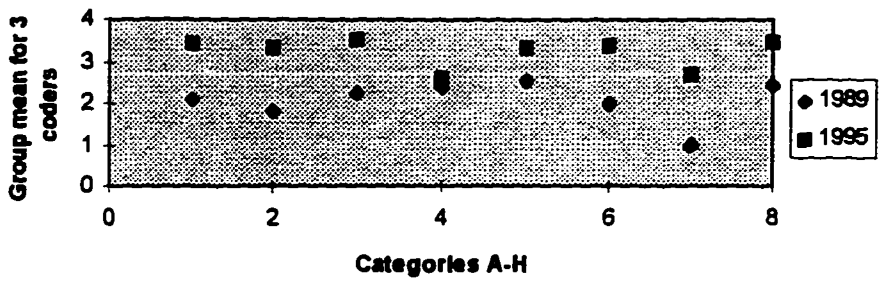

Figure 1: Distributions of coded values for grades 5-8 of P.A.S.S. curricula

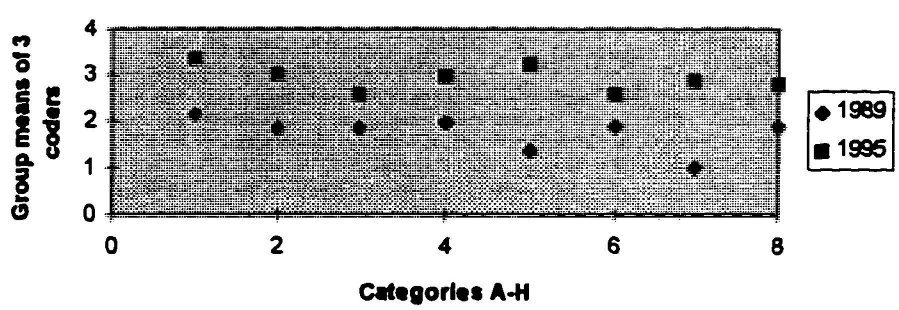

Figure 2: Distributions of coded values for grades 9-12 of P.A.S.S. curricula

had similar requirements relating to time frames and critical thinking processes. Examples are shown in Appendixes K-L, R, and U.

The data from the data collection worksheets were analyzed and computed as percentages of the total number of problems (see Table 8). The 1989 curriculum showed nearly all (86%) of its problems emphasized skill and drill exercises. There were no projects or investigations, and only 14% of the problems were considered to be word problems. The 1995 curriculum showed nearly two thirds (64%) of its problems emphasized skill and drill exercises. Projects, investigations, and word problems comprised the remaining one third (36%) of its contents. These percentages were interpreted as showing that the 1989 curriculum was largely traditional, and the 1995 curriculum more adequately reflected recommendations from the Standards. Figures 3-4 graphically depict this information. Figure 4 combines the data for the word problem and projects and investigations categories as representative of types of problems recommended by NCTM.

Table 8

Frequency Counts and Percentages of Types of Problems for P.A.S.S. Curricula

Year	Word Problems	Skill and Drill Problems	Projects and Investigations
1989	609	3866	-
1995	430	1124	195
As a percent of total problems			
1989	14%	86%	-
1995	25%	64%	11%

The 1989 and 1995 curricula were examined for major content areas. Three major conceptual sections were found in both curricula: spiral review exercises, core content, and practice exercises. Core content was defined for this study as relating to new ideas and problems exclusive to each of the 20 units in the two courses. In addition, the 1989 curriculum included a glossary for each of its 10 units in the course. The number of pages in each category were then counted and entered on the data collection worksheets.

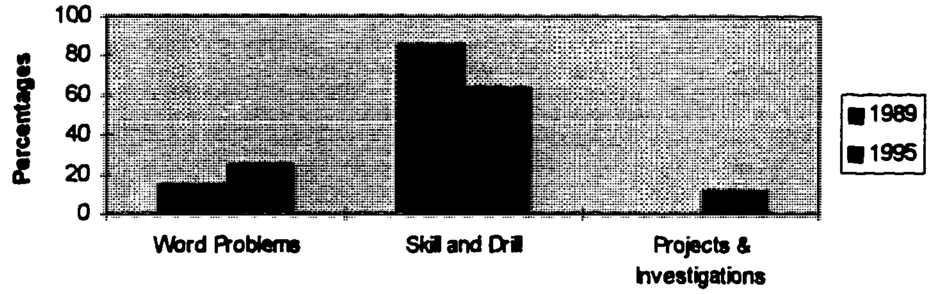

Figure 3: **Comparisons of types of problems in P.A.S.S. curricula.**

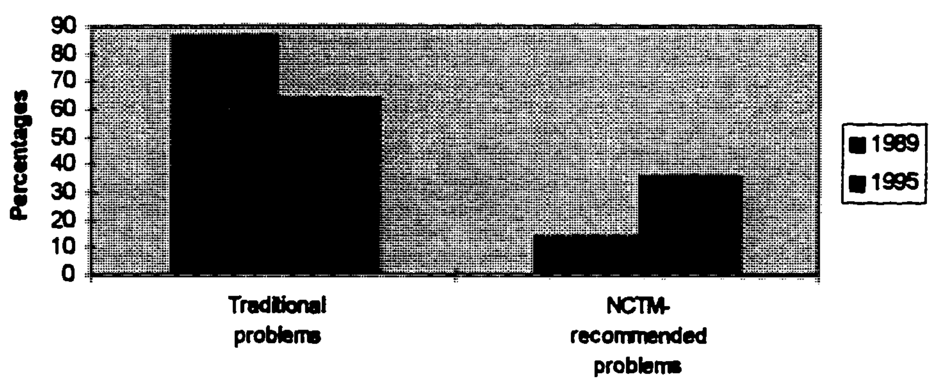

Figure 4: **Comparisons of combined types of problems from Figure 3 in P.A.S.S. curricula**

Percentages of total pages were then computed in each category for each curriculum (see Table 9). There were 842 pages in the 1989 curriculum and 544 pages in the 1995 curriculum. The pages devoted to core content represented over one half (59%) of the 1989 curriculum and nearly four fifths (78%) of the 1995 curriculum. There was very little spiral review in either curricula with only 1% of the total pages devoted to this type of exercise in the 1989 curriculum and 9% in the 1995 curriculum. More pages were devoted to practice exercises in the 1989 curriculum (38%) than in the 1995 curriculum (12%). Upon closer examination, these exercises were found to be mostly skill and drill exercises that have been discussed and shown in Figures 3-4. The 1989 curriculum devoted 1% of its pages to a glossary; the 1995 curriculum did not include a glossary in any of its units. A graphical depiction of these percentages is shown in Figure 5.

The 1989 and 1995 curricula, excluding spiral review and practice exercises, existed as on-line documents from the computer content analysis using Nud*Ist. A computer programmer was employed to compile a sorted

Table 9

Number of Pages and Percentages of Major Sections in P.A.S.S. Curricula

Year	Spiral Review	Core Content	Practice Exercises	Glossary
1989	11	500	321	10
1995	51	427	66	0
As a percent of total pages				
1989	1%	59%	38%	1%
1995	9%	78%	12%	0%

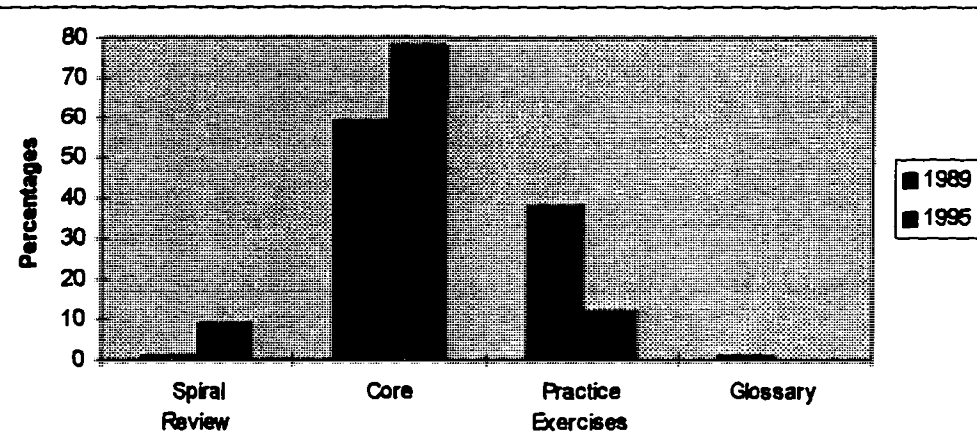

Figure 5: Comparisons of major sections of P.A.S.S. curricula

word list with frequency counts from these documents. No words were eliminated from the list. The 1989 word list contained 57,416 words; the 1995 word list contained 64,691 words. This similarity made an interesting observation because there were 842 pages in the 1989 curriculum and 544 pages in the 1995 curriculum. This seemed to support the previous findings relative to the preponderance of skill-and-drill exercises in the 1989 curriculum, which were numeral in nature rather than verbal.

The word lists were then sorted manually by the female assistant into selected categories that seemed relevant to traditional curriculum as well as curriculum recommended by NCTM Standards. The researcher and assistant discussed the types of words to be included for each category. The assistant then compiled the word lists with each relevant word treated as mutually exclusive, i.e., assigned to only one category. The selected categories were "traditional," "application," "reflective," and "technology." Table 10 shows the breakdowns for these categories.

Table 10

Number of Words and Percentages Relating to Major Categories in P.A.S.S. Curricula

Year	Traditional	Applications	Reflection	Technology
1989	16,001	4,326	281	0
1995	13,821	7,273	901	137
Words by category as a % of total				
1989	78%	21%	1%	0%
1995	62%	33%	4%	1%

The interpretations made from this data supported many of the earlier interpretations. Traditional words represented 78% of the categorized words in the 1989 curriculum and 62% of the 1995 curriculum. These percentages can be compared to the findings relating to skill-and-drill problems in the 1989 curriculum (86%) in Table 8 as compared to the traditional findings (78%) in Table 10. The 1995 curriculum showed similar percentages for skill-and-drill problems in Table 8 (64%) as compared to the traditional findings (62%) in Table 10. This manual observation therefore supports the computer data.

Similar relationships existed for the other categories. Table 10 shows 22% of the categorized words in the 1989 curriculum represent the application category (21%) and the reflection category (1%). This compares to the 1995 curriculum where 37% of the categorized words represent the application category (33%) and the reflection category (4%). These percentages can be compared to the findings in Table 8 where the 1989 curriculum showed word problems, and projects and investigations (14%) as compared to the application and reflection categories (22%) in Table 10. Similarly, the 1995 curriculum showed word problems, and projects and investigations (36%) as compared to the application and reflection categories (37%) in Table 10. This manual observation again supports the computer data. The findings for Table 10 were interpreted for this study as further validating the 1995 curriculum's movement toward NCTM Standards recommendations in relationship to the 1989 curriculum.

The low percentages reflected in the technology category stood out to this researcher as understated for the 1995 curriculum. Many problems in the units were designed as computer spreadsheets and graphing calculator exercises (see Appendixes R and U). Student directions encouraged and emphasized the use of technology in the 1995 curriculum (see Appendix Q). The word count did not reflect this because the words relating to technology were not used excessively. The researcher examined the 1989 curriculum page by page to see if this observed discrepancy also applied; there were not any references on any of the pages referring to technology or requiring the use of technology.

The advantage of qualitative research is the flexibility to examine new questions that emerge during the study. Many unforeseen categories emerged from the sorted word list. Two of the most provocative dealt with a new societal goal in the Standards, the need to provide equal opportunity.

> Creating a just society in which women and various ethnic groups enjoy equal opportunities and equitable treatment is no longer an issue. Mathematics has become a critical filter for employment and full participation in our society. We cannot afford to have the majority of our population mathematically illiterate. Equity has become an economic necessity. (NCTM, 1989, p. 4)

The categories "Latino culture," "non-Latino culture," and "gender" emerged as the word lists were examined. The category "Latino culture" was isolated due to the nature of the curriculum. The agreement with

P.A.S.S. for the 1995 curriculum was to provide materials aimed mainly at Latino students because they comprise the majority (99%) of the migrant population served by P.A.S.S. The ethnicity categories were further divided into subcategories "non-family names" and "family names." Words assigned to the "Latino" category were stereotypically representative of that culture. These words were chosen because they were immediately recognizable as terms of the Latino culture. Many of the "non-family name" words pertaining to Latino culture centered around food, i.e., burrito, jalapeno, nachos, chiles, and fajitas; "family name" words included first names and surnames, i.e., Juan, Pedro, Gonzales, and Rodriguez. Names of countries, cities, and states not located in Latin countries were compiled in the "non-family name" categories, i.e, Britain, Chicago, Alaska, California, the bulk of these occurring in the "non-Latino" category; "family name" words included first names and surnames, i.e., Patricia, Bob, Johnson, and Koch. Words that were ambiguous or could apply to either category were not counted. Table 11 shows the breakdowns for these categories.

The findings show the 1995 curriculum was more successful than the 1989 curriculum in directing its message to Latino students. Percentages were computed based on total words in each category. Latino terms and words were used in only 8% of the total ethnic words in the 1989 curriculum, as compared to 44% in the 1995 curriculum. Latino names were used in 28% of the total ethnic names used in the 1989 curriculum, as compared to an impressive 70% in the 1995 curriculum.

Gender equity did not fare as well. The 1989 and 1995 curricula were somewhat equally biased toward males as shown by the percentages in Table 11. Words denoting males accounted for 57% of the 1989 curriculum (43% females), and 60% of the 1995 curriculum (40% females) when compared to total words denoting gender. Names and surnames were not counted in the gender word count, however, which may have skewed the findings. Social equity has been addressed strongly since the 1960s and 1970s, however, and so it is not surprising the 1989 curriculum did show sensitivity to this issue.

The researcher finalized the analysis for this research question by examining introductory pages in each unit in the hopes of gleaning implied objectives and goals that may not have appeared in the previous data analysis. The 1989 curriculum began each unit with the first page consisting of three

Table 11

Number of Words and Percentages Relating to Ethnic and Gender Categories in P.A.S.S. Curricula

	Latino Words		Non-Latino Words		Gender	
Year	Non-family	Family	Non-family	Family	Male	Female
1989	9	76	104	197	288	213
1995	81	226	103	96	253	171

Percentages based on total words in ethnic and gender categories

	Latino Words		Non-Latino Words		Gender	
Year	Non-family	Family	Non-family	Family	Male	Female
1989	8%	28%	92%	72%	57%	43%
1995	44%	70%	56%	30%	60%	40%

paragraph sections titled "rationale," "primary idea," and "instructional goals" (see Appendix O). These sections varied for each unit in content. The second page was titled "general directions and requirements" and was identical for each unit (see Appendix P). The 1995 curriculum began each unit with the first two pages consisting of two paragraph sections titled "introduction" and "guidelines and directions." There were slight variations in each unit for these two pages, with key words substituted within the paragraph to fit the unit. Several unit examples are shown in Appendix Q.

The examination of these introductory pages in the 1989 course did not add to the researcher's analysis in any significant way. Instructional goals seemed to emphasize the mastery of skills, and previous analysis of data in this study had shown the preponderance of skill and drill problems in the 1989 curriculum. The examination of the introductory pages of the 1995 course did add insight to this analysis. The first paragraph in each unit emphasized the unit requirement for students to engage in cooperative learning, use technology, express themselves creatively through writing, art, and the use of other communicative skills. This emphasis is interpreted by the researcher as alerting the student to new ways of thinking in mathematics, which are recommended in the NCTM Standards.

Research Question 2

Can a researcher-designed evaluative instrument measure the extent to which curricular materials meet the NCTM Standards?

Content validity and interrater reliability are essential elements of instrument design. Interrater reliability in coding is an essential component of content analysis. The findings for this research question are therefore presented for each of these processes.

The evaluative instrument Mathematics Materials Analysis Instrument (MMAI) and supplementary attachments (see Appendixes A-E) designed for this study were validated for content by a panel of three expert educators who are familiar with and experienced in the vision of the NCTM Standards. The instrument was designed in the fall of 1995 and given to the content validation panel in January 1996. It was edited and panel validation was received in March 1996.

Interrater reliability for the instrument was established by nonparametric testing of data collected in a pilot study. This study is reviewed briefly. A team of five secondary mathematics teachers presently teaching all levels of secondary mathematics from general mathematics to calculus participated in the pilot study. Two of the teachers each have over 25 years of teaching experience, the third team member has approximately 5 years teaching experience, and the fourth and fifth team members are in their 2nd and 3rd years of teaching. The teachers with the greatest experience generally subscribe to a traditional philosophy of mathematics teaching based upon their experience and training. The teachers with the least experience have been exposed to contemporary training in the Standards and updated teaching techniques in their college programs.

Two texts were offered to the team members for analysis: Informal Geometry (Cummins, Kenney, & Kanold, 1988), and Integrated Mathematics, (Rubenstein, Craine, & Butts, 1995). The traditional teachers chose Informal Geometry, and the newly trained teachers chose Integrated Mathematics. One of the newly trained teachers agreed to analyze both texts to complete teams of three for each book. This provided more data for the pilot study because two different texts were analyzed by two different teams. Ordinal values were assigned to each subcategory of the evaluative instrument MMAI. The mean of ordinal values for each coder was then computed for each category.

The null hypothesis used for the pilot study was:

$H_{(O)}$: There is no statistically significant difference between coders in relationship to sample textbooks in the pilot study. $\mu_1 = \mu_2 = \mu_3$.

$H_{(R)}$: There is a statistically significant difference between coders in relationship to sample textbooks in the pilot study. $\mu_1 \neq \mu_2 \neq \mu_3$.

The nonparametric Kruskal-Wallis H-test was chosen to test the collected data (see Table 12). No significant difference was found in coding and the null hypothesis was retained for each sample text. This was interpreted as establishing interrater reliability between the coders using MMAI on the sample textbooks.

An interesting observation resulting from this pilot study was a subsequent decision made by the two traditional teachers. They had chosen their text sample because they were interested in obtaining it as a replacement text in their geometry courses. Their bias had been shown by comments prior to the study to the extent that the text was advertised as a transition text between traditional teaching and teaching strategies recommended by the

Standards. After participating in the study, they decided the text did not provide enough transitional materials and was in fact "very traditional." Therefore, they decided not to pursue the text as a replacement text in their courses. This decision provided an unmeasureable validation of the evaluative instrument MMAI.

The last step in the instrumentation process was to establish interrater reliability in coding for the actual study. These findings have been presented in Hypothesis 2. They confirmed the reliability between the two human coders and Nud*Ist computer coding using the 1989 and 1995 curricula in this study.

Other Findings

Content analysis is "valid to the extent its inferences are upheld in the face of independently obtained evidence" (Krippendorff, 1980, p. 155). The materials were examined manually by the researcher for uniqueness that could be overlooked in the major data collection strategies. The 1989 curriculum maintained a traditional curriculum although it did offer unique puzzles and formats as motivational incentives to enhance skill-and-drill exercises (see Appendix T). The 1995 curriculum provided an easily recognizable integrated and interdisciplinary curriculum in its unique variety of assignments, investigations and projects (see Appendix U). These examples further supported the researcher's interpretations that the 1995 curriculum more adequately represented Standards ideals than did the 1989 curriculum.

Table 12

Kruskal-Wallis H-test to Establish Interrater Reliability Between Coders in Pilot Study Using the Mathematics Materials Analysis Instrument (MMAI)

Text: Integrated Math

MMAI Category	Coder 1	Rank	Coder 2	Rank	Coder 3	Rank
A	3.50	13.5	3.50	13.5	3.50	13.5
B	3.17	6.5	3.83	20.5	4.00	24.0
C	2.67	2.0	3.17	6.5	3.50	13.5
D	2.83	3.0	3.83	20.5	3.33	9.5
E	3.17	6.5	3.50	13.5	3.67	17.0
F	3.50	13.5	3.17	6.5	3.83	20.5
G	3.83	20.5	3.83	20.5	3.83	20.5
H	2.50	1.0	3.00	4.0	3.33	9.5
	$N_1 = 8$	$R_{sum} = 66.5$	$N_2 = 8$	$R_{sum} = 105.5$	$N_3 = 8$	$R_{sum} = 128$

$H = 4.841$ $\alpha = .05$

table continued

Text: Informal Geometry

MMAI Category	Coder 1	Rank	Coder 2	Rank	Coder 3	Rank
A	1.33	6.0	1.67	14.5	1.83	20.0
B	2.00	23.0	1.83	20.0	2.17	24.0
C	1.17	2.5	1.83	20.0	1.50	9.5
D	1.67	14.5	1.33	6.0	1.67	14.5
E	1.33	6.0	1.17	2.5	1.17	2.5
F	1.50	9.5	1.17	2.5	1.67	14.5
G	1.67	14.5	1.83	20.0	1.67	14.5
H	1.83	20.0	1.50	9.5	1.50	9.5
	$N_1 = 8$	$R_{sum} = 96$	$N_2 = 8$	$R_{sum} = 95$	$N_3 = 8$	$R_{sum} = 109$

$H = 0.305$ $\alpha = .05$

CHAPTER 5

Summary, Conclusions, Significance,

and Recommendations

> Up in the mountains, he knew, the ants changed with the season. Bees hovered and darted in a dynamical buzz. Clouds skidded across the sky. He could not work the old way any more.
>
> - J. Gleick (1987, p. 317)

> Developing world-class standards is the cornerstone of our efforts to improve our schools. . . . The global economy is not standing still while we fiddle educationally.
>
> - Delaine Eastin
> State Superintendent of Public Instruction
> (California Department of Education, 1996)

The first quote was used in Chapter 1 to acknowledge the complex and chaotic discoveries in mathematics which are helping us visualize our world in a new way. The second quote represents the immediacy and timeliness of the concerns presented in this study.

Summary

The need for change in the mathematics curricula in our public schools has been well documented. Testing surveys show low overall performance at every age throughout the K-12 levels. The Curriculum and Evaluation Standards for School Mathematics, issued by the National Council of Teachers of Mathematics (NCTM) in 1989 are designed to move mathematics curriculum forward to meet the needs of students for the future. The analysis of new curricular materials is essential in order to produce materials that meet recommended standards.

Migrant students represent one segment of the student population with deficiencies in mathematics training at the K-12 level. Educating the migrant student population is one of the greatest challenges that the California educational system and the United States educational systems face today. Students from this population frequently relocate to other schools and to other states. The Portable Assisted Study Sequence (P.A.S.S.) Program serves 165 schools in California and was created to help assuage some of the difficulties that these students encounter. The P.A.S.S. Program must not only provide materials that will be appropriate for the migrant student, but must also comply with the NCTM Standards (1989).

The researcher conducted this study to analyze the content of a 1st-year mathematics course written for P.A.S.S. to meet the NCTM Standards and compare it to the course it replaced. The 1995 curricular materials entitled Integrated Math A and Integrated Math B replaced the 1989 curricular materials entitled General Math A and General Math B. An evaluative instrument, Mathematics Materials Analysis Instrument (MMAI), was designed to measure the extent to which reform ideas in the Standards are represented in the curricular materials.

The review of literature established that profound societal influences determine our educational needs. Our technological society today demands sophisticated, literate workers who are able to interpret complex biological, sociological, and technological issues. Integrated curricular design is proposed to meet the challenge of holistic learning. The Standards emphasize technology and the need for curriculum to be available equitably to all students if "they are to be productive citizens in the twenty-first century" (p. 9).

Content analysis was used to analyze the 1989 and 1995 P.A.S.S. curricula with respect to the Standards. The researcher utilized third-generation qualitative data analysis software, Nud*Ist, (Richards & Richards, 1995) to assist in the analysis. An evaluative instrument entitled Mathematics Materials Analysis Instrument (MMAI) was designed for the study. This involved validation from a panel of experts familiar with the Standards, and a pilot study to establish interrater reliability using MMAI with other curricular materials.

Data were obtained from various sources other than MMAI. Data collection worksheets were used to gather selected categorical information. The P.A.S.S. curricula were individually examined for uniqueness that might remain hidden from MMAI coding and data collection worksheets. The hypotheses and research questions were answered based upon data obtained in the collection and interpretation of these varied sources.

Conclusions from Hypothesized Findings

This study stated two hypotheses. The findings for each are based on nonparametric tests for ordinal data.

Substantive Hypothesis 1: The 1995 P.A.S.S. curricular materials are more likely than the 1989 P.A.S.S. curricular materials to reflect reform ideas expressed in the Standards.

Chi-square analysis was used to determine if there were any significant differences between the frequencies of ordinal value coding using Mathematics Materials Analysis Instrument (MMAI) on the 1989 and 1995 curricula. The analyses found significant differences at .05 level of significance for grades 5-8 and 9-12. The researcher concluded there were statistically significant differences in the 1989 and 1995 curricula, and that further analysis would delineate these differences.

Substantive Hypothesis 2: There is no difference between coding performed by human coders and coding performed with a computer in relationship to the 1989 and 1995 P.A.S.S. curricula.

Kruskal-Wallis H-test was used to determine if there were any significant differences in the coding assigned by two human coders and

Nud*Ist computer coding using Mathematics Materials Analysis Instrument (MMAI) on the 1989 and 1995 curricula. The tests found no significant differences at .05 level of significance for grades 5-8 and 9-12. The researcher concluded that data obtained from using MMAI for the study exhibited coding reliability and could therefore be used in data analysis.

Conclusions from Findings of Research Questions

This study asked the following research questions:

1. To what extent do the 1995 P.A.S.S. curricular materials improve upon the 1989 P.A.S.S. curricular materials with respect to the Standards of mathematics education delineated by the National Council of Teachers of Mathematics?

2. Can a researcher-designed evaluative instrument measure the extent to which curricular materials meet the NCTM Standards?

The first research question was answered with a combination of descriptive statistics and qualitative analyses. An examination of unit titles and tables of contents for the 1989 and 1995 curricula showed distinct topical differences in content. The researcher concluded this analysis showed the 1995 P.A.S.S. curriculum was more aligned to the Standards than the 1989 P.A.S.S. curriculum.

Descriptive statistics from the coded values obtained on Mathematics Materials Analysis Instrument (MMAI) further illuminated the emerging data. Measures of central tendency, frequency distributions, and scatterplots substantiated that the 1989 curriculum contained low levels of content relating to the Standards and the 1995 curriculum contained moderate levels relating to the Standards. These levels were defined by a general coding rubric used in conjunction with MMAI as supplementary worksheets (see Appendix C).

Content analysis strategies such as "word-frequency counts, . . . classification of words into content categories, content category counts, and retrievals based on content categories and co-occurrences" (Weber, 1990, p. 41) clarified the analyses. Categories pertaining to Standards ideals were represented in the 1995 curriculum in higher percentages than in the 1989 curriculum. The researcher concluded the 1995 curriculum was measurably superior to the 1989 curriculum to the extent that Standards ideals were reflected in the curricula.

Other findings and conclusions that emerged as the data were analyzed involved societal equity issues. The 1995 curriculum exhibited many more references to terms and names easily recognizable as Latino in nature. This finding was important to the P.A.S.S. program because the curriculum is targeted primarily at Latino students. Gender equity was not a major problem in either curriculum, although males were targeted more often than females, approximately 60:40 in each curriculum. Perhaps in the future this will be more balanced.

The use of technology is integral to mathematics reform ideals. The previously mentioned content analysis strategies did not highlight this issue to the extent that was truly representative of the 1995 curriculum. Word counts showed a minimal number of words assigned to the technology category. The researcher's manual examination of student directions and specific problems showed numerous opportunities in the 1995 curriculum for the use of computers, graphing calculators, and scientific calculators. The 1989 curriculum did not provide these opportunities.

The answer to the first research question is that the 1995 P.A.S.S. curricular materials improve upon the 1989 P.A.S.S. curricular materials with respect to the Standards of mathematics education delineated by the National Council of Teachers of Mathematics to a measurable extent. Mathematics Materials Analysis Instrument (MMAI) quantified the content as moderate in the 1995 curriculum as compared to low in the 1989 curriculum. These levels were defined by a general coding rubric used in conjunction with MMAI as supplementary worksheets (see Appendix C). The qualitative analyses verified this conclusion.

The second research question, "Can a researcher-designed evaluative instrument measure the extent to which curricular materials meet the NCTM Standards?", was answered in terms of processes integral to instrumentation design. These processes are the validation of content and interrater reliability in using the instrument.

The evaluative instrument Mathematics Materials Analysis Instrument (MMAI) and supplementary attachments (see Appendixes A-E) designed for this study were validated for content over a three-month period by a panel of three expert educators familiar with and experienced in the vision of the

NCTM Standards. A pilot study was then conducted with sample textbooks different from the study curricula to determine if differences in coding the same textbooks using the validated MMAI were statistically significantly different.

This question generated a new hypothesis for the pilot study: There is no statistically significant difference between coders in relationship to sample textbooks in the pilot study. The nonparametric Kruskal-Wallis H-test was used to determine if there were any significant differences in the coding assigned by the participants in the pilot study using the validated MMAI on the sample textbooks. The tests found no significant differences at .05 level of significance between coders. This was true for two independent trials. The researcher concluded that coding could be performed accurately and reliably by independent coders with the validated MMAI.

The last step in the instrumentation process had been anticipated in hypothesis 2. These findings have been presented earlier. They confirmed the reliability between the two human coders and Nud*Ist computer coding using the validated instrument on the 1989 and 1995 P.A.S.S. curricula. Mathematics Materials Analysis Instrument (MMAI) quantified the content as moderate in the 1995 curriculum as compared to low in the 1989 curriculum. These levels were defined by a general coding rubric used in conjunction with MMAI as supplementary worksheets (see Appendix C). The researcher concluded the instrument was effective and reliable, and can be used to measure the extent to which curricular materials meet the NCTM Standards.

Significant Findings

This study found the 1995 Portable Assisted Study Sequence (P.A.S.S.) curriculum to be measurably superior to the 1989 curriculum with respect to meeting NCTM Standards ideals and recommendations. An evaluative instrument, Mathematics Materials Analysis Instrument (MMAI), was designed for the study and was proven to be effective and reliable for purposes of this study.

Impact on Society

This study has value at three levels: local, state, and national. The P.A.S.S. materials are used locally, throughout the state, and manually carried by students to many other states as part of the P.A.S.S. program. The

P.A.S.S. Program offers four sequential 1-year mathematics courses to secondary migrant students. The 1989 general mathematics course is the first course in the sequence. The 1995 integrated mathematics course is intended to provide content and experiences in alignment with NCTM Standards to direct and guide teachers and students. This updated curriculum can be developed further as sequential courses are written. This can result in a new curriculum for migrant students designed around the concepts and transitions inherent in the NCTM Standards. Analysis of this important first course in the sequence can be valuable for future course developers as they make decisions to continue developing the courses to meet NCTM Standards.

Mathematics teachers throughout the state and nation can benefit from this study. The flexibility and adaptability of curriculum to meet NCTM Standards require mathematics teachers to provide and evaluate supplementary material to determine its applicability to the Standards. The analysis of content in relationship to the Standards is complex and time-consuming. This study can help all secondary mathematics educators who interpret and select the supplementary materials they produce or provide in their own mathematics classroom. The evaluative instrument, Mathematics

Materials Analysis Instrument (MMAI), can provide guidance and direction during the process of curriculum development as well as for curriculum selection.

The process of content analysis of mathematics curricular materials in respect to their relationship to the NCTM Standards, and the evaluative instrument MMAI, which was developed and used in this study can have value to further researchers. Research into content analysis was conducted to determine the best way to analyze the P.A.S.S. curricula. The NCTM Standards are replete with subjective goals. This study examined previous content analysis studies that have dealt with subjective text, as well as objective text. Processes for instrumentation were investigated. The culminating research produced an evaluative instrument, Mathematics Materials Analysis Instrument (MMAI), meeting NCTM Standards that can be used in curricular materials development.

This study can help the education profession at all levels identify problems that are encountered by the classroom teacher in the process of implementing NCTM Standards. The Standards reflect "a vision of appropriate mathematical goals for all students" (NCTM, 1995, p. 1). It assumes that all students are capable of learning mathematics, and that previous curriculum has "underestimated the mathematical capability of most students and perpetuated costly myths about students' ability and effort" (p. 1). The Standards were enacted to address this vision, and "many schools and teachers have responded enthusiastically . . . by changing both the mathematical content of their courses and the way in which the content is taught" (p. 3). This study can serve to simplify and demonstrate some of the problems faced in the distribution of the Standards' ideals to the mathematics curriculum.

The need for change in the mathematics curricula in our public schools has been well documented (Kirwan, 1990; National Commission on Excellence in Education, 1983; National Research Council, 1989; Overby, 1993). Testing surveys show low overall performance at every age throughout the K-12 levels. The Curriculum and Evaluation Standards for School Mathematics, issued by the National Council of Teachers of Mathematics (NCTM) in 1989 are designed to move mathematics curriculum forward to meet the needs of students for the future. The analysis of new curricular materials is essential in order to produce materials that meet recommended standards.

The 1989 Standards are not the last word. A February 1996, press release from the California Department of Education heralds the formation of the Commission for the Establishment of Academic Content and Performance Standards. The goal of this commission is to "develop rigorous state standards in all major subject areas and for all grade levels. . . . The first proposed standards will be for reading, writing, and mathematics in order to facilitate the development of statewide tests in those subjects" (p. 1). It is clear that standards are a major component of education and that this study can be extremely useful across all disciplines.

The potential for significant social change in mathematics education is enormous given the appropriate mathematics curricula, equitable opportunities for all students, and motivation for all concerned parties. This study represents a pioneering effort to quantify the changes that can hopefully help our society meet these goals. This process can be replicated in other disciplines, which increases the potential for social change. Significant curricular reform will have significant social impact.

Future Research Recommendations

> Although a good content analysis will answer some question, it is also expected to pose new ones. . . . The beginning and end of a content analysis mark but an arbitrary segment in time.
>
> (Krippendorff, 1980, p. 169)

This study represents a pioneering effort to quantify changes in our mathematics curriculum through the design and introduction of the evaluative instrument, Mathematics Materials Analysis Instrument (MMAI). Future research can improve the validity and reliability of this instrument through rigorous statistical treatments such as factor analysis, and more complex studies to improve interrater reliability and content validation. Interrater reliability studies using participants from dissimilar environments holding varied philosophical viewpoints could improve the reliability of MMAI. The instrument can be further streamlined, for example, by consolidation of categories. The study can be replicated with other curricular materials and in other disciplines to further strengthen its effectiveness and usefulness to education. The research design for this study can be used to analyze other educational issues. Finally, the power of third-generation content analysis software such as Nud*Ist has not been fully utilized in this study. Third-generation programs offer opportunities for qualitative theory building. Future researchers can unleash this power and build immensely on this pioneering study.

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Mathematics Materials Analysis Instrument (MMAI)

Adapted from A Guide for Reviewing School Mathematics Programs (1991)
National Council of Teachers of Mathematics (NCTM)

CURRICULUM
5-8

Problem solving, a central goal of the 5-8 curriculum, should focus on the analysis of situations and the posing of problems, on work with non-routine problems and problems with more than a single solution, and on the development of a variety of problem-solving strategies. Students' communications about mathematics must emphasize informal descriptions, the representation of ideas in various forms, and the use of the precise language and notation of mathematics. The transition from arithmetic to algebra should be accompanied by activities designed to promote the exploration of ideas in concrete settings and subsequent abstraction, generalization, and symbolization of those ideas.

CODING VALUES

TO WHAT EXTENT IS THIS REPRESENTED IN YOUR MATHEMATICS MATERIALS?

1-No	=	Not represented
2-Lo	=	Low level of representation
3-Mod	=	Moderate level of representation
4-Hi	=	High level of representation

Title:____________________

Publisher:____________________

Date of Publication:____________________

No. of Pages:____________________

No. of Chapters:____________________

Supplementary Materials (e.g., student activity workbook, projects, etc.)

1. Title:____________________
2. Title:____________________
3. Title:____________________

A. Problem Solving (Critical-Thinking Skills)

Learning to solve problems is the principal reason for studying mathematics. Problem solving is the process of applying previously acquired knowledge to new and unfamiliar situations. Solving word problems is one form of problem solving, but materials also should provide non-routine problems. Problem-solving strategies should include opportunities to pose questions, analyze situations, translate results, illustrate results, draw diagrams, and use trial and error. There should be alternative solutions to problems; problems should have more than a single solution.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Activities that promote original thinking are routinely encountered in the material.	1	2	3	4
2. The problem-solving process includes checks for reasonableness and completeness.	1	2	3	4
3. Topics are often applied to real-world situations.	1	2	3	4
4. Problems that are non- routine or require multi-step solutions are posed on a regular basis.	1	2	3	4
5. Situations are presented that require students to determine the problem; collect data ; use missing data, formulas, and procedures; and determine an acceptable solution.	1	2	3	4
6. Students use computer simulations to model and analyze complex situations.	1	2	3	4
7. Mathematical information routinely appears in various forms (e.g., tables, graphs, formulas, and functions).	1	2	3	4
8. Group problem solving is encouraged, with activities that promote students to share responsibility for the product of the activity and to discuss the results.	1	2	3	4
9. Activities are structured so that several strategies or techniques are available for use in the solution process	1	2	3	4
10. Activities are sequenced to guide student development from concrete instance to formal examinations.	1	2	3	4
11. Interdisciplinary projects and/or exercises are encouraged.	1	2	3	4
12. Activities encourage students to generalize results to other situations and subject-matter areas.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

B. Communication

The 5-8 program should provide opportunities for students to develop and use the language and notation of mathematics. Vocabulary that is unique to mathematics and terms that have a common, as well as a mathematical, connotation should be used throughout the materials. Opportunities to express mathematical ideas by writing, speaking, making models, drawing diagrams, and preparing graphs should be provided.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Mathematical situations are represented or described in a variety of ways (e.g., verbal, concrete, pictorial, graphical, algebraic).	1	2	3	4
2. The understanding of mathematics is developed through open-ended activities and exercises which promote reflection, organization, and communication of ideas.	1	2	3	4
3. Activities and exercises are designed in such a manner that students are required to take positions on mathematical processes and defend their solutions through sound argument.	1	2	3	4
4. The need for formal mathematical symbolism is demonstrated.	1	2	3	4
5. The ability to read and analyze mathematics is emphasized.	1	2	3	4
6. The ability to write mathematics problems from real-world situations is emphasized.	1	2	3	4
7. Activities encourage students to demonstrate proper mathematical vocabulary and notation.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

C. Computation

The 5-8 program should offer opportunities to compute with whole numbers, decimals, and fractions. Calculators or computers should be used for long, tedious computations. Additional mathematics topics should be provided for all levels of ability in addition to exercises promoting mastery of computational algorithms. Exercises should promote rapid approximate calculations using mental arithmetic and a variety of computational estimation techniques. When computation is needed, an estimate should be used to check reasonableness, examine a conjecture, or make a decision. Simple techniques for estimating measurements such as length, area, volume, and mass (weights) should be demonstrated. Appropriate levels of precision should be required.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Students are required to use pencil and paper to add, subtract, multiply, and divide decimals and fractions with common denominators.	1	2	3	4
2. A calculator is used to add, subtract, multiply, and divide more cumbersome fractions and decimals.	1	2	3	4
3. Computational algorithms are developed with an emphasis on having students understand the underlying principles (the whys).	1	2	3	4
4. Estimation is encouraged to check for reasonableness of computations (i.e., guess-and-check, mental arithmetic).	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

D. Measurement

Mathematics should be presented as having power, usefulness, and creative aspects so it is not viewed by students as a static, bounded set of rules and procedures to be memorized but quickly forgotten. When measurement is explored through rich, investigative, purposeful activity, it affords such opportunity. Fundamental concepts of measurement should be demonstrated through concrete experiences.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Basic units of measurement in the metric system and the relationships among those units of measurement--both within the dimension (e.g., length or volume)--are included.	1	2	3	4
2. Basic units of measurement in the English system and the relationships among those units within a dimension (e.g., feet in a yard or pints in a quart) are included.	1	2	3	4
3. Activities and exercises encourage students to select appropriate instruments to measure a dimension accurately.	1	2	3	4
4. Activities and projects encourage students to make and interpret scale drawings.	1	2	3	4
5. Activities and projects encourage students to develop and use procedures as well as formulas to determine area and volume.	1	2	3	4
6. Students are required to estimate measurements in both the metric system and the English system.	1	2	3	4
7. Student-developed systems of measurement are encouraged.	1	2	3	4
8. Concepts of perimeter, area, and volume are developed intuitively through the use of activities designed for counting units, covering surfaces, and filling containers.	1	2	3	4
9. Real-world activities encourage the use of measurements to generate student-collected data.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

E. Number and Number Systems

A critical part of the middle school mathematics curriculum is a student's ability to generate, read, use,. and appreciate multiple representations for the same quantity. A student's understanding of numerical relationships as expressed in ratios and proportions, equations, tables, graphs, and diagrams is of crucial importance in mathematics. Additionally, students need to understand the underlying structure of arithmetic. Emphasis must be placed on the reasons why various kinds of numbers (fractions, decimals, and integers) occur; on what is common among various arithmetic processes (how the basic operations are similar and different across sets of numbers--whole numbers versus fractions versus decimals, etc.); and on how one system relates to another (integers--an extension of whole numbers).

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. The sets of numbers are developed starting with the counting numbers and ending with the irrational numbers.	1	2	3	4
2. Numbers are understood to have several representations (fractions, decimals, etc.), and processes are available to convert from one to another.	1	2	3	4
3. Numbers are written as numerals, in words, and in expanded notation.	1	2	3	4
4. The relationship between a number (or set of numbers) and its graph(s) is emphasized.	1	2	3	4
5. The use of ratio and proportion is extended to cases that are different from the problems normally found in traditional materials (i.e., real-world applications, interdisciplinary topics, etc.).	1	2	3	4
6. The most appropriate form of a number is used in computation (i.e., scientific notation, decimal, fraction, percent, etc.)	1	2	3	4
7. Numbers with terminating, repeating, or non-repeating decimal forms are presented and used properly.	1	2	3	4
8. Number theory concepts such as prime numbers, GCF, LCM, and divisibility are introduced and developed.	1	2	3	4
9. Mathematics is viewed as a systematic development of a body of knowledge from a few accepted propositions by applying logical and procedural rules.	1	2	3	4
10. The concepts of relation and function are introduced and explored.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

F. Geometry

Students should have knowledge of concepts such as parallelism, perpendicularity, congruence, similarity, and symmetry. They should know properties of simple plane and solid geometric figures and should be able to visualize and verbalize how objects move in the world around them using terms such as slides, flips, and turns. Geometric concepts should be explored in settings that involve problem solving and measurement.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. The identification and description of geometric figures in 1, 2, and 3 dimensions are emphasized.	1	2	3	4
2. Opportunities to visualize, represent, and manipulate one-, two-, and three-dimensional figures are provided.	1	2	3	4
3. The relationships between geometric properties and other mathematical concepts are explored (i.e., similarity to ratio, congruence to equivalence, etc.).	1	2	3	4
4. Geometric relationships and their consequences are developed through non-classroom experiences and activities (i.e., research activities which explore community engineering projects, etc.).	1	2	3	4
5. Appreciation of geometry and its relationship to the physical world is developed.	1	2	3	4
6. Constructing, drawing, and measuring are used to further understanding of geometric properties.	1	2	3	4
7. Technology is used to explore geometric properties.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

G. Probability and Statistics

Understanding probability and the related area of statistics is essential to being an informed citizen and is important in the study of many other disciplines. Students in grades 5-8 have a keen interest in trends in music, movies, and fashion and in the notions of fairness and the chances of winning games. These interests can be excellent student motivators for the study of probability and statistics.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Activities and projects encourage the systematic collection and organization of data.	1	2	3	4
2. Collections of data are represented and described by developing and using charts, graphs, and tables.	1	2	3	4
3. Exercises and activities are provided to demonstrate and analyze the likelihood of bias in a collection of data.	1	2	3	4
4. Predictions are made by interpolation or extrapolation from events or a given collection of data.	1	2	3	4
5. Basic statistical notions (e.g., measures of central tendency, variability, correlation, and error) are developed.	1	2	3	4
6. The concept of probability is developed and applied both in a laboratory (classroom) and in the real world.	1	2	3	4
7. Simulations and experiments are devised and conducted to determine empirical probabilities.	1	2	3	4
8. The role of probability is emphasized in situations of chance, insurance, weather, and other activities.	1	2	3	4
9. When students calculate from real data, the level of accuracy and the precision needed are emphasized.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

H. Algebra

One of the most important roles of the middle grade mathematics curriculum is to provide a transition from arithmetic to algebra. It is crucial that students in grades 5-8 explore algebraic concepts in an informal way in order to build a foundation for the subsequent formal study of algebra.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. A variety of mathematical representations (e.g., physical models, data, tables, graphs, matrices, etc.) are demonstrated and required in informal explorations with algebraic ideas (e.g., variable, expression, equation).	1	2	3	4
2. Concrete experiences with situations that allow students to investigate patterns in number sequences, make predictions, and formulate verbal rules to describe patterns are emphasized.	1	2	3	4
3. Students' use of algebraic concepts in applications is emphasized with a concurrent de-emphasis on routine algebraic manipulations.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___ + ___ + ___

___Sum of Coded Values

Comments:

Mathematics Materials Analysis Instrument (MMAI)

Adapted from A Guide for Reviewing School Mathematics Programs (1991)
National Council of Teachers of Mathematics (NCTM)

CURRICULUM
9-12

Problem solving should occur throughout all courses and should address the development of mathematical models of realistic situations. Many different activities, such as gathering data, exploring patterns, making and testing conjectures, and justifying conclusions through logical arguments, are necessary to develop students' mathematical reasoning and ability to communicate about mathematics. The availability of calculator and computer technology should reduce the emphasis on by-hand procedures for arithmetic computation and symbolic algebraic manipulation in the 9-12 curriculum. This should give additional opportunity to address topics such as probability and statistics, discrete mathematics, and spatial visualization.

CODING VALUES

TO WHAT EXTENT IS THIS REPRESENTED IN YOUR MATHEMATICS MATERIALS?

1-No	=	Not represented
2-Lo	=	Low level of representation
3-Mod	=	Moderate level of representation
4-Hi	=	High level of representation

Title:______________________________

Publisher:______________________________

Date of Publication:______________________________

No. of Pages:______________________________

No. of Chapters:______________________________

Supplementary Materials (e.g., student activity workbook, projects, etc.)

1. Title:______________________________
2. Title:______________________________
3. Title:______________________________

CURRICULUM: 9-12

A. Problem solving (Critical-Thinking Skills)

Learning to solve problems is the principal reason for studying mathematics. Problem solving is the process of applying previously acquired knowledge to new and unfamiliar situations. Solving word problems in texts is one form of problem solving, but materials should also contain non-routine problems. Problem solving involves posing questions, drawing diagrams, analyzing situations, using guess and check, and illustrating and interpreting results. Materials should provide opportunities for alternative solutions to problems, and problems with more than a single solution. Problems and applications should be used to stimulate the study of mathematical concepts

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Problems are designed to introduce, develop, and review mathematical topics.	1	2	3	4
2. Concrete models are used to demonstrate realistic situations.	1	2	3	4
3. Activities and exercises encourage the use of a variety of problem-solving strategies to solve a broad range of problems.	1	2	3	4
4. Non-routine problems encourage the application of previous knowledge to unfamiliar situations.	1	2	3	4
5. The complexity of problem-solving is demonstrated through problems requiring more than one solution.	1	2	3	4
6. Exercises and activities are designed in such a manner as to encourage students to analyze incorrect solutions to identify errors in the problem-solving process.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+ ___+ ___

___Sum of Coded Values

Comments:

B. Communication

The 9-12 program should give students opportunities to develop, learn, and use the language and notation of mathematics. Vocabulary that is unique to mathematics and terms that have a common, as well as a mathematical, connotation should be developed and used throughout the curriculum. Mathematical ideas should be expressed by writing, speaking, making models, drawing diagrams, and preparing graphs. Opportunities should be provided for discussing mathematical topics.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Activities, projects, and exercises encourage students to work in small groups.	1	2	3	4
2. Mathematical concepts are demonstrated with a variety of communication strategies (i.e., speaking, writing, drawing diagrams, graphing, and demonstrating with concrete models).	1	2	3	4
3. Symbolism and mathematical notation are demonstrated throughout the materials.	1	2	3	4
4. Exercises and activities encourage students to use appropriate symbols and mathematical notation.	1	2	3	4
5. Exercises and activities encourage students to use appropriate mathematical vocabulary.	1	2	3	4
6. Writing deductive arguments in paragraph form is encouraged.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

C. Computation and Estimation

The 9-12 program gives students a variety of opportunities to gain facility in computing with whole numbers, decimals, and fractions and in using the four basic operations. It also provides opportunities for students to develop and use estimation skills and concepts on a continuing basis throughout the materials.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Choosing appropriate computational methods (mental arithmetic, paper-and-pencil algorithms, or calculating device) is emphasized in the materials.	1	2	3	4
2. Selecting the appropriate computation to be performed is stressed as well as performing the computations.	1	2	3	4
3. Activities and exercises encourage students to use estimation to judge reasonableness of results.	1	2	3	4
4. Activities and exercises encourage students to use estimation frequently as part of the problem-solving process.	1	2	3	4
5. Situations are presented for which the precision of results must be determined.	1	2	3	4
6. Activities and exercises encourage students to question the reasonableness of a solution to a problem as an important part of the problem-solving process.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

D. Reasoning

Provision is made at all levels for introducing and using simple valid arguments. The 9-12 program gives students opportunities to learn the basic tenets of logical argument and to validate arguments. Connections among various representations of mathematical ideas are used to develop arguments.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Activities and exercises provide opportunities for listening and discussion.	1	2	3	4
2. Activities and exercises provide opportunities for exploration and questioning.	1	2	3	4
3. Activities and exercises provide opportunities for summarization and evaluation.	1	2	3	4
4. Activities and exercises provide opportunities to explore patterns.	1	2	3	4
5. Activities and exercises provide opportunities to make and test conjectures.	1	2	3	4
6. Activities and exercises are designed to teach students to follow and judge logical arguments.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+ ___+ ___

___Sum of Coded Values

Comments:

E. Integration

The 9-12 program should provide integrated mathematics topics across the curriculum.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Function, as introduced in algebra, serves as a unifying concept across all mathematics courses (e.g., geometric transformations, trigonometric functions, and sequences).	1	2	3	4
2. The concepts of limit, maximum, and minimum are developed informally throughout the algebra strand.	1	2	3	4
3. The study of geometric properties is not restricted to formal geometry courses.	1	2	3	4
4. Discrete mathematics topics are included in the materials (i.e., finite graphs, matrices, sequences, series, combinations, permutations, and discrete probability).	1	2	3	4
5. Opportunities are provided in the materials to encourage students to collect, organize, and display data.	1	2	3	4
6. Activities and exercises promote the formulation of original problems which integrate mathematical content.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+___+___+___

___Sum of Coded Values

Comments:

F. Interdisciplinary Emphasis

The 9-12 program should provide real-world applications in realistic situations. A variety of mathematical topics should be extended to other curricular areas.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Problems are chosen to integrate strands of mathematics with applications from other curricular areas.	1	2	3	4
2. Data from real-world situations are used to illustrate the properties of trigonometric functions.	1	2	3	4
3. Applications of probability in related fields such as business and sports are integrated into the materials.	1	2	3	4
4. Charts, tables, and graphs are used to draw inferences from real-world situations.	1	2	3	4
5. Students are required to apply statistical techniques to other subject areas.	1	2	3	4
6. The approach to computation reflects the ways in which computation is, and may be, used outside the school setting.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. __+ __ + __ + __

__Sum of Coded Values

Comments:

G. Technology

The 9-12 program should use calculators and computers as tools for graphing, problem solving, performing tedious calculations, generating data, and developing concepts. Materials should allow students to appropriately choose calculators or computers to perform calculations that warrant their use.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. The systematic use of calculators and/or computers to explore algebraic concepts reduces the need for paper-and-pencil graphing.	1	2	3	4
2. The use of the scientific calculator is encouraged to reduce the need for tables and pencil-and-paper interpolation skills.	1	2	3	4
3. Students are encouraged in the materials to use calculators and computers as tools in statistical investigations.	1	2	3	4
4. Students are encouraged in the materials to use calculators in daily work and on examinations.	1	2	3	4
5. Students are encouraged in the materials to use computers in daily work and on examinations.	1	2	3	4
6. Students are encouraged to use calculators to develop estimation skills and to check for reasonableness of results.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+ ___ + ___ + ___

___Sum of Coded Values

Comments:

H. Other Curriculum Emphasis

There should be a change in the content emphasis in the secondary school curriculum. The strong emphasis traditionally placed on computational algorithms in the curriculum for non-college-bound students should give way to the inclusion of a broad range of studies, including problem solving, estimation, geometric concepts, applications, and mathematical reasoning. The program for college-bound students should integrate the same concepts and reduce the emphasis on algebraic manipulation skills. Lack of mastery of paper-and-pencil computation should not prohibit students from studying additional mathematics topics.

To what extent does this happen in your materials?	None	Lo	Mod	Hi
1. Opportunities are provided to study additional mathematics topics that do not require competence with paper-and-pencil computations.	1	2	3	4
2. The materials emphasize algebraic concepts such as linearity, function, equivalence, and solution.	1	2	3	4
3. Investigations and comparisons of various geometries are used to enhance the study of geometric concepts.	1	2	3	4
4. Materials encourage the use of three-dimensional figures to develop spatial skills.	1	2	3	4
5. Opportunities are provided for students to analyze the validity of statistical conclusions.	1	2	3	4
6. Opportunities are provided to analyze the uses and abuses of data interpretation.	1	2	3	4

Compute the Sum of Coded Values by calculating sums for each column, and then finding the sum of those calculations. ___+ ___ + ___ + ___

___Sum of Coded Values

Comments:

Appendix B

Instructions for using Mathematics Materials Analysis Instrument (MMAI)

Materials on hand:

1) Scope and Summary of National Council of Teachers of Mathematics (NCTM) Standards - 6 pages
2) General Coding Rubric for Mathematics Materials Analysis Instrument (MMAI)
3) Mathematics Materials Analysis Instrument (MMAI)
    - Grades 5-8 (pp. 1-9)
    - Grades 9-12 (pp. 10-18)
4) Worksheet (pp. 1-4) with Example-Grades 9-12 (pp. 5-8)

1) Preview the above materials to understand the topics and areas involved in the NCTM Standards and the MMAI. The evaluator can refer to the reference materials listed below for further clarification.

2) Review the mathematics curricular materials and supplementary materials that are being evaluated to obtain a vision of the contents, and to provide insight into the scope and direction of the content and objectives.

3) Complete the MMAI. The General Coding Rubric should be used to help focus on general considerations that are part of the vision of the NCTM Standards. A coding value from 1 to 4 is circled on the instrument for each subcategory. The materials listed at the top of this page, the mathematics curricular materials, supplementary materials, and the reference materials listed below may be referred to as often as necessary during the completion of the instrument.

4) The worksheet is completed after the instrument is completed. *The Sum of coded values* for each category is transferred to the appropriate section on the worksheet. The worksheet provides details for calculating and interpreting the results.

Recommended reference materials:

Mathematical Sciences Education Board. (1989). Everybody counts. Sacramento, CA: Author.

National Council of Teachers of Mathematics. (1995). Assessment standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics. (1995). Connecting mathematics across the curriculum. Reston, VA: Author.

National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

Appendix C

General Coding Rubric for Mathematics Materials Analysis Instrument (MMAI)

To what extent is this represented in your curriculum?

1-No	Not represented
2- Lo	Low level of representation
3-Mod	Moderate level of representation
4-Hi	High level of representation

The following considerations are important in determining which code is most applicable.

1 - No

- Traditional - non-integrated. Mathematics is presented in a linear fashion, i.e., Algebra, Geometry, Trigonometry, and so on.
- Rote learning, memorization, deductive reasoning is emphasized.
- Problems are close-ended; computational skills are emphasized.
- Calculators may be optional.
- Teacher is the expert and students are encouraged to work alone.
- The "decreased attention" topics are emphasized. (See "Scope and Summary of NCTM Standards - Summary of Changes in Content and Emphases).

2 - Lo

- Traditional - non-integrated. Mathematics is presented in a linear fashion, i.e., Algebra, Geometry, Trigonometry, and so on.
- Rote learning and memorization are emphasized but there is some flexibility.
- Problems are more complex and alternate solutions occasionally exist.
- Teacher is the expert but students are encouraged at times to work together.
- Computers and calculators are encouraged for computational exercises.

3- Mod

- Integrated mathematics curriculum (broad range of topics within mathematics).
- Students work periodically in cooperative groups.
- Projects, portfolios, manipulatives, and models are used to a limited degree.
- Computers and calculators are used for exploration as well as computational exercises.
- Students use several methods to communicate their ideas.
- The teacher and students share the "expert" role, but the teacher is the ultimate authority.

4- High

- Integrated mathematics curriculum (broad range of topics within mathematics).
- Interdisciplinary curriculum.
- Teacher is facilitator, provides resources, and introductory information.
- Students are team members, explorers, discoverers, and predictors.
- Computers, calculators (including graphing calculators), and multimedia are used extensively.
- Concrete models and manipulatives are available or are constructed by students to explore and refine ideas.
- Real-world applications are emphasized; students are encouraged to explore in their own community.
- Projects and investigations replace rote exercises.
- Students learn to compute through rote exercises but quickly advance to more complex ideas and problems.
- Problems emphasize open-ended responses.
- Students use a variety of communication methods.

Appendix D

Scope and Summary of National Council of Teachers of Mathematics (NCTM) Standards

The Curriculum and Evaluation Standards for School Mathematics issued by the National Council of Teachers of Mathematics in 1989 (NCTM Standards or Standards) are designed to move mathematics curriculum forward to meet the needs of students for the future. These needs center around environmental, biological, sociological, and technological issues. Many educators believe integrated curriculum design is the only way to meet these challenges of holistic learning.

The Standards reflect the reforms needed in mathematics. It defines curriculum as the "intended curriculum" or the "plan for a curriculum".

> A curriculum is an operational plan for instruction that details what mathematics students need to know, how students are to achieve the identified curricular goals, what teachers are to do to help students develop their mathematical knowledge, and the context in which learning and teaching occur. (National Council of Teachers of Mathematics, 1989, p. 1)

A standard is a "statement about what is valued" (NCTM, 1989, p. 2) and ensures quality, indicates goals, and promotes change. The Standards assert that the educational system must meet new social goals. These are defined as providing for society mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate. Students must learn to value mathematics, become confident in their mathematical abilities, become mathematical problem solvers, learn to communicate mathematically, and learn to reason mathematically. (p. 5)

The Standards emphasize the need to "do" rather than "know" (NCTM, 1989, p. 7). Interdisciplinary curriculum must be included to supplement and replace portions of traditional engineering and physical science applications. Technology must be included and updated to reflect the nature of mathematics. The curriculum must be available to all students if "they are to be productive citizens in the twenty-first century" (p. 9). Students must participate in activities which model genuine problems, and be encouraged to experiment, discuss, and discover ideas and concepts. The thinking processes of problem solving, communication, reasoning, and connections are emphasized at all levels.

Content standards are separated into elementary, middle, and high school grades with specific topics and sub-topics which should be addressed. Content in the elementary grades consists of estimation; number sense and numeration; whole number operations and computation; geometry and spatial sense; measurement; statistics and probability; fractions and decimals; and patterns and relationships. Content in the middle school grades consists of number and number relationships; number systems and number theory; computation and estimation; patterns and functions; algebra; statistics; probability; geometry, and measurement. Content in the high school grades consists of mathematical connections; algebra; functions; geometry from a synthetic perspective; geometry from an algebraic perspective; trigonometry; statistics; probability; discrete mathematics; conceptual underpinnings of calculus; and mathematical structure.

Instructional strategies are important to successful adaptation of the Standards proposed by NCTM. Students must have access to manipulatives, calculators, computers, and other appropriate tools and techniques. Interactive, cooperative groupwork is essential, and students must work independently and collaboratively. Assessment must be varied, practical, fair, and meet new standards of quality. Students should be given time to master material and opportunities to improve the quality of their work. Projects and investigations should be large-scale, and reflect social issues that help connect mathematics to society. Students should learn to communicate their learning and ideas in mathematics through written, oral, and electronic reports.

Teachers must adapt their styles in the classroom to the new instructional strategies. Teachers must become "facilitators of learning rather than imparters of information" (NCTM, 1989, p. 41.) They must be conscious of their prejudices and overcome them in the classroom. They must provide equal learning opportunities for all students, and adapt curriculum to multicultural needs in the classroom. Teachers must become practicing mathematicians to provide role models for their students and thereby encourage an interest in mathematics. Teachers must encourage discussion and freedom for students to make errors, while exercising caution to fit their own teaching style. They must "produce a classroom climate that encourages students to take risks and venture incomplete thoughts, knowing that others will try to understand and will value the individual's thinking" (NCTM, 1989, p. 53).

Providing curriculum that is aligned to the Standards require an understanding that

> the Standards offer a vision of, and a direction for, a mathematics curriculum but does not constitute a curriculum in itself. If a mathematics program is to be consistent with the Standards. its goals, objectives, mathematical content, and topic emphases should be compatible with the Standards' vision and intent. Likewise, the instructional approaches, materials, and activities specified in the curriculum should reflect the Standards' recommendations and be articulated across grade levels. In addition, the assessment methods and instruments should measure the student outcomes specified in the Standards. (NCTM, 1989, p.241)

The Mathematics Curricula Analysis Instrument is compiled for grades 5-8 and 9-12. The curriculum standards for each grade level are summarized below and the summaries of changes in content and emphasis for these grade levels are attached.

Grades 5-8: 13 Curriculum Standards

1) Problem solving
2) Communication
3) Reasoning
4) Mathematical connections
5) Number and number relationships
6) Number systems and number theory
7) Computation and estimation
8) Patterns and functions
9) Algebra
10) Statistics
11) Probability
12) Geometry
13) Measurement

Grades 9-12: 14 Curriculum Standards

1) Problem solving
2) Communication
3) Reasoning
4) Mathematical connections
5) Algebra
6) Functions
7) Geometry from a synthetic perspective
8) Geometry from an Algebraic perspective
9) Trigonometry
10) Statistics
11) Probability
12) Discrete mathematics
13) Conceptual underpinnings of Calculus
14) Mathematical structure

Summary of Changes in Content and Emphasis - Grades 5-8

Increased Attention	Decreased Attention
Problem Solving: •Pursuing open-ended problems and extended problem-solving projects. •Investigating and formulating questions from problem situations. •Representing situations verbally, numerically, graphically, geometrically, or symbolically.	Problem Solving: •Practicing routine, one-step problems. •Practicing problems categorized by types (e.g., coin problems, age problems).
Communication: •Discussing, writing, reading, and listening to mathematics ideas.	Communication: •Doing fill-in-the-blank worksheets. •Answering questions that require only yes, no, or a number as responses.
Reasoning: •Reasoning in spatial contexts. •Reasoning with proportions. •Reasoning from graphs. •Reasoning inductively and deductively.	Reasoning: •Relying on outside authority (teacher or an answer key).
Connections: •Connecting mathematics to other subjects and to the world outside the classroom. •Connecting topics within mathematics. •Applying mathematics.	Connections: •Learning isolated topics. •Developing skills out of context.
Number/Operations/Computation: •Developing number sense. •Developing operation sense. •Creating algorithms and procedures. •Using estimation both in solving problems and in checking the reasonableness of results. •Exploring relationships among representations of, and operations on, whole numbers, fractions, decimals, integers, and rational numbers. •Developing an understanding of ratio, proportion, and percent.	Number/Operations/Computation: •Memorizing rules and algorithms. •Practicing tedious paper-and-pencil computations. •Finding exact forms of answers. •Memorizing procedures, such as cross-multiplication, without understanding. •Practicing rounding numbers out of context.
Patterns and Functions: •Identifying and using functional relationships. •Developing and using tables, graphs, and rules to describe situations. •Interpreting among different mathematical representations.	Patterns and Functions: •Topics seldom in the current curriculum.

Summary of Changes in Content and Emphasis - Grades 5-8 - p. 2

Increased Attention:

Algebra:
•Developing an understanding of variables, expressions, and equations.
•Using a variety of methods to solve linear equations and informally investigate inequalities and nonlinear equations.

Statistics:
•Using statistical methods to describe, analyze, evaluate, and make decisions.

Probability:
•Creating experimental and theoretical models of situations involving probabilities.

Geometry:
•Developing an understanding of geometric objects and relationships.
•Using geometry in solving problems.

Measurement:
•Estimating and using measurement to solve problems.

Instructional Practices:
•Actively involving students individually and in groups in exploring, conjecturing, analyzing,
•Using appropriate technology for computation and exploration.
•Using concrete materials.
•Being a facilitator of learning.
•Assessing learning as an integral part of instruction.

Decreased Attention:

Algebra:
•Manipulating symbols.
•Memorizing procedures and drilling on equation solving.

Statistics:
•Memorizing formulas.

Probability:
•Memorizing formulas.

Geometry:
•Memorizing geometric vocabulary.
•Memorizing facts and relationships.

Measurement:
•Memorizing and manipulating formulas.
•Converting within and between measurement systems.

Instructional Practices:
•Teaching computations out of context.
•Drilling on paper-and-pencil algorithms.
•Teaching topics in isolation.
•Stressing memorization.
•Being the dispenser of knowledge.
•Testing for the sole purpose of assigning grades.

Summary of Changes in Content and Emphases - Grades 9-12

Increased Attention:

Algebra:

- The use of real-world problems to motivate and apply theory.
- The use of computer utilities to develop conceptual understanding.
- Computer-based methods such as successive approximations and graphing
- The structure of number systems.
- Matrices and their applications.

Geometry:

- Integration across topics at all grade levels.
- Coordinate and transformation approaches.
- The development of short sequences of theorems.
- Deductive arguments expressed orally and in sentence or paragraph form.
- Computer-based explorations of 2-D and 3-D figures.
- Three-dimensional geometry.
- Real-world applications and modeling.

Trigonometry:

- The use of appropriate scientific calculators.
- Realistic applications and modeling.
- Connections among the right triangle ratios, trigonometric functions, and circular functions.
- The use of graphing utilities for solving equations and inequalities.

Functions:

- Integration across topics at all grade levels.
- The connections among a problem situation, its model as a function in symbolic form, and the graph of that function.
- Function equations expressed in standardized form as checks on the reasonableness of graphs produced by graphing utilities.
- Functions that are constructed as models of real-world problems.

Statistics
Probability
Discrete Mathematics

Decreased Attention:

Algebra:

- Word problems by type, such as coin, digit, and work.
- The simplification of radical expressions.
- The use of factoring to solve equations and to simplify rational expressions.
- Operations with rational expressions.
- Paper-and-pencil graphing of equations by point plotting.
- Logarithm calculations using tables and interpolation.
- The solution of systems of equations using determinants.
- Conic sections.

Geometry:

- Euclidean geometry as a complete axiomatic system.
- Proofs of incidence and betweenness theorems.
- Geometry from a synthetic viewpoint.
- Two-column proofs.
- Inscribed and circumscribed polygons.
- Theorems for circles involving segment ratios.
- Analytic geometry as a separate course.

Trigonometry:

- The verification of complex identities.
- Numerical applications of sum, difference, double-angle, and half-angle identities.
- Calculations using tables and interpolation.
- Paper-and-pencil solutions of trigonometric equations.

Functions:

- Paper-and-pencil evaluation.
- The graphing of functions by hand using tables of values.
- Formulas given as models of real-world problems.
- The expression of function equations in standardized form in order to graph them.
- Treatment as a separate course.

Appendix E

WORKSHEET for Coding MMAI

Title: ____________________
Publisher: ________________
Date of Pub.: ______________

Enter the *Total Sums of Coded Values* from each subcategory on the MMAI to the appropriate curriculum section Grades 5-8 or 9-12.

No. of Items	Curriculum: 5-8	Sum of Coded Values
12	A. Problem Solving (Critical-Thinking Skills)	___
7	B. Communication	___
4	C. Computation	___
9	D. Measurement	___
10	E. Number and Number Systems	___
7	F. Geometry	___
9	G. Probability and Statistics	___
3	H. Algebra	___
61		
	Total:	___

No. of Items	Curriculum: 9-12	Sum of Coded Values
6	A. Problem Solving (Critical-Thinking Skills)	___
6	B. Communication	___
6	C. Computation and Estimation	___
6	D. Reasoning	___
6	E. Integration	___
6	F. Interdisciplinary Emphasis	___
6	G. Technology	___
6	H. Other Curriculum Emphasis	___
48		
	Total:	___

CALCULATIONS and INTERPRETATIONS

This instrument can be used by one evaluator or by a team of two or more evaluators. The calculations in subheading I apply to both cases. The calculations in subheading II are to be used for two or more evaluators and should be made in addition to those made in subheading I.

I: One Evaluator:

Finding the mean ($\bar{x}$) for all categories:
T = Total Sum of Coded Values

A = No. of Applicable Items:
[Grades 5-8: (A = 61) or Grades 9-12: (A = 48)]

Enter the sums from the worksheet:

T = ______ A = ________

$\bar{x} = \frac{T}{A} =$ ________ (to at least 3 decimal places)

Interpretation: The mean indicates the degree of movement toward the Standards. Compare it to the Coding Values: 1= None; 2= Low; 3 = Moderate; 4 = High.
Conclusions:____

____

____

Finding the mean for each subcategory: Further statistical tests can be done on each subcategory. The easiest comparisons can be made by simply finding the median and mean of each subcategory and comparing them to the Coding Values: 1= None; 2= Low; 3 = Moderate; 4 = High. This is a quick check to find weaknesses and strengths within the categories. (For Grades 9-12, use the formula shown below. For Grades 5-8, refer to page 1 of the worksheet and change the 6 in the formula to match the number of items in each subcategory.)

$\frac{\textit{Sum Coded Values}}{6} = \textit{Mean}$

Conclusions:

	Formula		Mean
A		=	____
B		=	____
C		=	____
D		=	____
E		=	____
F		=	____
G		=	____
H		=	____

Interpretation:
Categories with means above 3.0 can be seen to be moving toward the Standards and can be compared to the Coding Values: *3 - Moderate* and *4 - High*. Categories below 3.0 can be compared to the Coding Values: 1 - *None*, *2 - Low* and *3 - Moderate*. The materials will need to be supplemented in these categories with activities and exercises reflecting higher movement toward the Standards. Coding Values for each item can be examined in these categories to help in determining the type of supplementary activities that will be needed.

II: Two or More Evaluators:

Finding the mean ($\overline{X}$) and Standard Deviation (SD or σ) for all categories:

n = number of evaluators

i = 1, 2, 3, ... n

T_i = Total Sum of Coded Values for Evaluator i

A_i = No. of Applicable Items for Evaluator i:
[Grades 5-8: (A_i = 61) or Grades 9-12: (A_i = 48)]

i	T_i	A_i
1	____	____
2	____	____
3	____	____
4	____	____
...	____	____
n	____	____
Total	____ T_s	____ A_s

$T_s = \sum_{i}^{n} T_i$ $\qquad$ $A_s = \sum_{i}^{n} A_i$

T_s = ________ $\qquad$ A_s = ________

$\overline{X}$ (group mean) : $\frac{T_s}{A_s}$ = ________ (to at least 3 decimal places)

x_i = $\bar{x}$ (mean) from calculations in Part I for each evaluator

$$\sigma = \sqrt{\frac{\sum_{i}^{n} (x_i - \overline{X})^2}{n-1}}$$

σ = ________

Interpretation:
The mean indicates the degree of movement toward the Standards. Compare it to the Coding Values: 1 = None; 2 = Low; 3 = Moderate; 4 = High.
Conclusions:____

____

____

II. Continued

The standard deviation (SD or σ) measures the distribution of data in relationship to the mean. A small SD indicates the ***total sum of coded values*** are close together which means the evaluators are in close agreement in their opinions of the materials. A large SD indicates that ***the total sum of coded values*** are spread out which indicates the evaluators are not in close agreement in their opinions of the materials.

The mean and SD also indicate the percentage of values in a normal distribution:

$\overline{X} \pm 1.0$ SD = approximately 68% of the total coded values

$\overline{X} \pm 2.0$ SD = approximately 95% of the total coded values

$\overline{X} \pm 2.5$ SD = approximately 99% of the total coded values

$\overline{X} \pm 3.0$ SD = approximately 99+% of the total coded values

Conclusions:____

____

____

____

EXAMPLE - Grades 9-12
WORKSHEET

Title: INTEGRATED MATH
Publisher: XYZ PUBLICATIONS
Date of Pub.: 1995

Enter the *Total Sums of Coded Values* from each subcategory on the MMAI to the appropriate curriculum section Grades 5-8 or 9-12.

No. of Items	Curriculum: 5-8	Sum of Coded Values
12	A. Problem Solving (Critical-Thinking Skills)	___
7	B. Communication	___
4	C. Computation	___
9	D. Measurement	___
10	E. Number and Number Systems	___
7	F. Geometry	___
9	G. Probability and Statistics	___
3	H. Algebra	___
61		
	Total:	___

No. of Items	Curriculum: 9-12	Sum of Coded Values
6	A. Problem Solving (Critical-Thinking Skills)	21
6	B. Communication	16
6	C. Computation and Estimation	15
6	D. Reasoning	17
6	E. Integration	18
6	F. Interdisciplinary Emphasis	17
6	G. Technology	22
6	H. Other Curriculum Emphasis	15
48		
	Total:	141

CALCULATIONS and INTERPRETATIONS

This instrument can be used by one evaluator or by a team of two or more evaluators. The calculations in subheading I apply to both cases. The calculations in subheading II are to be used for two or more evaluators and should be made in addition to those made in subheading I.

I: One Evaluator:

Finding the mean $\bar{x}$ for all categories:
T = Total Sum of Coded Values

A = No. of Applicable Items:
[Grades 5-8: (A = 61) or Grades 9-12: (A = 48)]

Enter the sums from the worksheet:
T = *141* A = *48*

$$\bar{x} = \frac{T}{A} = 2.938$$ (to at least 3 decimal places)

Interpretation: The mean indicates the degree of movement toward the Standards. Compare it to the Coding Values: 1 = None; 2 = Low; 3 = Moderate; 4 = High.

Conclusions: *This material is moving toward the* Standards *as indicated by the mean of 2.938 compared to* 2.0 - Low and 3.0 - Moderate.

Finding the mean for each subcategory: Further statistical tests can be done on each subcategory. The easiest comparisons can be made by simply finding the mean of each subcategory and comparing it to the Coding Values: 1 = None; 2 = Low; 3 = Moderate; 4 = High. This is a quick check to find weaknesses and strengths within the categories.

$$\frac{\text{Sum Coded Values}}{6} = \text{Mean}$$

	Formula		Mean
A	21/6	=	3.50
B	16/6	=	2.67
C	15/6	=	2.50
D	17/6	=	2.83
E	18/6	=	3.00
F	17/6	=	2.83
G	22/6	=	3.67
H	15/6	=	2.50

Conclusions:

Categories A, B, E, F, and G are moving toward the Standards *and can be compared to the coding values 3 -* Moderate *and 4 -* High. *Categories B, C, D, F, and H can be compared to the Coding Values: 2 - Low and 3 -* Moderate. *The materials will need to be supplemented with activities and exercises reflecting higher movement toward the* Standards *in these categories. Further examination of the items in each category will indicate the specific areas to be targeted.*

Interpretation:
Categories with means above 3.0 can be seen to be moving toward the Standards and can be compared to the Coding Values: *3 - Moderate* and *4 - High*. Categories below 3.0 can be compared to the Coding Values: *1 - None, 2 - Low,* and *3 - Moderate.* The materials will need to be supplemented in these categories with activities and exercises reflecting higher movement toward the Standards. Coding Values for each item can be examined in these categories to help in determining the type of supplementary activities that will be needed.

II: Two or More Evaluators:

Finding the mean ($\overline{X}$) and Standard Deviation (SD or σ) of all categories:

n = number of evaluators

i = 1, 2, 3, ... n

T_i = Total Sum of Coded Values for Evaluator i

A_i = No. of Applicable Items for Evaluator i:

[Grades 5-8: (A_i = 61) or Grades 9-12: (A_i = 48)]

(For purposes of this example, assume three additional worksheets for Calculation I (Grades 9-12) have been completed for three additional evaluators. The totals for T_i *are entered from the four worksheets).*

i	T_i	A_i
1	*141*	*48*
2	*166*	*48*
3	*126*	*48*
4	*175*	*48*
Total	*608*	192
	T_s	A_s

$T_s = \sum_{i}^{n} T_i$ $A_s = \sum_{i}^{n} A_i$

T_s = *608* A_s = *192*

$\overline{X}$ (mean) : $\frac{T_s}{A_s}$ = *3.167* (to at least 3 decimal places)

x_i = $\overline{x}$ (mean) from calculations in part I for each evaluator

For purposes of this example, assume the calculated means x_i *are as follows:*

$x_i = 3.065$ $x_2 = 3.458$ $x_3 = 2.930$ $x_4 = 3.723$

$$\sigma = \sqrt{\frac{\sum_{i}^{n} (x_i - \overline{X})^2}{n-1}}$$

σ = *0.39*

Interpretation:

The mean indicates the degree of movement toward the Standards. Compare it to the Coding Values: 1 = None; 2 = Low; 3 = Moderate; 4 = High.

Conclusions: *This material is moving toward the* Standards *as indicated by the mean of 3.167 as compared to* 3.0 - Moderate *and* 4.0 - High.

II: Two or More Evaluators (Continued):

The standard deviation (SD or σ) measures the distribution of data in relationship to the mean. A small SD indicates the *total sum of coded values* are close together which means the evaluators are in close agreement in their opinions of the materials. A large SD indicates that *the total sum of coded values* are spread out which indicates the evaluators are not in close agreement in their opinions of the materials.

The mean and SD also indicate the percentage of values in a normal distribution:

$\overline{X}$ **± 1.0 SD = approximately 68% of the total coded values**

$\overline{X}$ **± 2.0 SD = approximately 95% of the total coded values**

$\overline{X}$ **± 2.5 SD = approximately 99% of the total coded values**

$\overline{X}$ **± 3.0 SD = approximately 99 + % of the total coded values**

Conclusions: *The mean 3.167 ± 0.39 = 3.557 or 2.778. This means 68% of the total coded values are between 2.778 and 3.557. These values can be compared to the Coding Value: 3* - Moderate. *Furthermore, the mean 3.167 ± 2.0 SD = 3.167 ± 2.0 x 0.39 = 3.947 or 2.387. This means 95% of the total coded values are between 2.387 and 3.947. The materials therefore seem to be moving toward the* Standards.

Appendix F

Letter to Validation Panel Dated January 7, 1996

(Identical letters to all three members of the panel)

January 7, 1996

Dr. Jane D. Gawronski
Escondido Union High School District
District Service Center
302 North Midway Drive
Escondido, CA 92027-2741

Dear Dr. Gawronski:

Thank you for agreeing to look at the instrument and supplementary attachments for my dissertation with Walden University (faculty advisor Dr. Marilyn K. Simon). I am enclosing the following documentation:

Instructions - 1 page

Scope and Summary of NCTM Standards - 6 pages (numbered 1-6)

Coding Rubric for Mathematics Curricula Analysis Instrument - 1 page

Mathematics Curricula Analysis Instrument -

Grades 5-8: 9 pages (numbered 1-9)

Grades 9-12: 8 pages (numbered 10-17)

Worksheet - 1 page

The material to be evaluated in my dissertation is the 1995 ten unit course "Integrated Math A" and "Integrated Math B", and the 1989 ten unit course "General Mathematics A" and "General Mathematics B". This material is written for secondary level migrant students who are below grade level. Therefore, the instrument includes Grades 5-8 and Grades 9-12. The appropriate categories will be used in the content analysis of the curricula.

As a member of my panel, I need your comments and suggestions regarding the appropriateness of this package to evaluate curriculum with regards to NCTM Standards. This package is intended to stand alone for evaluation; sources are recommended but are not needed unless the evaluator is unfamiliar with the NCTM Standards.

I look forward to your response.

Sincerely,

Karen Conger

Enclosures: 26

Appendix G

Letters to Validation Panel Dated March 31, 1996

March 31, 1996

Dr. Jane D. Gawronski
Escondido Union High School District
District Service Center
302 North Midway Drive
Escondido, CA 92027-2741

Dear Dr. Gawronski:

The final instrument and supplementary attachments for my dissertation with Walden University (faculty advisor Dr. Marilyn K. Simon) are enclosed. Your comments and the comments of the other panel members have resulted in the following changes:

The instrument has been changed by redistributing subcategories to give a more balanced treatment. This has occurred primarily with the 9-12th section because the original draft had so many items in the final category. Wording has been changed to reflect its intended use with curriculum materials as they relate to student activities, exercises, and projects. The instrument is not intended as a measuring tool for curriculum which requires evaluation by observation and other means.

The panel is asked to approve content rather than statistical treatment. The statistical treatment has been approved by Dr. Simon.

Again, thank you so much for your time and expertise.

Sincerely,

Karen Conger

(Same letter to Dr. Roy Bohlin)

March 31, 1996

Dr. Carol Fry Bohlin
San Joaquin Valley Math Project
School of Education and Human Devpt.
California State University, Fresno
Fresno, CA 93740-002

Dear Dr. Bohlin:

The final instrument and supplementary attachments for my dissertation with Walden University (faculty advisor Dr. Marilyn K. Simon) are enclosed. Your comments have resulted in the following changes:

The instrument has been changed by redistributing subcategories to give a more balanced treatment. This has occurred primarily with the 9-12th section because the original draft had so many items in the final category. Wording has been changed to reflect its intended use with curriculum materials as they relate to student activities, exercises, and projects. The instrument is not intended as a measuring tool for curriculum which requires evaluation by observation and other means.

The panel is asked to approve content rather than statistical treatment. The statistical treatment has been approved by Dr. Simon.

Again, thank you so much for your time and expertise. I really cannot adequately express my appreciation for this. Your comments and suggestions have definitely improved the final product.

Sincerely,

Karen Conger

Appendix H

Data Collection Worksheet
1989 Curriculum

Unit #	# of	# of lines	# of	# of	# of projects/
	pages	excl. spaces	word prob.	skill & drill	invest/etc.
1					
Review					
Core					
Pr. Ex.					
Glossary					
Total					
2					
Review					
Core					
Pr. Ex.					
Glossary					
Total					
3					
Review					
Core					
Pr. Ex.					
Glossary					
Total					
4					
Review					
Core					
Pr. Ex.					
Glossary					
Total					
5					
Review					
Core					
Pr. Ex.					
Glossary					
Total					

Data Collection Worksheet
1989 Curriculum

Unit #	# of pages	# of lines excl. spaces	# of word prob.	# of skill & drill	# of projects/ invest/etc.
6					
Review					
Core					
Pr. Ex.					
Glossary					
Total					
7					
Review					
Core					
Pr. Ex.					
Glossary					
Total					
8					
Review					
Core					
Pr. Ex.					
Glossary					
Total					
9					
Review					
Core					
Pr. Ex.					
Glossary					
Total					
10					
Review					
Core					
Pr. Ex.					
Glossary					
Total					

Data Collection Worksheet
1995 Curriculum

Unit #	# of pages	# of lines (excl. spaces)	# of word prob.	# of skill & drill	# of projects/ invest/etc.
1-Spiral Review					
S1					
S2					
S3					
S4					
S5					
S6					
Total					
2-Spiral Review					
S1					
S2					
S3					
S4					
S5					
Total					
3-Spiral Review					
S1					
S2					
S3					
S4					
S5					
S6					
Total					
4-Spiral Review					
S1					
S2					
S3					
S4					
S5					
S6					
Total					
5-Spiral Review					
S1					
S2					
S3					
S4					
Total					

Data Collection Worksheet
1995 Curriculum

Unit #	# of pages	# of lines (excl. spaces)	# of word prob.	# of skill & drill	# of projects/ invest/etc.
6-Spiral Review					
S1					
S2					
S3					
S4					
Total					
7-Spiral Review					
S1					
S2					
S3					
S4					
S5					
Total					
8-Spiral Review					
S1					
S2					
S3					
S4					
S5					
S6					
Total					
9-Spiral Review					
S1					
S2					
S3					
S4					
S5					
Total					
10-All					
Total					

NUD*IST Node Listing Report for Mathematical Materials Analysis Instrument (MMAI)

(1) /Grades 5-8
(1 1) /Grades 5-8/Problem Solving (Crit.Thinking)
(1 1 1) /Grades 5-8/Problem Solving (Crit.Thinking)/Original thinking
(1 1 2) /Grades 5-8/Problem Solving (Crit.Thinking)/Chk reasonable-complete
(1 1 3) /Grades 5-8/Problem Solving (Crit.Thinking)/Topics apply to real world
(1 1 4) /Grades 5-8/Problem Solving (Crit.Thinking)/Probs.non-routine;multi-step
(1 1 5) /Grades 5-8/Problem Solving (Crit.Thinking)/Determine prob;collect data; etc.
(1 1 6) /Grades 5-8/Problem Solving (Crit.Thinking)/Computer simulations
(1 1 7) /Grades 5-8/Problem Solving (Crit.Thinking)/Info in various forms (tables,graphs, formulas, & functions)
(1 1 8) /Grades 5-8/Problem Solving (Crit.Thinking)/Group problem solving
(1 1 9) /Grades 5-8/Problem Solving (Crit.Thinking)/Several strategies-techniquesd
(1 1 10) /Grades 5-8/Problem Solving (Crit.Thinking)/Concrete to formal
(1 1 11) /Grades 5-8/Problem Solving (Crit.Thinking)/Interdisciplinary projects-exercises
(1 1 12) /Grades 5-8/Problem Solving (Crit.Thinking)/Generalize results to other situations & subject-matter areas
(1 2) /Grades 5-8/Communication
(1 2 1) /Grades 5-8/Communication/Variety - verbal,concrete,gr.,pictorial,etc.
(1 2 2) /Grades 5-8/Communication/Open ended; reflection,org.,& communication
(1 2 3) /Grades 5-8/Communication/Take positions & defend
(1 2 4) /Grades 5-8/Communication/Formal symbolism demonstrated
(1 2 5) /Grades 5-8/Communication/Read, analyze math emphasized
(1 2 6) /Grades 5-8/Communication/Write math from real-world
(1 2 7) /Grades 5-8/Communication/Demonstrate vocab & notation
(1 3) /Grades 5-8/Computation
(1 3 1) /Grades 5-8/Computation/Pencil, paper fractions common denom
(1 3 2) /Grades 5-8/Computation/Calculator for more cumbersome fractions & decimals
(1 3 3) /Grades 5-8/Computation/Develop algorithms - whys
(1 3 4) /Grades 5-8/Computation/Guess-ck, mental arith used for reasonableness
(1 4) /Grades 5-8/Measurement
(1 4 1) /Grades 5-8/Measurement/Metric system - length,vol,etc
(1 4 2) /Grades 5-8/Measurement/English system & relationships
(1 4 3) /Grades 5-8/Measurement/Appropriate instruments
(1 4 4) /Grades 5-8/Measurement/Make & interpret scale drawings
(1 4 5) /Grades 5-8/Measurement/Area,volume formulas,procedures
(1 4 6) /Grades 5-8/Measurement/Estimate metric & English

listing continued

NUD*IST Node Listing Report for Mathematical Materials Analysis Instrument (MMAI)

(1 4 7)	/Grades 5-8/Measurement/Student developed-systems
(1 4 8)	/Grades 5-8/Measurement/Perimeter,area,vol intuitive
(1 4 9)	/Grades 5-8/Measurement/Real-world data collected
(1 5)	/Grades 5-8/Number and Number Systems
(1 5 1)	/Grades 5-8/Number and Number Systems/Sets: counting irrational
(1 5 2)	/Grades 5-8/Number and Number Systems/Numbers - several representations (fr.,dec.,etc.) & processes to convert
(1 5 3)	/Grades 5-8/Number and Number Systems/Nos.written num.,word,exp.not.
(1 5 4)	/Grades 5-8/Number and Number Systems/No.& graph relationships
(1 5 5)	/Grades 5-8/Number and Number Systems/Ratio & proportion -nontraditional uses
(1 5 6)	/Grades 5-8/Number and Number Systems/Appropriate forms of nos.used (sc.not.,dec.,fr.,etc.)
(1 5 7)	/Grades 5-8/Number and Number Systems/Term.,non-term,repeating
(1 5 8)	/Grades 5-8/Number and Number Systems/GCF,LCM, divisibility
(1 5 9)	/Grades 5-8/Number and Number Systems/Math as body of knowledge - logical & rules
(1 5 10)	/Grades 5-8/Number and Number Systems/Relation & function
(1 6)	/Grades 5-8/Geometry
(1 6 1)	/Grades 5-8/Geometry/Identify, describe 1-2-3 dimensions
(1 6 2)	/Grades 5-8/Geometry/Visualize, represent, manipulate 1-2-3 dim.
(1 6 3)	/Grades 5-8/Geometry/Geom prop: sim:ratio; congr:equiv.,etc.
(1 6 4)	/Grades 5-8/Geometry/Geom.reltnshps-non-classroom projects
(1 6 5)	/Grades 5-8/Geometry/Geom & physical world
(1 6 6)	/Grades 5-8/Geometry/Constr.,draw,measure geom properties
(1 6 7)	/Grades 5-8/Geometry/Technology-geom properties
(1 7)	/Grades 5-8/Probability & Statistics
(1 7 1)	/Grades 5-8/Probability & Statistics/Collection & org. of data
(1 7 2)	/Grades 5-8/Probability & Statistics/Data described charts,gr,tables
(1 7 3)	/Grades 5-8/Probability & Statistics/Bias in collection of data
(1 7 4)	/Grades 5-8/Probability & Statistics/'
(1 7 5)	/Grades 5-8/Probability & Statistics/Basis stat notions (measures of central tend., variab.,correlation, error)
(1 7 6)	/Grades 5-8/Probability & Statistics/Probability in lab & real world
(1 7 7)	/Grades 5-8/Probability & Statistics/Simulations-expmts - empirical probabilities
(1 7 8)	/Grades 5-8/Probability & Statistics/Prob. in chance,ins.,weather,etc.
(1 7 9)	/Grades 5-8/Probability & Statistics/Level of accuracy, precision needed emphasized

listing continued

NUD*IST Node Listing Report for Mathematical Materials Analysis Instrument (MMAI)

(1 8)	/Grades 5-8/Algebra
(1 8 1)	/Grades 5-8/Algebra/Models,data,tables,gr,matrices-used with variables,expressions,equations
(1 8 2)	/Grades 5-8/Algebra/Concrete to invest.patterns in no.seq.,make predictions, formulate verbal rules
(1 8 3)	/Grades 5-8/Algebra/De-emphasis on routine alg.manipulations
(2)	/Grades 9-12
(2 1)	/Grades 9-12/Problem Solving (Crit.thinking)
(2 1 1)	/Grades 9-12/Problem Solving (Crit.thinking)/Introduce,devl,review math topics
(2 1 2)	/Grades 9-12/Problem Solving (Crit.thinking)/Concrete models - realistic situations
(2 1 3)	/Grades 9-12/Problem Solving (Crit.thinking)/Variety strategies; broad range of problems
(2 1 4)	/Grades 9-12/Problem Solving (Crit.thinking)/Application knowledge to unfamiliar situations
(2 1 5)	/Grades 9-12/Problem Solving (Crit.thinking)/More than one solution
(2 1 6)	/Grades 9-12/Problem Solving (Crit.thinking)/Analyze incorrect solutions to identify errors in problem-solving process
(2 2)	/Grades 9-12/Communication
(2 2 1)	/Grades 9-12/Communication/Small groups
(2 2 2)	/Grades 9-12/Communication/Variety - speaking,writing,etc.
(2 2 3)	/Grades 9-12/Communication/Sym.,notation demonstrated
(2 2 4)	/Grades 9-12/Communication/Students use sym.,notation
(2 2 5)	/Grades 9-12/Communication/Students use math vocab
(2 2 6)	/Grades 9-12/Communication/Write deduct argum in paragraph form
(2 3)	/Grades 9-12/Computation & Estimation
(2 3 1)	/Grades 9-12/Computation & Estimation/Choice: mental,calc,pencil
(2 3 2)	/Grades 9-12/Computation & Estimation/Appropriate computation stressed
(2 3 3)	/Grades 9-12/Computation & Estimation/Estimation - judge reasonableness
(2 3 4)	/Grades 9-12/Computation & Estimation/Estimation frequently as part of problem-solving process
(2 3 5)	/Grades 9-12/Computation & Estimation/Precision of results determined
(2 3 6)	/Grades 9-12/Computation & Estimation/Reasonableness as important part of process
(2 4)	/Grades 9-12/Reasoning
(2 4 1)	/Grades 9-12/Reasoning/Listen & discuss
(2 4 2)	/Grades 9-12/Reasoning/Explore & question
(2 4 3)	/Grades 9-12/Reasoning/Summarize & evaluate

listing continued

NUD*IST Node Listing Report for Mathematical Materials Analysis Instrument (MMAI)

(2 4 4)	/Grades 9-12/Reasoning/Explore patterns
(2 4 5)	/Grades 9-12/Reasoning/Make & test conjectures
(2 4 6)	/Grades 9-12/Reasoning/Follow & judge logical arguments
(2 5)	/Grades 9-12/Integration
(2 5 1)	/Grades 9-12/Integration/Function, unifying across all math courses
(2 5 2)	/Grades 9-12/Integration/Limit, max,min throughout Algebra strand
(2 5 3)	/Grades 9-12/Integration/Geom properties not restricted to formal geometry courses
(2 5 4)	/Grades 9-12/Integration/Discrete math - matrices, finite graphs, seq.,series, comb., perm.,& discrete prob.)
(2 5 5)	/Grades 9-12/Integration/Collect, organize, & display data
(2 5 6)	/Grades 9-12/Integration/Original problems integrate math content
(2 6)	/Grades 9-12/Interdisciplinary Emphasis
(2 6 1)	/Grades 9-12/Interdisciplinary Emphasis/Integrate with other curricular areas
(2 6 2)	/Grades 9-12/Interdisciplinary Emphasis/Data real-world - trig functions
(2 6 3)	/Grades 9-12/Interdisciplinary Emphasis/Probability in sport, business, etc.
(2 6 4)	/Grades 9-12/Interdisciplinary Emphasis/Charts,tables,graphs -inferences from real-wold
(2 6 5)	/Grades 9-12/Interdisciplinary Emphasis/Apply stat techniques other subject areas
(2 6 6)	/Grades 9-12/Interdisciplinary Emphasis/Computation outside school setting
(2 7)	/Grades 9-12/Technology
(2 7 1)	/Grades 9-12/Technology/Calc&comp.for graphings
(2 7 2)	/Grades 9-12/Technology/Sc.calc instead of interp & tables
(2 7 3)	/Grades 9-12/Technology/Calc & comp in stat invest.
(2 7 4)	/Grades 9-12/Technology/Calculators daily work & exams
(2 7 5)	/Grades 9-12/Technology/Computers daily work & exams
(2 7 6)	/Grades 9-12/Technology/Calc for estim & reasonableness
(2 8)	/Grades 9-12/Other Curriculum Emphasis
(2 8 1)	/Grades 9-12/Other Curriculum Emphasis/Math topics not requiring competence with paper-and-pencil skills
(2 8 2)	/Grades 9-12/Other Curriculum Emphasis/Alg concepts: linearity,fnctn,equiv.,solution
(2 8 3)	/Grades 9-12/Other Curriculum Emphasis/Various geometries
(2 8 4)	/Grades 9-12/Other Curriculum Emphasis/3-d figures develop spatial skills
(2 8 5)	/Grades 9-12/Other Curriculum Emphasis/Validity of stat conclusions
(2 8 6)	/Grades 9-12/Other Curriculum Emphasis/Uses & abuses of data interpretation

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To whom it may concern:

I have known Karen Conger for several years and found her professional work to be creative and challanging. She has passed this creativity to the published work she has been doing for the migrant Pass program.

I find the migrant educational material that Mrs. Karen Conger has published very useful in the migrant pass program. It is a concise matrix of mathematical material that challenges the student in a program that relies on the students motivation and inertia in accomplishing an assigned task. Mrs. Conger has brought together mathematical material in a way that the student is able to accomplish their objective and gain credit toward their final goal. This material, as all Pass program material, is essential in the accomplishment of this schools mission.

Rudy Miranda, Ed.D
Director of Guidance
Shafter High School

Scholarships • Grants • Fellowships • College Loans

College Selections • College Visitations • College Forms • Tutoring

Appendix K

Examples of Word Problems from 1989 and 1995 P.A.S.S. Curricula

1989 P.A.S.S. Curriculum
(selected problems)

1. Pedro has a fruit stand. He sells each flat of boysenberries for 11 dollars. How much will he make if he sells 45 flats?

2. Patty earned 8,625 dollars for working 125 days. If she earned the same amount each day, how much did she earn each day?

3. At $ .33 per pound, how many pounds of apples can you buy for $1.65?

4. What is the volume of a can of soup if the radius of its base is 3 inches and its height is 6 inches?

5. Dr. Fixmeup prescribed 25 ml of protein supplement to be taken five times per day. How much protein supplement must the patient buy for 20 days?

Other: There were several problems requiring students to read charts and answer questions, e.g., temperature charts, bushels of corn harvested, but most word problems were of the caliber shown above.

1995 P.A.S.S. Curriculum
(selected problems. Also see Appendix U)

1. A section of land is defined as one mile square and 640 acres. An acre-foot of water is the amount of water required to cover an acre of land one foot deep. If cotton requires three acre-feet to grow to maturity during the season, how many acre-feet of water are required to water a section of cotton?

2. Cotton lint sells for $0.80 per pound and cotton seeds sell for $0.10. The farmer retains 40% of the seeds for replanting the following years crop. How much total revenue will the cotton lint and cotton seeds produce for the farmer:

a) per acre? b) per section?

3. The foreman at an oil company has a well drilled to a depth of 10,000 ft. with cylindrical tubing going all the way to the bottom of the hole. If the tubing has an inside diameter of 2.5 in., what is the volume, in gallons to the nearest thousandth, of the tubing:

a) per ft.? b) to the bottom of the well?

4. An oil well produces 185 bbls. of oil per day (BOPD). How many gallons of oil does the well produce per day?

5. A high powered drag racing vehicle has an elapsed time of 4.5 seconds in a 1/4 mile run. What is the average speed in miles per hour of the vehicle?

6. A baseball pitcher throws a ball that register 95 mph at home plate. If the ball travels at a constant rate of speed from the pitcher's mound to home plate (a distance of 60 feet), find the time (to the nearest hundredth second) required for the ball to travel from the pitcher's mound to home plate.

7. The distance from the Earth to the Moon is approximately 240,000 miles and light travels at approximately 186,000 miles per second. Find the time required for light to travel from the Earth to the Moon (to the nearest hundredth second)?

Appendix L

Examples of Projects and Investigations from 1989 and 1995 P.A.S.S. Curricula

1989: None

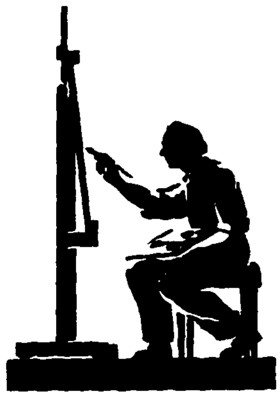
1995: (in addition to those found in Appendixes R and U)

From: Unit IV - Patterns, Functions, and Mathematical Connections

Research Project : Find pictures of great art and architecture that are known for their excellence. Make measurements and determine whether the golden rectangle or other Fibonacci ratio is present. Display sketches of your findings in the classroom.

Design Project: Create a drawing that uses the golden rectangle ratio or other Fibonacci ratio. You may design a building or create an artistic drawing that demonstrates the ratio.

Class Project: Examine branches from different plants and determine if they display phyllotactic ratios. Make a chart and list the type of plant and its ratio. Display the plants with phyllotactic ratios in a separate column.



Tessellation Project: Use the octagon-square grid paper on the next page to design a tessellation. Be creative and colorful! Have a class contest and vote for the best tessellations. Display the winners in the classroom!

Project: M. C. Escher was a famous Dutch artist who lived from 1898 to 1972. He is famous for his tessellation drawings and Moorish mosaics. Conduct research to find out facts about his life and his artistic contributions. Separate your research into group reports to make presentations to the class.

Cooperative Learning Problem 6: Draw a design using symmetry. This means you will draw a portion of the design, and then reflect it into mirror images. The process is shown with a simple line drawing. The design is drawn in Figure 1.
In Figure 2, the design is flipped horizontally ⇒. In Figure 3, the original design is rotated or tilted and then flipped horizontally. There are many variations. You can flip the design vertically ⇑ or diagonally / or \ also. Use your imagination once you have drawn your original design. It may help if you think of specific uses for your design such as a kite, a tee-shirt, a quilt, or a poster.

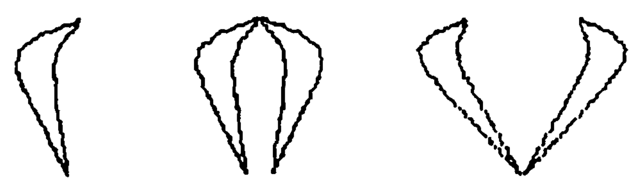


Figure 1 **Figure 2** **Figure 3**

Tables of Contents - 1989 P.A.S.S. Curriculum

(Subheadings are typed directly from tables of contents, and errors have not been corrected. Headings have been added for clarity.)

Unit I - Numeration Systems and Place Value

Unit II - Addition and Subtraction

Unit III - Multiplication

Unit IV - Division

Unit V - Application

Unit VI - Fractions

Unit VII - Decimals

Unit VIII - Percent

Unit X - Metrics

Appendix N

Tables of Contents - 1995 P.A.S.S. Curriculum

Unit I - Number and Number Relationships

Unit II - Number Systems and Number Theory

Unit III - Computation and Estimation

Unit IV - Patterns, Functions, and Mathematical Connections

Unit V - Measurement

Unit VI - Statistics and Probability

Unit VII - Algebra

Unit VIII - Geometry

Unit IX - Problem Solving

Unit X - Mathematics as Communication

Appendix O

Rationale, Primary Idea, and Instructional Goals for 2989 P.A.S.S. Curriculum

1989--Unit I

RATIONALE: In mathematics, symbols have special meaning, and are found in addition, subtraction, multiplication, and division sentences. Through activities in this unit, you will learn about symbols and their value. This understanding makes it possible to work math computations.

UnitI - General Math A

PRIMARY IDEA: Using your understanding of numbers and their value, you will be able to find answers to math problems in your daily life.

INSTRUCTIONAL GOALS: When you complete this unit, you will show these skills on a written test:

Place Value and Whole Numbers

1. Recognize whole numbers.
2. Identify place value of digits.
3. Write, in words and numbers, the total value of a whole number.
4. Write the total for an expanded notation.
5. Round whole numbers to the nearest hundred.

Roman Numerals

1. Identify Roman Numerals.
2. Write Roman~Numerals using the principal of addition.
3. Write Roman Numerals using the principal of subtraction.
4. Identify Roman Numerals in real-life situations.

Application

1. Use place value in real-life situations.

RATIONALE: Whether you are adding up your hours on a job, or purchasing something at a store, your understanding of addition and subtraction will be helpful to you. When you have a checking account or pay taxes, it is so: important that you be able to calculate numbers. This unit offers you an opportunity to become skillful at addition and subtraction .

PRIMARY IDEA: When you learn the basic math facts and can add and subtract, you'll find you have improved your computation skills.

INSTRUCTIONAL GOALS: When you complete this unit, you wili show these skills on a written test:

Identify the sum(s) of:

1. The basic addition facts

2. Two addends with no regrouping

3. Two addends with regrouping

4. Multiple addends with regrouping .

Find the difference (s) between:

1. The basic subtraction facts

2. Two numbers with no regrouping

3. Two numbers with regrouping

RATIONALE: When you buy food, clothing, a car, or some day, a home, you will have to compute the cost. Often, this means that you must be able to multiply, as well as add and subtract.

PRIMARY IDEA: By multiplying, you can be a confident buyer, you will know exactly how much something should Cost with tax, or how much you should earn in a week or month. With this skill, you will not be dependent on someone else or a salesperson for answers.

INSTRUCTIONAL OBJECTIVES: Upon completing this unit, you will show these skills on a written test.

1. The basic multiplication facts

2. Multiplication exercises without regrouping

3. Multiplication exercises , with regrouping

4. Daily life situations using multiplication.

RATIONALE:

Division is one of the basic skills, along with addition, subtraction, and multiplication, that are necessary in an adult's daily life. With these skills, you can be confident in earning, saving and spending money.

PRIMARY IDEA:

Understanding how to divide will help you become a confident and independent adult in this society.

INSTRUCTIONAL GOALS:

Upon completing this unit, you will show the following skills on a written test.

Identify the quotients for:

1. Single Digit Divisors and Dividends with and without remainders.

2. Multiple Digit Divisors and Dividends with and without remainders.

3. Real life division situations.

RATIONALE: In order to use the skills of addition, subtraction, multiplication, and division, you must be able to apply these skills in problem solving situations.

PRIMARY IDEA: With the ability to solve real life mathematical problems, you can be successful on a job or owning a business, or at making the wise purchase with your money.

INSTRUCTIONAL OBJECTIVES: Upon completion of these lessons, you will show the following on a written test:

1. Solve word problems using addition, subtraction, multiplication, and division.
2. Solve two-step problems.
3. Find averages.
4. Use charts, tables, and graphs to solve word problems.

Purpose

The study of mathematics helps students develop thinking skills, order thoughts, develop logical thought processes and make valid inferences. An understanding of fractions will assist the student in such varied activities as cooking, telling timer sewing, shopping and mechanics. An independent adult will have a working knowledge of fractions.

Instructional Objectives

Objectives

Upon completion of this unit, the student will be able to:

1. Identify proper, improper, and mixed number fractions.
2. Write equivalent fractions.
3. Reduce fractions to lowest terms.
4. Rename improper and mixed number fractions.
5. Identify the greatest common factor and the least common factor.
6. Add, subtract, multiply, and divide fractions.
7. Solve real-life problems involving fractions.

Purpose

The study of mathematics helps students develop thinking, logic and inference skills. As the age of technology unfolds, the importance of mathematical skills grows stronger. An understanding of decimals will increase your ability to find measurements, handle money successfully and compete for a variety of jobs or careers.

InInstructional Objectives

Upon completion of this unit, the student will be able to:

1. Change regular fractions to decimal fractions.
2. Change decimal fractions to regular fractions.
3. Name the place value for any digit in a decimal number.
4. Add, subtract, multiply, and divide decimals.
5. Use decimals to solve problems in real life situations.

Purpose

The Study of mathematics helps students develop thinking, logic and inference skills. As the age of technology unfolds, the importance the understanding of mathematics grows stronger.

The comprehension of percents is essential to successful living. The banking system in the U.S. is dependent on percentages. Local, state, and federal taxes are based on percentages, as are finance charges, sales commissions, interest on saving accounts and even your grades in schools.

Instructional

Instructional Objectives

Upon completion of this unit, the student will be able to:

1. Change a decimal to a percent and a percent to a decimal.
2. Change a fraction to a percent and a percent to a fraction.
3. Find the percent of a number.
4. Find the percent a number is of a total number.
5. Find a total number when the percent of it is known.
6. Use percent to solve real-life problems.

RATIONALE: Farmers, mechanics, carpenters, housewives, tailors, engineers, and people in other occupations use measurements as a tool in solving problems.

PRIMARY IDEA: Your ability to solve problems of area, perimeter, and volume are useful in situations on the job and at home.

INSTRUCTIONAL GOALS: At end end of this unit you will show on a written test your ability to:

1. Identify and classify plane figures
2. Measure angles
3. Use weights and measures
4. Find perimeter and area of plane figures
5. Solve practical problems involving perimeter, area, and volume.

RATIONALE:

The metric system is used world-wide by 92% of the population. In the United States, the system is being used more frequently by businesses and in industry. You may find a need to understand the metric system in the workplace.

PRIMARY IDEA:

It is important that you be able to solve problems using the metric system.

INSTRUCTIONAL GORLS:

On a written test, you will show yourability to:

1. Use metric measures to find length, area, perimeter, volume, and weight.
2. Convert metric units to other metric units.
3. Read a Celsius thermometer.
4. Solve real-life problems using metric units.

Appendix P

General Directions and Requirements for 1989 P.A.S.S. Curriculum

1989-All Units

GENERAL DIRECTIONS AND REQUIREMENTS

Working on the unit:

* Read each example carefully and complete the sample problem before starting on the assigned activities.
* Remember, you must complete the entire unit to receive credit.
* If you have any questions while working the unit, talk with your contact person or teacher.
* After you finish an activity, check it off on the Progress Report, on page 42.

When you're finished:

Return the completed unit to your contact person. He or she will give you directions for taking the unit test.

Appendix Q

Introduction, Guidelines and Directions for 1995 P.A.S.S. Curriculum

Unit I - Number and Number Relationships

Introduction

Welcome to Unit I - Number and Number Relationships. This is the first book in the five book series for Integrated Math A. It has been designed to help you explore mathematics with your friends and learn important concepts and ideas. It is based on the latest research which is aimed at the needs of all students. You will still have to do worksheets and sharpen your skills, but you will also be able to be creative and express yourself through writing, art, and other ideas which you think up! You will use calculators for much of the work, and you will have opportunities to use the computer if it is available. The success of this program depends on you! You must be willing to work with your friends and be serious about your work. Wasting time while you are having fun will prevent you from successfully completing this book. Having fun while you are learning will help you speed through this book. You will be successful when you complete the Unit Test at 70% mastery level. That means you must complete 35 out of 50 questions correctly.

Guidelines and Directions

To understand the arrangement of this book, go through the steps below:

- Refer now to the Table of Contents to help you get comfortable with the book. The Table of Contents tells you the page numbers so you can easily turn to them as you continue with these directions.
- The Review Exercises are arithmetic problems that you have encountered in earlier grades. Look at them now. They should be familiar. You need to be certain you have these concepts and skills nailed down! If you do not, you will need to work with other worksheets and problems before you can continue with this book. When you can complete these worksheets at mastery level, you may continue with the Sections.
- Look at the Table of Contents again and notice Sections One through Five. They are the main lessons in Unit I. You must listen carefully during all instruction, work through the examples, and ask lots of questions to be sure you understand the material. You need to take notes during the discussion and explanations. You should write down definitions and be certain you understand them. Do not be afraid to ask questions! Use the dictionary if you do not understand the meaning of words. The students who are the most successful are the ones who ask for help when they do not understand!
- Look at Section One now. Notice it is divided into headings such as Discussion, Definition, Example, Problems, and Cooperative Learning Problems. The Problems and Cooperative Learning Problems are your classwork and homework. They must be completed! The problems may seem strange to you if you have only been in traditional math classrooms. These problems sometimes ask you to think about things other than math. They are designed to help you see how the concepts of math fit into the real world. Have fun with them and work intelligently through them. Be a leader in your group and insist that the others work hard. Math is hard work

but it is also fun to do. You feel really good about yourself when you succeed in math!

- Use your Table of Contents and turn now to Section Six . This section gives additional practice exercises for the main sections. Successful completion of this section will help you understand the material for the Unit Test.
- The Completion Checklist is to help you check your progress. As you move through the classwork and homework, check off the box for each problem in each section. When you have completed the worksheets in the Review Exercises - Basic Concepts, and the problems in Sections One through Six you will be asked to sign the Completion Checklist. Your teacher will also sign the Checklist to affirm that you have mastered the material in the book. You are now ready to take the Unit Test.
- The Unit Test is multiple choice. You are required to perform at mastery level in order to continue to Unit Two. This means you must answer 35 out of 50 questions correctly.
- The last page in the book is the Bibliography. It is a list of books that have been used for reference material in the preparation of Unit I.

You are now ready to begin your work in this book. Have lots of fun and be sure to refer back to these pages when you start feeling lost. You can be successful in math! Your teacher will help you, but most importantly, you will help yourself and your friends as you work together. They will help you too.

Unit VII - Algebra

Introduction

Welcome to Unit VII - Algebra. This is the second book in the five book series for Integrated Math B. You should be more comfortable with group learning now and the variety of exercises and problems that are in the Units. Your success depends on your determination to learn the material in each Unit before proceeding to the next Unit. All Units require that you complete the Unit Test at 70% mastery level. That means you must complete 35 out of 50 questions correctly.

Guidelines and Directions

To remind you of the arrangement of this book, go through the steps below:

- Refer now to the Table of Contents to help you get comfortable with the book. The Table of Contents tells you the page numbers so you can easily turn to them as you continue with these directions.
- The Spiral Exercises are problems you encountered in Unit VI. You need to do these carefully and be certain you understand them. This will help you retain what you have learned.
- Look at the Table of Contents again and notice Sections One through Four. They are the main lessons in Unit VII. You must listen carefully during all instruction, work through the examples, and ask lots of questions to be sure you understand the material. You need to take notes during the discussion and explanations. You should write down definitions and be certain you understand them. Do not be afraid to ask questions! Use the dictionary if you do not understand the meaning of words. The students who are the most successful are the ones who ask for help when they do not understand!

  Look at Section One now. Notice it is divided into headings such as Discussion, Definition, Example, Problems, Cooperative Learning Problems, and 🖫 **Computer or Graphing Calculator Exercises. (Many of the 🖫 Computer or Graphing Calculator Exercises can be done by hand if computers or graphing calculators are not available. Others will be difficult and should be omitted.)** The Exercises, Problems, and Cooperative Learning Problems are your classwork and homework. They must be completed! The problems may seem strange to you if you have only been in traditional math classrooms. These problems sometimes ask you to think about things other than math. They are designed to help you see how the concepts of math fit into the real world. Have fun with them and work intelligently through them. Be a leader in your group and insist that the others work hard. Math is hard work but it is also fun to do. You feel really good about yourself when you succeed in math!
- Use your Table of Contents and turn now to Section Five. This section gives additional practice exercises for the main sections. Successful completion of this section will help you understand the material for the Unit Test.
- The Completion Checklist is to help you check your progress. As you move through the classwork and homework, check off the box for each problem in each section. When you have completed the worksheets in the Spiral Review - Unit VI, and the problems in Sections One through Five you will be asked to sign the Completion Checklist. Your teacher will also sign the Checklist to affirm that you have mastered the material in the book. You are now ready to take the Unit Test.

- **The Unit Test is multiple choice. You are required to perform at mastery level before you continue to Unit VIII. This means you must answer 35 out of 50 questions correctly.**
- **The last page in the book is the Bibliography. It is a list of books that have been used for reference material in the preparation of Unit VII.**

Unit X - Mathematics as Communication

Introduction

Welcome to Unit X - Mathematics as Communication. This is the final book in the five book series for Integrated Math B. You should be more comfortable with group learning now and the variety of exercises and problems that are in the Units. Your success depends on your determination to learn the material in each Unit before proceeding to the next Unit. All Units require that you complete the Unit Test at 70% mastery level. That means you must complete 35 out of 50 questions correctly.

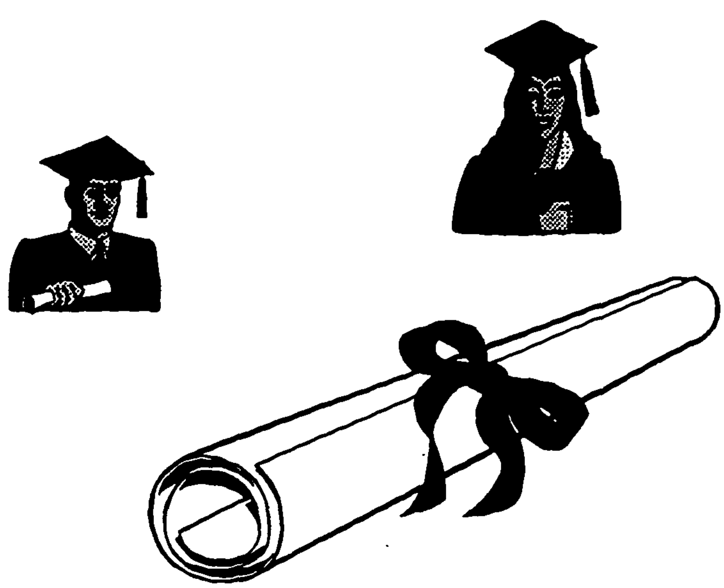
Guidelines and Directions

This unit is different from the other units. It consists of exercises and investigations designed to activate your creating writing and artistic talents. You will still do mathematics but you will also write and draw. Some of the exercises will allow you to be quite creative; others will require you use a dictionary and glossary to find precise definitions. Mathematics cannot be communicated without these skills. Your class should discuss each exercise and investigation, and make presentations of their findings. Oral, verbal, artistic, and written skills are essential communication tools!

The Completion Checklist is to help you check your progress. As you move through the exercises and investigations, check off the box for each problem in each section. When you have completed this work, you will be asked to sign the Completion Checklist. Your teacher will also sign the Checklist to affirm that you have mastered the material in the book. You are now ready to take the Unit Test.

The Unit Test is multiple choice. You are required to perform at mastery level to pass the test. This means you must answer 35 out of 50 questions correctly.
The last page in the book is the Bibliography. It is a list of books that have been used for reference material in the preparation of Unit X.

Congratulations on your progress! You are almost finished with the entire course Integrated Math A and Integrated Math B. You will soon be a first-class graduate of this course!



Appendix R

Examples of Problems Using Technology for
1995 P.A.S.S. Curriculum

From Unit III - Computation and Estimation

Calculator Problem 3: Use your calculator to find the solutions to the following problems. Then use estimation to check the accuracy of your answers. Show the numbers you use for estimation.

a) 175,000,015.341 x 175.3896734

b) 813,024.79643 x 1,012.176

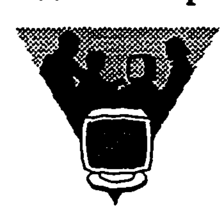
c) 1784.36795 ÷ 254.874

d) 175.357 - 17.11

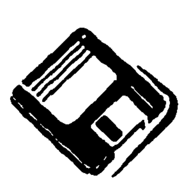
e) 8795 - 111.35

f) 142.77777 + 7539.000403

Discussion: Information stored on computers is measured in bytes, kilobytes, megabytes, and gigabytes. In metric measurement, *kilo* represents one thousand but in computer memory, it is not exactly one thousand. This is due to the use of the binary system for computers instead of base ten. The binary system is expressed in numbers which result from evaluating base 2 to every power. Therefore, some numbers in the binary system are 2^0, 2^1, 2^2, 2^3, 2^4, $2^{5,}$ 2^6, 2^7, 2^8, 2^9, 2^{10}, ... The number $2^{10} = 1024$ bytes and represents one kilobyte. Similarly, one megabyte represents approximately one million bytes and one gigabyte represents approximately one billion bytes.



Cooperative Learning Problem 6: A high density floppy disk holds 1.44 megabytes. One megabyte equals 1,048,576 bytes or 1024 kilobytes.



a) How many bytes and kilobytes are on the floppy disk?

b) Tammy uses the computer to write a 6 page report which contains 51.5 kilobytes and stores it on a floppy disk. Use proportion to find how many pages can still be stored on the floppy disk. Read carefully! ☺

Cooperative Learning Problem 4: **Determine the *value* of the number of coins and bills. Fill in the spreadsheets with your answers.**

Table 1:				
# of Pizzas		$ Given	Total $ Given	
Small	10	$8.00		
	18	10.00		
	12	20.00		
Large	9	21.00		
	16	25.00		
	15	30.00		
		Total $ Given		

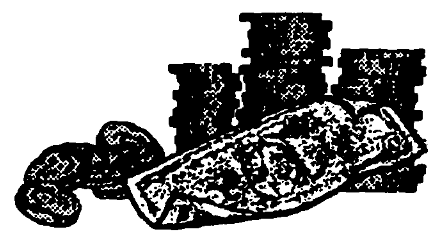


Table 2:			
	# of Pizzas	Price each	Total Sales
Small	40	$7.50	$
Large	40	20.37	
		Total Sales	$

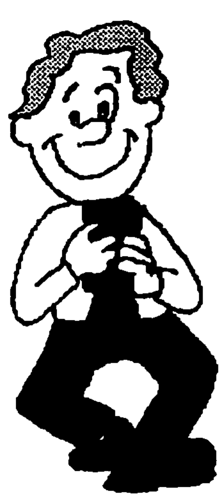
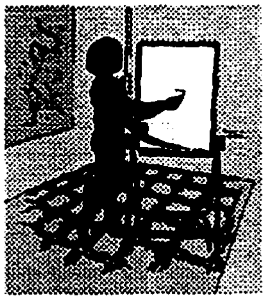
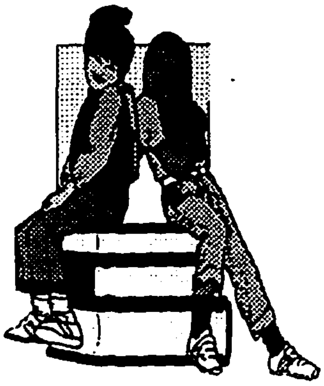


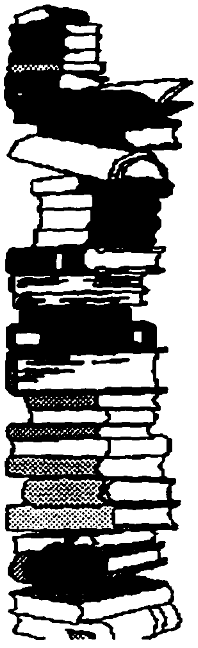
Table 3:		
	# of Bills	
Denomination	or Coins	$ Value
$1	184	$
$5	15	
$10	12	
Quarters	160	
Dimes	40	
Pennies	120	
	Total $ Value	$

Table 4:	Check Work		
Total $ Given - Total Sales = $ Value of change			
	Total $ Given		$
	Less Total Sales		
	$ Value of Change		$

Project: Contact local business owners and find out the ways they use estimation. Ask them how they determine how much change they need. Each group can contact a different type of business. Examples are real estate, insurance, farming and ranching, and many others. Use your library to research information about the business you have selected. Your group should decide together what information will be needed. Write a report and use diagrams such as spreadsheets and tables to illustrate your information. Assign responsibilities within the group so everyone is participating. You will need interviewers, researchers, writers, artists, and speakers. Your report will be presented to the class when you are finished.







From Unit VI - Statistics and Probability

Problem 2 (Computer Spreadsheet): You are an aide in Mrs. Martinez's math class. She asks you to enter the grades from the last test on the computer and to prepare a bar chart using the spreadsheet software. If you do not have access to a computer, do this by hand. Label the students as numbers 1 - 17. The grades are as follows:

75, 84, 96, 37, 65, 44, 92, 89, 75, 35, 45, 98, 87, 79, 55, 92, 84

What conclusions can you draw from the graph?

Cooperative Learning Problem 8 (Computer): Juan is a zoologist at the Los Angeles Zoo. He finds the following data in an Almanac and is curious whether there is any relationship between the number of species in a zoo and the number of acres in the zoo. You are a college student working as an intern for him and he tells you to make a scatterplot on the computer from the data in the table to see if there is a relationship. Make the scatterplot and see if there is a relationship. What interpretation can you make from the plot?

[redacted]

Acres	Species
198	200
58	500
265	670
23	206
215	400
67	761
165	563
70	329
76	310
125	413
50	596
35	339
113	500
133	395
70	445
290	281
200	350
163	509

Acres	Species
110	500
110	475
42	560
125	324
31	450
60	292
39	483
83	665
40	700
100	800
140	270
30	400
64	166
92	300

Cooperative Learning Problem 2: The speeds of animals have been clocked and their maximum speeds in miles per hour are shown in the table.

Animal	MPH	Animal	MPH	Animal	MPH
Cheetah	70	Greyhound	40	Human	28
Wildebeest	50	Rabbit (domestic)	35	Elephant	25
Lion	50	Mule deer	35	Mamba snake	20
Gazelle	50	Jackal	35	Wild turkey	15
Elk	45	Reindeer	32	Squirrel	12
Quarter horse	48	Giraffe	32	Pig (domestic)	11
Coyote	43	White-tailed deer	30	Chicken	9
Gray fox	42	Wart hog	30	Giant tortoise	0.17
Hyena	40	Grizzly bear	30	Three-toed sloth	0.15
Zebra	40	Cat (domestic)	30	Garden snail	0.03

a) Calculate the mean, median, and mode.

Mean: ______ Median: ______ Mode: ______

b) Which measure or measures of dispersion are useful for this problem?

c) Which measure or measures are relatively meaningless for this problem?

Cooperative Learning Problem 3: The test scores for Miss Leon's math test are:
{75, 86, 35, 97, 86, 73, 67, 98, 84, 83, 66, 55, 92, 89, 75, 36, 49, 98, 100, 91}

a) Find the mean, median, mode, and range for the data.

Mean: ______ Median: ______ Mode: ______

b) Which is the most meaningful measure of dispersion for Miss Leon to use in analyzing the test scores?

c) What conclusion can Miss Leon reach based upon her analysis?

Cooperative Learning Problem 4 (Computer Spreadsheet): Use a computer spreadsheet to graph the data in the last problem. Experiment with the following types of graphs: column graph, scatterplot, pie-chart, and histogram.

Which is the most useful data representation? (This can be completed by hand but it is easier on a computer).

From Unit VII - Algebra

🖫 **Computer or Graphing Calculator Exercise:** Investigate the changes that occur in the graphs of the following linear equations $y = ax + b$ when "a" and "b" are changed.

a) $y = x$ Note: $a = 1, b = 0$

b) $y = x + 1$ a = ___ b = ___

What happened to the graph when it is compared to $y = x$?

c) $y = x + 2$ a = ___ b = ___

What happened to the graph when it is compared to $y = x$?

d) $y = x + 5$ a = ___ b = ___

What happened to the graph when it is compared to $y = x$?

e) $y = x - 1$ a = ___ b = ___

What happened to the graph when it is compared to $y = x$?

f) y = x - 10 a = ___ b = ___

What happened to the graph when it is compared to y = x ?

g) Predict what the graph of y = x - 3 will look like.

h) y = 2x a = ___ b = ___

What happened to the graph when it is compared to y = x ?

i) y = 2x + 1 a = ___ b = ___

What happened to the graph when it is compared to y = x ?

j) y = 2x - 5 a = ___ b = ___

What happened to the graph when it is compared to y = x ?

k) y = 3x a = ___ b = ___

What happened to the graph when it is compared to y = x ?

l) y = 3x + 2 a = ___ b = ___

What happened to the graph when it is compared to y = x ?

m) y = 3x - 8 a = ___ b = ___

What happened to the graph when it is compared to y = x ?

n) **Predict what the graph of $y = 5x + 3$ will look like?**

o) $y = -2x$ a = __ b = __

What happened to the graph when it is compared to $y = x$?

p) $y = -4x$ a = __ b = __

What happened to the graph when it is compared to $y = x$?

q) $y = -10x$ a = __ b = __

What happened to the graph when it is compared to $y = x$?

r) $y = -\frac{1}{2}x$ a = __ b = __

What happened to the graph when it is compared to $y = x$?

s) $y = -\frac{3}{4}x$ a = __ b = __

What happened to the graph when it is compared to $y = x$?

t) **Predict what the graph of $y = -\frac{1}{4}x$ will look like?**

u) **Predict what the graph of $y = \frac{1}{4}x$ will look like?**

Write your conclusions from this exercise.

🖫Computer or Graphing Calculator Exercise 1:

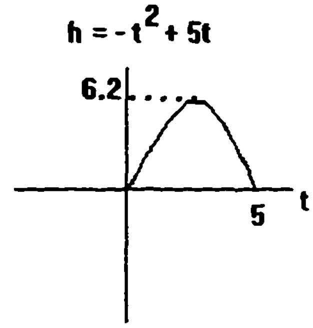
Graph the following equations and sketch the graphs below.

a) $y = -x^2 + 5x$

b) $y = x^3$

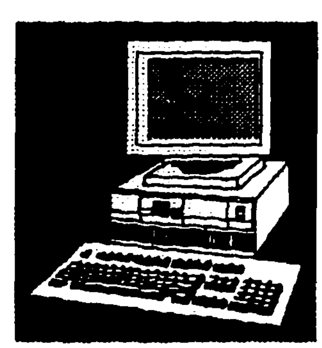
c) $y = |x|$ (This means every value of y is positive even when x is positive or negative).

Discussion: Examine the graph $y = -x^2 + 5x$ for the values of $x \geq 0$. A real-world example for this graph is the path of a ball when it is thrown. We will label the horizontal axis *t* for time in seconds, and the vertical axis will be labeled *h* for height in feet. The equation is now $h = -t^2 + 5t$. At $t = 0$ we throw the ball. Tracing this curve on the graphing calculator or computer shows the ball rises until it reaches the maximum height of 6.2 feet and then falls back to the ground at $t = 5$ or in 5 seconds. Is this problem realistic? A young child might not be able to throw a basketball any higher than this.



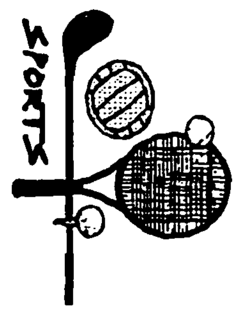
🖫Computer or Graphing Calculator

Exercise 2:



Use the same equation $h = -t^2 + 5t$ and find out what changes need to be made to make the equation realistic for someone your age who is throwing a ball in the air. Vary the coefficients of t^2 and t. What equation will you need to enter into the computer or graphing calculator? What equation(s) did you find that would work?

Use the trace command to find the maximum height. You will trace the curve to find the y-coordinate at the top of the curve. Remember that the y-coordinate on your calculator or computer is the same as the h-coordinate in your equation. The x-coordinate is the same as the t-coordinate in your equation. When will the ball hit the ground?



Maximum height: __________

Time when ball hits the ground: __________

Cooperative Learning Problem 1: Complete the table using the equation $h = -t^2 + 5t$ with the values shown for t. Then answer the following questions:

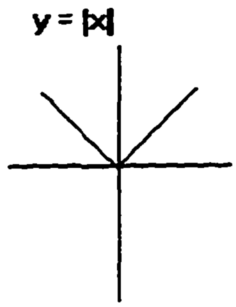
a) What does the table tell you about the maximum height and when does it occur?

b) What does the table tell you about the times the ball is at ground level?

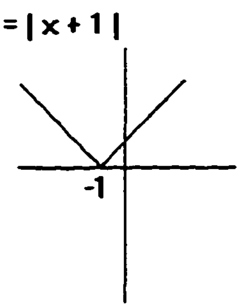
c) What is wrong with the graph? Can you think of a scenario that would make this table true?

t	$h = -t^2 + 5t$
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	

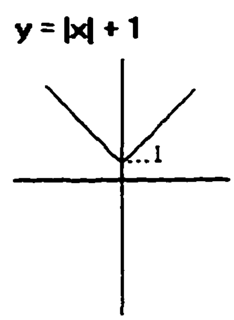
Discussion: Absolute value functions make interesting nonlinear graphs also. The equation $y = |x|$ graphed as a V-shape in Computer or Graphing Calculator Exercise 1. We can move the graph around by changing values in the equation.



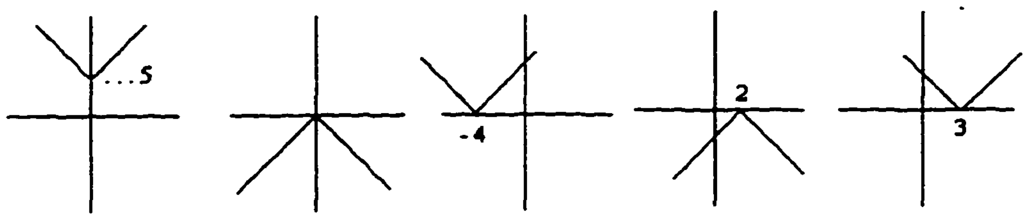
For example, $y = | x + 1 |$ is the graph below:



The equation $y = |x| + 1$ gives a different graph:



🖫Computer or Graphing Calculator Exercise 3:
Experiment with the computer or graphing calculator and write the equation for each graph:



(a) (b) (c) (d) (e)

Assignment of Ordinal Values to P.A.S.S. Curricula by Coder 3 (Nud*Ist) Using the Mathematics Materials Analysis Instrument (MMAI)

Node	X	Y	M[a]	Ordinal Value
1995 curriculum, grades 5-8				
1 1 1	62.0	59.0	60.5	4
1 1 2	20.0	11.0	15.5	2
1 1 3	54.0	51.0	52.5	4
1 1 4	63.0	56.0	59.5	4
1 1 5	31.0	15.0	23.0	3
1 1 6	19.0	1.5	10.3	2
1 1 7	68.0	47.0	57.5	4
1 1 8	49.0	46.0	47.5	4
1 1 9	44.0	38.0	41.0	4
1 1 10	74.0	58.0	66.0	4
1 1 11	44.0	39.0	41.5	4
1 1 12	46.0	38.0	42.0	4
1 2 1	73.0	73.0	73.0	4
1 2 2	39.0	36.0	37.5	4
1 2 3	15.0	6.6	10.8	2
1 2 4	26.0	16.0	21.0	3
1 2 5	50.0	23.0	36.5	4
1 2 6	31.0	17.0	24.0	3
1 2 7	25.0	18.0	21.5	3

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = X + Y / 2. [a]The weighted average for node 1 1 is 19.7% and for node 1 2, 11.5%. Ordinal value scale at end of table.

table continues

Node	X	Y	M[b]	Ordinal Value
1995 curriculum, grades 5-8				
1 3 1	5.2	0.3	2.8	2
1 3 2	27.0	7.7	17.4	4
1 3 3	52.0	17.0	34.5	4
1 3 4	35.0	11.0	23.0	4
1 4 1	17.0	2.4	9.7	2
1 4 2	38.0	20.0	29.0	3
1 4 3	21.0	6.4	13.7	2
1 4 4	22.0	6.0	14.0	2
1 4 5	51.0	11.0	31.0	4
1 4 6	26.0	4.2	15.1	3
1 4 7	7.1	0.3	3.7	2
1 4 8	44.0	5.3	24.7	3
1 4 9	22.0	2.8	12.4	2
1 5 1	48.0	7.7	27.9	3
1 5 2	46.0	13.0	29.5	3
1 5 3	40.0	6.9	23.5	3
1 5 4	25.0	9.5	17.3	3
1 5 5	48.0	23.0	35.5	3
1 5 6	37.0	6.0	21.5	3
1 5 7	68.0	8.2	38.1	4
1 5 8	100.0	6.6	53.3	4
1 5 9	63.0	5.3	34.2	3
1 5 10	80.0	10.0	45.0	4

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = X + Y / 2. [b]The weighted average and for node 1 3 is 6.6%; for node 1 4, 14.8% and for node 1 5, 16.4%. Ordinal value scale at end of table.

table continues

Node	X	Y	M[c]	Ordinal Value
1995 curriculum, grades 5-8				
1 6 1	63.0	23.0	43.0	4
1 6 2	55.0	20.0	37.5	4
1 6 3	69.0	19.0	44.0	4
1 6 4	12.0	1.8	6.9	2
1 6 5	42.0	17.0	29.5	4
1 6 6	44.0	12.0	28.0	4
1 6 7	33.0	2.7	17.9	3
1 7 1	28.0	3.8	15.9	3
1 7 2	25.0	5.1	15.1	3
1 7 3	8.7	0.5	4.6	2
1 7 4	8.7	0.5	4.6	2
1 7 5	50.0	2.0	26.0	3
1 7 6	49.0	4.1	26.6	3
1 7 7	67.0	3.7	35.4	4
1 7 8	67.0	3.7	35.4	4
1 7 9	6.5	0.3	3.4	2
1 8 1	58.0	19.0	38.5	4
1 8 2	56.0	12.0	34.0	4
1 8 3	66.0	31.0	48.5	4

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = X + Y / 2. [c]The weighted average and for node 1 6 is 11.5%; for node 1 7, 14.8% and for node 1 8, 4.9%. Ordinal value scale at end of table.

table continues

Node	X	Y	M^d	Ordinal Value
1995 curriculum, grades 9-12				
2 1 1	71.0	71.0	71.0	4
2 1 2	42.0	24.0	33.0	4
2 1 3	58.0	53.0	55.5	4
2 1 4	60.0	51.0	55.5	4
2 1 5	48.0	36.0	42.0	4
2 1 6	19.0	9.3	14.2	3
2 2 1	46.0	43.0	44.5	4
2 2 2	72.0	69.0	70.0	4
2 2 3	28.0	16.0	22.0	3
2 2 4	27.0	14.0	20.5	3
2 2 5	24.0	17.0	20.5	3
2 2 6				1
2 3 1	14.0	5.0	9.5	2
2 3 2	42.0	4.5	23.3	3
2 3 3	35.0	3.7	19.4	3
2 3 4	35.0	3.7	19.4	3
2 3 5	28.0	9.5	18.8	3
2 3 6	19.0	10.0	14.5	3
2 4 1	49.0	48.0	48.5	4
2 4 2	32.0	28.0	30.0	4
2 4 3	23.0	19.0	21.0	3
2 4 4	38.0	10.0	24.0	3
2 4 5				1
2 4 6	44.0	1.2	22.6	3

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = X + Y / 2. [d]The weighted average for nodes 2 1, 2 2, 2 3 and 2 4 is 12.5%. Ordinal value scale at end of table.

table continues

Node	X	Y	M[e]	Ordinal Value
1995 curriculum, grades 9-12				
2 5 1	100.0	6.7	53.4	4
2 5 2	27.0	2.1	14.6	3
2 5 3	52.0	24.0	38.0	4
2 5 4	54.0	20.0	37.0	4
2 5 5	36.0	7.2	21.6	3
2 5 6	56.0	35.0	45.5	4
2 6 1	29.0	23.1	26.1	4
2 6 2				1
2 6 3				1
2 6 4	36.0	13.0	24.5	3
2 6 5	38.0	3.5	20.8	3
2 6 6	41.0	37.0	39.0	4
2 7 1	62.0	9.5	35.8	4
2 7 2	58.0	3.5	30.8	4
2 7 3	15.0	1.4	8.2	2
2 7 4	21.0	8.8	14.9	3
2 7 5	36.0	14.0	25.0	3
2 7 6	13.0	2.6	7.8	2
2 8 1	50.0	41.0	45.5	4
2 8 2	71.0	31.0	51.0	4
2 8 3	86.0	16.0	51.0	4
2 8 4	24.0	4.7	14.4	3
2 8 5				1
2 8 6				1

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = X + Y / 2. [e]The weighted average for nodes 2 5, 2 6, 2 7 and 2 8 is 12.5%. Ordinal value scale at end of table.

table continues

Node	X	Y	M[f]	Ordinal Value
1989 curriculum, grades 5-8				
1 1 1	29.0	23.0	26.0	3
1 1 2	5.0	0.5	2.8	2
1 1 3	49.0	49.0	49.0	4
1 1 4	24.0	10.0	17.0	2
1 1 5				1
1 1 6				1
1 1 7	16.0	10.0	13.0	2
1 1 8				1
1 1 9	7.0	0.9	4.0	2
1 1 10	18.0	4.0	11.0	2
1 1 11	25.0	7.0	16.0	2
1 1 12	77.0	37.0	57.0	4
1 2 1	33.0	21.0	27.0	4
1 2 2				1
1 2 3				1
1 2 4	7.0	2.0	4.5	2
1 2 5	4.0	0.3	2.1	2
1 2 6				1
1 2 7	4.0	1.0	2.5	2

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = X + Y / 2. [f]The weighted average for node 1 1 is 19.7% and for node 1 2, 11.5%. Ordinal value scale at end of table.

table continues

Node	X	Y	M[g]	Ordinal Value
1989 curriculum, grades 5-8				
1 3 1	100.0	7.0	53.5	4
1 3 2				1
1 3 3				1
1 3 4	13.0	2.0	7.5	3
1 4 1	70.0	12.0	41.0	4
1 4 2	50.0	17.0	33.5	4
1 4 3	16.0	3.0	9.5	2
1 4 4	17.0	1.0	9.0	2
1 4 5	49.0	8.0	28.5	3
1 4 6	15.0	1.0	8.0	2
1 4 7	2.0	0.3	1.1	2
1 4 8	36.0	10.0	23.0	3
1 4 9				1
1 5 1	62.0	8.0	35.0	3
1 5 2	43.0	14.0	28.5	3
1 5 3	15.0	2.0	8.5	2
1 5 4	3.0	0.5	1.8	2
1 5 5	68.0	11.0	39.5	4
1 5 6	76.0	14.0	45.0	4
1 5 7	100.0	6.0	53.0	4
1 5 8	12.0	0.9	6.5	2
1 5 9				1
1 5 10				1

Note. X = % of retrieved text to retrieved documents. Y = % of retrievedtext to all documents. M = X + Y / 2. [g]The weighted average for node 1 3 is 6.6%, for node 1 4, 14.8% and for node 1 5, 16.4%. Ordinal value scale at end.of table.

table continues

Node	X	Y	M[h]	Ordinal Value
1989 curriculum, grades 5-8				
1 6 1	30.0	6.0	18.0	3
1 6 2	42.0	9.0	25.5	4
1 6 3				1
1 6 4				1
1 6 5	14.0	2.0	8.0	2
1 6 6	44.0	7.0	25.5	4
1 6 7				1
1 7 1				1
1 7 2				1
1 7 3				1
1 7 4				1
1 7 5				1
1 7 6				1
1 7 7				1
1 7 8				1
1 7 9				1
1 8 1	68.0	9.0	38.5	4
1 8 2	8.0	0.3	4.1	2
1 8 3	33.0	16.0	24.5	4

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = X + Y / 2. [h]The weighted average for node 1 6 is 11.5%; for node 1 7, 14.8% and for node 1 8, 4.9%. Ordinal value scale at end of table.

table continues

Node	X	Y	M[i]	Ordinal Value
1989 curriculum, grades 9-12				
2 1 1	38.0	29.0	33.5	4
2 1 2	10.0	3.0	6.5	2
2 1 3	16.0	6.0	11.0	2
2 1 4	48.0	25.0	36.5	4
2 1 5				1
2 1 6				1
2 2 1				1
2 2 2	33.0	21.0	27.0	4
2 2 3	6.0	2.0	4.0	2
2 2 4	4.0	1.0	2.5	2
2 2 5	2.0	0.1	1.1	1
2 2 6				1
2 3 1				1
2 3 2				1
2 3 3	13.0	2.0	7.5	2
2 3 4	20.0	1.5	10.8	2
2 3 5				1
2 3 6	5.0	0.5	2.8	2
2 4 1	52.0	52.0	52.0	4
2 4 2	46.0	46.0	46.0	4
2 4 3				1
2 4 4	2.0	0.5	1.3	2
2 4 5				1
2 4 6				1

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents M = X + Y / 2. [i]The weighted average for nodes 2 1, 2 2, and 2 3 is 12.5%. Ordinal value scale at end of table.

table continues

Node	X	Y	M[j]	Ordinal Value
1989 curriculum, grades 9-12				
2 5 1				1
2 5 2				1
2 5 3				1
2 5 4				1
2 5 5				1
2 5 6	58.0	16.0	37.0	4
2 6 1	48.0	14.0	31.0	4
2 6 2				1
2 6 3				1
2 6 4	9.0	2.0	5.5	2
2 6 5				1
2 6 6	47.0	39.0	43.0	4
2 7 1				1
2 7 2				1
2 7 3				1
2 7 4				1
2 7 5				1
2 7 6				1
2 8 1	26.0	16.0	21.0	3
2 8 2	12.0	2.0	7.0	2
2 8 3				1
2 8 4	55.0	2.0	28.5	4
2 8 5				1
2 8 6				1

Note. X = % of retrieved text to retrieved documents. Y = % of retrieved text to all documents. M = X + Y / 2. [j]The weighted average for nodes 2 5, 2 6, 2 7 and 2 8 is 12.5%.

table continues

Node	Range	Ordinal Value
1 1	$0 \leq M \leq 1$	1
	$1 < M \leq 20$	2
	$20 < M \leq 40$	3
	$M > 40$	4
1 2	$0 \leq M \leq 1$	1
	$1 < M \leq 12$	2
	$12 < M \leq 25$	3
	$M > 25$	4
1 3	$0 \leq M \leq 1$	1
	$1 < M \leq 7$	2
	$7 < M \leq 14$	3
	$M > 14$	4
1 4	$0 \leq M \leq 1$	1
	$1 < M \leq 15$	2
	$15 < M \leq 30$	3
	$M > 30$	4
1 5	$0 \leq M \leq 1$	1
	$1 < M \leq 17$	2
	$17 < M \leq 35$	3
	$M > 35$	4
1 6	$0 \leq M \leq 1$	1
	$1 < M \leq 12$	2
	$12 < M \leq 25$	3
	$M > 25$	4

table continues

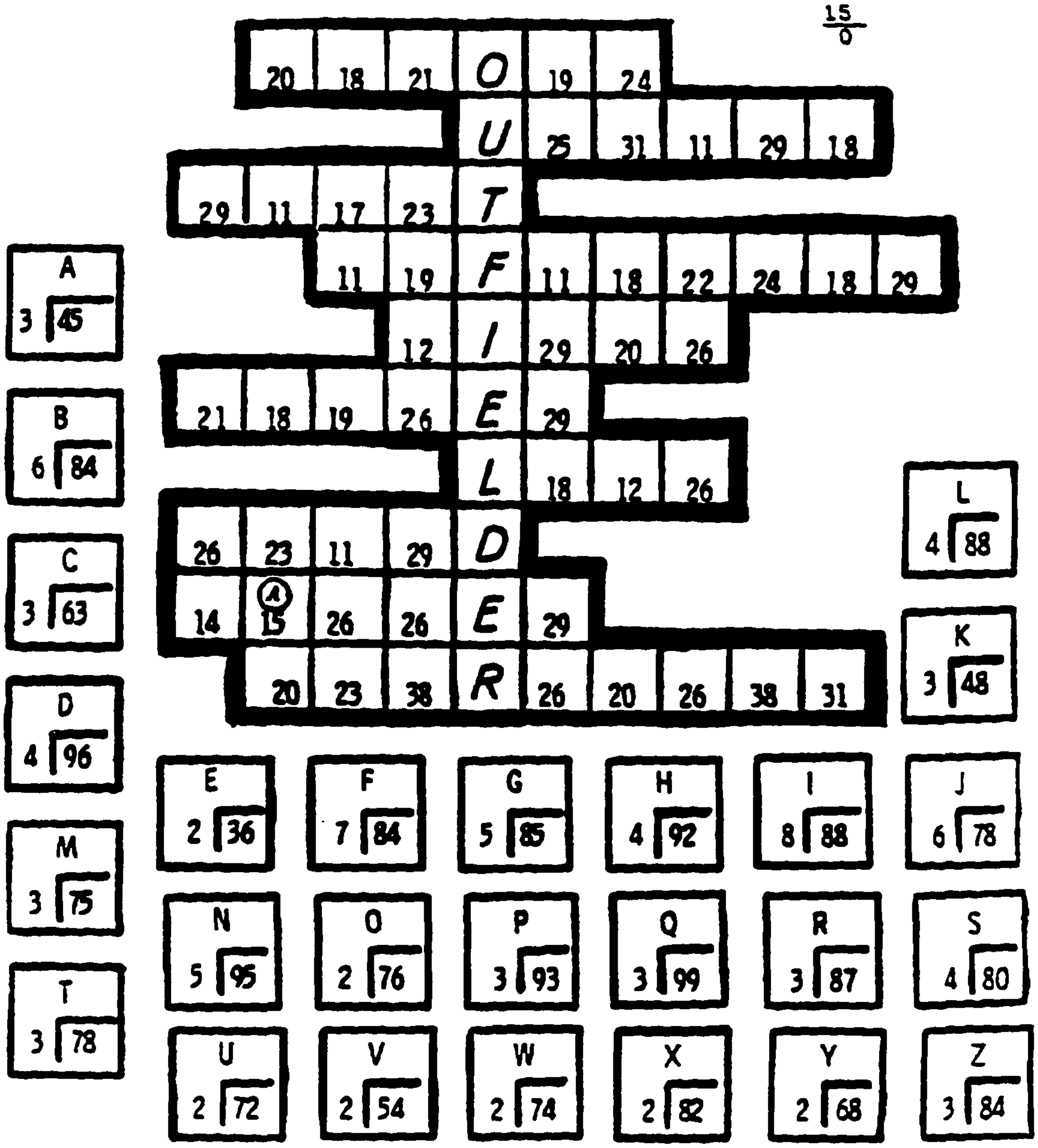
Node	M Range	Ordinal Value
1 7	$0 \le M \le 1$	1
	$1 < M \le 15$	2
	$15 < M \le 30$	3
	$M > 30$	4
1 8	$0 \le M \le 1$	1
	$1 < M \le 5$	2
	$5 < M \le 10$	2
	$M > 10$	4
2, All	$0 \le M \le 1$	1
	$1 < M \le 13$	2
	$13 < M \le 26$	3
	$M > 26$	4

ACTIVITY 6

Write the letter in the crossword puzzle that matches the quotient for that letter.

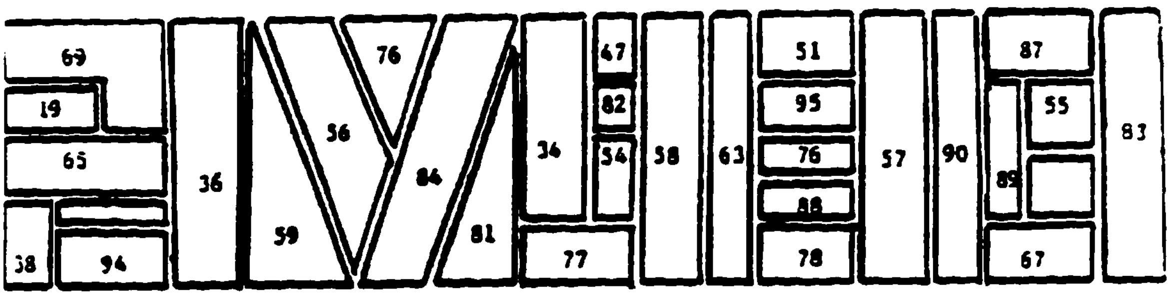
A

EXAMPLE: 3/45 = 15 (3, 15, 15, 0)



ACTIVITY 16

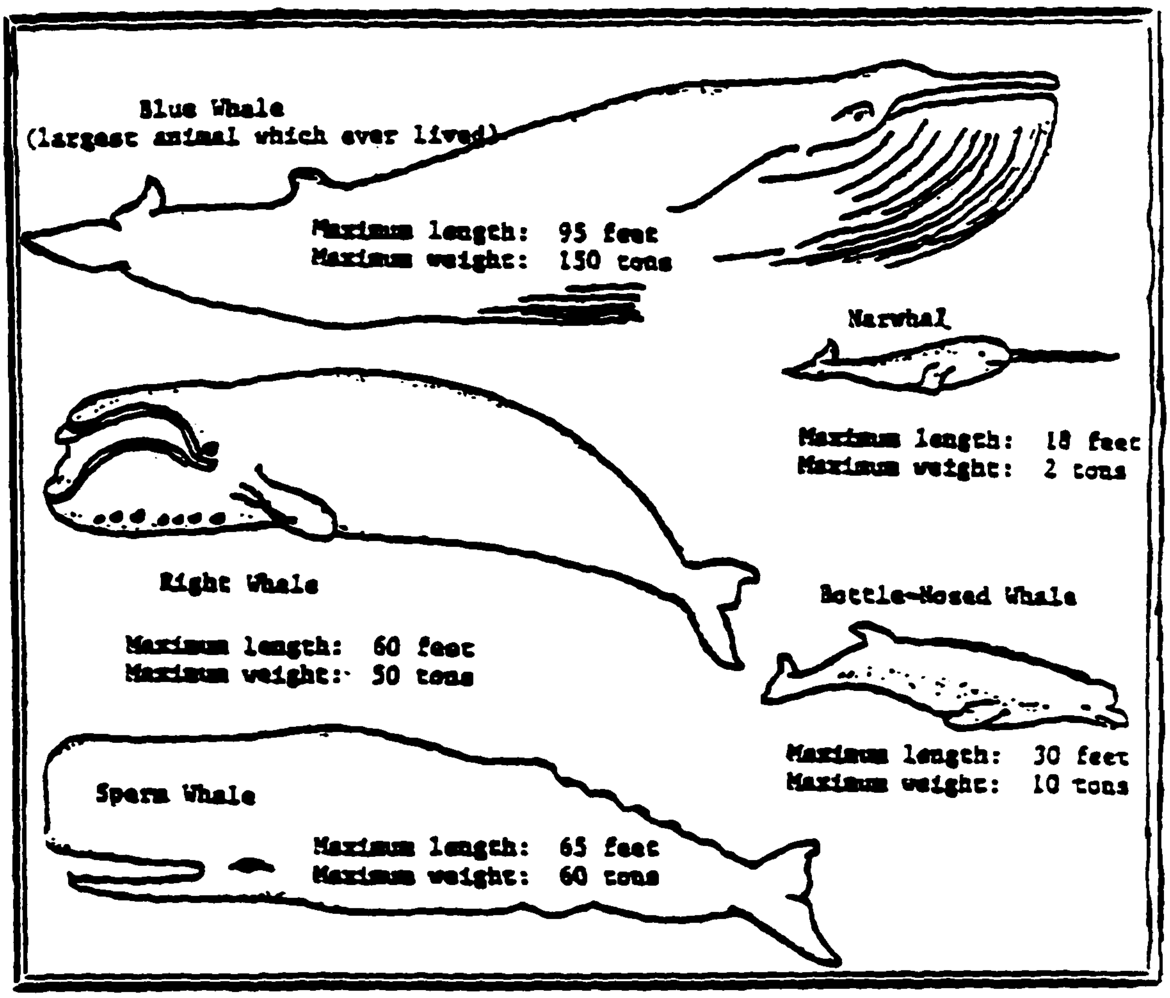
To get the name of a city, color in the sections that have matching quotients below. Hold the paper before a mirror. Read the name in the reflection.



1. 54/1,836
2. 25/1,675
3. 37/1,406
4. 34/1,938
5. 56/2,016
6. 61/3,416
7. 56/3,248
8. 36/2,484
9. 44/3,432
10. 77/3,619
11. 46/3,818
12. 57/3,705
13. 53/4,452
14. 76/6,612
15. 84/6,468
16. 85/7,990

ACTIVITY 19

Whale Chart



Use the chart to answer these questions. Show your work.

1. How much longer is the Blue Whale than the Narwhal?

____

2. How many Bottle-Nosed Whales would it take to equal the weight of one Right Whale?

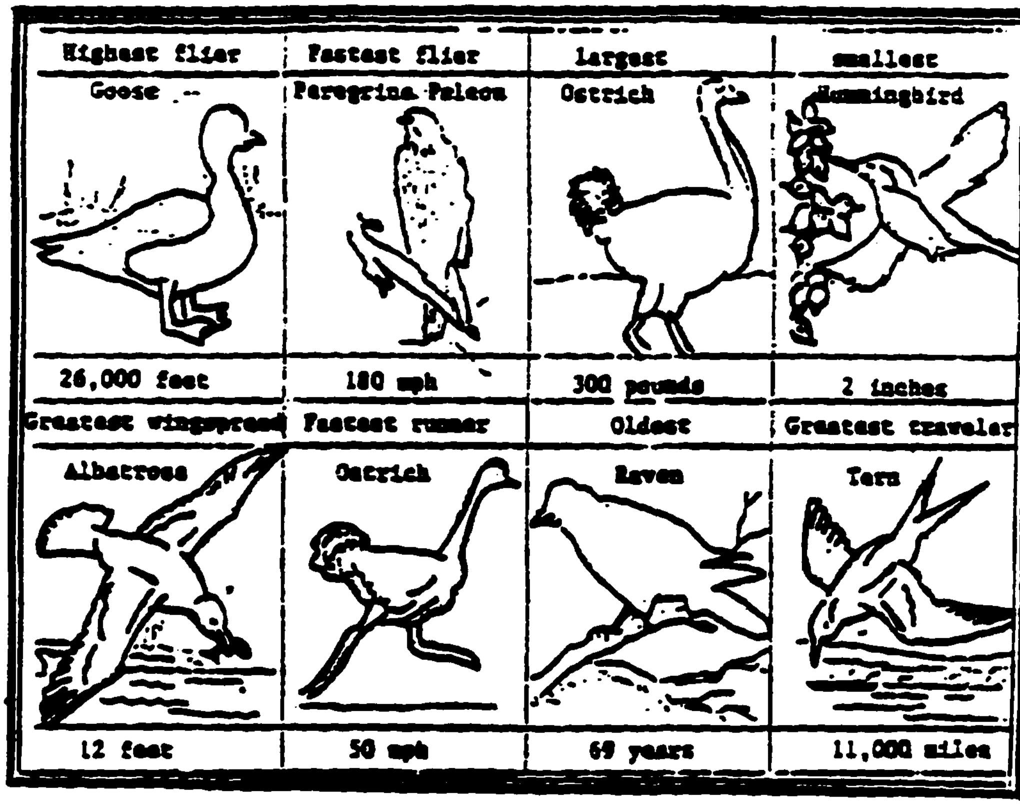
____

3. One ton = 2000 pounds. How much does a Blue Whale weigh in pounds?

____

ACTIVITY 20

Bird Chart



Use this chart to answer these questions. Show your work.

1. The oldest person lived to be about 130 years. How much older is this than the "old" raven?

   ____

2. Some jet airliners cruise at 35,000 feet. How much higher is this than the highest flying bird?

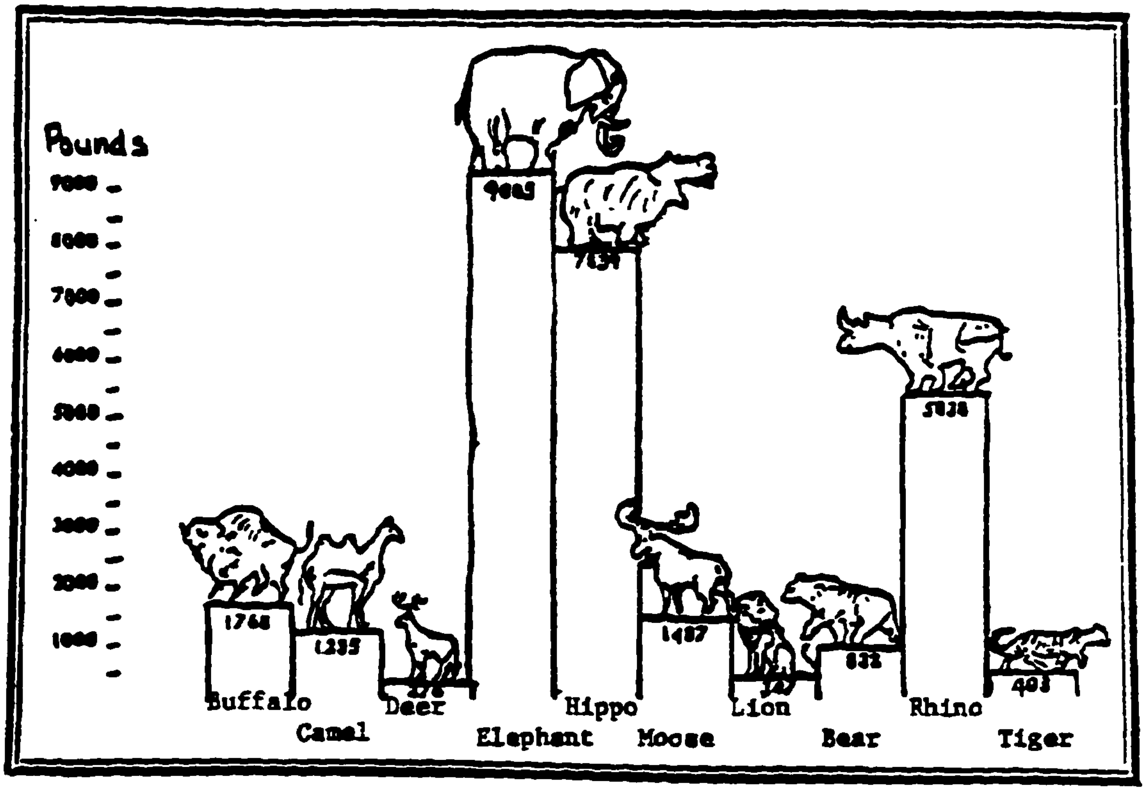
   ____

3. The fastest a person can run is about 25 miles per hour. How many times faster can the ostrich run?

   ____

ACTIVITY 21

Animal Chart



Use this graph to answer these questions. Show your work.

1. **Which animal is the lightest?** ______________________

2. **Which animal is the heaviest?** ______________________

3. **What is the difference in weight between the heaviest and the lightest animals?**

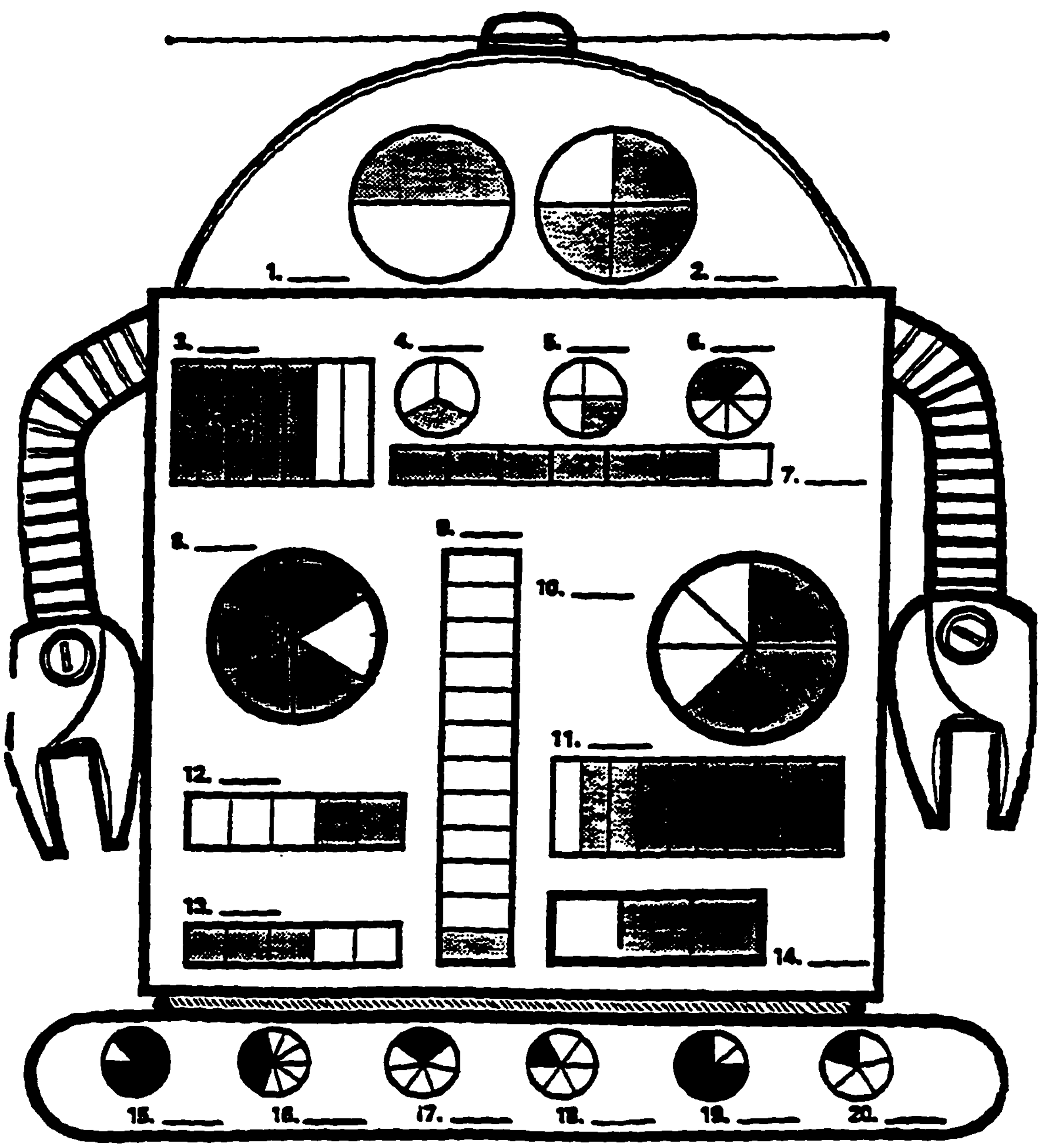
   ____

4. **How much would the camel have to gain to weigh as much as the buffalo?**

   ____

ACTIVITY I

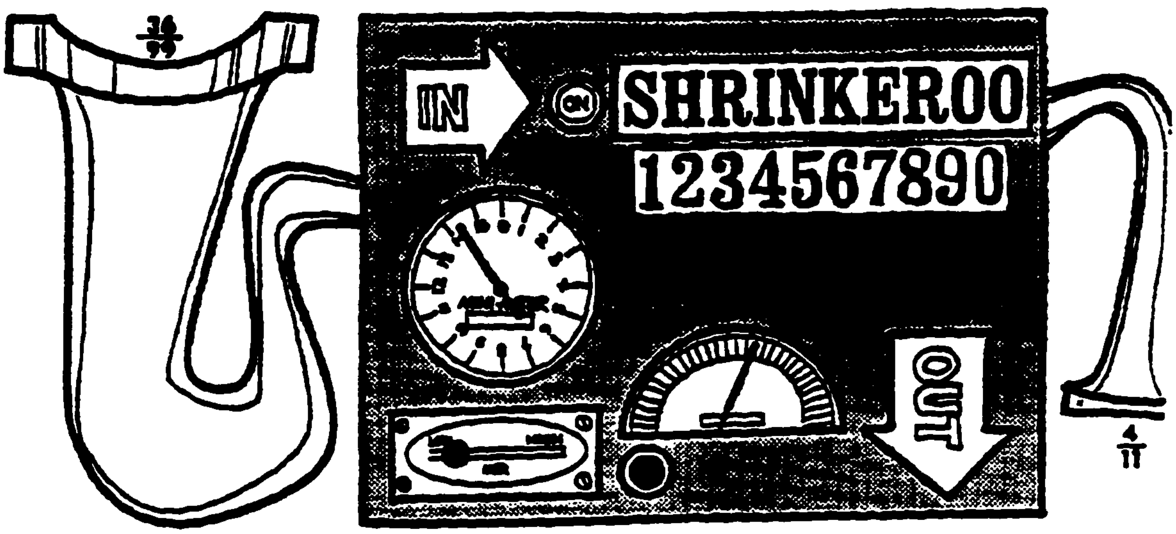
Write a fraction for each shaded part of the robot.



ACTIVITY VIII

Put these fractions into the "shrinking machine." Reduce to lowest terms.

(1) $\frac{2}{4}$	(5) $\frac{4}{8}$	(9) $\frac{5}{15}$	(13) $\frac{9}{81}$	(17) $\frac{18}{32}$
(2) $\frac{3}{9}$	(6) $\frac{9}{12}$	(10) $\frac{4}{20}$	(14) $\frac{20}{32}$	(18) $\frac{12}{20}$
(3) $\frac{6}{8}$	(7) $\frac{4}{10}$	(11) $\frac{6}{10}$	(15) $\frac{16}{24}$	(19) $\frac{15}{21}$
(4) $\frac{3}{6}$	(8) $\frac{6}{12}$	(12) $\frac{6}{9}$	(16) $\frac{5}{20}$	(20) $\frac{12}{48}$

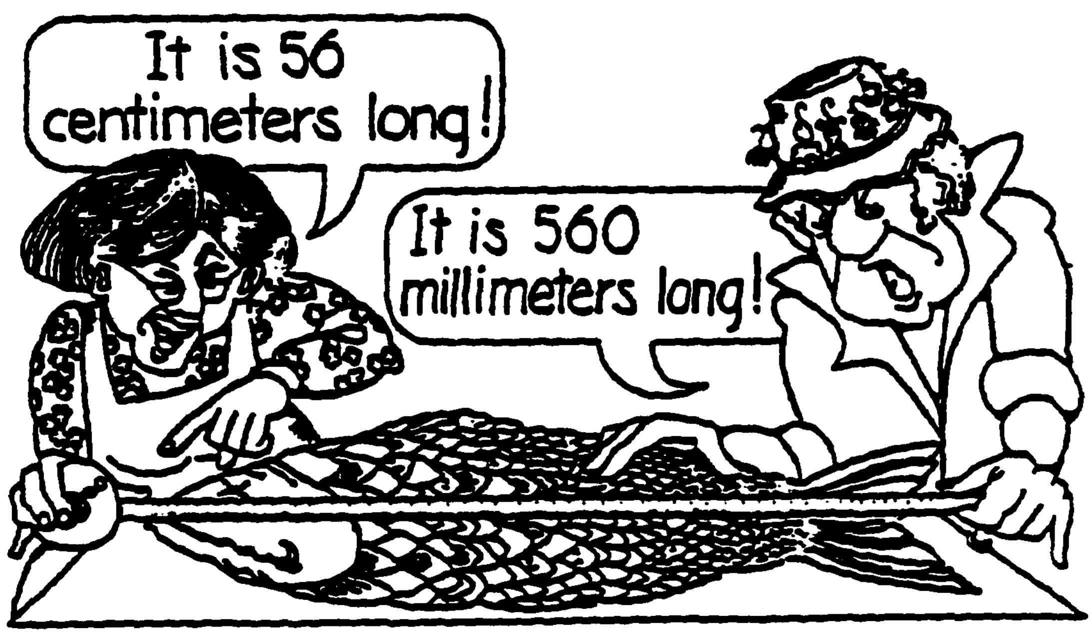


(1) ____	(5) ____	(9) ____	(13) ____	(17) ____
(2) ____	(6) ____	(10) ____	(14) ____	(18) ____
(3) ____	(7) ____	(11) ____	(15) ____	(19) ____
(4) ____	(8) ____	(12) ____	(16) ____	(20) ____

ACTIVITY V

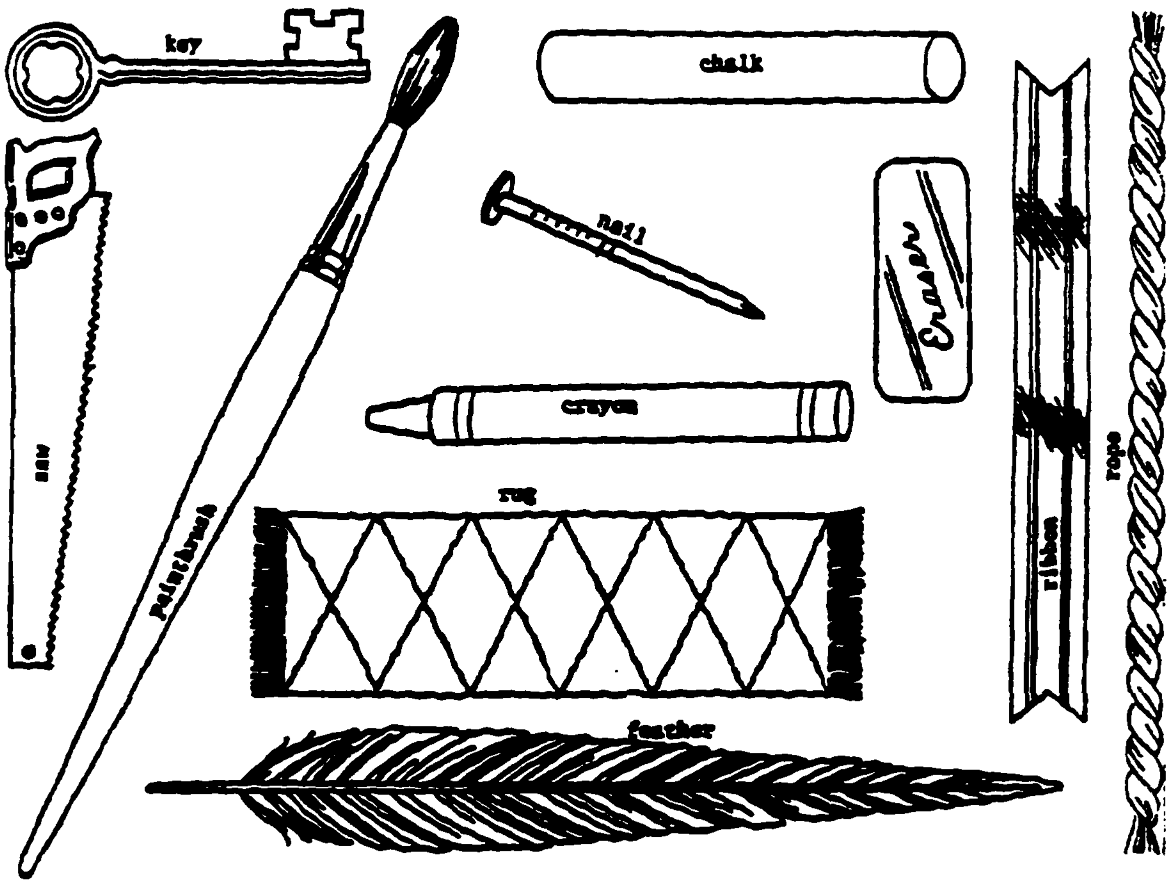
Are the measurements equivalent? Write yes or no.

1. 450 cm, 4.5 m ______
2. 7.2 m, 7200 cm ______
3. 200 m, 2 cm ______
4. 54 mm, 0.54 cm ______
5. 925 mm, 92.5 cm ______
6. 4.1 cm, 41 mm ______
7. 36.2 cm, 3620 mm ______
8. 1.94 mm, 194 cm ______
9. 56 cm, 0.56 m ______
10. 14 m, 140 cm ______
11. 6.8 mm, 86 cm ______
12. 9.2 m, 209 cm ______



13. Who is correct? __________

A Centimeter Puzzle



ACTIVITY XIV

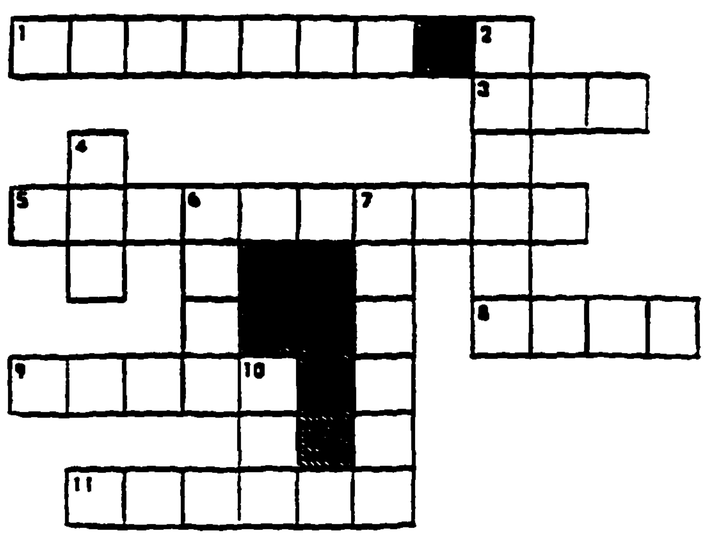
Using your metric ruler, find the item that fits each measurement and place its name in the appropriate box of the crossword puzzle.

Across

1. 15 cm
3. 10 cm
5. 16 cm
7. 14 cm
9. 7 cm
11. 8 cm

Down

2. 4 cm
4. 9 cm
6. 5 cm
8. 11 cm
10. 6 cm



Appendix U

Unique Activities - 1995 P.A.S.S. Curriculum

From: Unit I - Number and Number Relationships
Section Three - Real Numbers

Cooperative Learning Connections (Science): The distance traveled by light in one year is called a light-year. One light-year is 5,880,000,000,000 miles.

a) How do you read this number?

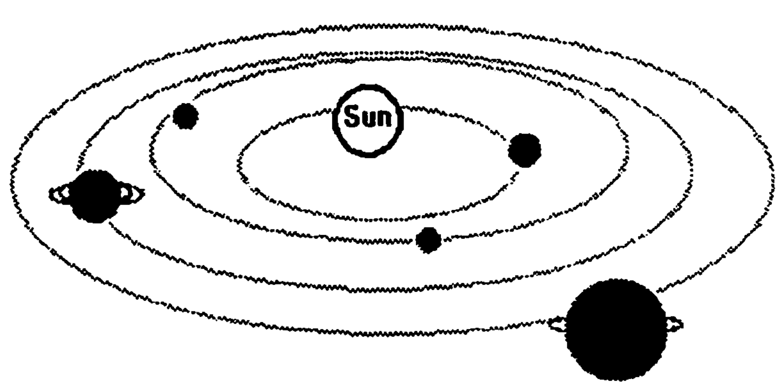
b) Write this number in scientific notation.

c) Conduct research at the library to find the distance in light-years from the sun for each planet of the solar system. Record your information in scientific notation and display the information in a table in order from largest to smallest.

Include other interesting facts and numbers such as the age of each planet, the diameter of each planet, the rotational period and period of revolution of each planet, and the highest and lowest temperatures of each planet. Notice the lowest temperatures are negative integers. Estimate the temperatures for the earth and compare them to the facts you discover.

Display the information in a table and use scientific notation for large numbers.

Project: Draw a diagram or build a model illustrating the diameter of the planets and the distance in light-years from the sun. Resources in the library or science textbooks can help you with this project. The diagram below can help you think about placement and size but it is not meant to be accurate. You will provide the accuracy.



From: Unit III - Computation and Estimation
Section Three - Proportion

Cooperative Learning Problem 5: In the United States, Cinco de Mayo is the day reserved to celebrate Mexican independence from Spanish rule. Mariachis stroll freely during the festivities to serenade the crowds. Your group is in charge of the food and have decided you want to serve chili. Your recipe is designed for 6 people.

Chili recipe

3 lb. ground beef	dash red pepper
2 large chopped onions	1 Tbs. flour
2 chopped garlic buttons	1/4 c. chili powder
1 tsp. salt	3 cups boiling water
1/2 tsp. pepper	1 can tomato paste

a) What are the conversion ratios?

b) Estimate and then calculate the exact ingredients needed in the recipe to serve 350 people. Were your estimates close?

From: Unit III - Computation and Estimation
Section Four: Problem Solving

Project: Quinceanera parties are given by Latino families for fifteen year olds and can be very expensive. It is very helpful to make a budget to plan large parties such as these. Your group project is to make a budget for this type of party or some other gathering of your choice. Estimate costs for food, entertainment such as musicians, hall rental, clothing, and all other costs associated with your party. Use a spreadsheet to itemize your costs.

Discussion: In the above problem, the cartoon has extremely exaggerated features which are not visually pleasing. Measurements from the cartoon would definitely not give a golden rectangle ratio! The golden rectangle is known for its visually pleasing ratio. Warning! Many beautiful people may not have faces that fit the golden rectangle ratio. We will all agree, however, that this cartoon is not visually pleasing. ☺

Example 1: Measure the face from the bottom of the chin to the bottom of the nose. Write this measurement as the dimensions of another rectangle using the width of the face measured in step 1. Write these measurements as a ratio and reduce it to simplest form. For example, the measurements might give you the dimensions of a rectangle that is $\frac{3}{4} \times 1\frac{1}{2}$.

Then the ratio $\frac{3}{4} \div 1\frac{1}{2} \Rightarrow \frac{3}{4} \div \frac{3}{2} \Rightarrow \frac{3}{4} \bullet \frac{2}{3} \Rightarrow \frac{2}{4} \Rightarrow \frac{1}{2}$.

This is the ratio of two Fibonacci numbers. The problem can also be done with the largest number in the numerator. The Fibonacci ratio is then 2:1 which is also acceptable. In this case, the proportions of the face between the chin and the nose gives a Fibonacci ratio. You will now find other rectangles on the face that will give Fibonacci ratios.

Cooperative Learning Problem 5:

a) Measure the face from the bottom of the nose to the middle of the eyes. Write this measurement as the dimensions of another rectangle using the width of the face measured in Problem 4. Write the measurements as a ratio and determine whether it fits the Fibonacci ratio or the golden rectangle ratio.

b) Find other rectangles by measuring the features of the face and determine whether the ratios fit the Fibonacci ratios or the golden rectangle.

c) Share your findings with the other groups. Discuss the ideas behind the golden rectangle.

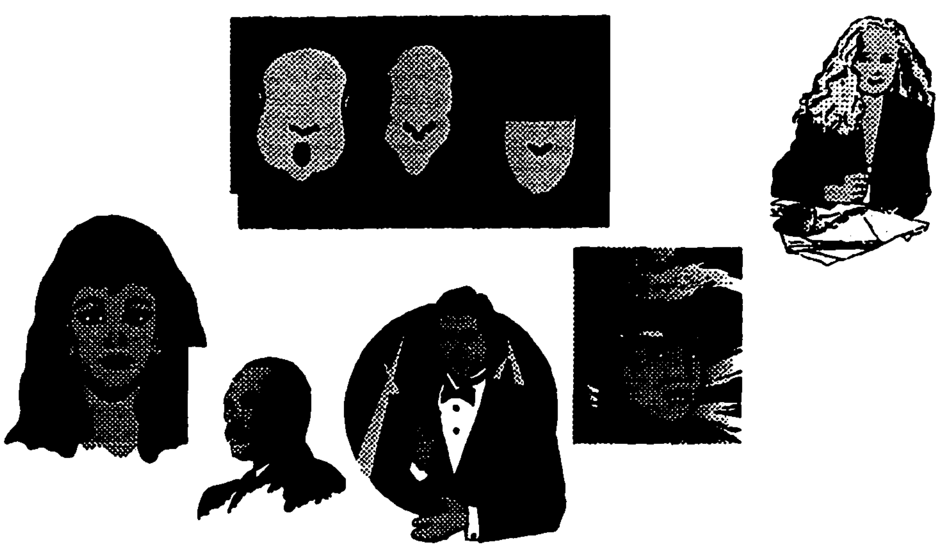
What *is* visually pleasing?

Does "visually pleasing" differ between cultures?

Were models used in the class who are considered beautiful but whose dimensions did not fit these ratios?

Is there a new ratio that your class can create from your measurements to define the beauty of your class members?

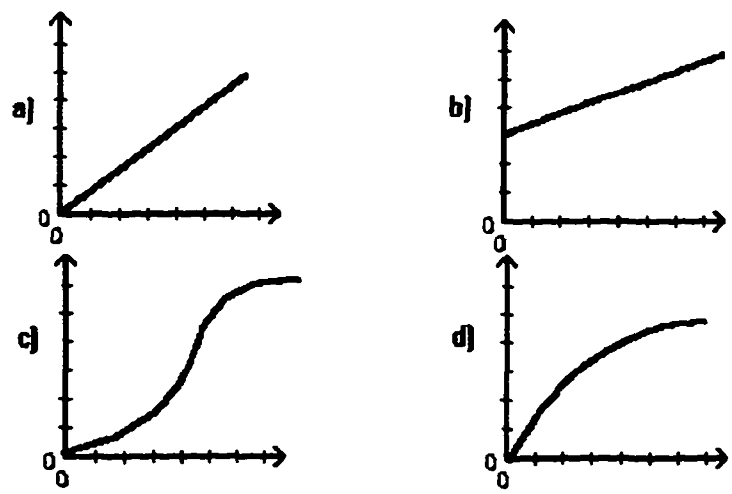
The Fibonacci ratio was named after Leonardo Fibonacci. Make up a name for your class ratio.



From: Unit IV - Patterns, Functions, and Mathematical Connections
Section Four: More on Functions

Discussion: The same function can represent many different types of problems. The same graph can have different meanings in business, in engineering, in medicine, in education, and in other professional areas.

Cooperative Learning Problem 1: Examine the following graphs and create three problem situations for each graph. You may use the professional areas listed above or you may make up your own.



Cooperative Learning Problem 2: Create a graph and write two problem situations for the graph. Present your graph to the class. Discuss other problem situations that could be used for your graph.

Cooperative Learning Problem 3: This graph will change when the number in front of the x variable is changed. Make a table and graph for each function. A computer spreadsheet may be used to make the tables.

a) $y = 2x$ b) $y = 3x$ c) $y = \frac{1}{2}x$

Cooperative Learning Problem 4: Create a problem situation that would cause the graph to change as shown in Cooperative Learning Problem 3.

From: Unit IV - Patterns, Functions, and Mathematical Connections
Section Five: Mathematical Connections

Problem 4: Frederico is a graduate student in biology and is studying the growth rate of cancer cells in mice. He measures the width of the new growth at regular intervals of time and records the data in a table.

Time in seconds	Size of cell
1	.02 mm
2	.04 mm
3	.06 mm
4	.08 mm
5	?
6	?
7	?
8	?
9	?
10	?

a) Fill in the table.

b) Using *t* for the time in seconds, and *s* for the size of the cell, write an equation which expresses the pattern in the table.

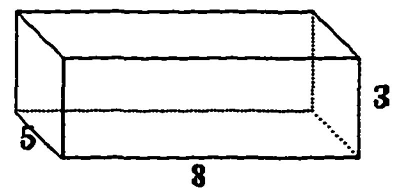
c) Use the equation to find the size of the cell in one minute. (Careful - one minute, not one second. Change the one minute to seconds.)

d) Use the equation to find the size of the cell in one hour. (Careful - one hour, not one minute. How many seconds are in one hour?)

e) Does this problem seem reasonable? Use a ruler to determine how large the tumor would be for your answer in part d.
What are the conclusions that might be drawn by Frederico?

From: Unit V - Measurement
Section One: Measurable Properties of Physical Objects

Cooperative Learning Problem 14:
Practice drawing a picture of the rectangular prism with dimensions 5" x 8" x 3".



Mentally unfold it and draw a picture of the resulting two-dimensional figure. Label the measurements on each edge.

Definition: *Surface area* is the total area of the faces of a solid. To find the surface area of a solid, the areas of each face are added together.

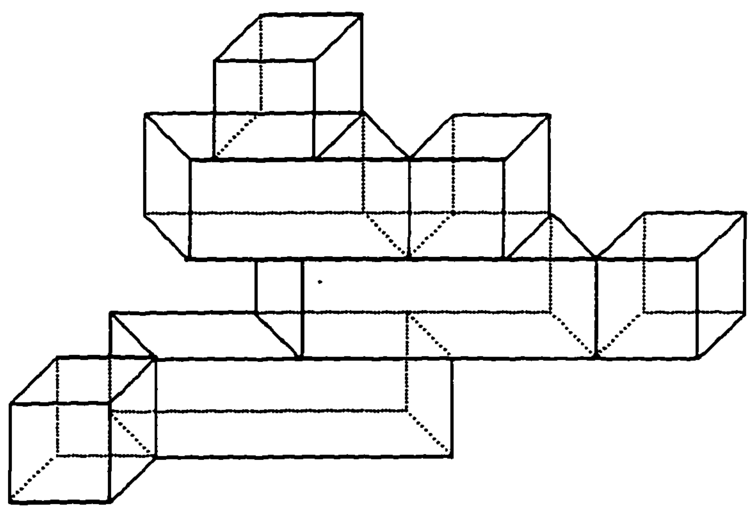
Problem 15:

a) How many faces are on a cube?
b) How many faces are on a rectangular prism?
c) Find the surface area of a 4" x 4" x 4" cube.
d) Find the surface area of a 5" x 8" x 3" rectangular prism.
e) Write a formula for surface area of a rectangular prism. Use the variables *S, l, w, h.* Hint: Use the drawing you made in Cooperative Learning Problem 14 and label the edges with the variables to help you write the formula.

Cooperative Learning Problem 16: The solid below has the following dimensions:

	a	b
Square cube	1"	3"
Small rectangular length	5"	6"
Large rectangular length	10"	10"

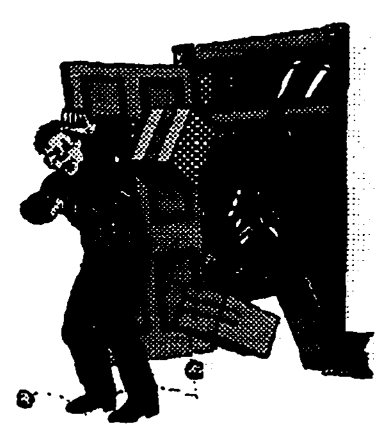
Find the volumes of the solids a and b.



From: Unit V - Measurement
Section One: Measurable Properties of Physical Objects

Project:

Victor has a very disorganized closet. He sees an advertisement from your group to build closet organizers. These are groups of shelves and cubby holes to hold shoes, sweaters, shirts, pants, suits, and other items. Victor wants separate compartments for 10 pairs of shoes, and



a space large enough to hang 5 suits, 10 shirts, and 12 pairs of pants. He wants separate compartments for 10 pairs of shoes, and a space large enough to hang 5 suits, 10 shirts, and 12 pairs of pants. He wants separate spaces to store 10 sweaters and 15 ties, and space for miscellaneous items. His closet is a rectangular prism with the following dimensions: l = 10' w = 3' and h = 12' .

a) Name your company.

b) Design a closet organizer for Victor. Make a sketch of your design with measurements included on the sketch.

c) You will need to paint it when you are finished. How many square feet will need to be painted?

From: Unit VI - Statistics and Probability
Section Two: Data Analysis

Project (Endangered Species): Conduct research in the library and/or on the Internet concerning endangered species. Collect data, make tables, matrices, and graphs to represent your data. Write a report and present it to the class (or to your contact person) using your graphs for displays.

Cooperative Learning Problem 3: The test scores for Miss Leon's math test are:

{75, 86, 35, 97, 86, 73, 67, 98, 84, 83, 66, 55, 92, 89, 75, 36, 49, 98, 100, 91}

a) Find the mean, median, mode, and range for the data.

Mean: ______ Median: ______ Mode: ______

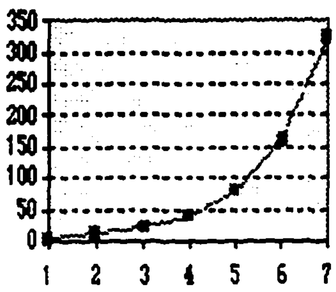
b) Which is the most meaningful measure of dispersion for Miss Leon to use in analyzing the test scores?

c) What conclusion can Miss Leon reach based upon her analysis?

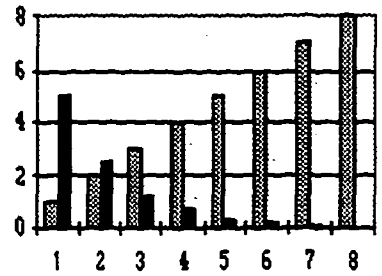
Cooperative Learning Problem 4 (Computer Spreadsheet): Use a computer spreadsheet to graph the data in the last problem. Experiment with the following types of graphs: column graph, scatterplot, pie-chart, and histogram.
Which is the most useful data representation? (This can be completed by hand but it is easier on a computer).

Cooperative Learning Problem 7: Make up stories for each of the following graphs. Share them with the other groups. Who has the best story? Who has the funniest story? Who has the most unbelievable story?

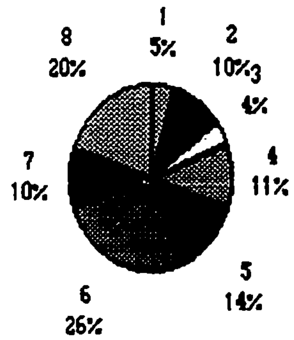
a)



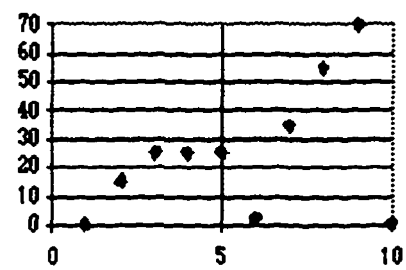
b)



c]



d]



8) Pablo and Luis enjoy playing marbles, and each of them has 24 marbles. They have decided to trade each other one marble in a random selection by reaching into the other's bag and selecting a marble without looking. Pablo has 5 green, 4 clear, 8 blue, 3 red swirls, 3 yellow swirls, and 1 agate. Luis has 4 blue, 2 white, 5 orange swirls, 3 green, 5 clear, 3 yellow swirls, and 2 agates.

a) Create one large matrix to display the information about Pablo's and Luis' collections of marbles.

b) Find the probability of Pablo selecting each of the following from Luis' collection:

i) P(red swirl)
ii) P(not choosing an agate)
iii) P(blue)
iv) P(orange swirl or green)

c) Find the probability of Luis selecting each of the following from Pablo's collection:

i) P(clear)
ii) P(agate)
iii) P(white, green, or blue)
iv) P(not choosing yellow swirl or white

d) Find the probability of Pablo choosing a type of marble he already owns.

e) Find the probability of Luis choosing a type of marble he already owns.

f) What could the boys do to make sure that they each get a new type of marble? Find the probability of each boy getting one of the "new" marbles.

From: Unit VII - Algebra
Section One: Abstraction and Symbolism

Brainstorm: You are explorers in a new world and you cannot communicate with the citizens. You are hungry and want to buy a Dagwood sandwich. Describe this new world and brainstorm the various ways you can solve this problem. Share your findings with the other groups.

Problem 1: Answer the following questions:

a) List at least three symbols for patriotism in a country of your choice.
b) List at least five abstract ideas and three symbols for each.

Cooperative Learning Problem 2: Your group has been chosen to take inventory of the school supplies in the Principal's supply closet in her office because you are considered to be quick-witted problem solvers. You must finish as quickly as possible because Dr. Soto needs her office. You look in the supply closet and see there are the following items that need to be counted: boxes of pencils, pens, paper clips, staples, and binder clips; scotch tape, staplers, memo pads, post-it notes, typing paper, and stationery. In each box there are 20 pencils, 10 pens, 100 paper clips, 5000 staples, 12 binder clips, 1 scotch tape, and 1 stapler. The memo pads and post-it notes are in packs of 10 each, and the typing paper and school stationery are each in reams of 500.

Devise an inventory method to simplify your task so that you are in the supply closet for as little time as possible.

Cooperative Learning Problem 3: Take a piece of $8\frac{1}{2}$"x 11" paper and cut it in half. How many pieces are there? Cut each piece in half again. Now how many pieces are there? Continue doing this and writing down the number of pieces. How long can you do this? How many pieces are there?

Cut #1 - Number of pieces: __
Cut #2 - Number of pieces: __
Cut #3 - Number of pieces: __
Cut #4 - Number of pieces: __
Cut #5 - Number of pieces: __
Cut #6 - Number of pieces: __
Cut #7 - Number of pieces: __
Cut #8 - Number of pieces: __
Cut #9 - Number of pieces: __
Cut #10- Number of pieces: __
Cut #11- Number of pieces: __
Cut #12- Number of pieces: __
Cut #13- Number of pieces: __
and so on.

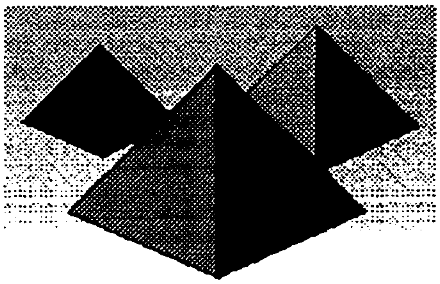
Discussion: You should have discovered that you could not continue cutting the paper because the pieces were too small to cut. However, you can mentally visualize being able to continue cutting this paper forever and there would be an infinite number of pieces.

Infinity (the symbol is ∞) is an abstract idea. The sum of the number of pieces can be written as

$$1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 + 256 + 512 + 1024 + 2048 + 4096 + \ldots$$

This is an infinite arithmetic series whose sum is infinity. Prove this by adding the terms shown above of the series, and then continuing to add one term at a time to see that the sum is continuously increasing.

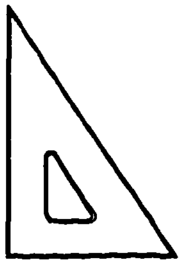
Project (Symbols): There are many symbols used in mathematics. Use textbooks, library resources, and other resources to find math symbols. When the class has found a large variety of symbols, use colored markers to make posters for the classroom by arranging the symbols in categories or in collages.



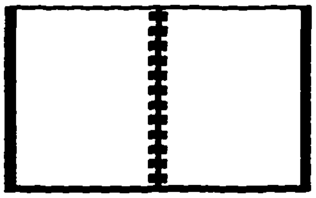
From: Unit VIII - Geometry
Section Three: Congruence and Similarity

Brainstorm: Look in a dictionary or math text for the definitions of *congruence* and *similarity*. Examine the following figures. Which concept applies? Write the words *congruence* or *similarity* on the blank lines.

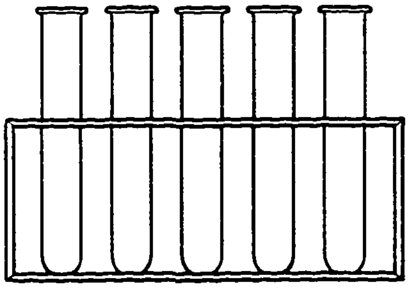
a) ____________________



b) ____________________

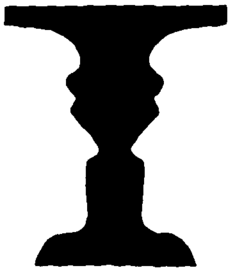


c) ____________________

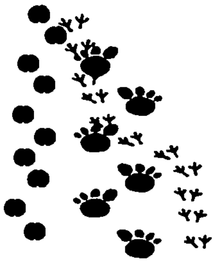


d) ____________________

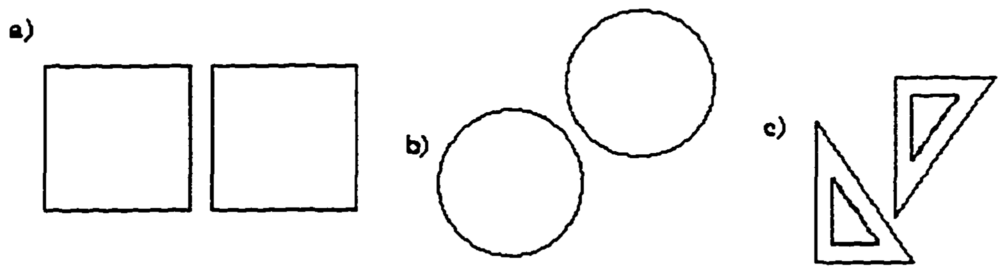
e) ____________________



f) ____________________



Cooperative Learning Problem 1: The figures below are congruent according to definitions of congruency. Discover the relationships that make these figures congruent by using your protractor, ruler, and compass. You may also trace the figures onto another piece of paper and cut them out.



<u>From: Unit IX - Problem Solving</u>
<u>Section Three: Non-Routine Problem Solving</u>

Project: Create your own fractal figure by drawing a polygon that has 5 or more equal sides. Connect the diagonals. Then find similar polygons inside and connect the diagonals on those polygons. This is the iterative process.

Create other examples of fractal geometry.

Research Project: Conduct research and make a report to the class about two of the pioneers of Chaos theory, Benoit Mandlebrot and Edward Lorenz. Find examples of the beautiful fractals they discovered using the computer and present them to the class. (They can be found under the Mandlebrot set and the butterfly effect.) Find examples in nature which demonstrate Chaos theory.

From: Unit X - Mathematics as Communication

Exercise 3 - What Am I Saying (Part I)?: Writing instructions clearly is an important communications skill. The reader must be able to follow the instructions and reproduce the design. The reader cannot ask the writer for further clarification because the writer is not present. In this exercise, you will strengthen your writing and reading skills. Read the following steps before you begin this exercise.

Step 1: Create a simple design using the properties of reflection, rotation, and symmetry.

Step 2: Write instructions for creating your design. Do not use diagrams.

Step 3: Use your instructions to duplicate your design. Do the instructions work? If not, edit your instructions and make them more precise.

Step 4: Give your instructions to a classmate as an exercise. Can the classmate duplicate your design? If not, go through each step with your classmate and see where the difficulty lies. Rewrite those steps.

Step 5: Give the edited instructions to another classmate and repeat Step 4.

Step 6: This exercise is complete when your instructions can be used correctly.

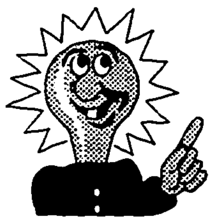
Investigation 2 - The Mystery of the Can:

a) This spray can needs a new label. Decide what the can contains and then design a label which is appropriate for those contents.

b) Amy and Joshua are college interns at the local can manufacturing plant. Manuel, the plant engineer, is their boss. He tells them to work together to design a can and label. What do Amy and Joshua need to ask Manuel in order to complete this task successfully?

c) Manuel tells Amy and Joshua that they should produce a soft drink can which holds 400 milliliters. The can should be at least 1 inch in height. The can should stack easily and therefore balance is important. The label must cover the cylindrical portion of the can, and should be colorful, but Amy and Joshua should be aware that printing costs increase as the number of colors increase.

How should Amy and Joshua solve this problem?



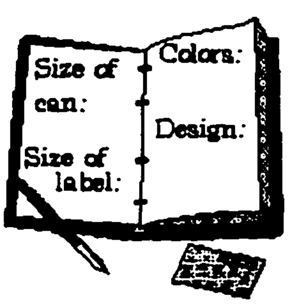
d) Amy and Joshua decide a computer spreadsheet is perfect for this problem. They know they need the formulas for volume of a cylinder, and the surface area of a cylinder (excluding the bases). What are these formulas?

They fill in the data they know on a spreadsheet.
Why did they stop at h=20? ________________________________

Volume	r	height h	SA
400		1	
400		2	
400		3	
400		4	
400		5	
400		6	
400		7	
400		8	
400		9	
400		10	
400		11	
400		12	
400		13	
400		14	
400		15	
400		16	
400		17	
400		18	
400		19	
400		20	

Use the formulas below to fill in the spreadsheet for Amy and Joshua. The computer can do this easily for you. Otherwise, you can do the calculations with a calculator.

$\mathbf{r} = \sqrt{400/3.14h}$ $\qquad\qquad$ $\mathbf{SA} = 2(3.14)\mathbf{rh}$



e) Write your reason(s) for your recommendations in complete sentences.

Size of can - radius: _____ height: ________

Size of label - radius: _____ height: ________

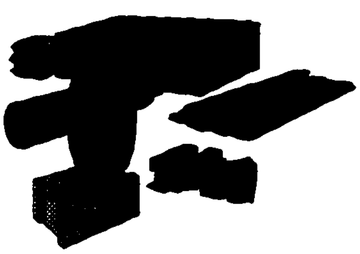
Design label - Number of colors: ___

Draw your design label here:

Exercise 5 - Car Mathematics: Most careers require an understanding of mathematics. The design, manufacturing, and selling of automobiles is an example of an industry whichdepends on mathematics. Write a 2-3 page essay which discusses the uses of mathematics in the automotive industry.

Exercise 6 - Building a House:

Another industry which requires an understanding of mathematics is the construction industry. Write a 3-4 page essay which discusses the mathematics involved in building a house. Attach diagrams which demonstrate your understanding of the geometry involved in building a house.



Exercise 9 - Poetic Justice:

You have now completed the ten-unit course Integrated Math A and Integrated Math B. Write a poem or limerick comparing your feelings about mathematics when you started the program and your feelings now that you are completing the program.

VITA

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1989	M.A. - Education Curriculum and Instruction California State University, Bakersfield
1986 - present	Teacher of Secondary Mathematics, Kern High School District, Bakersfield, CA.
Other -	GTE Gift Fellow, 1994-1995; Various curriculum development projects; California Math Project, 1991.