# AN EXPERIMENTAL STUDY TO MEASURE THE EFFECTS OF THE ENGLISH LANGUAGE GRAMMAR METHOD OF TEACHING MATHEMATICS ON THE MATHEMATICS PERFORMANCE OF THE VISUALLY IMPAIRED

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# ABSTRACT

## AN EXPERIMENTAL STUDY TO MEASURE THE EFFECTS OF THE ENGLISH LANGUAGE GRAMMAR METHOD OF TEACHING MATHEMATICS ON THE MATHEMATICS PERFORMANCE OF THE VISUALLY IMPAIRED

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The purposes of this study were to measure the effects that the English Language Grammar Method would have on the performance of visually impaired students, grades 9 to 12, in solving mathematics word problems, and the influence of the Method on the students' attitudes towards the subject.

The English Language Grammar Method is one way to teach mathematics as a language by comparing parts of speech in the English language such as nouns, pronouns, verbs, adjectives and conjunctions with their mathematic equivalents.

The study was conducted over a five-week period during the summer of 1976 with sixteen (16) visually impaired learners at the Algebra One level in the Dade County School System, Miami, Florida. The learning and test materials used in the study were sound recordings; that is, the content of the instructional units and tests were read and recorded on cassette tapes and the subjects recorded their responses on cassette tapes. No braille, other tactile materials or ink print were used.

The following hypotheses were tested:

Hypothesis 1. There is no significant difference between pretest and posttest scores on mathematics problem solving performance based on the English Language Grammar Method by visually impaired students as measured by the researcher's instruments.

Hypothesis 2. There is no significant statistical difference in students' attitudes towards mathematics attributable to the English Language Grammar Method as measured by a forty-item questionnaire before and after the use of the method.

Hypotheses 1 and 2 were tested at the .05 level of significance using the difference between correlated means obtained from the same test, pre and post administered to the same group after the five-week English Language Grammar treatment. Since the research was concerned only with progress, a one-tailed $t$ test of significance was used.

## Data Collection Procedures

At the first class meeting, students were given the purpose and the nature of the study. Prior to administering the Mathematics pretest, a forty-item questionnaire was administered to each student. The purpose of the questionnaire was to measure students' attitude towards Mathematics and its applicability prior to the English Language Grammar Method. The questionnaire items were measured on a 5-point semantic differential scale: easy-difficult, interesting-boring, helpful-useless, clear-unclear, and to the degree to which the student would prefer laboratory work with classroom instruction. The forty-item questionnaire was also administered as a posttest on the last day of the study. Pre and posttest mean scores were compared.

The Mathematics pretest, designed by the researcher consisted of five parts with a total of forty-seven points. Questions in Parts A, B, C and D were worth one point each; questions in Part E were worth two points each. Students were given instructions via cassette tapes. Instructions for each part were explicitly expressed and teachers were instructed not to give additional instructions. If a student scored 80 percent or above on the pretest he/she was excluded from the treatment.

Each teacher involved in the study completed a fifteen-item evaluation questionnaire. The questionnaire generated some descriptive statistics regarding the English Language Grammar Method and materials such as: (1) suitability of content for course and grade level; (2) the step-by-step presentation format of a single concept with applications; (3) the amount of time required to plan and present a lesson using the English Language Grammar Method as compared to Braille instruction; and (4) ways to improve the English Language Grammar Method.

The results of the study indicated that (1) visually impaired learners participating in the study improved in their abilities to solve mathematic word problems; and (2) there was a change in a positive direction of students' attitudes towards mathematics. In addition, teachers using the English Language Grammar Method responded positively to the method and materials presentation format.

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# CHAPTER I

# THE PROBLEM

The purposes of this study were to measure the effects of the English Language Grammar Method of teaching mathematics on mathematics performance of the visually impaired in solving word problems, and to measure attitudes of learners before and after the treatment. Additional information was obtained regarding attitudes of teachers involved in the use of the English Language Grammar Method.

## Need for the Study

The large number of blind and visually impaired students studying mathematics in residential schools and public institutions has made the study of mathematics teaching for such students a significant topic of study for researchers and educators. Another concern for the need of the study is because the achievement scores of visually impaired students in mathematics are significantly lower than achievement scores of sighted contemporaries. Brothers (1972) stated that the need for mathematics education for the blind learner is governed by three principal factors: social, educational and economic skills.[1]

In the past twenty years efforts have been made by mathematics teachers and researchers to answer two major questions.

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[1] R. J. Brothers, "Arithmetic Computation by the Blind: A Look at Current Achievement," Education of the Visually Handicapped, 1972, 1, 1-8.

Namely, what is mathematics? And how can it be taught more effectively to blind and visually impaired learners? However, Nolan and Aschroft (1959) stated that the results of these efforts have had little effect on the mathematics performance of the blind in concept formation, vocabulary building and comprehension. These higher level concepts are perhaps the most important functions of the mathematics skills for both students and professional people.[2] Riddle (1948) stated that the initial stumbling block for blind learners is in the development of number concepts.[3] In the early grades, number concepts are taught in school as generalizations such as two apples, two boys, two girls, two blocks.

Cambridge (1948) focused his attention on methods of teaching mathematics to blind children and reported that blind children have often been required to closely follow instructional materials designed for sighted children.[4]

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[2]C. Y. Nolan and S. C. Aschroft, "The Stanford Achievement Arithmetic Computation Tests: A Study of an Experimental Adaptation for Braille Administration," Int. J. Educ. Blind, 1959, 8, 89-92.

[3]C. F. Riddle, "What Are the Most Retarding Factors in Learning Seventh and Eighth Grade Arithmetic?" Proceedings of the American Association of Instructors of the Blind, 1949, 86-95.

[4]M. Cambridge, "Questioning the Application of Public Schools Methods in Teaching Arithmetic Computation to Blind Children," Proceedings, American Association of Instructors of the Blind, 1948, 74-78.

Nolan and Aschroft (1959) found it difficult to adapt instructional materials for blind learners that were designed for sighted children. High levels of abstraction combined with inadequate instructional methods further complicate the learning of mathematics by blind children.[5] They also reported that there is about a 20 percent lag among the blind learner at the junior and senior high levels in achievement in mathematics.[6]

Stern (1949) stated that in mathematics programs sighted children are taught arithmetic concepts and operations much earlier than under previous programs. To accomplish this, the drill and rote learning procedures previously stressed have been de-emphasized.[7]

With the beginning of the space programs in the United States and the shortage of engineers, scientists and mathematicians came the many, varied and so-called "Modern Mathematics" programs for sighted learners. These changes further increased the problem of blind students since many additional abstract concepts were added to the curriculum (Report: The Blind in the Age of Technology, April 1970).

During the early 1960s, the National Science Foundation, along with several mathematics study groups, developed materials to improve mathematical literacy among sighted learners, with some

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[5]Nolan and Aschroft, loc. cit., 89-92.

[6]Nolan and Aschroft, loc. cit., 89-92.

[7]Catherine Stern, Children Discover Arithmetic (New York: Harper and Brothers, 1949), p. 126.

adaptations for the blind learner. Materials developed by the study groups have had wide appeal and distribution to both sighted and blind learners, but scores on standardized achievement tests over the past half decade continue to show a marked inferiority in mathematics performance of blind learners contrasted with their sighted contemporaries (Report from CEC, 1967).

Nolan (1964) emphasized the objectives outlined by Dr. Samuel G. Howe regarding the education of blind learners in 1831 as being applicable to present-day teaching and learning theories. Howe's three main principles that he outlined for the first school for the blind in America were:

1. Each child will be trained and taught as an individual and in accordance with his individual capabilities and needs.

2. The school will offer education that is similar to what seeing children receive, except that music and crafts will be emphasized.

3. The main objective will be to train blind young people to be able to take their places in the social and economic life of their communities.[8]

The principles of Howe are congruent to the thinking of Gagne (1965), Ausubel (1963) and Piaget (1964) relative to individual needs and how children learn abstract concepts.[9, 10, 11] They all emphasize

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[8] C. Y. Nolan, "The Japanese Abacus as a Computational Aid for Blind Children," Exceptional Children, 1964, 31, 15-17.

[9] Robert M. Gagne, The Conditions of Learning (New York: Holt Rinehart, and Winston, 1965).

[10] David P. Ausubel, The Psychology of Meaningful Verbal Learning (New York: Grune and Stratton, 1963).

[11] Jean Piaget, "Development and Learning," Journal of Research in Science Teaching II, 3, 1964.

more class teaching with verbal and symbol exposition to improve individual discovery and association patterns. Gagne (1965) states that problem solving demands masses of structurally organized knowledge. Ausubel (1963) concurs that verbal learning and problem solving through active methods can be meaningful if they rest on a base of understood concepts. Ausubel also states that if the learner can relate new materials, given by verbal exposition, in a substantive and nonarbitrary way to what has gone before, the learning will be meaningful for the learner and will have transformed one reality state into another. Piaget (1964) states that teachers should be more concerned with structure than content, with how the mind works rather than what it does. Theoretically, he states that it is important to ask what sort of correspondences exists between the structures described by logic and the actual thought processes studied by psychology.

Kilpatrick (1967) states that teachers and learners now require greater powers of verbal comprehension and explicit definitions in mathematics than in traditional programs.[12]

Research data in the teaching of mathematics to blind children as reported in the International Journal for the Education of the Blind indicates there is a strong need to change programs and teaching techniques in mathematics in the junior and senior high grades.[13] In

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[12]Jeremy Kilpatrick, Analyzing the Solution of Word Problems in Mathematics: An Exploratory Study, Doctor's Thesis, Stanford University, 1967.

[13]International Journal for the Education of the Blind, Vol. XIII, No. 4, May 1964.

general, it is at the junior and senior high levels that students are able to discover and apply mathematical properties and theories based on logic and pattern formation. Nolan (1959) cites several changes in programs and teaching techniques in lower and upper elementary grades, but little effort at the junior and senior levels.[14] Schott (1961b) states that a change in mathematics education for blind learners at the senior high level is of primary concern due to lack of instructional materials to improve cognitive skills and problem solving performance. Schott also states that due to limitations imposed by blindness on the learner such as (1) poor reading ability; (2) lack of environmental and imagery experiences; and (3) slow computational techniques, there is a need to explore other forms of sensory learning.[15] The English language approach utilized in the present study is seen as one way to provide for more student-teacher interaction and to improve problem solving performance.

Although some research has been conducted on teaching mathematics problem solving to the blind, it was done through the use of instructional materials in braille, large print and/or sound recording forms. The need exists for studies of the effectiveness of the

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[14] C. Y. Nolan, "Research in Teaching Mathematics to Blind Children," International Journal for the Education of the Blind, Vol. XIII, No. 4, May 1964, pp. 97-100.

[15] A. F. Schott, "Individualized Mathematics - Level Two," Teachers Guidebook (Burlington, Wis.: Tools for Education, Inc., 1961b).

learning of mathematics by blind students by means of the type of listening that is required by the English Language Method. The effect which blindness has on the development of critical listening and organizational abilities of blind learners is not easily identified. Yet, there is evidence to support the fact that blind learners do possess the abilities to study academic subjects beyond the general education level (Tillman 1967).[16]

Lowenfeld (1959) indicated that comprehension ability varies among blind learners.[17] Each learner, he claimed, has functional and potential listening comprehension and organizational abilities. Some learners, because of their age at the onset of blindness and their early training and experiences, have matured into employable and socially adjusted persons. Other blind students who lack adequate academic skills and organizational habits have remained in remedial programs and classes.

In an extensive review of the research literature and information on the effects of reading mathematics instructional materials upon the performance of sighted learners, Thorndike (1917) stated that,

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[16]M. H. Tillman, "The Performance of Blind and Sighted Children on Weschler Intelligence Scale for Children: Study I," The International Journal for the Education of the Blind, March 1967.

[17]Lowenfeld, "What is Creative Teaching?," in E. P. Torrance (Ed.), Creativity: Proceedings of the Second Minnesota Conference on Gifted Children (Minneapolis: University of Minnesota Press, 1959), 38-50.

> understanding a paragraph is like solving a problem in mathematics . . . the mind is assailed, as it were, by every word in the paragraph. It must select, repress, soften, emphasize, correlate, and organize, all under the influence of the right mental set or purpose or demands.[18]

At the same time, there is research evidence pointing to the delimiting nature of blindness upon a learner's experiences.

It has been stated that mathematics is the language of science. But what is the language of mathematics? What medium do mathematicians use to communicate their findings? Like all languages, mathematics has sentences or equations that have their own form and structure, and are used in different ways to represent different meanings. One of the most common forms of sentences or equations used in mathematics has been the interrogative sentence, a sentence that asks a question.

Teachers and students must be aware that not all sentences or equations in mathematics are questions; some are declarative sentences or equations. A declarative sentence is a statement or an assertion. These two sentences or equations forms in mathematics must be clearly defined for improved problem solving performance.

The study of mathematics consists almost completely of an analysis of ideas expressed symbolically. Accordingly, a language which can be used efficiently and effectively in such a study must be characterized by clarity and exactness in interpretation. In this

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[18]Edward L. Thorndike, "Reading as Reasoning," Journal of Educational Psychology, Vol. 8, No. 6, June 1917, p. 329.

study certain English language concepts and symbols are introduced and compared to the language of mathematics.

The following four characteristics of the English Language Grammar Method seem to make this method worthy of investigation as an alternative strategy for teaching mathematics to blind students:

1. The English Language Grammar Method is adapted to the use of the Unit Method of Instruction. The Unit Method offers an alternative solution to several problems of pupil differentiation. Units are organized by topics and they can be linked with subjects other than mathematics.

2. The English Language Grammar Method materials are designed to show relationships in a developmental form to purpose and content. Learning mathematics by listening depends on knowing the literal meaning of words in various contexts. The learner must be able to distinguish between the main idea and supporting information and to perceive the relation of each part to the others and to each part to the whole.

3. The English Language Grammar Method materials are packaged for easy use and programmed for independent study by the learner. A minimum amount of hardware is required.

4. The English Language Grammar Method materials are designed to encourage cooperation between English teachers and mathematics teachers by focusing on improving the problem solving performance of the learner. In order to maximize the use of the materials a period of pre-service and in-service education is essential for the teachers who are involved.

The study of mathematics has been conducted for many years, and the number of public school students who study mathematics has steadily increased over the years. Almost every academic discipline and technical area requires at least one year of mathematics.

Among mathematicians and educators there are varied reasons as to why mathematics is taught. In fact, there is some misunderstanding of what mathematics is, what it purports to do, and what place it should occupy in the curriculum. As a result, the subject matter presented as mathematics has consisted primarily of the simple "solve" or "work" for the answer. Thus, rote learning and memorization of concepts and skills have been receiving most attention.

Mathematics teachers often encounter among the general public the idea and notion that mathematics deals only with numbers, and the four basic operations: addition, subtraction, multiplication and division. The frequently repeated questions, "why do we study mathematics?," and "how can we use it in everyday life?," are a reflection of this idea. While it is true that the discipline of mathematics is concerned with numbers and mathematical operations, this is only a small part of the total field. For example, students in the early grades in elementary schools are constantly faced with basic identification problems, grouping problems and general names associated with numbers and are not oriented to more complex concepts. However, there is opportunity at the junior and senior high school levels to introduce more advanced information in a graphic or pictorial form.

Mathematics education is defined by the National Council of Teachers of Mathematics (1964) as a dynamic field of knowledge which deals with the concepts of number, magnitude, and form.[19] This definition of mathematics can be traced historically to the earliest days of the human race. Mathematics is vital in helping us to understand man and the ways in which he earns his living from and in relationship to his environment.

Currently, many blind learners are in the mainstream of education and receive some form of special instruction from a resource, itinerant, or other special educator. This special educator in most cases must provide supplementary activities and experiences in several academic disciplines. This creates a high anxiety level for the teacher when there is a shortage or lack of training in the more scientific and technical subjects.

The following hypotheses have been set forth for investigation in this study:

Hypothesis 1. There is no significant difference between pretest and posttest scores on mathematics problem solving performance based on the English Language Grammar Method by visually impaired students as measured by the researcher's instruments.

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[19] National Council of Teachers of Mathematics Preliminary Report of the Conference on the Low Achievers in Mathematics, Washington, D.C.: U.S. Office of Education, 1964.

Hypothesis 2. There is no significant statistical difference in students' attitudes towards mathematics, attributable to the English Language Grammar Method as measured by a forty-item questionnaire before and after use of the method.

Hypothesis 1 was tested by instruments designed and developed by the researcher. Hypothesis 2 was tested using a forty-item questionnaire to measure students' attitude towards mathematics. Nominal measurement was used to identify sex and name of school in the study. Ordinal measures were used to report test scores. Instruments are included in the Appendix.

## Definitions

1. Visually Impaired is a term used to emphasize the medical condition relative to an individual's defective visual sensory system. The reading mode each individual uses depends upon the degree of his or her remaining near point vision. Some visually impaired persons read regular size type (i.e., 10 point size) with or without magnifying aids; others read type that has been enlarged in size; and, of course, those whose vision is too poor to see print read braille with their fingers. The learning of most visually impaired persons can be facilitated through listening to sound recordings of equivalent print information, since listening provides faster imput than reading either braille or large type. Visually impaired learners include 3 groups of readers: braille, large type and regular type readers with and without aids.

2. Concept is an idea or symbol that brings together a group of ideas or symbols in a meaningful interpretation.

3. Auditory learning, "learning by listening" and "reading by listening" are synonymous terms, indicating a knowledge through a sequential process of listening.

4. Listening is the ability to analyze or select meaning, to associate and organize meaning, to evaluate meaning and to retain meaning.

5. Reading is a process of comprehending, interpreting and evaluating words or symbols into meaningful relationships and applications.

6. Special education is an umbrella term, a classification of programs designed for individuals who differ from the normal growth development in one or more ways, intellectually, physically, socially, or emotionally.

7. Mainstreaming is the process of moving handicapped children from a segregated status in special education classes to regular classrooms where they are educated with non-handicapped children.

8. Word problems (verbal problems) is a description of a situation that involves both known and unknown quantities and that also involves certain relations between these quantities.

9. Mathematics is the study of quantities and relations through the use of numbers and symbols.

10. Algebra is a branch of mathematics which is concerned with certain operations on numbers using alphabets (literal numbers) such as *x* or *y*, to solve problems in which certain numbers are unknown.

11. Arithmetic refers generally to the elementary aspects of theory of numbers, arts of measurement, and numerical calculations such as addition, subtraction, multiplication and division.

12. English Language Grammar Method is a process of identifying and analyzing mathematic word problems as a language by comparing grammatical speech parts of the English language with its mathematic equivalent. A full description of the English Language Grammar Method is included in Chapter III.

## Procedures

A complete discussion of the procedures for the study are presented in Chapter III. A summary follows here.

After several meetings with the Dade County Office of Exceptional Children Division of Visually Impaired, permission was given to conduct the study in the public schools and to use their students as subjects with two stipulations: (1) schools must volunteer to participate; (2) students must receive parental permission. From the lists obtained indicating potential subjects in the summer term of the public school programs, each teacher involved was given a written overview of the treatment including the objectives of the study.

One week prior to the delivery of study materials to each school, teachers were introduced to the entire English Language Grammar Method of teaching mathematics. Information regarding the use of the materials by units, the importance of monitoring instructional tapes and tests were clearly outlined. All tapes and materials for each school had been color coded and numerically coded for each subject. Arrangements were made for each school or learner to have cassette tape recorders.

Teachers involved in the study had received written instructions to follow the printed manual prepared by the researcher for definitions and additional information that may be unclear to the learner via tapes. There was to be no references to the subject matter content or solutions given by the learner, but if a subject questioned or referred to a problem or unit, the teacher was instructed to say, "I know you wish to comment about the wording of the problem and you will be given an opportunity to do so; however, our aim now is to complete the units as outlined." Teachers reviewed written objectives of each unit with the subjects and defined new vocabulary words by giving its meaning in the English language context and its equivalent meaning in the mathematics context.

A time schedule was worked out with each teacher for visiting his/her classes during the study to observe and to answering questions regarding the printed or taped materials. Teachers had been given instructions to administer all tests and leave the scoring of the tests to the researcher, after which a complete record sheet would be completed by the researcher and returned for discussion.

## Summary

The nature of the problem involved in the teaching and learning of mathematics has been discussed. This chapter has explained the need for the study, hypotheses to be tested, definitions and general procedures to be used for conducting the study. Also, a review of the instruments and statistical measures to be used in collecting and analyzing data.

# CHAPTER II

## REVIEW OF RELATED LITERATURE

The principles underlying good language usage in reading and listening are essentially the same for successful learning in all subject areas, although there are particular learning experiences and related skills that fall into one category or another. The purpose of this chapter is to discuss and evaluate studies and reports as related to the problems associated with mathematics performance of both sighted and visually impaired learners in the area of solving word problems.

No literature at the appropriate level of interest nor in the same context at the elementary level has been found. There is one distantly related study by Pearla A. Nesher (1972) at Harvard University titled "From Ordinary Language to Arithmetical Language in the Primary Grades." This study was designed to determine the number of difficult words found in mathematics textbooks and to measure the vocabulary comprehension level of learners.

Nesher states that there are certain factors which affect the student's ability to solve problems in the primary grades. One of these factors is the extent of the student's vocabulary. She further states that the use of an important but unfamiliar word greatly increases the difficulty of solving problems.[1]

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[1]Pearla A. Nesher, From Ordinary Language to Arithmetical Language in Primary Grades (Doctor's thesis, Harvard University, 1972).

Because of the lack of studies associated with Mathematics as a language and the low level of performance by learners at all levels in Mathematics, there have been serious criticisms of the Mathematics programs both in the teaching and in the content in the school systems. The results of the varied research studies show that large numbers of students both sighted and visually impaired had minimum training in Mathematics beyond the junior high grades, and that, due to disuse, the skills that they may at some time have possessed had seriously deteriorated.

Included in this chapter are general studies related to mathematics education of visually impaired learners. There are three major categories to be discussed: (1) Comparison of Learning Characteristics of Blind and Sighted Children; (2) Instructional Strategies for Promoting the Development of Problem Solving the Abilities in Learners; and (3) Learning by Listening.

## Comparison of Learning Characteristics of Blind and Sighted Learners

Literature in mathematics education of blind and sighted learners over the last twenty years indicates there is no significant differences between the IQ ranges of blind and sighted learners as measured by the Weschler Intelligence Scale (WISC) for Children (Report from CEC, 1966).

Tillman (1967) concluded that (1) blind children score about the same as sighted children on arithmetic operations such as addition, subtraction, multiplication and division; (2) blind learners tend to approach abstract conceptualization problems from a concrete level; and (3) blind learners do less well on comprehension and similarities.[2] Comprehension as defined on the WISC is the measure of social concepts. It is a test of common sense. Similarities is a test of the logical character of a person's thinking, and measures ability to make abstract generalizations.

Studies by Piaget (1941), Reichard, Schneider and Rapport (1944) and Gesell and Ilg (1959) on concept development indicates that by the onset of puberty abstract levels of concept formation should have been attained in sighted children.[3,4,5] However, Zweibelson and Borg (1967) found that blind subjects at puberty continued to function primarily on a concrete level.[6] Studies by Onwake and Solnit (1961)

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[2]M. H. Tillman, "The Performance of Blind and Sighted Children on Weschler Intelligence Scale for Children: Study I," The International Journal for the Education of the Blind, March 1967; "The Performance of Blind and Sighted Children on Weschler Intelligence Scale for Children: Study II," The International Journal for the Education of the Blind, May, 1967.

[3]Jean Piaget, The Child's Conception of Number (New York: Humanities Press, 1941).

[4]S. Reichard, M. Schneider and D. Rapport, "The Development of Concept Formation in Children," American Journal Orthopsychiatry, 14 (1): 156-1616, 1944.

[5]A. Gesell and F. Illg, Youth: The Years from Ten to Sixteen (New York: Harper and Brothers, 1959).

[6]I. Zweibelson and C. Fisher Borg, "Concept Development of Blind Children," The New Outlook, September 1967.

and Carroll (1964) concluded that attention must be given to the limitations imposed by blindness on sensory perception. The factors of recognition and differentiation which play an important role in concept development are limited or totally absent due to the lack of sight. The ability to organize and store mental representations is impeded, thus affecting secondary process, thinking.[7,8]

Zigmond (1968) compared the role of hearing with that of vision in language development and found that hearing is the primary channel for language acquisition and communication. Zigmond stated further that "listening skills of both blind and sighted learners have not yet been subjected to the same type of careful observation and analysis as Gesell and others have given to visual, motor and perceptual learning tasks."[9]

Axelrod (1969) stated that auditory and tactile tasks which were abstract in nature presented greater difficulty for early-blinded children than sighted children.[10] According to Stocker's findings

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[7]E. Onwake and A. Solnit, "It Isn't Fair, The Treatment of a Blind Child," Psychoanal. Stud. Child 16: 352-404, 1961.

[8]J. B. Carroll, Language and Thought (Englewood Cliffs, New Jersey: 1964).

[9]Naomi K. Zigmond, Auditory Learning (San Rafael, California: Dimensions Publishing Co., 1968).

[10]S. Axelrod, "The Effects of Early Blindness," American Foundation for the Blind, 1959.

reported in the Kansas Project on Listening Education for the Blind (1970), hearing is the blind person's most important remaining sensory modality; and although the individual may have an excellent sense of touch and a good kinesthetic memory, if he cannot properly interpret words and sound, he cannot properly receive instructions or follow directions in learning new skills.[11]

## Instructional Strategies for Promoting the Development of Problem Solving Abilities in Learners

The search for improved teaching and learning strategies in problem solving has continued for many years. Research studies relating to language development of the mathematically deprived sighted learner have been limited to the reading level with regard to prerequisite skills, speech development, vocabulary acquisition and grammatical usage (Kulm, 1973).[12]

Gagne (1965) defined three different kinds of learning tasks which are applicable to mathematics. The tasks are: deductive inferences, inductive inferences and hypotheses formulation. According

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[11]Stockers, Kansas Project on Listening Education for the Blind, 1970.

[12]Gerald Kulm, Sources of Reading Difficulty in Elementary Algebra Textbooks, Mathematics Teacher, November 1973, pp. 649-652.

to Gagne, these tasks are essential for student's growth and development in problem solving and understanding mathematical concepts and principles that will enable them to demonstrate cognitive skills.[13]

Mathematics educators are now utilizing ideas and methods from psychological studies of higher cognitive processes to assist in identifying strategies for improving mathematics problem solving among sighted learners. Research in Instructional Strategies in Mathematics Education by Hernandez (1973) indicates that there are several viable alternative teaching strategies available for promoting acquisition of specific mathematical skills.[14] Operant conditioning (Brown, 1971), concept induction (Bruner, Goodnow, and Austin, 1967), and expository teaching (Ausubel, 1963), are the three strategies most often used by teachers for knowledge development among learners.[15, 16, 17]

Research studies in mathematics education for sighted learners have generally been restricted to the elementary grades and junior high

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[13]Robert Gagne, The Conditions of Learning (New York: Holt, Rinehart and Winston, 1965).

[14]Norma G. Hernandez, Instructional Strategies in Mathematics Education, Mathematics Teacher, November 1973, pp. 607-612.

[15]Duane Brown, Changing Student Behavior: A New Approach to Discipline (Dubuque, Iowa: W. C. Brown Co., 1971).

[16]Jerome Bruner, Jacqueline Goodnow, & George A. Sustin, A Study of Thinking (New York: Science Editions, 1967).

[17]David P. Ausubel, The Psychology of Meaningful Verbal Learning (New York: Grune and Stratton, 1963).

school and concentrated on sources of reading difficulties in mathematics (Riedesel and Gorman). Findings from most of the studies implied that learners have more difficulty when required to translate from words to symbols in solving word problems than when given numerical problems in symbol form (Martin, 1963).[18] Thorndike (1924) found that problems faced by learners in writing mathematical sentences from word problems have been traced to their lack of knowledge and experience with symbolism. If learners were unable to comprehend symbolic expressions and relationships, then it was unlikely that they would be able to translate from words to symbols.[19]

Kilpatrick (1969) indicated that increasing the ability of students to solve problems has long been a goal of mathematics instruction.[20] Conferees at the Cambridge Conference on School Mathematics (1963) stated that the solving of mathematical problems would continue to be important in the mathematics curriculum and urged curriculum developers to devote more time and energy to creation of problem sequences emphasizing problems that introduce new mathematical ideas.

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[18]Mavis D. Martin, Reading Comprehension: Abstract Verbal Reasoning and Computation as Factors in Arithmetic Problem Solving (Doctor's thesis, Iowa City: State University of Iowa, 1963, Dissertation Abstracts 24: 45, 47-48; No. 11, 1964.

[19]Edward L. Thorndike, The Psychology of Algebra (New York: MacMillian, 1924).

[20]Jeremy Kilpatrick, "Problem Solving in Mathematics," Journal of Educational Research, Vol. 39, No. 4, 1969, pp. 523-534.

Martin (1963) found that reading comprehension, computation, abstract verbal reasoning, and arithmetic concepts were correlated with problem solving. The correlation between reading and problem solving, with computational skill held constant, was higher at both grade levels than the correlation between computation and problem solving, with reading held constant. This suggests that the relationship between problem solving ability and its underlying skills, particularly higher order verbal skills, is more complex than has been perceived.[21]

Jamison (1966) investigated the language of mathematics used in verbal problems. He reported that sentence diagraming helped learners to identify parts of speech in English sentences and could help in translating the English of algebra problems into symbols of a mathematical sentence.[22]

Following is a sentence translated from the English language into mathematics symbols using a schematic outline called diagraming by Jamison in his study:

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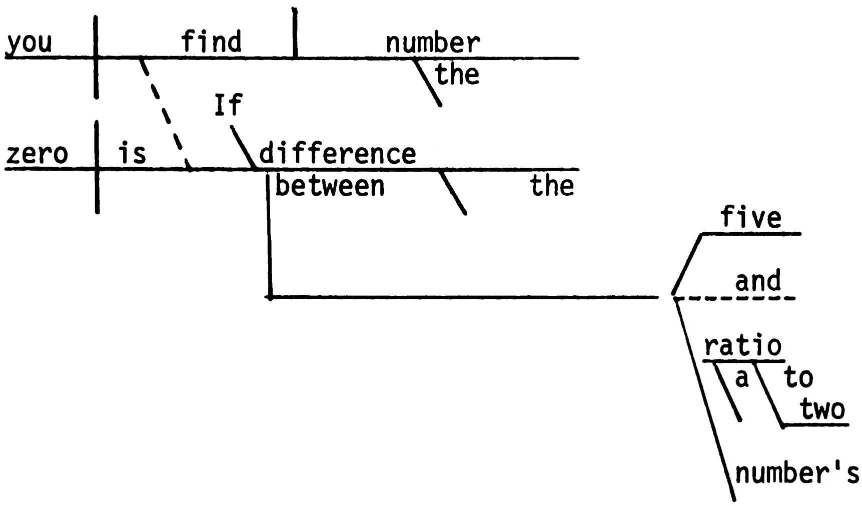
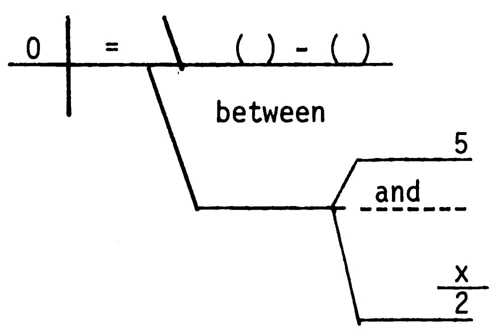
[21]Mavis D. Martin, Reading Comprehension: Abstract Verbal Reasoning and Computation as Factors in Arithmetic Problem Solving (Doctor's thesis, Iowa City, State University of Iowa, 1963).

[22]King Jamison, "Grammatically Speaking," The Mathematics Teacher, November 1966, pp. 640-645.

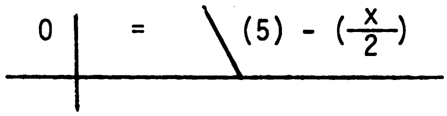
Example I. If zero is the difference between five and a number's ratio to two, find the number.




In this example the English imperatives, such as show that or find are not translated into mathematics. They are implied by the symbol sentence. The word if is not translated. The word if is a cue for the learner to assume something. In order to translate the word sentence into a mathematics sentence, one needs to be concerned with only that part of the sentence which mentions number and its modifiers. In this sentence it would be the clause containing the verb is. According to standardized symbols used in mathematics, Jamison diagrammed the sentence in symbols as:



When the prepositional phrase is used to limit the parenthesis of the mathematical word, ( ) - ( ), the diagram is further simplified to:




The mathematical sentence is then simplified into symbols without the use of the diagram:

$$0 = 5 - \frac{x}{2} .$$

Jamison concluded it is not absolutely necessary to diagram the sentence in one form, but indicated that the learner and teacher must understand the functions of the words, phrases, and clauses in the word problems. He further pointed out that the sentence translation and diagraming approach is a possible method of showing utility and importance of the English curriculum to the discipline of mathematics.

Steffe (1967) studied the effects of two variations in the language used in a problem on level of comprehension. He used 20 one-step addition problems which were presented orally to first graders in individual interviews. In ten of the problems the names of the two sets to be combined and the total were the same ("There are four cookies on one plate and two cookies on another. How many cookies are on the plates?"), and in ten of the problems the names of the three sets were different ("Mary has four kittens and two goldfish. How many pets does Mary have?"). Half of the subjects were given problems in which an existential quantifier was used at the beginning of the problem without quantifiers. The presence of a quantifier had no effect on problem difficulty, problems with a common name for the sets proved to be significantly easier than the problems with different names for the sets.[23]

Thompson (1967) reported that the effects of readability and mental ability on arithmetic problem solving performances were interactive. Although ease of reading was associated with higher performance at both high and low levels of mental ability, the effect was greater with subjects of low mental ability.[24]

The arrangement and ordering of data in word problems are other factors in problem difficulty. Williams and McCreight (1965) demonstrated that a problem can be made more difficult, especially for low ability learners, by presenting the information in some order other than that used to solve the problem.[25]

According to Suppes, Loftus and Jerman (1969) the sequence in which problems are presented is an important factor in problem

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[23]Leslie P. Steffe, The Effects of Two Variables on the Problem Solving Abilities of First Grade Children. Technical Report No. 21, Madison, Wis., Research and Development Center for Cognitive Learning, University of Wisconsin, March 1967.

[24]Elton N. Thompson, Readability and Accessory Remarks: Factors in Problem Solving in Arithmetic (Doctor's thesis, Stanford University, 1967; Dissertation Abstracts 28; 246A-65A; No. 7, 1968).

[25]Mary Williams and R. McCreight, "Shall We Move the Question?", Arithmetic Teacher 12:418-421, 1965.

solving. They also observed that structural variables were less influential in determining problem difficulty than whether or not the problem could be solved the same way as the preceding one.[26]

Karl Duncker (1945) is one of the few psychologists to study how mathematics word problems are solved. He used a teaching technique called "thinking aloud." The thinking aloud technique has been used in research and to a limited degree in instruction.[27]

Hunt (1968) states that with the advent of information-processing approaches to the study of problem solving, more mathematics teachers and other educators have begun to make use of this technique.[28]

Information-processing theories have stimulated interest in the role of heuristic rules in problem solving. The most significant evidence on this process was reported by Polya (1965). He observed that the incorporation of general heuristic rules, such as working

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[26] Patrick Suppes, Elizabeth Loftus and Max Jerman, "Problem-Solving on a Computer-based Teletype," Technical Report No. 141, Psychology Series, Stanford Institute for Mathematical Studies in the Social Sciences, Stanford University, March 1969.

[27] Karl Duncker, On Problem-Solving, Psychological Monographs: General and Applied, Vol. 58, No. 5, Washington, D.C., American Psychological Association, 1945.

[28] Earl Hunt, "Computer Simulation: Artificial Intelligence Studies and Their Relevance to Psychology," Annual Review of Psychology 19: 135-168, 1968.

backward or using a diagram, not only facilitates problem solving, but also results in performance by the computer that closely resembles the behavior of humans attempting to solve similar problems.[29]

Paige and Simon (1966) compared the language of learners asked to think aloud as they solved algebra word problems with the processes used in a computer program for translating English sentences into equations and then solving them. Analysis of the language showed that learners used some kind of internal representation of the physical situation described by the problem in developing their equations. When given contradictory problems in which equations can be written even though the solution is physically impossible, learners consistently differed in their ability to identify the contradiction. Paige and Simon concluded that good problem solvers are more likely than poor problem solvers to identify contradictions.[30]

In reviewing literature over the past five years, it appears there has been an increase in sophisticated theory-based problems of instruction in problem solving. Some studies continue to be evaluations of a single device or technique while some attempts have been made to develop broader programs having a more defined and explicit theoretical rationale.

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[29]George Polya, Mathematical Discovery: On Understanding, Learning, and Teaching Problem Solving (New York: Wiley, 1962, Vol. 1; 1965, Vol. 2).

[30]Jeffery Paige and Herbert Simon, Cognitive Processes in Solving Algebra Problems. Problem Solving: Research, Method and Theory, edited by Benjamin Kleinmuntz (New York: John Wiley, 1966), Chapter 3.

## Learning by Listening

Rankins (1928) stated that listening, as a communication skill is an essential tool for all learners. He further reported that of the time learners spend in communicating each day, approximately 45 percent is devoted to listening; 30 percent to speaking; 16 percent in reading; and 9 percent in writing.[31] The Commission on the English Curriculum, National Council of Teachers of English (1954) pointed out that listening is specifically related to speaking, and is developed in context as a "living-and-learning" setting.

According to Foulke (1967) blind learners must be taught how to listen and utilize the results of listening in determining their future actions.[32] Foulke (1970) in a series of reports on Reading by Listening identified three major types of listening and described their general characteristics as:

1. Purposeful Listening

   Purposeful listening requires both motive and awareness of purpose on the part of the teachers and learners. Much has been said in educational literature about establishing a wholesome listening climate. Activity both in the classroom and outside gives frequent practice in excluding noise and irrelevant conversation so that one may concentrate on his own thoughts. Learners in school must

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[31]Paul T. Rankin, "The Importance of Listening Ability," English Journal (College Edition), XVII (October, 1928), pp. 623-630.

[32]Nelson Foulke, Report of the Louisville Conference on Time Compressed Speech, 1967.

learn to work in one part of the classroom while talking is going on in another. Situations demanding alertness and attention must therefore be clearly recognized by the learners.

2. Accurate Listening

Listening must not only be purposeful, but accurate. Foulke (1967) studied the problem of listening to structured speech with college students and concluded that the structuralization of subject matter should be based on one or more of the following elements: (a) listening for the answer to a definite question; (b) listening to a question, with the intention to answer; (c) listening to form an opinion on a controversial question; (d) listening for news; and (e) listening to an argument in order to answer it.

3. Critical Listening

Critical listening in a technical discipline such as mathematics is a built-in "command" for the learner to analyze what is heard against personal experiences. This kind of listening must be highly developed for the blind learner due to the lack of visual experiences.[33]

Foulke (1970) compared critical listening with critical reading for the blind. He stated that the procedures are probably the same in improving critical listening. He further stated that listening by blind learners had additional problems since the teacher and learner are not face to face.[34]

Morris (1966) summarized the results of several studies which compared the relative efficiency of learning through listening with learning through reading braille or large type. Results of six

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[33]Nelson Foulke, "Reading by Listening VI," Education of the Visually Handicapped, 1970, pp. 23-25.

[34]Nelson Foulke, loc. cit.

studies involving both elementary and high school level subjects and materials from the areas of literature, social studies, and science were described. The major findings reported was that at the elementary level there was no statistically significant difference between the effectiveness of learning through reading and that of learning through listening. At the high school level, learning through reading exceeded that of listening for literature and social studies, but not for science. However, when amounts learned were expressed in terms of time required to listen and to read, learning through listening appeared to be from 155 percent to 360 percent more efficient than reading either braille or large type. Comparative efficiency for listening was greater for braille reading than for large type reading.[35]

According to Rowe (1958) there is a need for developmental programs in the area of listening for blind learners at early grade levels, akin to those that exist for sighted learners. He further states that the blind learner only learns from what he hears or touches and his progress in speech and language development sometimes is slower than that of seeing children. Therefore, it is not only speech development, but also acquisition of word concepts which is affected.[36]

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[35]Morris, "Education - Listening," The Visually Handicapped, 1966, pp. 59-60.

[36]E. D. Rowe, Speech Problems of Blind Children (New York: American Foundation for the Blind, 1958).

Cratty (1969) stated that since auditory learning plays a vital role in the progress of a blind learner, auditory training should be introduced as soon as possible in the life of the child.[37]

Mathematics and listening can be compared in the same manner as mathematics and reading. For example, sometimes teachers will state that a learner cannot solve verbal problems because he does not have the ability to read. This is not an accurate evaluation because the process of reading is very complex, involving many skills and understandings and the problem is not based on reading alone since aural presentation of problems will not increase performance.

Lees (1976) reported that it is generally agreed that mathematical writing is very compact and that omitting words or symbols in a sentence must be discouraged.[38]

Smith (1964) identified some basic patterns of writing in mathematical texts:

1. The short paragraph setting of a problem situation. These are the ever-present verbal problems which require an analytical approach.

2. The comparatively short explanatory paragraphs. These paragraphs usually have illustrations placed adjacent to them and require the reader to read in a very specialized way.

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[37] B. Cratty, Perceptual-Motor Behavior and Educational Processes (Springfield, Ill.: Charles C. Thomas, 1969).

[38] Fred Lees, "Mathematics and Reading," Journal of Reading, May 1976, pp. 621-626.

3. The graphs and charts which are important conveyors of information and ideas and pose unique problems of reading. Detailed study of every facet is needed before proper use can be made.

4. The mathematical reading done when interpreting special symbols, signs, and formulas. To many students, the quote, "it is all Greek to me!" seems applicable here. In general, these symbols should be the product of experience. When students show a lack of understanding, it is usually a sign that more background experiences are needed. "The symbols of mathematics were invented for the purpose of expressing ideas, but it is well to recognize that the idea was clearly understood before it was symbolized" (Fawcett, 1946).[39, 40]

Freeman (1973) suggested that mathematics teachers should provide supplementary exercises or matching exercises for the learner when teaching vocabulary to enhance instruction.[41]

Call and Wiggin (1966) reported a helpful technique to teachers of mathematics for improving word problem performance.[42] They suggested a revised study skill originally developed by Robinson (1946) called SQ3R (Survey, Question, Read, Recite, and Review).[43]

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[39] Nila Banton Smith, "Patterns of Writing Different Subject Areas," Journal of Reading, Vol. 8, No. 1, October 1964, pp. 31-33.

[40] Harold P. Fawcett, "Nature and Extent of Reading in Mathematics," Improving Reading in Content Fields (Chicago, Ill.: University of Chicago Conference on Reading, 1946.

[41] George F. Freeman, "Reading and Mathematics," The Arithmetic Teacher, November 1973, pp. 523-529.

[42] R. Call and N. Wiggin, "Reading and Mathematics," The Mathematics Teacher, 5, February 1966, pp. 149-157.

[43] F. Robinson, Effective Study (New York: Harper and Row, Publishers, 1946).

Thomas and Robinson (1972) modified the system to read PQ4R (Preview, Question, Read, Reflect, Recite, and Review). Thomas and Robinson claim that this is a do-it-yourself method of reading that can be very useful in helping students study subjects in topic and paragraph form such as English, social studies and the sciences.[44] The use of PQ4R on word problems stresses a careful reading and rereading of the problem with emphasis on mathematical word and phrase meanings and their relationship to the whole problem.

There are two recently completed major studies regarding readability of algebra using the Cloze technique with sighted learners at the junior and senior high grade levels. Kulm (1971) investigated the structural variables that might predict the readability of Mathematics English as found in first-year algebra textbooks. He concluded that a large portion of school mathematics textbook material can be classified either as explanatory, in which a concept is defined and explained, or as illustrative, to which specific problems or exercises that illustrate a concept are worked out for the learner.[45] The Cloze procedure deals with the words in context and is useful for determining the relative reading difficulty of the text. The procedure

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[44]E. Robinson and H. Alan Robinson, Improving Reading in Every Class (abridged edition; Boston: Allyn and Bacon, Inc., 1972).

[45]Gerald Kulm, "The Readability of Elementary Algebra Textual Materials" (Doctor's dissertation, Teacher's College, Columbia University, 1971).

used in his testing was done in four major steps: First, the students read entire passages aloud and students offer choices for the missing words. Students must give reasons for their choices as well. Third, one acceptable response is decided upon for each missing word. Fourth, the final passage is compared to the passage in the original text.

The Cloze procedure has been used to measure constructs in both written and oral communication for English and, in some cases, for other languages. The Cloze technique was designed and developed by Taylor (1953) by deleting certain words or symbols from passages and replacing them with blanks.[46] The subject then attempts to complete the passages. His score for each passage is the number of responses which match the deleted materials.

Kane (1967, 1969) pointed out differences between ordinary English and mathematical English. Kane reported that although the Cloze technique has been validated as a measure of comprehensibility and difficulty of ordinary English passage, it has not been validated for use with mathematical English. He further states that the Cloze technique cannot readily be applied to mathematical English since (1) the Cloze technique is not defined to include deletions of mathematical symbols, and (2) the Cloze technique requires an ordering of

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[46]W. L. Taylor, "Cloze Procedure: A New Tool for Measuring Readability," Journalism Quarterly, 1953, 30, 415-433.

words, but unlike ordinary English which has a one-dimensional ordering or words on a printed page, mathematical English has a two-dimensional arrangement for which no definite ordering is defined.[47]

## Summary

No studies were found in the use of the English Language Grammar Method as a technique of improving problem solving performance by visually impaired students.

Call and Wiggin (1966) conducted a study on Reading and Mathematics for sighted learners. They made the following inferences from the data acquired: (1) There is some merit in teaching special reading skills for the solution of mathematical problems; (2) Even very good readers, as measured by the Cooperative Reading Test, have difficulty in the interpretation of the kind of reading found in word problems; (3) Part of the difficulty which teachers encounter in the teaching of mathematics comes from a special kind of reading disability which does not appear on standard measuring instruments; (4) Part of the difficulty which teachers encounter in the teaching of mathematics is that they are not equipped to teach reading; and (5) If by teaching reading, instead of mathematics, we can get better results, it seems reasonable to infer that the competent mathematics teacher may get better results if he/she is trained to teach reading of the kind encountered in mathematics problems.

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[47]R. B. Kane, The Readability of Mathematical English, Journal of Research in Science Teaching, 1967-1968, 5, 296-298; The Readability of Mathematical Textbooks: Revisited Mathematics Teacher, 1969.

Literature in the area of problem solving by sighted learners has little or no value for this study in view of the lack of concrete data at appropriate grade and subject levels.

Studies cited that are related to the mathematics teaching for the blind and visually impaired have clearly demonstrated a lack of instructional materials to meet the needs of the learners at the junior and senior high grades. Although instructional materials and various techniques have been used in the lower and upper elementary grade levels to teach word problems to blind and visually impaired learners, there is still a need for instructional materials to improve comprehension skills.

The review of related literature regarding mathematics instruction for both sighted and visually impaired learners may be summarized with the following specific recommendations:

1. Mathematics teaching should provide for continuity of instruction in concept formation.

2. Mathematics teaching should be presented as a mode of thinking about quantitative skills in both applied and social situations.

3. Mathematics concepts should be introduced early and their development regarded as being gradual until comprehension is attained.

4. Mathematics teaching should provide for integration of concepts to other subject areas, thus assuring the maintenance of skills and concepts previously presented.

# CHAPTER III

# THE STUDY

This study investigated the effects of the English Language Grammar Method of teaching mathematics on the mathematics performance of the visually impaired in the area of problem solving. Problem solving has two major components, concept formation and vocabulary comprehension.

## Population

The sample selected for this investigation consisted of 20 visually impaired students enrolled in regular public day schools and private schools of Dade County, Florida. Subjects were drawn from twelve schools, grades 9-12. Learners ages ranged from 13.5 to 18.5. All participants were enrolled in either a general mathematics course or a pre-algebra course. All subjects were of average or above average intelligence as measured by the WISC administered by Dade County School Board. Some of the participants read Braille, some read large print. A description of each learner who participated in this study is reported in Table 3, Appendix G. These data were collected by the classroom teachers using the data responding sheet in Appendix H; and by classroom teachers from the learners' school cumulative record folder.

All subjects participating in this study had regular academic courses in regular classes with their sighted contemporaries. In addition to their regular classes they were involved in learning to read braille and varying type size with aids.

Reading modes listed in Table 3 are categorized as the preferred mode use for learning by each learner.

Criteria used in selecting subjects were that subjects must be:

1. Visually impaired and of at least average intelligence.
2. At the algebra one entry level.
3. Between grade levels 9 through 12.
4. At a minimum age level of 13.5.

*5. Able to hear well enough to function normally without special consideration.

*6. Able to work independently.

*7. Able to use cassette tape recorders.

*The learner could not have any mental, physical or sensory impairment other than visual impairment.

## Overview of Existing Program for the Visually Impaired in Dade County

The study took place in several of the Dade County Public Schools, Miami, Florida. Miami is the largest and busiest city in the State of Florida. The Dade County Public School System is the sixth largest system in the United States.

Visually impaired students comprise .09 percent of the total school population in the State of Florida. Approximately 222 students in Dade County are visually impaired. The number of visually impaired students who have been identified and who are receiving special services in the county as of Summer 1976 was 165.

The Dade Special Education Program attempts to provide for the basic and special needs of blind students ranging from the totally blind, those who can use supplementary low vision aids to use their residual vision more efficiently, through those who are educationally partially seeing.

Services for blind students are not offered through a single resource classroom. Rather, blind students participate in regular classes with sighted learners throughout the county. Academic and extra curricular activities are joint efforts of the school, homes, federal, state and community agencies.

During the 1975-1976 school year, 13 Dade County special teachers of the visually handicapped students served approximately 165 visually handicapped students. These services begin at age 3 and continue through high school.

## Program Objectives for Dade County Teachers and Staff of the Visually Impaired

a. To identify students with visual handicaps.

b. To identify and provide the appropriate educational program for each visually handicapped student regardless of severity, geographic area or grade level.

c. To have classes for the visually handicapped accepted as an integral part of the total school program.

d. To provide efficient distribution and exchange of special materials and books as needed.

e. To assist in the coordination and training of volunteer help.

f. To reduce the incidence of blindness through a planned program of eye safety.

g. To promote research and innovative programs relating to visual impairment.

## Facilities and Instructional Programs

In each of the six areas of Dade County there is a Special Education Center which has at least one well-equipped resource room for the visually impaired. The school curriculum is designed to meet the needs of children at various age levels. If visually impaired students are to participate with normally seeing students in the regular school classes, they should be able to fit into the same broad curriculum plan, learn from the same textbooks (regular type; large type; Braille; or sound recordings) and share in the same educational program.

The learner's academic progress is evaluated periodically (a minimum of twice a year) to determine behavioral changes and new skills and abilities acquired. Results are entered by the teacher on the learner's cummulative record folder.

## English Language Grammar Method

The English Language Grammar Method is a technique for teaching mathematics as a language by comparing sentence structures in the English language. The method was designed by the researcher based on literature of Edward L. Thorndike. Thorndike (1924) stated in his book The Psychology of Algebra that comprehension skills in both mathematics and the English language are based on the ability to read.[1] Reading is defined as a process of comprehending, interpreting and evaluating words or symbols into meaningful relationships and applications. The language approach to teaching mathematics is a way of illustrating how mathematics sentences (equations) can be broken down into the three major component parts used in any basic language structure, subject, verb, and the complete predicate nominative. For an example, "six more than two is eight" is translated into mathematics symbols as "2 + 6 = 8" and "six is more than two," is translated into "6 > 2." According to Fitzgerald (1965) word problems of this type are confusing in the mind of a learner because he must be able to recognize the difference between "more than" and "is more than."[2]

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[1]Edward L. Thorndike, The Psychology of Algebra (New York: MacMillan, 1924), pp. 132-165.

[2]J. T. Fitzgerald, Programmed Modern Arithmetic Logic (Boston: D. C. Heath Co., 1965).

The English language grammar method's overall objective as outlined by the researcher is not to teach computational skills, but, rather, to concentrate on the essential elements required for analytical thinking. Mitchell (1974) states that there are two kinds of abilities necessary for effective quantitative thinking. The first is total familiarity and competence with specific mathematical concepts. Second is a working knowledge of cognitive skills such as reasoning, analytic thinking and problem solving.[3]

The language of mathematics is compared to the English language in three distinctive ways: (1) the development and use of alphabets and literal numbers; (2) the origin of operational signs; and (3) methods of developing sentence structures using basic grammar such as nouns, pronouns, verbs, adjectives and conjunctions.

Since the language of mathematics is compact and writing is generally limited to essential ideas, the lack of any one skill in reading makes problem solving more difficult. Reading word problems in mathematics requires a different approach than reading descriptive literature. The comparison between the English language and the language of mathematics is viewed by the researcher as a strategy to eliminate some of the problems caused by the lack of adequate skills to read. Streby (1957) identified some of these problems as: (1) lack

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[3]Lazarus Mitchell, "Mathophobia: Some Personal Speculations," The National Elementary Principal, Vol. LIII, No. 2, January/February 1974, pp. 16-22.

of purpose of reading word problems as compared to numerical problems; (2) the lack of vocabulary knowledge along with appropriate meaning; (3) the inability to associate word problems with a visual image; (4) the inability to isolate important facts from extraneous materials; (5) inadequate background in recognizing operation signs when presented in word form instead of mathematics symbols; and (6) the inability to relate concepts.[4]

The English Language Grammar Method is designed by the researcher to systematically introduce the learner to fundamentals that will help avoid reading difficulties in mathematics by making him aware of the purpose and role for reading. From research studies cited and the viewpoint of the researcher reading mathematics is oriented toward work-type reading and is slow and intensive. The learner must be constantly aware that he is reading for details that must be organized into meaningful mathematical relationships.

Reading mathematics efficiently depends to a great extent on the comprehension and meanings of mathematics terms. In the English Language Grammar Method, all terms and operations are defined and illustrated prior to class drills to assure that the learner has some frame of reference prior to attempting word problems of varying lengths.

Another major stumbling block in mathematics reading is the inability to isolate important facts from extraneous materials. Many

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[4]George Streby, "Reading in Mathematics," Arithmetic Teacher, Vol. IV, March, 1957, pp. 79-81.

learners think that they must use all information to solve the problem. It is speculated that the English Language Grammar Method will assist the learner in identifying facts, re-reading for general impression, and in re-reading to put facts in the appropriate form to express the relationship. Exercises are designed for the learner to identify major parts of speech and to show their relationships using mathematical symbols.

The language method will reinforce earlier drills and exercises by helping the learner to understand the importance of sequencing. The learner must be fully aware that mathematics performance is built on sequential skills and that an understanding of earlier units is necessary to comprehension of future exercises.

In mathematics, both upper- and lower-case letters of the alphabet from the English language are used. Capital letters are used primarily for points and small letters for lines. The nouns and pronouns in mathematics are simply numbers or letters representing quantities. The nouns and pronouns of the English language represent the subject of the sentence. In the word sentence, "Gerald Ford is the President of the United States," the name Gerald Ford is a noun and the subject of the sentence.

In the mathematics sentence "three plus four equals seven," three and four are nouns and the subject of the sentence. Other examples using letters are: $P = 2L + 2W$ means that the perimeter of a rectangle (P) is equal to twice the length (L) plus twice the width (W); and $a^2 + b^2 = c^2$ means that the length of the side named c is equal to the square root of the sum of a squared and b squared. The superscript or exponent performs an adverbial function, as in the mathematics sentence (equation) $a^2 + b^2 = c^2$, where the 2 (squared) answers the question, "how many?" In a list of elements such as $A_1$, $A_2$, $A_3$, the numbers 1, 2, and 3 are called subscripts, and they answer the question "what kind?" and are classified as adjectives in the English language.

In mathematics there is a definite need to identify an open sentence. An open sentence in the English language is more readily identified. For example, "He is president of the United States." <u>He</u> holds the place for a name and is classified as a pronoun. In the mathematics sentence, "X + 2 = 8," the letter "X" performs the same function as pronouns in an English language sentence.

The language of mathematics has many operational symbols that are used to form equations, inequalities and other mathematical relationships. Symbols such as + (plus), - (minus), x (times), ÷ (divide), = (equal), ≠ (not equal), > (is greater than), and < (is less than) are the verbs of mathematics. They indicate to the reader what the noun does. Sometimes the verb is not present, but is implied, for example XY means X times Y. The interpretation of operational symbols is of major importance to a learner in visualizing word order and translating word problems into mathematics sentences. Verbs are identified according to their relation to each other and in relation to the rest of the sentence. For example, "8 - 4 = 4," might be read as "from 8 take away 4 to get 4." Another way to analyze this problem is to ask the question, what number has to be added to 4 to get 8? This question is illustrated using mathematical symbols as "$4 + X = 8$," where the letter x represents an unknown quantity and when solved correctly will make this open sentence a true sentence.

The conjunction "and" is used in both English and mathematics to connect two simple sentences into one compound sentence. A functional definition of a simple sentence is that it is a group of words expressing a complete thought and containing a subject and a verb. The use of the conjunction "and" to join two different sentences does not seem to cause as much difficulty as the use of "or" in English language or in the language of mathematics. When the conjunction "and" is used in general, compound sentences formed are false except when both simple sentences are true.

The word sentence expressed in English language is called an equation in the language of mathematics. The equation is unique because there is only one structure used, the left-hand member and the right-hand member and they are separated by the equality sign. There are two major kinds of sentences in the English language and in the language of mathematics. They are the declarative sentence and the interrogative sentence. A declarative sentence states a fact. An interrogative sentence asks a question. The identical equation in mathematics corresponds to the declarative sentence in the English language, it states a mathematical fact. In the example of an identical equation, $4(a + b) = 4a + 4b$, the left-hand member $4(a + b)$ equals the right-hand member $4a + 4b$. The conditional equation is similar to the interrogative sentence in English; it asks a mathematical question. For example, "3X = 6" is translated to read "three times what number equals 6?" The example 3X = 6, is an open sentence by structure because there is an unknown quantity represented by the letter "X." When solved correctly the open sentence is then called a true sentence or equation. The position of the equality in this mathematical sentence establishes a relationship between the left-hand member and the right-hand member.

Because the structures and patterns of the English language sentence are perceived in somewhat different ways in speech and in writing, teachers of blind students must be aware of the distinctions. These distinctions are observed in aural presentation when there are non-verbal cues given for conveying meaning.

The teacher provides additional cues through stresses in pitch and pauses that indicate a particular sequence. In written form these cues are given by punctuation and capitalization.

According to Fries (1940) the "grammar of structure" in the teaching of a language is essential in developing comprehension skills and offers an approach to the problems of "sentence analysis" that differs in point of view and in emphasis from the usual treatment of language snytax.[5] The English Language Grammar Method approach to teaching mathematics to the blind is a possible way of identifying and

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[5]Charles C. Fries, American English Grammar (New York: Appleton-Century Crofts, Inc., 1940).

conveying meaning through complete mathematical sentences by overcoming some of the limitations imposed on the learner due to blindness. According to Lowenfeld (1959), the lack of visual imagery is a major limitation imposed by blindness and causes teachers and learners to make adaptations to meet these differences within the classroom and in everyday living.[6]

Two important characteristics of the English Language Grammar Method are that the exercises are developed step-by-step and that drills are applicable to individual concepts. The drill exercises are presented after a major concept and operations have been introduced. The procedure followed in this study of the English Language Grammar Method of teaching mathematics involved six steps: (1) Pretesting; (2) explanation of the problem; (3) using cassette tapes of recorded lessons for drill and practice; (4) having students analyze problems orally; (5) unit tests followed by a discussion; and (6) posttest.

Exercises presented in the English Language Grammar Method were aimed at improving concept formation in mathematics. Therefore, students were encouraged to begin to organize facts as soon as they perceived them. The language approach of teaching mathematics utilized

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[6]B. Lowenfeld, "What is Creative Teaching?" in E. P. Torrance (Ed.), Creativity: Proceedings of the Second Minnesota Conference on Gifted Children (Minneapolis: University of Minnesota Press, 1959), pp. 38-50.

the inductive method to problem solving, beginning with several concrete illustrations that permitted the learner to analyze and generalize, to explain and summarize the mental mathematical operations involved. Zacharias (1974), Fries (1940), Fitzgerald (1974), and Thorndike (1924) agree that beginning at the concrete level minimizes the danger of rote learning of abstract ideas without an understanding of their basic meanings.[7,8,9,10]

The comparison of the English language to the language of mathematics is another way of showing relationships and bringing about a transfer of learning from daily experiences to problem solving.

To reinforce the skills required for translating word problems into mathematical sentences (equations), exercises were grouped under the following general headings, and only oral responses are accepted: (1) listening to recall specific facts; (2) identifying parts of speech in the English language and matching them to their mathematical equivalents; (3) listening for sequential facts; (4) listening to identify

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[7]Jerrold R. Zacharias, "The Importance of Quantitative Thinking," The National Elementary Principal, Vol. LIII, No. 2, January/February 1974, pp. 8-13.

[8]Charles C. Fries, American English Grammar (New York: Appleton-Century-Crofts, Inc., 1940), pp. 16-25.

[9]J. T. Fitzgerald, Programmed Modern Arithmetic Logic (Boston: D. C. Heath Co., 1974).

[10]Edward L. Thorndike, The Psychology of Algebra (New York: MacMillan, 1924), pp. 132-165.

the main idea or question to be answered; and (5) identifying mathematical operations involved in the problem.

The initial word problems illustrated through the language grammar method are those without numbers since learners tend to give more attention to the numbers in a problem than attempting to determine the important facts and relationships between the facts. This approach is designed to assist learners in more analytical thinking and visualization, thereby providing a foundation for better organization of facts which, in turn, will lead to improved mathematics performance. The terms used in the mathematics word problems are defined and matched to their English language equivalents. The English Language instructional lessons are included in Appendix F.

## Procedures

Prior to identifying schools for the experimental study, several personal meetings were held with the Director of Dade County Program for the Visually Impaired and the Director of Special Education for the Dade County Public Schools.

During meetings held at area offices and with the classroom teacher, an Experimental Study Information Form was completed. The form is included in Appendix E. The study form collected data, such as the number of classes in pre-algebra and Algebra I, to be taught during the summer session, the expected number of students to enroll in each, the number of class sessions per week and the length of each class session. Also, a review of the course objectives was made along with materials presented in the approved textbooks. Each teacher was asked to describe their general teaching techniques for various topics that were covered under solving word problems.

Upon completion of area and school visitations with the Director of the Visually Impaired Program appointments were established for the researcher to meet and review the entire treatment of the English Language Grammar Method and to discuss procedures to be used in completing Student Record Sheets. At the second and third meetings with teachers, instructional materials were delivered for the entire class including color-coded tapes for schools with numerical codes for participating students.

Data received from each teacher after the pretest determined specifically the number of schools and students to participate in the study. A total of nine public schools and three private institutions were selected from five of the six school areas in the county. Approved letters were signed by parents permitting their children to participate. A copy of each letter was on file at the local school, with a copy in the area office. A copy of this letter is included in Appendix A. A total of twenty students were approved to participate. Subjects were selected after securing their eye examination report forms (see Appendix I). Actual copies of subjects' forms are not included for ethical reasons.

The English Language Grammar instructional materials were developed by the researcher from objectives listed by the County for the subject area and by topics identified by classroom teachers. The text cited most frequently was Algebra Book I, by Dolciani. Each unit in the

English Language Grammar Materials consisted of at least two objectives. Objectives were developed in such a manner as to require the learner to use bits of information with sufficient drill to develop competencies required for solving word problems of varying length.

After developing each unit lesson and test materials, a trial run was made using two functionally blind students enrolled in the researcher's general education mathematics class for 2-3 hours per week. All test items were read to the learners by one of the college counselors. Responses from the students were recorded by the counselor and all grading of work was done by the researcher. Each learner was questioned about the materials in terms of content, method of presentation and suggestions for improving the units. The counselor was asked to evaluate the method as a possible technique for blind learners and to suggest possible ways to improve it. Different sections of each unit were revised according to comments received and test items changed to meet the vocabulary comprehension level of the learners. A review of vocabulary lists cited in the County textbooks and information received from classroom teachers aided in deleting the more difficult terms.

In addition to these trials and revisions the researcher consulted with teachers of English at the Secondary and Post-Secondary level to identify some of the problems associated with reading comprehension with particular emphasis on scientific and technical materials. Vocabulary cited in Mathematics texts was compared with the English Grammar and the Handbook of English for general and specific rules governing their usage.

Each unit was revised and put into booklet form for each teacher. Teachers were instructed to write comments directly in the booklet where any misunderstanding occurred or where specific questions were raised by the learner regarding definitions and usage. Suggestions for improving materials are listed in Chapter IV.

Other guidelines outlined for teachers included the following:

1. Review unit objectives with learners prior to listening to instructional tapes.
2. Review examples in booklet with learners to verify their understanding of the instructions.
3. Check cassette recorders for proper working condition.
4. Check for appropriate instructional tapes and test tapes for each learner.
5. Permit the student response tape to run continuously during the test to avoid mechanical problems and erasures of solutions.
6. All tests must be completed at one sitting, a class period.
7. No additional explanations were to be provided outside of those presented in booklet during the instructional phase.
8. Be sure to use appropriate code numbered tapes for each learner for the entire study.
9. Review test results with learners upon completion of each test.
10. Do not allow any writing or tactile materials to be used during the course of the study.
11. Drill tapes must be used only at school.
12. All tests must be administered and supervised by the classroom teacher.
13. Upon completion of the study, all materials, booklet and tapes must be returned to the researcher.
14. Upon completion of Unit Five, a posttest is to be administered.

The following schedule of activities was initiated:

| FIRST WEEK | ACTIVITIES |
| --- | --- |
| Day | |
| 1 | PRETEST |
| 2 | REVIEW OF PRETEST |
| 3 & 4 | UNIT ONE LESSON: VOCABULARY AND DEFINITIONS |
| 5 | UNIT ONE TEST |
| **SECOND WEEK** | |
| 1 | INTRODUCTION TO PHRASES AND SENTENCES |
| 2 | IDENTIFICATION OF OPERATION(S) IN PHRASES: TRANSLATIONS-ENGLISH LANGUAGE PHRASES INTO MATHEMATICAL PHRASES |
| 3 | CONTINUATION OF ACTIVITIES FROM DAY 2 |
| 4 | SENTENCES: TRANSLATIONS AND IDENTIFICATION OF SUBJECT AND VERB |
| 5 | UNIT TWO TEST |
| **THIRD WEEK** | |
| 1 | INTRODUCTION TO SIMPLE AND COMPOUND SENTENCES |
| 2 | TRANSLATIONS: COMPOUND SENTENCES |
| 3 | CLASS EXERCISES: SIMPLE AND COMPOUND |
| 4 | TRANSLATIONS AND CLASS REVIEW |
| 5 | UNIT THREE TEST |
| **FOURTH WEEK** | |
| 1 | ANALYSIS OF WORD PROBLEMS |
| 2 | ANALYSIS OF WORD PROBLEMS |
| 3 | CLASS EXERCISES: WORD PROBLEMS |
| 4 | TRANSLATIONS: WORD PROBLEMS |
| 5 | UNIT TEST FOUR |

| FIFTH WEEK | ACTIVITIES |
|---|---|
| Day | |
| 1 | DRILL EXERCISES: TRANSLATING WORD PROBLEMS INTO MATHEMATICAL SENTENCES AND FINDING SOLUTIONS |
| 2 | DRILL EXERCISES: WORD PROBLEMS |
| 3 | REVIEW: GENERAL DEFINITIONS, PARTS OF A MATHEMATICAL SENTENCE AND TRANSLATION OF WORD PROBLEMS |
| 4 | UNIT TEST FIVE |
| 5 | POSTTEST AND REVIEW OF POSTTEST |

The instruction in the English Language Grammar Method lasted for five weeks. During that time the three teachers involved in the study did not consult with each other relative to the method used. The Hawthorne effect was an important variable which the researcher hoped to minimize to the degree possible. To avoid this effect the researcher agreed with each classroom teacher and the Director of the county visually impaired program, area office staff and learners that there was some pertinent work to do in the next five weeks and that periodic school visitations would be made by the researcher and/or director.

The instructional period during which the research was conducted was five weeks of a summer term. At the first class a pretest was administered to each learner. The pretest was designed and written by the researcher and approved by the Dade County Educational Research Department. The pretest consisted of five parts with a total of forty-seven points. Any student scoring eighty percent or above on pretest was excluded from the study. A copy is included in Appendix D.

All instructional materials and test materials for the students were recorded on individual cassette tapes. This allowed teachers to administer the materials on an individualized basis.

Teachers in the study were provided with a complete booklet entitled The Language Approach to Mathematics, designed and written by the researcher. The booklet was divided into two major sections; a general introduction and instructions for teachers; and five complete lesson units with examples by topics with corresponding tests and their solutions.

The purpose of the booklet was threefold. The first purpose was to give instructions as to how the materials were to be used during the study; second, to supply the instructor with detailed lessons including objectives, illustrations and tests keyed to the objectives of each unit; and third, to provide the answers for each unit test.

An instructional unit included four lessons and a unit test. Each unit was introduced with objectives, samples, new vocabulary and concepts. Concepts involved were clearly defined using a comparison between the English language and the language of mathematics. All instructional units are included in Appendix F.

## Data Collection Procedures

At the first class meeting, students were given the purpose and the nature of the study. Prior to administering the Mathematics pretest, a forty-item questionnaire was administered to each student. The purpose of the questionnaire was to measure student's attitude towards Mathematics and its applicability prior to the English

Language Grammar Method. The questionnaire items were measured on a 5-point semantic differential scale: easy-difficult, interesting-boring, helpful-useless, clear-unclear, and to the degree to which the student would prefer laboratory work with classroom instruction. The forty-item questionnaire was also administered as a posttest on the last day of the study. Pre- and posttest mean scores were compared.

The Mathematics pretest, designed by the researcher consisted of five parts with a total of forty-seven points. Questions in Parts A, B, C and D were worth one point each; questions in Part E were worth two points each. Students were given instructions via cassette tapes. Instructions for each part were explicitly expressed and teachers were instructed not to give additional instructions. If a student scored 80 percent or above on the pretest he/she was excluded from the treatment.

Each student was given a coded blank cassette tape to record all responses. At the end of each test, tapes were collected by the researcher and scored on answer sheets upon completion of each test in an area for each student; a Student Record Sheet was completed by the researcher and returned to the classroom teacher. Questions were answered for the teachers regarding the results. Classroom teachers were instructed to discuss test results with each student.

Individual unit tests were designed by the researcher. All unit tests were criterion-referenced tests. That is, the tests were used to measure a learner's level of achievement with respect to some standard. Tests for this purpose are interpreted differently than norm-referenced tests which are used to measure the achievement of an individual in relation to the achievement of other students.

Students received immediate feedback concerning test results. They were able to listen to the solutions on tape.

Each teacher involved in the study completed a fifteen-item evaluation questionnaire. The questionnaire generated some descriptive statistics regarding the English Language Grammar Methods and materials such as: (1) suitability of content for course and grade level; (2) the step-by-step presentation format of a single concept with applications; (3) the amount of time required to plan and present a lesson using the English Language Grammar Method as compared to Braille instruction; and (4) ways to improve the English Language Grammar Method.

These two hypotheses that are indicated below were set forth and tested.

Hypothesis 1. There is no significant difference between pretest and posttest scores on mathematics problem solving performance based on the English Language Grammar Method by visually impaired students as measured by the researcher's instruments.

Hypothesis 2. There is no significant statistical difference in students' attitudes towards mathematics, attributable to the English Language Grammar Method as measured by a forty-item questionnaire before and after the use of the method.

Hypotheses 1 and 2 were tested at the .05 level of significance using the difference between correlated means obtained from the same test, pre and post administered to the same group after the five-week English Language Grammar treatment. Since the research was concerned only with progress, a one-tailed *t*-test of significance was used.

## Summary

Included in Chapter III is the framework for testing proposed hypotheses and their appropriate instruments. The chapter includes criteria for the selection of subjects, a general overview of the visually impaired program for the Dade County Schools, a detailed description of the English Language Grammar Method, a detailed explanation of the operating procedures for teachers involved in the study, and a schedule of activities to be followed during the five-week period in each of the schools.

# CHAPTER IV

# ANALYSIS OF DATA

Presented in this chapter are analyses of the experimental data in both descriptive and table form. Each hypothesis is described along with the instrumentation used to obtain data.

Data were collected for analysis from results of the pretest, posttest, teacher questionnaire and student attitude questionnaire. Before considering the analysis of the data, special mention should be made of lost data due to subject mortality.

The total number of students enrolled at the Algebra One level in the six school areas varied widely. In one area, a total of four students had registered for Algebra One, but due to excessive absences and course conflicts, two students withdrew from the class, leaving a total of two. In another area, five students had enrolled for Algebra One, but due to the increased duties and responsibilities placed on the classroom teacher, only one student completed the study.

Of the 20 students who were included in the experimental group, four completed fewer than three of the five instructional units which were suggested for them. These people were eliminated because this would influence their score on the posttest used to evaluate their performance in problem solving. Other reasons cited by teachers for the withdrawals were: 1. Student illness or family vacation; 2. student failure to take test on schedule date; 3. student withdrawal from school. Another reason given by one student was that since he had band and music rehearsal, he had difficulty getting transportation to school during the regular scheduled class time.

Hypothesis 1 was tested using an instrument designed by the researcher. The null hypothesis: There is no significant difference between pretest and posttest mean scores on mathematics problem solving performance based on the English Language Grammar Method by visually impaired students.

Mean scores for the treatment group were computed using the number of correct item responses for each student on the pretest and posttest. The pretest analysis yielded a mean score of 18.81 with a standard deviation of 7.46. The posttest analysis yielded a mean score of 24.94 with a standard deviation of 6.24. Individual pre and posttest scores are listed in Tables 4 and 5 in the Appendix H.

To determine whether an observed difference between the means was due to chance, or whether the English Language Grammar Method made a significance difference, pre and posttest means were tested using a one tail t-statistics with n-1 degrees of freedom at the .05 level of significance. A t value of 2.63 was obtained from the pre and posttest mean scores. The critical region for a t value with 30 degrees of freedom at the .05 level of significance is 1.64. Since this value is less than the obtained value of 2.63, the null hypothesis was rejected.

Summary of Calculations

Hypothesis 1

$\overline{X}_1 = 24.94$

$\overline{X}_2 = 18.81$

$S_1 = 6.24$

$S_2 = 7.46$

$N_1 = 16$

$N_2 = 16$

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}$$

$$t = \frac{24.94 - 18.81}{\frac{(6.24)^2}{16} + \frac{(7.46)^2}{16}} = \frac{6.13}{\frac{38.94}{16} + \frac{55.65}{16}} = \frac{6.13}{\frac{94.59}{16}}$$

$$t = \frac{6.13}{\frac{9.73}{4}} = \frac{6.13}{2.33} = 2.63$$

Pre and posttest mean scores for student attitudes are 62.15 and 55.30, respectively. Standard deviations were 9.18 and 7.86, respectively. Hypothesis 2 was tested at the .05 level of significance. A t value of 3.58 was obtained for the attitude assessment. The critical region for rejection is 2.01. Since this value is less than the calculated value of 3.58, the null hypothesis was rejected.

There were four teachers involved in the study at the twelve participating schools. At the end of the study each teacher received a fifteen item questionnaire. They were requested to answer each question and to make additional comments regarding any segment of the study. The four teachers involved in the study did not respond negatively to any of the questionnaire items. However, they did suggest areas for improvement. Some of their suggestions were common to those mentioned by some of the learners at the end of the study. Comments shared by students and teachers are indicated by an asterisk.

Principal advantages of the English Language Grammar Method as stated by teachers:

1. The English Language Grammar Method is viewed as a method of meeting individual's needs. Due to the large range of ability, level of achievement, interests, background experiences and social status of students, methods of mathematics instruction in public schools have been affected. In "Mainstream" classes where the number of students is large it is not convenient for the individual teacher to organize several sections or groups, have differentiations of content, and to provide supplementary instruction. Therefore, the need for improving instruction for the more exceptional learners and for facilitating learning by the slower students present many problems for both teachers and learners.

2. The English Language Grammar Method is an auditory approach to learning mathematics, but is contrasted from the oral method of "mental arithmetic." Mental arithmetic is defined as a method of solving problems that arise in an oral manner or "in the head" and the solutions are given without the use of paper and pencil or other tactile materials. The mental arithmetic method does not present mathematics as a language, it emphasizes the importance of place value and the "ten-ness" of our number system. The major emphasis of the English Language Grammar Method is to present mathematics word problems as an organized language with structure and syntax.

3. The English Language Grammar Method is seen as a supplementary method of instruction to the rote-learning procedures in the

mathematics classroom. For example, one student may have memorized basic arithmetic facts and the other student may have learned the facts by discovery of meanings and relationships. The student who learned the facts mechanically by rote as isolated elements may not be resourceful enough to give additional ways to solve a problem. The English Language Grammar Method is designed to assist the learner to discover relationships and classify situations according to some pattern or framework.

4. The English Language Grammar Method of teaching mathematics is seen as a way to teach mathematics meaningfully. If a student learns mathematics meaningfully he must solve problems as he deals with problematic social situations.

5. The English Language Grammar Method is viewed as a method of aiding students to develop a working mathematical vocabulary which is comparable to the vocabulary skills learned in an English class.

6. The English Language Grammar Method as presented in the auditory form is seen as a method of equating reading skills for the sighted learner to listening skills for the blind learner. Therefore, providing an opportunity for full classroom participation.

7. Teachers using the English Language Grammar Method pointed out a difference in time required to present subject matter content as compared to Braille instruction. They all agreed that more material could be presented over a shorter period of time. Thus, providing more time for student-teacher interaction.

8. Teachers viewed the English Language Grammar Method as a tool to help students to improve their verbal skills as well as their organizational skills.

The following suggestions for improving the English Grammar Method were cited by teachers. Suggestions preceded by an asterisk were also stated by students.

*1. Provide more illustrations in analyzing mathematics compound sentences (techniques of identifying clauses and translating into symbols).

*2. Allow more time for the student to analyze word problems containing two or more sentences.

*3. Provide at least three readings of the more difficult problems to allow students sufficient time for comprehension and organization of facts (specifically in units four and five when students are required to isolate facts from extraneous information).

4. Provide a comprehensive vocabulary section for each unit, the same as the vocabulary unit in chapter one.

5. Provide more time to assist teachers in using the language materials. Provide at least a week of in-service training to allow each teacher to become totally familiar with the method prior to using it in the regular classroom.

6. Provide alternative methods for organizing mathematic sentences to obtain the same solution. For an example: $x + 3 = 9$ and $3 + x = 9$. The solution is 6, even though the reading interpretation and organization is different.

| | |
|---|---|
| $x + 3 = 9$ | $3 + x = 9$ |
| $x = 9 - 3$ | $x = 9 - 3$ |
| $X = 6$ | $x = 6$ |

Check:

| | |
|---|---|
| $6 + 3 = 9$ | $3 + 6 = 9$ |
| $9 = 9$ | $9 = 9$ |

This suggestion involved the use of the mathematic concept of order, a commutative property.

7. Provide explicit examples in the beginning units on the English Grammar and the Mathematics equivalence. For example, 3x = 12; in analyzing this open sentence for parts of speech noun, pronoun, and adjective - point out that the numerical coefficient, 3, in the open sentence is an adjective, modifying the pronoun (the alphabet or literal number x); and when the problem has been solved correctly, then the value substituted for "x" is part of the subject, a noun.

$$3x = 12$$

Divide both sides by 3

$$\frac{3x}{3} = \frac{12}{3}$$

Cancellation Property

$$x = 4$$

*8. Provide a detailed explanation on each answer tape when giving solutions - by reading the problem again and identifying the important facts required for problem solving, instead of stating only the mathematic sentence and solution. This would assist those learners who did not differentiate important facts from extraneous information.

## Summary

The statistical analysis of the study has been presented in this chapter. Decisions made on the basis of the statistical analysis are summarized in tables following.

Advantages and suggestions of the English Language Grammar Method as identified by both teachers and learners involved in the study have been summarized.

A complete discussion of the findings, conclusions, implications and recommendations for future research is presented in Chapter V.

Table 1. Statistical Decisions. Mathematics Problem Solving Performance.

| Test Mean | | S.D. | Level | Obtained t Value | Critical Region | Test |
|---|---|---|---|---|---|---|
| Pretest | 18.81 | 7.46 | .05 | 2.63 | 1.64 | t-statistics |
| Posttest | 24.91 | 6.24 | .05 | | | t-statistics |

Table 2. Student Attitude Questionnaire.

| Mean | | S.D. | Level | Obtained t Value | Critical Region | Test |
|---|---|---|---|---|---|---|
| Before | 62.15 | 9.18 | .05 | 3.58 | 2.01 | t-statistics |
| After | 55.30 | 7.86 | .05 | | | t-statistics |

# CHAPTER V

## SUMMARY

The major questions addressed in this study centered around the effects the English Language Grammar Method would have on student performance in solving word problems and their attitudes towards the subject. The results of this study indicate that when mathematics word problems are presented as a language, learning does occur.

The data for this investigation were contributed by sixteen subjects enrolled in Algebra One classes in twelve different schools chosen from the Dade County Public School System. All classes cooperating in the research were given the same information such as the purpose of the study, instructional procedures, instructional tapes, tests and teachers booklet.

All subjects were given a pretest in Mathematics. The test contained the following five parts: 1. Vocabulary and Definitions; 2. Phrases; 3. Simple and Compound Sentences; 4. Analysis of Word Problems; and 5. Translation of Word Problems. In the five-week period that elapsed between the administration of the pretest and the posttest subjects received instruction in the English Language Grammar Method of solving verbal problems. Five unit lessons were presented to these subjects by their teachers. One unit lesson was taught each week with practice exercises on the skill following each lesson.

To test the effectiveness of the instruction received by the subjects, an analysis of pre and posttest mean scores was made. Students' attitudes were also measured before and after the treatment by an Attitudinal Questionnaire. To ascertain whether or not teachers liked the English Language Grammar Method as a teaching strategy, the researcher tried to determine: (1) the amount of time teachers used in presenting materials, (2) the role and value of the English Language Grammar Method of teaching mathematics as seen by teachers as compared to the Oral and Tactile Method, and (3) teachers' opinion of the English Language Grammar Method format, comparing the language of mathematics with the English language equivalent. The data were gathered by a questionnaire designed and developed by the researcher.

T values were obtained for Hypothesis One and Two and tested at the .05 level of significance.

This investigation revealed the following:

Findings

1. There was a significant change in problem solving performance among visually impaired learners from pre to posttest.

2. There was a significant change in attitudes of visually impaired students towards mathematics.

3. Teachers responded positively to the use of the English Language Grammar Method.

## Conclusions

Several limitations of the present study are cited: Limitation of the sample size and selection; lack of a control group; lack of an opportunity for daily school visitations and observations by the researcher; and use of measuring instruments of unknown validity and reliability, it is possible to draw only very tentative conclusions. While it is believed the conclusions have some basis they should be viewed primarily as evidence that warrants further investigation.

1. The English Grammar Method of teaching mathematics has potential for positively effecting the problem solving performance of visually impaired students. This conclusion is consistent with the findings of Brothers (1971) who identified the following commonalities between listening and reading comprehension in understanding problem solving concepts among blind students: (1) basic vocabulary is common to both; (2) sentence patterns are similar; (3) the purposes of communication are much the same.[1] However, observations from the present study cannot be directly compared to Brothers regarding these commonalities.

Additionally, the findings of the present study were consistent with a related study by Foulke (1962) who found a correlation between listening and comprehension skills. He found that blind learners listening and comprehension skills vary according to subject matter and

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[1]Roy Brothers, "Learning Through Listening." The New Outlook, September, 1971, pp. 224-231.

maturation level.[2] Findings in this study and suggestions for improving the English Language Grammar Method made by both students and teachers indicated that more time is required to analyze the more difficult and lengthy word problems. Thus, based on the data from the present study and those mentioned above, it is tentatively concluded that the English Language Grammar Method does have instructional value and should be further studied.

2. Results of the present study indicate a change in student attitudes towards mathematics in a positive direction from pre to posttest means. This change was measured by an Attitudinal Questionnaire developed and validated by the Education Development Center, Newton, Massachusetts. A discussion of the Questionnaire is contained in Chapter III and the Questionnaire is included in the Appendix. Since the instrument is generally recognized as having a reasonable degree of validity and reliability, and there is no reason to suspect the data, it is concluded that attitudes of learners using the English Grammar Method did change in a positive direction. This change in attitudes may however be accounted for by: effects of new materials; more developmental work in teaching concepts and skills; an increase in independent teaching and learning conditions or the Hawthorne effect.

3. Responses made by teachers using the English Language Grammar Method of teaching mathematics to visually impaired learners

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[2]Nelson Foulke, "Rapid Listening." Listening: Readings and Reports (New York: The Scarecrow Press, Inc.), pp. 170-171.

at the end of the study were positive. Although no pre-study attitudinal data were gathered, results from the researcher's designed questionnaire suggest the English Language Grammar Method had an influence on their attitudes thus increasing their interest level. This is seen as an important quality because it leads to a chain-reaction of ideas and the potential of the English Language Grammar Method may prove to be an alternative teaching method to the visually impaired. It may also explain the change in student attitude. A discussion of the responses may be found in Chapter IV.

## Implications

Under the limitations and circumstances of this study, the English Language Method of teaching mathematics to visually impaired learners did demonstrate sufficient predictive value to warrant attention and research. Teachers probably need to be sensitized to vast differences among visually impaired learners in their ability to understand and interpret mathematics as a language.

1. Visually impaired students may benefit from the English Language Grammar Method of Teaching Mathematics, if such strategy was commensurate with their ability and level to understand basic rules of grammar. Therefore, learners and teachers should take measures to modify instruction and opportunities to learn and teach mathematics as a language so that experiences shared may contribute to problem-solving success.

2. The present study indicates a relationship between teaching strategy and attitude of both teacher and learner. The English Language Grammar Method may be used with visually impaired students as a means to provide vocabulary growth and problem-solving skills. Thus, serving as a catalyst to improve interest motivation and thereby improving attitudes and increasing performances.

3. Another implication of considerable importance is that of the teacher. The fact that teachers viewed the English Language Grammar Method of teaching mathematics with a positive attitude suggests that this strategy is crucial in two ways: (1) for providing learning situations that are appropriate to the learner; and (2) for identifying, examining and providing instructions to those learners who have difficulty in analyzing verbal problems.

## Recommendations for Further Research

Although the results obtained from the present study cannot be considered as conclusive, they do suggest four major areas in which further research might be fertile.

1. In general, the results of the study suggest that more research is needed in the broad area of verbal problem solving to determine more explicitly the factors which are essential to the task, and how these factors can be accomplished.

2. A study similar to the one reported here should be conducted using a control group and random sampling from the school area using other instructional methods for comparison.

3. Attention should be given to developing measuring instruments directed toward both teachers and learners. Instruments for learners should gather data on individual mathematical skills, concepts and the relationship between each. Instruments designed for teachers should include pre and post measures on attitudes and performance levels in the classroom.

4. The present findings indicate that student attitudes towards mathematics may be related to the performance level of the learner. Also, that there may be outside influences on student attitudes towards mathematics. These findings would suggest that more analytical studies might be done to identify major characteristics within the classroom and in the environment that will aid in improving attitudes towards mathematics and its applicability.

# APPENDICES

# APPENDIX A

# LETTERS OF PERMISSION

# DADE COUNTY PUBLIC SCHOOLS

**ADMINISTRATIVE OFFICE**

**LINDSEY HOPKINS BUILDING**

1410 N. E. 2ND AVENUE MIAMI, FLORIDA 33132

DR. E. L. WHIGHAM
SUPERINTENDENT OF SCHOOLS



May 3, 1976

Mr. Robert E. Sharpton
10709 N. Kendall Drive, C-16
Miami, Florida 33176

Dear Mr. Sharpton:

Your research project "To Measure the Effects of the English Language Grammar Method on the Problem Solving Performance of Blind Learners" has been approved subject to 1) voluntary participation of schools and 2) written parental approval for pupil participation and access to records.

We wish you well with your study and look forward to reading your results and conclusions.

Sincerely,

Horace L. Martin, Chairman
Educational Research Committee

HLM:pw

SAMPLE FOR SCHOOLS

Dear Parents,

The Department of Exceptional Child Education of the South Central Area, Dade County Public School System is participating in a research project designed to help visually impaired students in learning mathematical problem solving skills.

Your child __________ has been selected as a participant for the project. Participation in this research project is on a voluntary basis and your permission is needed to include your child in the project.

The project, which has the approval of the Dade County Public Schools Educational Research Committee, will be conducted at the school your child attends. It is expected the project will improve the problem solving ability of each participant.

No student names will be included in the study. Each student will be given a code number which will be kept confidential.

If you are agreeable to your child being included in the project, please sign below. Have your child return this form to his/her school or to Mr. Gary VanDoren, Itinerant Vision Teacher.

______________________________
Parent or Guardian

__________________
Date

If you have any further questions regarding this matter, please contact the Principal at __________.

Sincerely,

# APPENDIX B

# EVALUATION QUESTIONNAIRE FOR STUDENTS

## EVALUATION QUESTIONNAIRE FOR STUDENTS

Instructions:

There are 40 questions in this questionnaire. There are no "right" or "wrong" answers; it merely examines your attitudes towards mathematics and certain features of the course. All questions are multiple choice, and your replies should be stated and recorded. For example, question 1 reads:

I personally find mathematics 1. easy 1 2 3 4 5 hard.

If in your experience mathematics has been hard, you will state "5". But if your feelings are neutral in this matter you might state "3" as your reply.

Make sure you answer each question. If you make a mistake or change your mind about a reply be sure to erase the unwanted answer correctly. Give only one answer per question. Please answer all 40 questions.

| | | | | |
|---|---|---|---|---|
| I personally find mathematics: | 1. | easy | 1 2 3 4 5 | hard |
| | 2. | useful | 1 2 3 4 5 | useless |
| | 3. | interesting | 1 2 3 4 5 | boring |
| | 4. | enjoyable | 1 2 3 4 5 | not enjoyable |
| Compared to other school subjects, I find mathematics: | 5. | easiest | 1 2 3 4 5 | hardest |
| | 6. | most useful | 1 2 3 4 5 | least useful |
| | 7. | most interesting | 1 2 3 4 5 | least interesting |
| | 8. | most enjoyable | 1 2 3 4 5 | least enjoyable |
| When confronted with a problem involving math, I am: | 9. | confident | 1 2 3 4 5 | fearful |
| I personally find arithmetic: | 10. | clear | 1 2 3 4 5 | confusing |
| | 11. | useful | 1 2 3 4 5 | useless |
| I personally find math: | 12. | clear | 1 2 3 4 5 | confusing |
| | 13. | useful | 1 2 3 4 5 | useless |
| I personally find geometry: | 14. | clear | 1 2 3 4 5 | confusing |
| | 15. | useful | 1 2 3 4 5 | useless |
| I personally find graphs: | 16. | clear | 1 2 3 4 5 | confusing |
| | 17. | useful | 1 2 3 4 5 | useless |
| I think I will find calculus: | 18. | clear | 1 2 3 4 5 | confusing |
| | 19. | useful | 1 2 3 4 5 | useless |
| | 20. | boring | 1 2 3 4 5 | interesting |
| | 21. | hard | 1 2 3 4 5 | easy |
| When I walk into a lab, I am: | 22. | confident | 1 2 3 4 5 | fearful |
| I find lab work: | 23. | interesting | 1 2 3 4 5 | boring |
| | 24. | valuable | 1 2 3 4 5 | waste of time |

| | | | |
|---|---|---|---|
| When I think about using a computer, I am: | 25. confident | 1 2 3 4 5 | fearful |
| I find (or think I will find) computer work: | 26. interesting | 1 2 3 4 5 | boring |
| Compared to lecture courses, I think self-paced courses are or will be: | 27. more interesting | 1 2 3 4 5 | less interesting |
| | 28. harder | 1 2 3 4 5 | easier |
| I think the number of exercises in most math texts is: | 29. too high | 1 2 3 4 5 | too low |
| I think word problems (sometimes called "story problems") are: | 30. easy | 1 2 3 4 5 | hard |
| | 31. valuable | 1 2 3 4 5 | worthless |
| In everyday life I use math: | 32. very frequently | 1 2 3 4 5 | never |
| I think the amount of time spent on applications in my math course has been: | 33. too little | 1 2 3 4 5 | too much |
| When I find an application for the math I know, I am: | 34. excited | 1 2 3 4 5 | uninterested |
| I find that science helps me understand the world: | 35. a great deal | 1 2 3 4 5 | not at all |

| | | | |
|---|---|---|---|
| I find that math helps me understand the world: | 36. a great deal | 1 2 3 4 5 | not at all |
| When studying math, the amount of time I spend memorizing rules is: | 37. very small | 1 2 3 4 5 | very large |
| When I learn a mathematical rule or technique, it seems: | 38. natural | 1 2 3 4 5 | artificial |
| I have had the opportunity to apply and discover mathematical ideas myself: | 39. never | 1 2 3 4 5 | frequently |
| I would like my math courses better if they required: | 40. less creativity | 1 2 3 4 5 | more creativity |

Attitude towards Mathematics Questionnaire Record Sheet

Student Code ______________

| ITEM | RESPONSE RATING: 1 2 3 4 5 |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
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| 30 | | |
| 31 | | |
| 32 | | |
| 33 | | |
| 34 | | |
| 35 | | |
| 36 | | |
| 37 | | |
| 38 | | |
| 39 | | |
| 40 | | |

*Rating: Lower numerical values indicate a positive feeling. Higher numerical values indicate a negative feeling towards the field of Mathematics.

# APPENDIX C

# EVALUATION QUESTIONNAIRE FOR TEACHERS

## Evaluation Questionnaire for Teachers

In order to design better instructional materials to suit the needs of both the learner and teacher it is important to evaluate your feelings about various portions of the materials and the method of presentation. Please indicate how you feel about the following items:

1. Does this material satisfy the needs of your course (Yes or No)?
2. The step-by-step development of each operation was an interesting way to analyze mathematics problems (Yes or No)?
3. What are its strongest features?
4. How could the materials be improved?
5. Do you feel that the English Language Grammar Method of teaching mathematics helped you to teach more materials (Yes or No)?
6. How have the materials improved your ability to teach word problems?
7. In comparison with braille instruction in Mathematics, do you think that the amount of work required by the language approach is greater than; about the same; or less than?
8. In comparison with braille instruction in Mathematics, the percentage of your preparation time of assignments in this course was greater than; about the same; or less than?
9. In comparison with braille instruction in Mathematics, the feeling of accomplishment (goals) generated by step-by-step instructions and tests in the course was greater than; about the same; or less than?
10. In comparison with braille instruction in Mathematics, generally, my presentation of basic concepts and principles in this course was greater than; about the same; or less than?
11. In comparison with braille instruction in Mathematics, generally, my tendency to teach detail in this course was greater than; about the same; or less than?
12. Would you like to continue the use of the tape recorder in your Mathematics teaching (Yes or No)?

13. Did you find it difficult to operate the recording equipment and maintain classroom contact (Yes or No)?

14. Would you like to share the teaching method with others within your department and other subject areas (Yes or No)?

15. Other comments you wish to make about the use of the English Language Grammar Method of teaching Mathematics.

APPENDIX D

PRETEST-POSTTEST

## Pretest-Posttest

Instructions: This is a diagnostic test designed to identify and evaluate your background knowledge in general mathematics and beginning algebra. There are five parts to this test, designated as Parts A, B, C, D, and E. Listen carefully to each statement or question and respond to each when you hear the word "answer". You will hear a signal indicating that the next statement or question is to begin. All correct answers to questions in parts A, B, C, and D are worth 1 point each, while the correct answers in Part E are worth 2 points each.

At the end of the five-week study you will take another test to evaluate your progress.

Note to teachers: Answers are given in parentheses.

Part A. COMPLETION. Use only one word to complete the thought.

1. A symbol that is used to denote any member or number of a given set is called a ____(Literal)____.

2. A statement which is neither true or false is called an __(open)__ sentence.

3. A variable with one value is called a __(constant)__.

4. A number or variable read as "a to the nth power", the superscript n is called the ____(exponent)____.

Part B. State orally each of the following expressions in an abbreviated form.

1. $X \cdot X =$ __$(X^2)$__.

2. $Y \cdot Y \cdot Y =$ __$(Y^3)$__

3. Five times a number equals sixty. __$(5X = 60)$__.

4. An unknown number increased by eleven is fourteen. __$(X + 11 = 14)$__.

5. A number less than three equals seven and a half. __$(X - 3 = 7\ 1/2)$__.

Part C. In the following open sentences identify orally the word or variable which makes it an open sentence.

1. Four increased by a number is greater than eight. (a number) .

2. A number minus one equals zero. (a number) .

3. An unknown number plus six equals thirty. (unknown number) .

4. Five times a number equals fifteen. (a number) .

5. Six minus three equals x. (X) .

6. A certain number multiplied by four is equal to a hundred. (certain number) .

7. An unknown number divided by six is equal to six. (unknown number) .

Part D. State whether the following sentences are true, false or neither.

1. Three and five are odd numbers. (true) .

2. Multiplication and division are inverse operations. (true) .

3. Eighteen is twice as much as nine. (true) .

4. Eight is a multiple of six. (false) .

5. He is twice as old as Mary's sister. (neither) .

6. Two times a number equals twenty-eight. (neither) .

7. A quantity squared increased by eleven is twenty. (neither) .

Part E. Translate the following English language sentences into their mathematical equivalent. Use the alphabet or letter "X" for the unknown number.

1. Two-thirds of what number equals 10? (2/3X = 10) .

2. Three times the sum of a number and six is 33. [3(X + 6) = 33] .

3. What number increased by 20 equals three times the same number? (X + 20 = 3X) .

4. What number increased by 5 equals twice the same number decreased by 4? ___(X + 5 = 2X - 4)___.

5. The sum of 8 and twice a number is 18. ___(2X + 8 = 18)___.

6. Twice a number less 8 is 18. ___(2X - 8 = 18)___.

7. Twice the sum of a number and 8 is 18. ___[2(X + 8) = 18]___.

8. Eight times the difference of a number and 2 is 18. ___[8(X - 2) = 18]___.

9. One-half the difference of 8 and a number is 18. ___[1/2(8 - X) = 18]___.

10. If 7 is subtracted from 4 times a certain number, then the result is 8 more than the number. ___(4X - 7 = X + 8)___.

11. One-third the sum of a certain number increased by 4 is 12 less than twice the number. ___[1/3(X + 4) = 2X - 12]___.

12. Seven more than the product of a number 5 is twice the difference of the number decreased by 4. ___(7 + 5X = 2X - 4)___.

APPENDIX E

EXPERIMENTAL STUDY INFORMATION SHEET

EXPERIMENTAL STUDY INFORMATION FORM

Name of Dept. Head (Mathematics) ____________________ Date __________
School or Institution ____________________________________________
Address (Street, City, State, Zip) ________________________________
________________________ Telephone (include area code) __________

1. No. of pre-Algebra Classes ______________ Class size ________

2. No. of Algebra I Classes ______________ Class size ________

3. What is the planned beginning date of class? ______________

4. What is the planned termination date of first term? ____________

5. How many are involved in teaching (Pre-Algebra/Algebra I)? ______

6. How many class sessions are included per week? ______________

7. How long is each class session? ________________________

8. When are the class sessions generally held (morning, afternoon)?

9. Is classroom participation mandatory? ____________________

10. If not, do teachers have released time to provide additional instructional services (tutorial)? ____________________

11. List specific skills to be learned.

PRE-ALGEBRA ALGEBRA I

A. ______________________________________________
B. ______________________________________________
C. ______________________________________________
D. ______________________________________________
E. ______________________________________________
F. ______________________________________________

12. Briefly describe the teaching/learning techniques used to achieve these skills. ______________________________

13. Briefly describe your evaluation techniques. ______________
______________________________________________

14. Title/Author of Texts. ________________________________
______________________________________________

# APPENDIX F

# INSTRUCTIONAL OUTLINES

## Unit One: VOCABULARY AND DEFINITIONS

Objective: To identify and define five major parts of speech in the English language and in the language of mathematics.

As in any study, in the study of mathematics it is well for us to begin by learning the names of the things that we shall talk about. The words of the mathematics language are classified and named according to their use or function in a sentence, the same as the words are classified and named in the English language. The classes or groups of words in the English language are called the parts of speech. In mathematics they are called parts of an equation or mathematics sentence. It is important to remember that it is the use in the equation or sentence that determines the part of speech to which a word belongs.

The five parts of speech from the English language most frequently used in the language of mathematics are: (1) noun, (2) pronoun, (3) verb, (4) adjective, and (5) conjunction.

| | | |
|---|---|---|
| I. | NAMING WORDS .................. | nouns<br>pronouns |
| II. | ACTION WORDS .................. | verbs |
| III. | DESCRIPTIVE WORDS .............. | adjectives |
| IV. | CONNECTIVE WORDS ............... | conjunctions |

DEFINITIONS AND EXAMPLES:

A noun is a word that names something, such as a person, a place, a thing, a quality, or an idea.

English language example: James is five years old. James is a noun, because it identifies a person.

Mathematics example: Five is a number. Five is a noun, because it identifies a concept.

A pronoun is a word used in place of a noun or as a substitute for a noun.

| | |
|---|---|
| English language example: | She is a student at the university. She is a pronoun, because it represents a person. |
| Mathematics example: | X is the age of John. "X" is a pronoun, because it represents a number. |

A verb is a word that expresses action. The major functions of verbs are to make a statement, to ask a question, and to give a command.

| | |
|---|---|
| English language example: | The boy threw a ball. Threw is the verb, because it describes the action. |
| Mathematics example: | Add five and six. Add is a verb in mathematics, it tells what action (operation) is to be performed. |

An adjective is a word that describes or limits a noun or pronoun.

| | |
|---|---|
| English language example: | A red house is next door. Red is an adjective, because it describes the color of the house. |
| Mathematics examples: | One boy took the test. One is an adjective in mathematics, it limits the noun, boy. It tells how many took the test. |
| | 3X = 15. 3 is an adjective in mathematics, it limits the pronoun, X. It tells how many Xs are required to equal 15. |

A conjunction is a word that joins words, phrases, or clauses.

| | |
|---|---|
| English language example: | A man and a child entered the car. And is the conjunction. The word and connects two nouns, man-child. |
| Mathematics example: | Eight and four equals twelve. And is the conjunction. The word and connects two nouns, eight and four. |

This vocabulary list is divided into four parts, based on the four basic mathematical operations called addition, subtraction, multiplication and division. The name of the mathematics process is identified, defined and then a corresponding part of speech from the English language grammar is assigned.

Using this approach will help to improve your ability to read (listen to) mathematics sentences and develop better comprehension skills necessary for problem solving in mathematics.

Comprehension of what you hear is closely related, in the nature of the task, to comprehension of what you read. If the material such as mathematics is of a technical or specialized character, then a certain amount of specialized information and vocabulary is necessary.

Listening for main ideas is one of the most valuable comprehension skills, the ability to find the main idea or central thought. In the English language the main ideas of most sentences can be tested by questions, asking who, what, where, when, how and why.

In mathematics we need a structure to solve problems more effectively. Structure may be thought of as a pattern. As we use it in mathematics, it is called an Analysis Method, in which effort is made to have learners systematically analyze the problem by requiring him to go through the following sequence of questions: (a) what is required? (b) what is given? (c) what operations are to be used, with what numbers and in what order? (d) estimate the answer, (e) solve the problem, (f) check the answer.

The first mathematical operation learned involving a pair of numbers is ADDITION.

ADDITION is a process of combining two or more sets of numbers so as to find their sum.

ADDITION is a noun in the English language grammar.

There are two parts in an ADDITION problem, the addend and the sum.

ADDEND is any of a set of numbers to be added.

ADDEND is a noun in the English language grammar.

In order to perform the operation of ADDITION, a command is given. This command is an ADDITION SYMBOL in written form or the word "add" in the spoken form. This command is an action word and is called a VERB in the English language.

SUM is the answer in an addition problem and it is a noun in the English language grammar.

LET US REVIEW THIS MATHEMATICS STATEMENT AND ANALYZE THE PARTS AND THEIR DEFINITIONS.

PROBLEM: 9 and 3 are twelve.
(a) the numbers 9 and 3 are called addends.
(b) the word "and" implies addition; or we may say "add 9 and 3". The word and is a conjunction in the English language grammar. It connects two numbers.
(c) the answer "twelve" is called sum.

TEACHER-STUDENT ILLUSTRATION: Analyze the following problem by identifying each part and giving the English language grammar equivalent.

PROBLEM: 5 plus 16 equals 21.

TEACHER: What is the number five called?

STUDENT RESPONSE: ___________ (addend).

TEACHER: What is the number 16 called?

STUDENT RESPONSE: ___________ (addend).

TEACHER: What is the sum of the problem?

STUDENT RESPONSE: ___________ (twenty-one).

TEACHER: What word in the problem 5 plus 16 equals 21 denotes addition?

STUDENT RESPONSE: ___________ (plus)

SUBTRACTION is the second major mathematics operation.
SUBTRACTION is a process of deduction (to take one number from another number).
SUBTRACTION is a noun in the English language grammar.

There are four parts associated with the process of SUBTRACTION problems, minuend, subtrahend, difference or remainder.

MINUEND is the quantity or number from which another quantity or number is to be subtracted. MINUEND is a noun in the English language grammar.

SUBTRAHEND is a quantity or number to be subtracted from another. SUBTRAHEND is a noun in the English language grammar.

DIFFERENCE or REMAINDER, is the result obtained by subtracting one number from another.

PROBLEM: 15 from 25 equals 10.

The number "25" is called the minuend.
The number "15" is called the subtrahend.
The answer "10" is called the difference.

TEACHER-STUDENT ILLUSTRATION:

TEACHER: Subtract 50 from 100, what is the difference?

STUDENT RESPONSE: ______________ (50).

TEACHER: What is the minuend in the problem?

STUDENT RESPONSE: ______________ (100).

TEACHER: What is the subtrahend in the problem?

STUDENT RESPONSE: ______________ (50)

MULTIPLICATION is the third major mathematics operation.
MULTIPLICATION is a process of putting together two numbers in which the number of times either is taken in summation is determined by the value of the other.

There are three parts associated with the process of MULTIPLICATION: multiplicand, multiplier, and product.

MULTIPLICAND is the number that is or is to be multiplied by another. It is a noun in the English language.

MULTIPLIER is the number by which the multiplicand is multiplied. Multiplier is a noun in the English language.

PRODUCT is the result obtained by multiplying two numbers. PRODUCT is a noun in the English language.

TEACHER: The product of 7 and 4 is 28.
The numbers 7 and 4 are factors or we may call 7 the multiplier and 4 the multiplicand. The answer, 28, is called the product.

TEACHER-STUDENT ILLUSTRATION:

TEACHER: Multiply 4 times 3. What is the product?

STUDENT RESPONSE: ____________ (12).

TEACHER: The number 4 is called what in the problem?

STUDENT RESPONSE: ____________ (Multiplier).

TEACHER: The number 3 is called what in the problem?

STUDENT RESPONSE: ______________(Multiplicand).

DIVISION is the fourth major mathematics operation.
DIVISION is a process of determining how many times one quantity is contained in another.
DIVISION is a noun in the English language grammar.

There are four parts associated with the process of DIVISION: dividend, divisor and quotient and remainder.

DIVISOR is the quantity (number) by which another quantity (number), the dividend, is to be divided. It is a noun in the English language.

DIVIDEND is a quantity (number) to be divided. Divided is a noun in the English language grammar.

QUOTIENT is the result obtained when one number, the dividend, is divided by another. It is a noun in the English language.

REMAINDER is something that is left over after other parts have been taken away. Remainder is a noun in the English language.

TEACHER-STUDENT ILLUSTRATION:

TEACHER: Forty-eight divided by 6 equals what number?

STUDENT RESPONSE: __________ (eight).

TEACHER: What is the number eight called?

STUDENT RESPONSE: __________(Quotient).

TEACHER: What is the dividend in the problem?

STUDENT RESPONSE: ____________ (forty-eight).

TEACHER: Is the number six the divisor?

STUDENT RESPONSE: __________ (Yes).

## PARTS OF SPEECH USED IN ENGLISH AND MATHEMATICS

### NOUNS

| English | Mathematics |
|---|---|
| 1. Number | X, Y (alphabets or literal numbers) |
| 2. Numbers | $X_1$ $X_2$, $X_3$; $Y_1$, $Y_2$, $Y_3$ |
| 3. Quotient | $\frac{Y}{Y_2}$ ÷ sign |
| 4. Difference | $X_1 - X_2$ - sign |
| 5. Sum | $X_1 + X_2$ + sign |
| 6. Product | $(X_1)(X_2)$ x sign |

### VERBS

| English | Mathematics |
|---|---|
| 1. is greater than | $>$ |
| 2. is less than | $<$ |
| 3. is, are, equal, equals | $=$ |

### ADJECTIVES

| English | Mathematics |
|---|---|
| 1. squared | $(\ )^2$ |
| 2. cubed | $(\ )^3$ |
| 3. square root of and exponential form | $\sqrt{\ }$, $(\ )^{1/2}$ |
| 4. cube root of | $\sqrt[3]{\ }$, $(\ )^{1/3}$ |
| 5. twice, two times, doubled | $2(\ )$ |
| 6. one-fourth of, 1/4 times | $1/4(\ )$, $\frac{(\ )}{4}$ |
| 7. one-half of, 1/2 times | $1/2(\ )$, $\frac{(\ )}{2}$ |

<u>Examples of the above adjectives</u>

| | | |
|---|---|---|
| 1. | squared | $(2)^2 = (2)\ (2) = 4$ |
| 2. | cubed | $(2)^3 = (2)\ (2)\ (2) = 8$ |
| 3. | square root of | $(9)^{1/2} = \sqrt{9} = 3$ |
| 4. | cube root of | $(27)^{1/3} = \sqrt[3]{27} = 3$ |
| 5. | twice, two times | $2(2) = 4$ |
| 6. | one-fourth of | $^{1/4}(8) = 2$ or $\frac{8}{4} = 2$ |
| 7. | one-half of | $^{1/2}(10) = 5$ or $\frac{10}{2} = 5$ |

## VOCABULARY AND DEFINITIONS

1. add (verb).--to combine or unite so as to increase in size, quantity or to form a sum.
2. addition (noun).--the process of computing with sets of numbers so as to find their sum.
3. addend (noun).--any of a set of numbers to be added.
4. sum (noun).--the amount obtained as a result of adding.
5. difference (noun).--a. the amount by which one quantity is greater or less than another; b. the amount that remains after one quantity is subtracted from another.
6. subtraction (noun).--the process of subtracting, deduction.
7. minuend (noun).--the quantity from which another quantity is to be subtracted.
8. subtrahend (noun).--a quantity or number to be subtracted from another.
9. remainder (noun).--something that is left over after other parts have been taken away.
10. multiplicand (noun).--the number that is or is to be multiplied by another.
11. multiplier (noun).--the number by which the multiplicand is multiplied.
12. multiplication (noun).--the conjunction of two real numbers in which the number of times either is taken in summation is determined by the value of the other.
13. product (noun).--the result obtained by performing multiplication.
14. quotient (noun).--the quantity resulting from division of one quantity by another.
15. dividend (noun).--a quantity to be divided.
16. divisor (noun).--the quantity by which another quantity, the dividend, is to be divided.

17. division (noun).--the operation of determining how many times one quantity is contained in another.

18. fraction (noun).--an indicated quotient of two quantities.

19. equation (noun).--a linear array of mathematical symbols separated into left and right sides that are designated at least conditionally equal by an equal sign.

20. divide (verb).--to separate into parts by the process of division.

21. equal (adjective).--the same quality or same capability, quantity, or effect as another. Related by a reflexive, symmetric, and transitive relationship.

22. equivalent (adjective).--the quality of being put into a one-to-one relationship.

23. expression (noun).--a designation of any symbolic mathematical form, such as an equation.

24. number (noun).--a member of the set of positive integers.

25. numerals (noun).--a symbol, such as a letter, figure or word used alone or in a group to denote a number.

26. sentence (noun).--a grammatical unit consisting of a word or a group of words that is separate from any other grammatical construction, and usually consists of at least one subject with its predicate.

27. more (adjective).--greater in number. A comparative of many.

28. truth set is the set of all elements contained in the replacement set of the variable which, when used as a replacement for the variable, the open sentence is then a true statement.

29. inequalities are symbols expressing $>$, $<$, $\geq$, or $\leq$ in open sentences.

30. solve (verb).--to find a solution to; to answer, or to explain.

31. plus (preposition).--added to; increased by; involving, or pertaining to addition.

32. times (preposition).--multiplied by.

33. symbol (noun).--something that represents something else by association, resemblance, or convention. A printed or written sign used to represent an operation, element, quantity, quality, or relation.

34. minus (preposition).--to reduce by the subtraction process.

35. unknown (adjective).--a quantity of unknown numerical value.

36. variable (adjective).--a quantity capable of assuming any of a set of values; a symbol used to denote any element of a given set.

37. phrase (noun).--a group of related symbols both numerical and literal (variable) without a subject and a predicate.

38. verb (noun).--is a word or symbol that expresses action or existence.

39. noun is a number or letter denoting quantity and is the subject of the sentence.

40. open sentence is a statement containing one or more variables.

41. simple sentence is made up of a simple clause that expresses a complete quantitative thought.

42. compound sentence is made up of at least two main clauses.

43. adjective is a class of words or letters used to modify a noun in a sentence.

44. conjunction is a word, letter or symbol used to join two or more sentences.

45. numerical coefficient is a specified quantity (value) in front of a literal number, 3x, 4x; 3 and 4 are called numerical coefficients.

46. superscript (exponent) serves an adverbial function in a mathematics expression, $4^x$; the x answers the question, "How many?"

47. subscript serves as an adjective in a mathematics expression, $4_x$; the x answers the question "What kind?"

48. algebra is a branch of mathematics that uses positive and negative numbers, letters and other systematized symbols to express and analyze the relationship between concepts of quantity in terms of formulas and equations.

49. formula is a set of algebraic symbols expressing a mathematical fact, rule or principle.

## UNIT ONE TEST

State orally each part of the following problems as the addend, sum, multiplier, multiplicand, product, difference, minuend, subtrahend, divisor, dividend, remainder or quotient.

1. 23 + 16 + 38
   23, 16 and 38 are called ______(addends)______.
2. 42 ÷ 7
   42 is called ___(dividend)___.
   7 is called___(divisor)___.
3. 46 ÷ 9
   46 is the ___(dividend)___.
   9 is the ___(divisor)___.
   5 is the ___(quotient)___.
4. three into 57
   three is the ___(divisor)___.
   fifty-seven is the ___(dividend)___.
   19 is the answer; what is the name given for the number 19?
   ______(quotient)______.
5. Four times 86 = 344
   What is the number 344 called? ___(product)___.
6. 57 and 29 equals 86
   What is the number 29 called? ___(addend)___.
7. What is the correct name for 1 over 2? ___(fraction)___.
8. How many parts are in a fraction? ___(two)___.
9. The top part of a fraction is called the ___(numerator)___.

10. The bottom part of a fraction is called

____(denominator)________.

11. In the following problem: 3/16 plus 4/12, what are the numerators ___(3 and 4)____; and what are the denominators __(16 and 12)___.

# UNIT TWO: Phrases and Sentences

Objectives:

1. The learner will be able to identify a phrase in the English language and in the language of mathematics.

2. The learner will be able to translate an English language phrase into a mathematical phrase.

3. The learner will be able to translate an English language sentence into a mathematical sentence (equation).

DEFINITIONS AND EXAMPLES:

E = English M = Mathematics

E. A phrase is a group of related words not containing a subject and verb.

M. A phrase is a group of related symbols both numerical and literal without a subject and a verb.

EXAMPLES:

E. Four more than a certain number.
Twelve less than twice a number.
Mary's age if she is one year less than three times her son's age.

M. X + 4, X represents the number.
2X - 12, X represents the number.
3X - 1, X represents the son's age.

EXERCISES: PHRASES

IDENTIFY THE WORD(S) IN EACH OF THE FOLLOWING PHRASES THAT DENOTE A MATHEMATICAL OPERATION AND IDENTIFY THE OPERATION AS EITHER ADDITION, SUBTRACTION, MULTIPLICATION OR DIVISION.

| | PHRASE | WORD | MATH OPERATION |
|---|---|---|---|
| 1. | the sum of the number and 6 | sum | addition |
| 2. | the number plus 7 | plus | addition |
| 3. | the number increased by 12 | increased | addition |
| 4. | 16 plus the number | plus | addition |
| 5. | 25 increased by the number | increased | addition |
| 6. | 25 decreased by the number | decreased | subtraction |
| 7. | the difference if the number is subtracted from 16 | difference | subtraction |
| 8. | the number diminished by 30 | diminished | subtraction |
| 9. | 23 less than the number | less than | subtraction |
| 10. | 26 less the number | less | subtraction |
| 11. | the difference of 16 is subtracted from the number | difference | subtraction |
| 12. | 60 subtracted from the number | subtracted (from) | subtraction |
| 13. | the number subtracted from 45 | subtracted (from) | subtraction |
| 14. | the number reduced by 95 | reduced | subtraction |
| 15. | _a_ increased by twice _b_ | increased | addition |

| | PHRASE | WORD | MATH OPERATION |
|---|---|---|---|
| 16. | <u>a</u> increased by two times <u>b</u> | increased | addition |
| 17. | twice the sum of <u>b</u> and <u>c</u> | twice, sum | multiplication and addition |
| 18. | 28 decreased by three times <u>b</u> | decreased, times | subtraction and multiplication |
| 19. | three times the difference of 2 and <u>b</u> | times, difference | multiplication and subtraction |
| 20. | 40 minus the product of 8 and <u>a</u> | minus, product | subtraction, multiplication |

# DRILL EXERCISES

INSTRUCTIONS: EXPRESS EACH OF THE FOLLOWING PHRASES IN MATHEMATICAL SYMBOLS.

| | MATHEMATICS PHRASES (SYMBOLS) |
|---|---|
| 1. the sum of 4 and 5 ______ | $4 + 5$ |
| 2. 4 added to 6 ______ | $6 + 4$ |
| 3. the sum of 5 and a number <u>x</u> ______ | $5 + X$ |
| 4. a number X plus a number Y ______ | $X + Y$ |
| 5. a number X minus a number Y ______ | $X - Y$ |
| 6. 6 less than a number X ______ | $X - 6$ |
| 7. 4 subtracted from 5 ______ | $5 - 4$ |
| 8. 5 subtracted from Y ______ | $Y - 5$ |
| 9. 5 increased by X ______ | $5 + X$ |
| 10. 5 decreased by Y ______ | $5 - Y$ |
| 11. the product of 4 and 6 ______ | $4 \cdot 6$ |
| 12. 5 times a number X ______ | $5X$ |
| 13. a number X multiplied by a number Y ______ | $X \cdot Y$ |
| 14. 6 divided by 3 ______ | $\frac{6}{3}$ |
| 15. the quotient of 8 divided by X ______ | $\frac{8}{X}$ |
| 16. X divided by Y ______ | $\frac{X}{Y}$ |
| 17. the quotient when 9 is divided into Y ______ | $\frac{9}{Y}$ |
| 18. twice X ______ | $2X$ |
| 19. one-half of X ______ | $\frac{X}{2}$ |
| 20. one-third of Y ______ | $\frac{Y}{3}$ |

## PHRASES

INSTRUCTIONS: TRANSLATE THE FOLLOWING ENGLISH LANGUAGE PHRASES INTO MATHEMATICAL PHRASES. USE THE LITERAL NUMBER X IN ALL PHRASES.

---

| | | |
|---|---|---|
| 1. | one-half of the number | $\frac{1}{2}X$ or $\frac{X}{2}$ |
| 2. | twice the number | 2X |
| 3. | five less than half the number | $\frac{X}{2} - 5$ |
| 4. | three times the number increased by 8 | 3X + 8 |
| 5. | the additive inverse of the number | - X |
| 6. | forty-five percent of X | .45X |
| 7. | twenty percent of X | .20X |
| 8. | a price of X dollars/decreased by 25% | X - .25X |
| 9. | two consecutive integers if the first one X | X and X+1 |
| 10. | the square of X | $X^2$ |
| 11. | the sum of the squares of X and 4 | $X^2+4^2$ or $X^2+16$ |
| 12. | the rate of a car traveling 8 miles per hour faster | X + 8 mph |
| 13. | the rate of a car traveling 10 miles per hour slower | X - 10 mph |
| 14. | a number four more than X | X + 4 |
| 15. | the number X decreased by 3 | X - 3 |
| 16. | 7 less than X | X - 7 |
| 17. | 5 more than twice Y | 2X + 5 |
| 18. | 4 less than half of X | $\frac{1}{2}X - 4$ |
| 19. | 8 less than 1/3 of X | $\frac{1}{3}X - 8$ |
| 20. | the cube of X | $X^3$ |

OPEN SENTENCE DEFINITION

A statement which has at least one variable that may be replaced by any member of a given set of words or symbols. It is open because one cannot decide whether the sentence is true or false until the variable is replaced by a specific word or number.

EXAMPLES:

English

He is the President of the United States

ANALYSIS OF THE OPEN SENTENCE:

The word he in the open sentence makes it an open sentence because when replaced with a specific name, it may be true or false. If he is replaced with the name Gerald Ford the sentence then is true, but if replaced with the name John Brooks, it is false.

Mathematics

X + 2 = 5

ANALYSIS OF THE OPEN SENTENCE IN MATHEMATICS:

The variable X in the sentence makes it an open sentence because when replaced with a specific number, it may be true or false. If X is replaced with the number 3 the sentence then is true, but if replaced with the number 2 it is false.

INSTRUCTIONS: IN THE FOLLOWING EXERCISES TRANSLATE INTO MATHEMATICAL SENTENCES.

| | ENGLISH SENTENCES | MATH SENTENCES |
|---|---|---|
| 1. | 4 less than what number equals 8? | $X - 4 = 8$ |
| 2. | One-half of what number equals 10? | $\frac{X}{2} = 10$ |
| 3. | Ten times what number equals 20? | $10X = 20$ |
| 4. | What number increased by 12 equals 17? | $X+12 = 17$ |
| 5. | Twice the number added to 8 is 16? | $2X+8 = 16$ |
| 6. | 15 less than three times what number is 27? | $3X-15 = 27$ |
| 7. | The sum of what number and twice the same number is 18? | $X+2X = 18$ |
| 8. | What number and 4 more equals five times the number? | $X+4 = 5X$ |
| 9. | Twice the sum of a certain number and five is 24. What is the number? | $2(X+5) = 24$ |
| 10. | The product of 8 and a number is 40. | $8X = 40$ |
| 11. | A number increased by 8 is 40. | $X+8 = 40$ |
| 12. | 8 less than a number equals 40. | $X - 8$ |
| 13. | Eight times a number less 8 is 40. | $8X-8 = 40$ |
| 14. | Eight times the sum of a number and 8 is 40. | $8(X+8) = 40$ |
| 15. | One-eighth of a number is 40 | $\frac{X}{8} = 40$ |
| 16. | What number plus 4 equals 12? | $X+4 = 12$ |
| 17. | What number minus 4 equals 12? | $X-4 = 12$ |
| 18. | What number multiplied by 4 equals 12? | $4X = 12$ |
| 19. | What number divided by 4 equals 12? | $\frac{X}{4} = 12$ |
| 20. | What number diminished by 8 equals 13? | $X - 8 = 13$ |

# UNIT TWO TEST

Part A. Translate the following English phrases into mathematical phrases. Let Y be the variable in each case.

1. Eight more than a number. $Y + 8$
2. Five less than a number. $Y - 5$
3. A number is divided by 3. $Y/3$
4. A number is multiplied by 4. $4Y$
5. One-fifth of a number. $1/5Y$
6. Four more than twice a number. $2Y + 4$
7. Three less than twice the positive integer Y. $2Y - 3$
8. Six more than four times the positive integer Y. $4Y + 6$

Part B. Translate each English open sentence into a mathematics open sentence (equation). Use X for the unknown variable (pronoun) in each problem.

1. Thirty-seven plus what number is seventy-three? $37 + X = 73$
2. Forty-four is two-thirds of what number? $44 = 2/3X$
3. What is 23% of 48? $X = 23\% (48)$
4. 25% of 40 is what? $25\% \cdot 40 = X$
5. What is 12% of 59? $X = 12\% \cdot 59$
6. 15 is what percent of 45? $15 = X\% \cdot 45$
7. 3 is 16 percent of what? $3 = 16\% \cdot X$
8. Fifteen minus what number is seven? $15 - X = 7$
9. What number is 4 more than 5? $X = 5 + 4$
10. Twenty-two is what number plus five? $22 = X + 5$
11. Twice some number is 3 more than five. $2X = 5 + 3$
12. Four-fifths of what number is twelve? $4/5 \cdot X = 12$

## UNIT THREE: Simple and Compound Sentences

Objectives: 1. The learner will be able to identify mathematical simple and compound sentences.

2. The learner will be able to translate simple and compound English language sentences into their mathematics equivalence using appropriate mathematics symbols.

Definitions and Examples:

A simple sentence is a structural unit with a verb and its subject. The subject of a sentence is a noun or pronoun. The verb tells that the subject does something.

English language example: Henry rides his bicycle every day.

Henry is the subject. Rides says that the subject does something.

Mathematics language example: Three and two equals five.

Three/two is the subject; equals says that the subject does something.

A compound sentence expresses two or more thoughts and are joined together by a conjunction or a disjunction.

The conjunction used most often in mathematics is "and". The disjunction used most often is "or".

English language example: Some birds can fly, and no monkeys fly.

Thought I: Some birds can fly.
Thought II: No monkeys can fly.

Mathematics language example: Two is less than four, and five is less than six.

Thought I: Two is less than four.
Thought II: Five is less than six.

When a compound sentence consists of two clauses, connected by the word and, the sentence is true only if both parts are true.

When the connective or is used in a compound sentence, the sentence is true if and only if either one or both of the parts are true. It is false only when both parts are false.

## DRILL EXERCISES

INSTRUCTIONS: LISTEN TO THE FOLLOWING ENGLISH LANGUAGE SENTENCES AND MATHEMATICS LANGUAGE SENTENCES AND IDENTIFY THE CONNECTIVES IN EACH. AFTER IDENTIFYING THE CONNECTIVES EXPRESS THE THOUGHT OR THOUGHTS STATED IN EACH.

AFTER EACH SENTENCE YOU WILL HAVE 15-20 SECONDS TO ANSWER, AFTER WHICH THE CORRECT ANSWERS WILL BE GIVEN.

---

1. The rain is cold and the crops are frozen.
2. Two times two is four and five times five is twenty-five.
3. Four is greater than two and two is greater than one.
4. Twelve is not two times four and twelve is two times six.
5. The boy is good at day and he is bad at night (the boy is bad at night).
6. John went home and Sue was out.
7. Nine plus eight equals seventeen and two plus eight equals ten.
8. John is tall and Bob is short.
9. Five equals X and three equals Y.
10. Mary went swimming and John went skating.
11. Five is more than three and three is less than five.
12. Carol went home and Susan studies French.
13. Two plus three equals three plus two and five plus four equals nine.
14. Find two numbers such that twice the first plus 5 times the second is 20 and 4 times the first less 3 times the second is 14 (use X and Y as the variables). $2X + 5Y = 20$ and $4X - 3Y = 14$.

NOTE: THE CONNECTIVE IN ALL SENTENCES IS THE CONJUNCTION "and".

# UNIT THREE TEST

Translate the following English sentences into mathematical sentences (equations). Let X represent the number in each case.

1. What number diminished by 8 equals 13? $X - 8 = 13$
2. Two-thirds of what number equals 10? $2/3X = 10$
3. Three times the sum of a number and six is 33. $3(X + 6) = 33$
4. What number increased by 20 equals three times the same number? $X + 20 = 13X$
5. What number increased by 5 equals twice the same number decreased by 4? $X + 5 = 2X - 4$
6. The sum of 8 and twice a number is 18. $2X + 8 = 18$
7. Twice a number less 8 is 18. $2X - 8 = 18$
8. Twice the sum of a number and 8 is 18. $2(X + 8) = 18$
9. Eight times the difference of a number and 2 is 18. $8(X - 2) = 18$
10. One-half the difference of 8 and a number is 18. $1/2(8 - X) = 18$
11. 2 more than one-eighth of a number is 18. $\frac{X}{8} + 2 = 18$
12. 8 less than half a number is 18. $\frac{X}{2} - 8 = 18$
13. A team won three times as many games as it lost. It played a total of 52 games. $X + 3X = 52$
14. A team won 20 games more than it lost. It played a total of 84 games. $X + X + 20 = 84$
15. A team won 15 games less than twice the number lost. It played a total of 78 games. $X + X - 15 = 78$
16. The sum of X and 12 is 21. $X + 12 = 21$
17. The result of adding X and 15 is 4X. $X + 15 = 4X$
18. 27 is the difference obtained when X is subtracted from 40. $27 = 40 - X$

19. 20 increased by twice X is 32. $20 + 2X = 32$

20. 7 less than three times X is 23. $3X - 7 = 23$

Translate the following English compound sentences into their mathematics equivalence.

21. Two times two is four and five times five is twenty-five.
$2 \cdot 2 = 4, 5 \cdot 5 = 25$

22. Four is greater than two and two is greater than one.
$4 > 2; 2 > 1$

23. Twelve is not two times four and twelve is two times six.
$12 \neq 2 \cdot 4; 12 = 2 \cdot 6$

24. Nine plus eight equals seventeen and two plus eight equals ten.
$9 + 8 = 17; 2 + 8 = 10$

25. Five equals X and three equals Y. $5 = X; 3 = Y$

26. Five is more than three and three is less than five. $5 > 3 > 5$

## UNIT FOUR: Analysis of Word Problems

Objective: The learner will listen for comprehension and relationships and formulate (translate) into equations clearly in a sequential pattern.

TEACHER-STUDENT ILLUSTRATION

Problem: Mr. Sharp sold his house for $9,000. His loss amounted to two-fifths of his cost. What did the house cost him?

| ANALYSIS | |
|---|---|
| Main Idea | Computing housing cost |
| Question | What was the original cost? |
| Important Fact(s) | Sold for $9,000<br>2/5 loss from original cost |
| Mathematics Sentence | C = Cost of house<br>$9,000 = Cost - 2/5 Cost<br>Note: Change C to 5/5/ to have like denominators |
| Computation | $9,000 = 3/5 Cost |
| Solution | $15,000 = Cost |
| Conclusion | The original cost of house was $15,000 |

CHECK YOUR SOLUTION:

$15,000 original cost

2/5 ($15,000) = $6,000

Selling price was $9,000

Therefore, $9,000 + $6,000 = $15,000

Problem: John is 3 years more than twice as old as his sister Jane. If Jane is 6 years old, how old is John?

| ANALYSIS | |
|---|---|
| Main Idea | To compute the age of John |
| Question | How old is John? X = John's age |
| Important Fact(s) | John is 3 years more than twice as old as Jane. Jane is 6 years old. |
| Mathematics Sentence | $X = 2(6) + 3$ |
| Computation | $X = 12 + 3$; $X = 15$ |
| Solution | 15 equals 3 more than 2 times 6 |
| Conclusion | John's age is 15 years |

Problem: How many boys are there in a class of 36 pupils if the number of girls is 6 more?

| ANALYSIS | |
|---|---|
| Main Idea | Number of boys and girls in the class total 36 |
| Question | How many X boys? X + ¢ for the number of girls |
| Important Fact(s) | 36 students in class. 6 more girls than boys |
| Mathematics Sentence | $X + X + 6 = 36$ |
| Computation | $2X = 30$, $X = 15$ |
| Solution | There are 15 boys in the class; 15 + 6 = 21 girls in the class |
| Conclusion | 15 + 21 = 36 students |

# UNIT FOUR TEST

Analyze each word problem according to four of the six major steps used to organize a word problem, main idea, question, important facts and mathematics sentence (equation).

1. A baseball team won 3 times as many games as it lost. It won 84 games. How many games did it lose? (Let X represent the number lost.) 28

2. Mr. Jonas got a roll of 50 pennies to use only for parking meters. If he used 5 pennies daily, how many days did the roll last? 10

3. A house cost $18,200. It cost seven times as much as the lot on which it was built. What was the cost of the lot? $2,600

4. J's age is 1/7 that of his aunt. If J is 8 years old, how old is his aunt? 56 years

5. The perimeter of a square is 50 inches. How long is one side? 12-1/2 inches.

6. After Jack deposited $55.25, his total bank balance was $1,342.70. How much did Jack have in his account before that deposit? $1,287.45

7. Jane's weight is 11 pounds more than normal for her height and age. If Jane weighs 109 pounds, what is the normal weight? 98 lbs.

8. Fred earns \$7.50 per week more than Bill. If Fred's weekly salary is \$115, what does Bill earn per week? \$107.50

9. A man traveled a certain number of miles by automobile, and then nine times as far by airplane. His total trip was 500 miles in length. How far did he travel by automobile? 50 miles

10. A certain number was doubled. Then the product was multiplied by 3. If the result was 84, find the number. 14

11. Sue owns 1 more than twice as many books as John. If Sue owns 59 books, how many books does John own? 29

## UNIT FIVE: Translations, Drill Exercises and General Review

Objectives:

1. The learner will be able to compare English language sentences with their mathematics equivalent sentences using appropriate symbols.

2. The learner will be able to translate a problem stated in words into a mathematics equation.

3. The learner will be able to solve the equation for the correct solution using the Analysis Method (main idea, question, important facts and correct sentence structure in symbols).

### DRILL EXERCISE I

Translate each expression into a mathematics sentence and find the solution that will make it a true sentence.

1. The sum of 5 and 9 is _________.

2. The sum of 3 and the number which is 4 more than 3 is _______.

3. The sum of 7 and the number which is 5 less than 7 is ______.

4. The number which is 2 more than 10 is ______.

5. The number which exceeds 5 by 3 is _______.

6. The number which exceeds 3 by 5 is ______.

7. Mary is 14 and Mike is twice as old as Mary; in 7 years Mike will be _____ years old and Mary will be ____ years old.

8. The sum of three consecutive integers, of which the first is $^{+}5$, is _______. (An integer is a real number whose absolute value is a whole number of arithmetic. Examples: -6, 0, 2, and 100.)

9. The integer between -6 and -8 is _______.

10. The difference of 12 from 15 is ______.

## REVIEW COMMENTS

We have examined some sentences and we have had to decide what numbers make open sentences true and what numbers make them false. We have established a set of symbols to indicate relations between numbers:

| | | |
|---|---|---|
| A. $=$ | C. $<$ | E. $\leq$ |
| B. $\neq$ | D. $>$ | F. $\geq$ |

A. $=$ means "is" or "is equal to."

B. $\neq$ means "not equal to."

C. $<$ means "is less than."

D. $>$ means "is greater than."

E. $\leq$ means "is less than or equal to."

F. $\geq$ means "is greater than or equal to."

The word "open" implies that we do not necessarily know whether the sentence is true or false. The sentence $5 + 2 = 7$ makes a true statement; but it is not an open sentence. $X + 5 > 2$ is an open sentence. We cannot state whether it is true or false until we have replaced the variable by some element of the domain.

It is possible to decide whether or not a numerical sentence like $4 + 3 = 7$ is true. Such a sentence involves only specific numbers. If you were asked to decide whether the sentence $X + 3 = 7$ is true or false, you could not tell. Until you know what "x" represents, you cannot decide. In the same way you cannot decide whether the sentence "He is a doctor" is true until the "he" is identified. In this sense, the variable "x" is used in much the same way as a pronoun in ordinary language.

To improve your ability to read (listen to) mathematics and to solve problems, you must recognize the usefulness of mathematics in your everyday life; begin your mathematics reading with ease as you would in a course less scientific and technical to nature; remember that scientific materials are written in a compact form, each word and symbol must be read; look for and identify key terms; attempt to establish relationships between words and symbols and make sure that your mathematical translation is identical to the English language verbal (word) problem. Also, it would help to have a general knowledge of common terms and their definitions. Do not attempt to use rote memorization for translations. Remember that mathematics is a language and you are working toward problem-solving and the problems must express complete thoughts.

We say that a sentence such as $x + 3 = 7$, which contains one or more variables, is an open sentence. The word "open" is suggested by the fact that we do not know whether it is true or false without more information.

In the same way, a phrase like $5x + 3$ or $7p + q$, involving one or more variables, is called an open phrase.

In the expression $\frac{2x - 3}{x}$, if the admissible numbers for the variable "x" are 1, 2, 5, 7, then x could be any one of the four members of the $X = (1, 2, 5, 7)$.

> A number which a given variable can represent is called a value of the variable.

All the sentences discussed so far have been simple. That is, they contained only one verb form. Let us consider a sentence such as:

$$4 + 1 = 5 \text{ and } 6 + 2 = 8$$

Your first impression may be that we have written two sentences. But actually the sentence is one compound sentence with the connective and between two clauses. In mathematics, as well as in English, we encounter sentences which are compounded out of simple sentences.

If the clauses are connected by the word or, the sentence is true if and only if at least one clause is true; otherwise it is false. If the clauses are connected by and, the sentence is true if and only if both clauses are true; otherwise it is false.

## UNIT FIVE TEST

Translate the following word problems into mathematics sentences using appropriate symbols and solve. Be sure to make complete sentences, subject with its complete verb. Use X as the variable in each problem.

1. Let us solve the following problem: "John's age increased by 5/6 of his age is equal to 33 years. Find his age."

2. Solve the following problem: The sum of 1/4 of a certain number and 1/7 of the same number is 22. What is the number?

3. The difference between 1/4 of a certain number and 1/5 of the same number is 6. What is the number?

4. Four-fifths of a certain number is 60. What is the number?

5. Five-sevenths of Mary's age is 30 years. How old is Mary?

6. John had a certain number of marbles and then purchased some more marbles. If he bought 3/4 as many marbles as he already had and, after his purchase, he had 84 marbles, how many marbles did he have at first?

7. John's age increased by 4/5 of his age is equal to 27 years. How old is John?

8. Mary's age diminished by 3/5 of her age is equal to 10 years. How old is Mary?

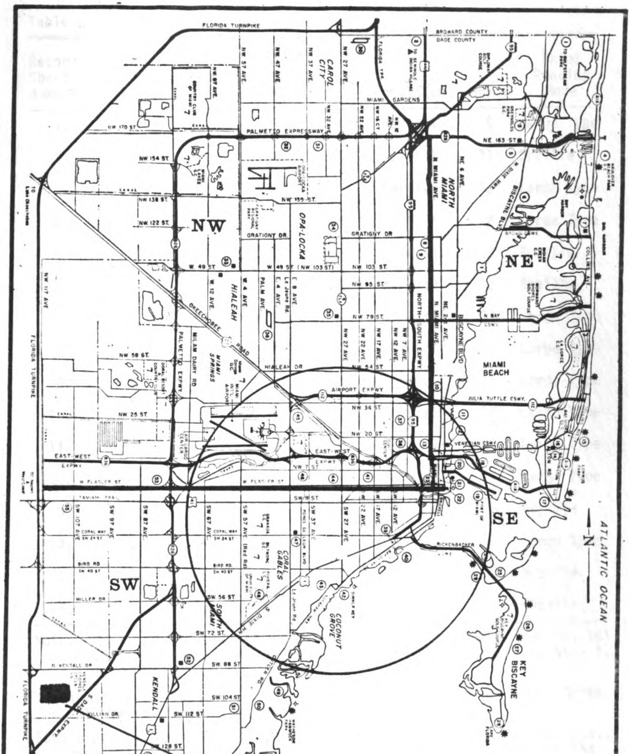
9. The sum of 1/3 of a certain number and 1/8 of the same number is 22. What is the number?

10. If 1/4 of Charles' age is added to 1/7 of his age, the sum is 11 years. What is Charles' age?

11. The difference between 1/3 of a certain number and 1/5 of the same number is 8. What is the number?

# APPENDIX G

# GEOGRAPHIC REGIONS OF SCHOOLS




Geographic Regions of Schools - Dade County

Miami-Dade Community College

Table 3. Characteristics of Subjects.

| Record Sheet Number | Area* and Subject | CA (yrs.) | Years at School | Sex | Condition | Grade | Chief Reading Mode |
|---|---|---|---|---|---|---|---|
| 1. | $S_1$ | 14 | 2 | M | Partial | 9 | Large Type |
| 2. | $SC_1$ | 16 | 4 | M | Partial | 11 | Braille |
| 3. | $SC_2$ | 17 | 3 | F | Partial | 12 | Large Type |
| 4. | $SC_3$ | 14 | 2 | M | Partial | 8.5 | Large Type |
| 5. | $NW_1$ | 15 | 3 | F | Partial | 9 | Braille |
| 6. | $SC_4$ | 17.5 | 2 | F | Partial | 12 | Braille |
| 7. | $S_2$ | 18 | 2 | F | Partial | 12 | Large Type |
| 8. | $S_3$ | 18 | 3 | F | Partial | 12 | Large Type |
| 9. | $S_4$ | 18.5 | 3 | M | Partial | 12 | Large Type |
| 10. | $SW_1$ | 18 | 3 | M | Partial | 12 | Large Type |
| 11. | $NC_1$ | 17.5 | 2 | F | Partial | 12 | Large Type |
| 12. | $SW_2$ | 17.5 | 2 | M | Partial | 12 | Large Type |
| 13. | $SW_3$ | 18 | 2 | M | Partial | 12 | Braille |
| 14. | $SW_4$ | 18 | 1 | F | Partial | 12 | Large Type |
| 15. | $SC_6$ | 18 | 1 | F | Partial | 12 | Braille |
| 16. | $SW_5$ | 17 | 2 | F | Partial | 12 | Braille |

NOTE: There were a total of 9 public schools and 3 private (13, 15, 16) schools involved in the study. By areas: S = 4; SC = 6; NC = 1; NW = 1.

*Area Codes: S = South; SW = Southwest; SC = South Central; NC - North Central; NW = Northwest; NE = Northeast.

Subscripts indicate the number of subjects from a particular area (i.e., S is read "1st student from the South area;" $S_2$ = 2nd student from the South area).

# APPENDIX H

# STUDENT RECORD SHEET

STUDENT RECORD SHEET

Name ____(Code)____________________ Sex ________ Age ___________

Subject __Algebra One Level__ Grade Level _____ Yrs. at School ___

Condition: Total _______ Partial _____ Name of School ___________

| WEEKS | UNIT TEST SCORES | COMMENTS |
|---|---|---|
| ONE | | |
| TWO | | |
| THREE | | |
| FOUR | | |
| FIVE | | |

NOTE: All Student Record Sheets must be returned along with test tapes and materials. You may wish to Identify the learner by a CODE NUMBER and record scores for your class roll.

PRETEST SCORE __________ POSTTEST SCORE __________

RES

Table 4. Individual Pretest Analysis.

| $X$<br>Scores | $X - \bar{X}$<br>Scores-Means | $(X - \bar{X})^2$<br>Difference Squared |
|---|---|---|
| 24 | 5.19 | 26.94 |
| 11 | -7.81 | 61.00 |
| 13 | -5.81 | 33.76 |
| 10 | -8.81 | 77.62 |
| 17 | -1.81 | 3.28 |
| 21 | 2.19 | 4.80 |
| 38 | 19.19 | 368.25 |
| 21 | 2.19 | 4.80 |
| 13 | -5.81 | 33.76 |
| 31 | 12.19 | 148.60 |
| 20 | 1.19 | 1.42 |
| 20 | 1.19 | 1.42 |
| 19 | .19 | .04 |
| 24 | 5.19 | 26.94 |
| 24 | 5.19 | 26.94 |
| 15 | -3.81 | 14.52 |

EQUATIONS: Pretest $\bar{X} = 18.81$

$$\text{Standard Deviation} = \frac{\Sigma(X_1 - \bar{X}_1)^2}{n - 1}$$

$$\text{Standard Deviation} = \frac{834.09}{15} = 55.61$$

Standard Deviation = 7.46

Table 5. Individual Posttest Analysis

| $X$<br>Scores | $X - \bar{X}$<br>Scores-Means | $(X - \bar{X})^2$<br>Difference Squared |
|---|---|---|
| 31 | 6.06 | 36.72 |
| -- | -- | -- |
| 35 | 10.06 | 101.20 |
| 28 | 3.06 | 9.36 |
| 26 | 1.06 | 1.12 |
| 28 | 3.06 | 9.38 |
| 39 | 14.06 | 197.68 |
| 24 | -.94 | .88 |
| 17 | 7.94 | 63.04 |
| 32 | 7.06 | 49.84 |
| 28 | 3.06 | 9.36 |
| 22 | -2.94 | 8.64 |
| 20 | -4.94 | 24.40 |
| 24 | -.94 | .88 |
| 28 | 3.06 | 9.36 |
| 17 | -7.94 | 63.04 |

EQUATIONS: Posttest $\bar{X} = 24.94$

$$\text{Standard Deviation} = \frac{584.88}{15} = 38.97$$

Standard Deviation = 6.24

Table 6. Unit Test Scores

| Subject | Unit Test One Maximum score: 18 | Two Maximum score: 20 | Three Maximum score: 26 | Four Maximum score: 11 | Five Maximum score: 11 |
|---|---|---|---|---|---|
| $S_1$ | 15 | 17 | 18 | 9 | 9 |
| $SC_1$ | -- | -- | -- | - | - |
| $SC_2$ | 18 | 15 | 18 | 8 | 7 |
| $SC_3$ | 16 | 17 | 15 | 7 | 6 |
| $NW_1$ | 12 | 15 | 19 | 8 | 7 |
| $SC_4$ | 14 | 7 | 2 | 3 | 2 |
| $S_2$ | 15 | 13 | 18 | 9 | 7 |
| $S_3$ | 9 | 11 | 10 | 5 | 5 |
| $S_4$ | 10 | 9 | 5 | 2 | 1 |
| $SW_1$ | 9 | 10 | 13 | 7 | 5 |
| $NC_1$ | 18 | 15 | 13 | 7 | 6 |
| $SW_2$ | 13 | 8 | 6 | 2 | 2 |
| $SW_3$ | 6 | 9 | 8 | 4 | 2 |
| $SW_4$ | 8 | 10 | 13 | 8 | 7 |
| $SW_5$ | 12 | 9 | 5 | 2 | 3 |
| $SC_6$ | 10 | 7 | 7 | 6 | 5 |

Table 7. Attitude Towards Mathematics Pretest Analysis.

| Question Number | X Scores | $X - X_1$ Scores-Mean | $(X - X_1)^2$ Difference Squared |
|---|---|---|---|
| 1 | 70 | 7.85 | 61.62 |
| 2 | 65 | 2.85 | 8.12 |
| 3 | 60 | -2.15 | 4.62 |
| 4 | 65 | 2.85 | 8.12 |
| 5 | 70 | 7.85 | 61.62 |
| 6 | 60 | -2.15 | 4.62 |
| 7 | 62 | -.15 | .02 |
| 8 | 63 | .85 | .72 |
| 9 | 68 | 5.85 | 34.22 |
| 10 | 73 | 10.85 | 117.72 |
| 11 | 59 | -3.15 | 9.92 |
| 12 | 66 | 3.85 | 14.82 |
| 13 | 73 | 10.85 | 117.72 |
| 14 | 61 | -1.15 | 1.32 |
| 15 | 49 | -13.15 | 172.92 |
| 16 | 52 | -10.15 | 103.02 |
| 17 | 63 | .85 | .72 |
| 18 | 74 | 11.85 | 140.42 |
| 19 | 68 | 5.85 | 34.22 |
| 20 | 71 | 9.00 | 81.00 |
| 21 | 64 | 1.85 | 3.42 |
| 22 | 66 | 3.85 | 14.82 |
| 23 | 65 | 2.85 | 8.12 |
| 24 | 71 | 9.00 | 81.00 |
| 25 | 55 | -7.15 | 51.12 |
| 26 | 53 | -9.15 | 83.72 |
| 27 | 48 | -14.15 | 200.22 |
| 28 | 52 | -10.15 | 103.02 |
| 29 | 61 | -1.15 | 1.32 |
| 30 | 77 | 14.85 | 220.52 |
| 31 | 69 | 6.85 | 46.92 |
| 32 | 71 | 8.85 | 78.31 |
| 33 | 53 | -9.15 | 83.72 |
| 34 | 54 | -8.15 | 66.42 |
| 35 | 62 | -.15 | .02 |
| 36 | 35 | -27.15 | 737.12 |
| 37 | 47 | -15.15 | 229.52 |
| 38 | 48 | -14.15 | 200.22 |
| 39 | 61 | -1.15 | 1.32 |
| 40 | 72 | 9.85 | 97.02 |

EQUATIONS: Pretest $\bar{X} = 62.15$ Standard Deviation $= \dfrac{\Sigma(X - \bar{X})^2}{n - 1}$

Standard Deviation $= \dfrac{3284.04}{39} = 84.21$

Standard Deviation = 9.18

Table 8. Attitude Towards Mathematics Posttest Analysis.

| Question Number | X Scores | $X - X_2$ Scores-Mean | $(X - X_2)^2$ Difference Squared |
|---|---|---|---|
| 1 | 52 | -3.30 | 10.89 |
| 2 | 60 | 4.70 | 22.09 |
| 3 | 48 | -7.30 | 53.29 |
| 4 | 53 | -2.30 | 5.29 |
| 5 | 66 | 10.70 | 114.49 |
| 6 | 59 | 3.70 | 13.69 |
| 7 | 61 | 5.70 | 32.49 |
| 8 | 59 | 3.70 | 13.69 |
| 9 | 54 | 1.30 | 1.69 |
| 10 | 67 | 11.70 | 136.89 |
| 11 | 43 | -12.30 | 151.29 |
| 12 | 54 | -1.30 | 1.69 |
| 13 | 67 | 11.70 | 136.89 |
| 14 | 54 | 1.30 | 1.69 |
| 15 | 39 | -16.30 | 265.69 |
| 16 | 50 | -5.30 | 28.09 |
| 17 | 58 | 2.70 | 7.29 |
| 18 | 66 | 10.70 | 114.49 |
| 19 | 60 | 4.70 | 22.09 |
| 20 | 58 | 2.70 | 7.29 |
| 21 | 50 | -5.30 | 28.09 |
| 22 | 62 | 6.70 | 44.89 |
| 23 | 51 | -4.30 | 18.49 |
| 24 | 65 | 9.70 | 94.09 |
| 25 | 49 | -6.30 | 39.69 |
| 26 | 51 | -4.30 | 18.49 |
| 27 | 43 | -12.30 | 151.29 |
| 28 | 50 | -5.30 | 28.09 |
| 29 | 58 | 2.70 | 7.29 |
| 30 | 65 | 9.70 | 94.09 |
| 31 | 60 | 4.70 | 22.09 |
| 32 | 65 | 9.70 | 94.09 |
| 33 | 49 | -6.30 | 39.69 |
| 34 | 53 | -2.30 | 5.29 |
| 35 | 58 | 2.70 | 7.29 |
| 36 | 36 | -19.30 | 372.49 |
| 37 | 45 | 10.30 | 106.09 |
| 38 | 53 | -2.30 | 5.29 |
| 39 | 56 | .70 | .49 |
| 40 | 65 | 9.70 | 94.09 |

EQUATIONS: Posttest $\bar{X} = 55.30$ Standard Deviation - $\frac{\Sigma(X - X)^2}{n - 1}$

Standard Deviation = $\frac{2412.10}{39} = 61.85$

Standard Deviation = 7.86

# APPENDIX I

# PHYSICIAN'S REPORT OF EYE EXAMINATION

PLEASE SUBMIT TO: Coordinator, Programs for the Visually Impaired
Exceptional Child Education
Dade County Public Schools
1444 Biscayne Blvd., Suite 215
Miami, Florida 33132

## PHYSICIAN'S REPORT OF EYE EXAMINATION

Name of Pupil ______________ Birthdate _________ Sex _______ Phone_____

Address ______________________________ School ________________________

Name of Parent or Guardian __________________ Address _________________

REASON FOR REFERRAL: History of eye condition, date of onset, eye conditions of others in family, type of placement, etc. _________________

______________________________________________________________________

______________________________________________________________________

| | Right | Left | Both |
|---|---|---|---|
| Visual acuity without glasses | | | |
| Visual acuity with present glasses | | | |
| Visual acuity with prescription recommended | | | |

Type of ocular defect or disease _____________________________________

______________________________________________________________________

Etiology (Probable) __________________________________________________

Prognosis ____________________________________________________________

*If unable to check visual acuity, due to immaturity or other factors, is this child, in your opinion, legally blind?

Restrictions: Close eye work __________________ Physical Activity ____

Use of glasses: None _______ Close work only ______ Constantly ______

Angular distance subtended by peripheral field (in degrees) __________

Symptoms to watch for ________________________________________________

RECOMMENDATIONS: _____________________________________________________

______________________________________________________________________

______________________________________________________________________

DATE OF EXAMINATION __________ DATE OF NEXT EYE EXAMINATION ___________

*See A. reverse side.

____________________________________
Examiner's Signature

____________________________________
Address

MIS-21665 (5-76)

## SERVICES FOR PARTIALLY SEEING AND BLIND CHILDREN IN DADE COUNTY

In general, the following criteria are considered in admitting a child to the program for the visually impaired:

A. *Children having a visual acuity of 20/200 or less in the better eye after correction or treatment are considered "legally blind".

B. Children having a visual acuity of 20/70 or less in the better eye after correction or treatment are also eligible for the visually impaired programs.

C. Progressive eye diseases.

D. Children with corneal opacities irrespective of vision, who are developing symptoms of ocular fatigue.

E. Children suffering from diseases of the eye where the condition is local or which are the result of a general disease or body condition, and where the vision is seriously affected.

F. Since harmful psychological reactions may result from eye difficulties, special educational facilities may be necessary as a temporary measure for readjustment as well as for educational processes in the following:

1. Eye operations, especially where enucleations have taken place.

2. Treatment in which the temporary occlusion of one eye is necessary.

3. Childhood diseases which may temporarily affect the eyes.

## SCOPE OF SERVICES:

Itinerant teachers provide weekly or bi-weekly service to children who are able to function adequately in a regular classroom situation in their own home schools. These children participate fully in the regular activities of the school but receive some additional help, depending upon individual need, in the form of large type, low vision aids, reading stands, instruction in such special skills as typing and/or tutoring in academic skills as needed. These teachers also provide counseling in regard to lighting, seating arrangements, signs to watch for which might indicate lessening vision, or other special needs related to the eye condition.

Blind or near-blind children who need more help than can be provided in this way are provided transportation to a special education center where there is a qualified teacher to give instruction in Braille, mobility, and other special skills. These children also spend varying amounts of time in a regular classroom with normally seeing peers, depending upon individual need and ability.

# BIBLIOGRAPHY

# BIBLIOGRAPHY


Ausubel, David P. The Psychology of Meaningful Verbal Learning, (New York: Grune and Stratton, 1963).

Axelrod, S. "The Effects of Early Blindness." American Foundation for the Blind, 1959.

Brothers, R. J. "Arithmetic Computation by the Blind: A Look at Current Achievement." Education of the Visually Handicapped, 1972, 1, 1-8.

________. "Learning Through Listening." The New Outlook, September, 1971, pp. 224-231.

Brown, Duane. Changing Student Behavior: A New Approach to Discipline (Dubuque, Iowa: W. C. Brown Co., 1971).

Bruner, Jerome, Jacqueline Goodnow, & George A. Sustin. A Study of Thinking (New York: Science Editions, 1967).

Call, R. and N. Wiggin. "Reading and Mathematics," The Mathematics Teacher, 5, February 1966, pp. 149-157.

Cambridge, M. "Questioning the Application of Public Schools Methods in Teaching Arithmetic Computation to Blind Children," Proceedings, American Association of Instructors of the Blind, 1948, 74-78.

Carroll, J. B. Language and Thought (Englewood Cliffs, New Jersey: 1964).

Cratty, B. Perceptual-Motor Behavior and Educational Processes (Springfield, Ill.: Charles C. Thomas, 1969).

Duncker, Karl. On Problem-Solving, Psychological Monographs: General and Applied, Vol. 58, No. 5, Washington, D.C., American Psychological Association, 1945.

Faucett, Harold P. "Nature and Extent of Reading in Mathematics," Improving Reading in Content Fields (Chicago, Ill.: University of Chicago Conference on Reading, 1946.

Fitzgerald, J. T. Programmed Modern Arithmetic Logic (Boston: D. C. Heath Co., 1974.

Foulke, Nelson. "Rapid Listening." Listening: Readings and Reports (New York: The Scarecrow Press, Inc.), pp. 170-171.

________. "Reading by Listening VI," Education of the Visually Handicapped, 1970, pp. 23-25.

________. Report of the Louisville Conference on Time Compressed Speech, 1967.

Freeman, George F. "Reading and Mathematics," The Arithmetic Teacher, November 1973, pp. 523-529.

Fries, Charles C. American English Grammar (New York: Appleton-Century-Crofts, Inc., 1940), pp. 16-25.

Gagne, Robert. The Conditions of Learning (New York: Holt, Rinehart and Winston, 1965).

Gesell, A. and F. Illg. Youth: The Years from Ten to Sixteen (New York: Harper and Brothers, 1959).

Hernandez, Norma G. Instructional Strategies in Mathematics Education, Mathematics Teacher, November 1973, pp. 607-612.

Hunt, Earl. "Computer Simulation: Artificial Intelligence Studies and their Relevance to Psychology," Annual Review of Psychology 19: 135-168, 1968.

International Journal for the Education of the Blind, Vol. XIII, No. 4, May 1964.

Jamison, King. "Grammatically Speaking," The Mathematics Teacher, November 1966, pp. 640-645.

Kane, R. B. The Readability of Mathematical English, Journal of Research in Science Teaching, 1967-1968, 5, 296-298; The Readability of Mathematical Textbooks: Revisited, Mathematics Teacher, 1969.

Kilpatrick, Jeremy. Analyzing the Solution of Word Problems in Mathematics: An Exploratory Study, Doctor's Thesis, Stanford University, 1967.

________. "Problem Solving in Mathematics," Journal of Educational Research, Vol. 39, No. 4, 1969, pp. 523-534.

Kulm, Gerald. "The Readability of Elementary Algebra Textual Materials" (Doctor's dissertation, Teacher's College, Columbia University, 1971).

_______. Sources of Reading Difficulty in Elementary Algebra Textbooks, Mathematics Teacher, November 1973, pp. 649-652.

Lees, Fred. "Mathematics and Reading," Journal of Reading, May 1976, pp. 621-626.

Lowenfeld, B. "What is Creative Teaching?" in E. P. Torrance (Ed.), Creativity: Proceedings of the Second Minnesota Conference on Gifted Children (Minneapolis: University of Minnesota Press, 1959), pp. 38-50.

Martin, Mavis D. Reading Comprehension: Abstract Verbal Reasoning and Computation as Factors in Arithmetic Problem Solving (Doctor's thesis, Iowa City: State University of Iowa, 1963, Dissertation Abstracts 24: 45, 47-48; No. 11, 1964.

Mitchell, Lazarus. "Mathophobia: Some Personal Speculations," The National Elementary Principal, Vol. LIII, No. 2, January/February 1974, pp. 16-22.

Morris, B. "Education - Listening," The Visually Handicapped, 1966, pp. 59-60.

National Council of Teachers of Mathematics Preliminary Report of the Conference on the Low Achievers in Mathematics, Washington, D.C.: U. S. Office of Education, 1964.

Nesher, Pearla A. From Ordinary Language to Arithmetical Language in Primary Grades (Doctor's thesis, Harvard University, 1972).

Nolan, C. Y. "The Japanese Abacus as a Computational Aid for Blind Children," Exceptional Children, 1964, 31, 15-17.

Nolan, C. Y. and S. C. Aschroft. "The Stanford Achievement Arithmetic Computation Tests: A Study of an Experimental Adaptation for Braille Administration," Int. J. Educ. Blind, 1959, 8, 89-92.

_______. "Research in Teaching Mathematics to Blind Children," International Journal for the Education of the Blind, Vol. XIII, No. 4, May 1964, pp. 97-100.

Onwake, E. and A. Solnit. "It Isn't Fair, The Treatment of a Blind Child," Psychoanal. Stud. Child 16: 352-404, 1961.

Paige, Jeffery and Herbert Simon. Cognitive Processes in Solving Algebra Problems. Problem Solving: Research, Method and Theory, edited by Benjamin Kleinmuntz (New York: John Wiley, 1966), Chapter 3.

Piaget, Jean. The Child's Conception of Number (New York: Humanities Press, 1941).

________. "Development and Learning," Journal of Research in Science Teaching II, 3, 1964.

Polya, George. Mathematical Discovery: On Understanding, Learning, and Teaching Problem Solving (New York: Wiley, 1962, Vol. I; 1965, Vol. 2).

Rankin, Paul T. "The Importance of Listening Ability," English Journal (College Edition), XVII (October, 1928), pp. 623-630.

Riddle, C. F. "What Are the Most Retarding Factors in Learning Seventh and Eighth Grade Arithmetic?" Proceedings of the American Association of Instructors of the Blind, 1949, 86-95.

Robinson, E. and H. Alan Robinson. Improving Reading in Every Class (Abridged edition; Boston: Allyn and Bacon, Inc., 1972).

Robinson, F. Effective Study (New York: Harper and Row, Publishers, 1946).

Rowe, E. D. Speech Problems of Blind Children (New York: American Foundation for the Blind, 1958).

Schneider, S. Reichard M. and D. Rapport. "The Development of Concept Formation in Children," American Journal Orthopsychiatry, 14 (1): 156-1616, 1944.

Schott, A. F. "Individualized Mathematics - Level Two," Teachers Guidebook (Burlington, Wis.: Tools for Education, Inc., 1961b).

Smith, Nila Banton. "Patterns of Writing Different Subject Areas," Journal of Reading, Vol. 8, No. 1, October 1964, pp. 31-33.

Steffe, Leslie P. The Effects of Two Variables on the Problem Solving Abilities of First Grade Children. Technical Report No. 21, Madison, Wis., Research and Development Center for Cognitive Learning, University of Wisconsin, March 1967.

Stern, Catherine. Children Discover Arithmetic (New York: Harper and Brothers, 1949), p. 126.

Stockers. Kansas Project on Listening Education for the Blind, 1970.

Streby, George. "Reading in Mathematics," Arithmetic Teacher, Vol. IV, March 1957, pp. 79-81.

Suppes, Patrick, Elizabeth Loftus and Max Jerman. Problem-Solving on a Computer-based Teletype," Technical Report No. 141, Psychology Series, Stanford Institute for Mathematical Studies in the Social Sciences, Stanford University, March 1969.

Taylor, W. L. "Cloze Procedure: A New Tool for Measuring Readability," Journalism Quarterly, 1953, 30, 415-433.

Thompson, Elton N. Readability and Accessory Remarks: Factors in Problem Solving in Arithmetic (Doctor's thesis, Stanford University, 1967; Dissertation Abstracts 28: 246A-65A; No. 7, 1968).

Thorndike, Edward L. The Psychology of Algebra (New York: MacMillan, 1924), pp. 132-165.

________. "Reading as Reasoning," Journal of Educational Psychology, Vol. 8, No. 6, June 1917, p. 329.

Tillman, M. H. "The Performance of Blind and Sighted Children on Weschler Intelligence Scale for Children: Study I," The International Journal for the Education of the Blind, March, 1967.

________. "The Performance of Blind and Sighted Children on Weschler Intelligence Scale for Children: Study II," The International Journal for the Education of the Blind, May 1967.

Williams, Mary and R. McCreight. "Shall We Move the Question?" Arithmetic Teacher 12:418-421, 1965.

Zacharias, Jerrold R. "The Importance of Quantitative Thinking," The National Elementary Principal, Vol. LIII, No. 2 January/February 1974, pp. 8-13.

Zigmond, Naomi K. Auditory Learning (San Rafael, California: Dimensions Publishing Co., 1968).

Zweibelson, I. and C. Fisher Borg. "Concept Development of Blind Children," The New Outlook, September 1967.