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Some Cognitive and Affective Outcomes of Modality Structured Instruction in the Linear Metric System.

Jocelyn Marie Rees
Louisiana State University and Agricultural & Mechanical College

SOME COGNITIVE AND AFFECTIVE OUTCOMES OF MODALITY STRUCTURED INSTRUCTION IN THE LINEAR METRIC SYSTEM

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Jocelyn Marie Rees
B.A., Southwestern Louisiana University, 1960
M.A., Catholic University of America, 1970
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ABSTRACT

The purpose of this study was to investigate the effectiveness of teaching strategies structured in four learning modalities. The modality presentations were used to teach a unit on linear measurement in the metric system to fourth grade students. Objectives of the unit were identified and activities to achieve them were devised for a visual, an auditory, and a kinesthetic-tactile presentation. A fourth presentation (VAKT) utilized selected activities from the first three presentations. Each class participating in the study was taught by one of the four modality presentations for forty minutes a day over a period of three weeks. All teaching was done by a single individual.

Subjects were members of one fourth grade class in each of four schools in the Catholic Diocese of Baton Rouge. Modality treatments were randomly assigned to the classes. A total of 125 students received instruction as follows: Group A (visual treatment), thirty-four students; Group B (auditory treatment), twenty-nine students; Group C (kinesthetic-tactile treatment), thirty-four students; Group D (visual-auditory-kinesthetic-tactile treatment), twenty-eight students.

Scores were provided for each student on three instruments, a pre-test and a post-test measuring achievement of the content unit objectives, and an attitude scale. This scale included three items

which would be scored in the study and nine items which were irrelevant. Since appropriate standardized tests were not available, all instruments were constructed by the investigator. The pre-test and the post-test were validated by a jury of experts in the teaching of elementary mathematics; the attitude scale was refined by a committee of fourth grade teachers.

The post-test scores were analyzed by use of an analysis of covariance procedure in order to correct for initial differences among the groups. The adjusted means on the thirty-one item post-test were: Group A, 28.028; Group B, 25.314; Group C, 27.7727; Group D, 25.9366. Tests for the significance of the difference between means revealed differences, significant at the .05 level, between the achievement of Groups A and B and that of Groups B and C. Differences between the other four pairs of groups were not significant.

The attitude scale was administered at the close of the unit. Student responses were converted to numerical values as follows: +1 for a positive response, 0 for an indifferent response, -1 for a negative response. For each item responses of students in Group B were least favorable. Scores provided by the four groups on each of three items were analyzed for variance.

Item Three was intended to measure student attitudes toward the metric system. There was a difference, significant at the .05 level, between the responses of students in Groups B and D. There

was a difference, significant at the .01 level, between the responses of students in Groups B and C.

Item Seven attempted to measure students' feelings about the respective modality presentations which each group experienced. There was a difference, significant at the .05 level, between the responses of students in Groups A and B. There were differences, significant at the .01 level, between the responses of students in Groups B and C and Groups B and D.

Item Eleven was intended to measure student attitudes toward the general management of the class during the study. There were differences, significant at the .01 level, between the responses of students in Groups A and B, Groups B and C, and Groups B and D.

The study showed a need for a rapid and reliable procedure to identify modality preference. It was also recommended that additional research be undertaken to determine the effects of modality preference upon the learning of mathematics.

Chapter 1

INTRODUCTION

The ideal of individualization has long beckoned to members of the teaching profession. Attempts to reach this ideal have resulted in changes in organizational patterns, curriculum adjustments, and methodological innovations. The success of each of these adjustments depends upon an accurate assessment of the characteristics of the individual student. Frequently this evaluation has consisted of acquiring information about the student's communication skills, intellectual ability, motivational patterns, and knowledges and skills possessed prior to instruction. Now differences in students' facility in utilizing sensory learning modalities are beginning to be recognized as another aspect of the assessment process. Largely as a result of the work being done with children having learning disabilities, there is a growing realization that the sensory pathways are not equally functional among all children. For some a visual approach produces the best results; others learn more efficiently through auditory presentations; and for a few, kinesthetic and tactile pathways produce the greatest gain.

Teachers occasionally attempt, through observation and informal techniques, to determine a student's preferences among sensory modalities and adjust instruction accordingly, but formal instruments for such evaluation are still lacking.

STATEMENT OF THE PROBLEM

This study was an attempt to evaluate the effectiveness of employing teaching methods structured in four different sensory modalities in presenting to fourth grade students a unit on linear measurement in the metric system. The presentations were structured to be primarily visual, primarily auditory, primarily kinesthetic-tactile, and visual-auditory-kinesthetic-tactile. Students participating in the study were designated as Groups A through D. Each group received instruction through only one of the modality presentations.

This study attempted to answer the following questions:

1. Will there be significant differences between the achievement of the unit objectives by students in each pair of groups? Specifically, will there be such differences between the achievement of students in Groups A and B, Groups A and C, Groups A and D, Groups B and C, Groups B and D, and Groups C and D?

2. Will there be significant differences between the attitudes expressed by students in each of the pairs of groups in regard to:

   a. The metric system?

   b. The modality presentation experienced by each group?

   c. The teaching methods and general management of the class during the study?

IMPORTANCE OF THE STUDY

This study was important for the following reasons:

1. The greatest number of studies to determine the effects of employing a particular learning mode in instruction have been performed in the discipline of language arts.

2. No studies have been found dealing with the application of learning modalities to the presentation of mathematics concepts and skills.

3. Modality preference can have an effect upon the learning of mathematics since perception is a prerequisite to the formation of concepts.

4. An attempt to measure students' attitudes toward instruction structured in distinct learning modalities could help to clarify the utility of devising such presentations.

DEFINITION OF TERMS

Auditory treatment: A learning strategy which depends primarily upon the sense of hearing was considered an auditory treatment.

Kinesthetic-tactile treatment: A learning strategy which depends primarily upon the sense of touch and awareness of bodily movement was considered a kinesthetic-tactile treatment.

Preferred learning modality: That sensory pathway which provides the most effective input channel for a particular individual was described as his preferred learning modality.

Visual treatment: A learning strategy which depends primarily upon the sense of sight was considered a visual treatment.

VAKT treatment: A learning strategy which combines activities using visual, auditory, kinesthetic, and tactile modalities was classified as a VAKT treatment.

DESIGN OF THE STUDY

Content

A unit on linear measurement in the metric system was constructed as the content for the study. This selection was made partly on the basis of the timeliness of such a unit since there were strong indications that the United States would adopt the metric system as the primary system of measurement within the next decade. The topic was also practical since measurement concepts are frequently needed in the activities of daily life. Further, it was felt that the fourth grade level was a suitable placement for this unit. It was unlikely that fourth grade students had had any extensive previous experience with the metric system. An examination of several series of recently published mathematics texts revealed very slight attention (usually not more than two pages of text) to the topic, frequently placed near the end of the text and presumably taught toward the end

of the school year. Supplementary materials for instruction in the metric system were becoming increasingly available, but few of these had yet appeared in the schools. Nevertheless, children in this grade could be expected to have attained the Piagetian stage of concrete operations and to have matured sufficiently to profit from instruction in the use of a standard unit. Trueblood (1973:6) recommended that "systematic instruction of the metric system should begin when students are about eight years old."

Population and Sample

The population was defined as the fourth grade students in the regular classes of the schools of the Catholic Diocese of Baton Rouge during the academic year 1973-1974.

The sample consisted of four classes selected from among those in the population. Since it was necessary to use pre-formed groups, the selection of the classes for use in the study was made so that these groups were as nearly representative of the entire population as possible.

Treatments

Four treatment approaches were devised to achieve the objectives of the unit of content. In Treatment A, activities were primarily visual in nature. Treatment B was built around predominantly aural activities, while Treatment C approached the objectives

through activities which are mainly kinesthetic-tactile. Treatment D consisted of activities in all three of the above modes.

Each of the classes participating in the experiment was randomly assigned to one of the four treatments. A single individual instructed all four groups.

Instrumentation

Because the content unit in this study has not in the past been a part of the fourth grade mathematics curriculum, it was not possible to make use of existing standardized tests as instruments of evaluation. Instead, it was necessary to construct instruments to measure the achievement of the objectives of the unit. Validation of these instruments was accomplished through obtaining a consensus among a committee of experts in elementary mathematics.

An attitude scale was constructed to measure the subjects' reactions to the instruction experienced in this unit. Students were asked to mark one of three "faces" to indicate their feelings about the content and the presentation of the unit. A number of items which had no bearing on the study were used to make the purpose of the study less obvious. A group of fourth grade teachers was asked to assist in refining th scale.

Procedures for Gathering and Analyzing Data

Each student was given both a pre-test and a post-test on the objectives of the unit. An analysis of covariance was used to correct for initial differences among the four classes. The six comparisons possible among the four treatment groups were formed and the resulting comparisons were analyzed for statistical significance.

The attitude scale was administered to all groups at the close of the unit. Those questions having no bearing upon the study were eliminated and only those which reflected attitudes toward the teaching unit of the study were analyzed.

Chapter 2

REVIEW OF RELATED LITERATURE

NEED FOR LEARNING MODALITY RESEARCH

Among the kinds of accommodation to individual differences which have currently been receiving attention was the recognition of variations among students in the preferred learning modality.

Clemmens (1967:95) indicated the need for such provisions and pointed out the most commonly observed symptoms of children who could profit from them.

> It is well known that the schools contain many children who seem destined to be educational casualties--bright children whose school life is burdened because of inordinate difficulty in mastering the basic academic skills. A characteristic of most of these children is delayed acquisition of reading ability. They may also have similar difficulty with arithmetic, spelling, and writing.

Cooper (1970:3) felt that we must begin to match the teaching method to the child's learning style. He noted that some reading clinics treat retarded readers by selecting a teaching method which matches the child's modality strength and suggested that this same procedure might well be employed in beginning reading instruction so that each child could be taught by a method appropriate for him.

As suggested by Clemmens, the primary impetus for developing techniques by which to identify a child's learning mode and to utilize his preferred modality in instruction has come from educators

who work with exceptional children. Therefore, it was from this area that related information was sought.

PERCEPTUAL BASIS OF LEARNING MODES

Rosner (1972:3) stated that developers of instructional programs make important assumptions about the basic information processing skills which students bring to the classroom. There was recognition of and provision for variation in students' cognitive abilities, but differences in the processes by which sensory data are organized were given little attention. It was assumed that a child who possessed normal intelligence and normal visual and auditory acuity would also unquestionably be adept in interpreting the data gathered by his senses. However, this was not always the case. Rosner (1972:10) stated:

> These are the ones who, in varying degrees, are less capable than expected in one or more of the performance skills described above: that is in receiving and/or producing visual and/or acoustical sensations in a reliable and efficient manner.

The most frequent cause of these learning difficulties was, according to Frostig, a disturbance of the child's perceptual abilities. "Many children have perfect hearing and 20-20 vision yet lack perceptual skills. The difficulty lies in the brain's faulty interpretation of the sense data." (Frostig, 1967:389) Because perception is the means by which we form connections between

ourselves and our environment, the child whose visual, auditory, or kinesthetic perception is inadequate is isolated by a lack of recognition of his world.

Such children would not necessarily be considered for special education classes since, according to Rosner, (1972:4) these students usually possess all the characteristics of the "unimpaired." Adelman (1971:528) has expressed the view that many children labeled as "learning disabled" may not really be so. Since most of these children have already experienced some degree of school failure, and since this experience itself tends to compound the difficulty of diagnosing causes of problems, he felt that data used in making an evaluation of such children might reflect mainly the effects of their school failure.

Regardless of its etiology, the inadequate processing of sensory data constitutes a major obstacle to the child's normal intellectual development. Piaget classified perception among the figurative activities; that is, those which "attempt only to represent reality as it appears, without seeking to transform it." (Piaget, 1970:7)

Osborne, (1973:626) speaking of the perceptual burdens occurring in the learning of mathematics, called attention to the critical position of perception. "To a marked extent the attainment of the cognitive outcome depends upon the perceptual base, particularly for the younger child."

The above statement contributed significance to Wepman's view that among children there are major differences in perceptualization which are fundamental to learning (Wepman, 1967:354). His position was that the levels of learning form a hierarchy in which perception underlies conception so that the coding of an input signal is without meaning until association with previously stored information raises it to the level of comprehension. This integration of present experience with past learning could take place only if the input transmission pathways were intact and each type of signal was capable of arousing past learning received along other modalities.

There might even be an element of urgency in the remediation of perceptual difficulties. Frostig (1967:390-391) felt that there are certain "optimum periods" in human beings for the development of motor skills, speech, perception, and intelligence, with that for perception normally occurring between the ages of three and seven and a half. After this time, the child's primary task becomes that of cognitive development. Children with perceptual difficulties have been found to make significant progress in overcoming them provided specialized training was begun early during the optimum period.

The interrelationships among modalities referred to above led Wepman (1967:358) to raise the question of the degree of limitation which a given child might have along a specific pathway. He has found that most children have some ability along both the visual and the auditory pathways, but that each ability has its own rate of

development and, when mature, the two abilities are only approximately equal. He was also concerned that the other sensory input pathways, those of the tactile and kinesthetic skills, be not overlooked. Fortunately, these are the best modalities for only a very few children, but in these cases, Wepman believed, they should receive the same concentration of attention as were suggested for vision and audition.

DETERMINING LEARNING MODALITY

An instrument widely used by those working with children suspected of suffering from some form of learning disability was the Illinois Test of Psycholinguistic Ability, described by its authors as a "method of differential diagnosis of children which can be presented in the form of a psychodiagnostic profile. Such a profile depicts the abilities and deficits of a particular child." (Kirk and McCarthy, 1967:207) With such a profile it should be possible to devise an individualized remediation program for the child.

To accomplish this the child's behavior was measured at the representational level by six subtests, two each in decoding (auditory and visual), association (auditory-vocal and visual-motor), and encoding (vocal and motor); at the automatic-sequential level there were three tests: auditory-vocal automatic (in which the child

was asked to supply correct grammatical forms), auditory-vocal sequential (tapped by a digit repetition task), and visual-motor sequential (assessed by the duplication of a series of pictures). The results of the nine subtests, when plotted on a line graph showing age norms, typically revealed a pattern of more or less extreme peaks and lows. If the child were notably deficient in visual or auditory skills, it would be easily noted.

In his study of the learning modalities of good and poor first grade readers Cooper (1970:3-4) used the Mills Learning Methods Test to determine whether a child learns word recognition best by the visual modality, the phonic or auditory modality, the kinesthetic modality, or by a combination of the three.

Frostig believed that deficits in visual perception are the most critical. The Marianne Frostig Developmental Test of Visual Perception can be used to determine a child's performance in each of the five areas of visual perception. These areas Frostig identified as "(1) perception of position in space, (2) perception of spatial relationships, (3) perceptual constancy, (4) visual-motor coordination, and (5) figure-ground perception." (Frostig, 1964:10) Deficiency in any of these abilities would handicap the child's academic progress in all subjects, but they would probably have the greatest effect upon his progress in reading. The first two are necessary for a child to differentiate between letters that have the same form but different

positions, and to recognize the sequence of letters in a word, and of words in a sentence. Perceptual constancy assists the child in recognizing words previously learned when they are seen in an unfamiliar context. Visual-motor coordination relates to the child's ability to control eye movements needed in reading and the hand and eye movements required for writing. Figure-ground perception is necessary for the analysis and synthesis of words, phrases, and paragraphs and in situations where information must be found in a certain place on the page such as in using a dictionary.

Ashlock (1966:18-19) recommended the test Examining for Aphasia by Einsenson (1954) as an instrument valuable in locating specific perceptual problems and for indicating the sensory modalities which should be used for teaching a particular child.

The Auditory Discrimination Test developed by Wepman (1958) could be used for measuring abilities even more basic than those sampled by the ITPA's auditory tests since the child is required only to decide whether the same word has been pronounced twice or whether the two words heard were similar but different.

Tests which measure tactile and kinesthetic ability are limited in number. However, Benton and his associates (1955) have done some research in this area.

The Bender Motor Gestalt Test (1938), a measure of eye-hand coordination, requires the child to copy eight figures. His reproductions are scored on how closely they resemble the original.

Although the ITPA, the Mills Learning Methods Test, the Frostig Test, and the others mentioned above can be used as formal instruments for the detection of learning disabilities and for inferring modal preference, it may be possible "that with training and experience the classroom teacher can learn to assess the individual differences that significantly influence the rate and effectiveness of learning." (Rosenberg, 1968:19) Rosenberg further stated that the teacher has three sources of information upon which to make this assessment. The first is analysis of the kinds of errors a child makes in daily oral and written work. The second is observation of the child's behavioral characteristics as he works independently, in interaction with his teacher, or in relationships with his peers. The third is the use of standardized tests such as those above which measure individual differences impinging upon the learning process (Rosenberg, 1968:21). This last requires considerable expenditure of time and resources, and as yet few teachers are prepared to make informal evaluation of children's learning modality strengths. At the time of this writing no feasible procedure has been found for making such a determination whenever a large number of children must be tested.

For smaller groups, such as a single class, an assessment might be made with the informal modality inventory described by Meehan (1974:901). This procedure samples behavior in various modes

in much the same way as the formal inventions, but has the advantage of yielding an ongoing record to be used over a period of time for purposes of diagnosis and as a record of development.

STUDIES USING THE MODALITY CONCEPT

DeHirsch (1966) stated that the strengths and weaknesses inherent in learning modalities should largely determine teaching method. However, he noted that few studies have explored this matter and that there is definite need for empirical evidence.

Among the few studies that were found was one conducted by Waugh (1973) with a group of second grade students. The subjects were classified as auditory or visual learners on the basis of discrepancies in individual profiles on the ITPA. Two primarily visual and two primarily auditory instructional procedures were presented in classroom settings. These involved recall and recognition of words. Both the group classified as auditorially discrepant and the group labeled visually discrepant performed equally well. Subjects with a marked visual preference did not perform better on the visual task, and those with a marked auditory preference had almost identical scores for the visual and the auditory tasks. The investigator concluded that this experiment would not support the premise that certain children have a preferred modality which facilitates recall and recognition of words (Waugh, 1973:465-469).

Wepman worked with language-impaired adults and concluded that the approach through a single modality is more effective than a combination approach which he considered to be a potential source of confusion. It was recommended that in the teaching of reading the modality of preference should be used while separate training is given to the underdeveloped or impaired pathway, and that the two be brought together only when they can be mutually reinforcing (Wepman, 1967:358).

A study which attempted to show that the spelling performance of elementary and secondary students could be improved through the use of the Visual-Auditory-Kinesthetic-Tactile Method was conducted by Taschow (1970). There was evidence that at the high school level approximately two-thirds of the students are predominantly visually minded, somewhat less than one-third rely primarily on their auditory senses, and a small percentage, mostly boys, learn best through their kinesthetic or proprioceptive senses. However, he concluded that none of the modes existed in isolation in the process of learning to spell, and that it was very difficult to discern where one began and the other ended. All modes seemed to be interrelated in the senses to initiate encoding and correct decoding. Because of this, Taschow believed, the visual-auditory-kinesthetic-tactile technique permitted students to learn to spell through stimulation of one or more senses according to his individual needs. Consequently most students

benefitted greatly from combining all four functions. Use of this method enabled each student to learn to spell individually since he selected the approach by which he learned best. Furthermore, if the method was used consistently until the student had thoroughly mastered the sequential steps, it provided him with independent skills for learning the spelling of the words he needed because he knew the procedure and could apply the VAKT technique whenever necessary.

As previously stated, Cooper (1970:3-19) conducted a study to determine whether modality strengths and weaknesses were readily discernible in beginning readers. It was first necessary to assess the type of program to which each subject had already been exposed since this could affect modality preference. A questionnaire was devised concerning the type of instruction employed in reading. The questions were answered by the teachers involved in the study, and the returns were followed up with an interview. It was concluded that instruction was similar in the eight prospective classrooms and that it was not necessary to eliminate any of them.

The selection of the final sample was based upon two criteria. Teachers were first asked to classify each of their students as being either a good, an average, or a poor reader. All potential subjects were then given the Gates MacGinitie Reading Test, Primary A, Form 1. The scores on these tests were listed in order from high to low. Those subjects whose scores were in the upper 30 percent were classified

as good readers and those whose scores were in the lowest 30 percent were classified as poor readers. The final sample was drawn from those subjects who fell into the category of "good reader" or "poor reader" on both criteria. This arrangement yielded thirty-one good readers and twenty-nine poor readers. The names of these subjects were listed randomly in each group and the first fifteen from each list were used to constitute the final sample.

The procedure for studying learning modalities was based upon the Mills Learning Methods Test. Each subject was individually taught five nonsense syllables by each of the four learning modalities being investigated; that is, by the visual, the auditory, and the kinesthetic modalities, and by a combination of the three. The order of the presentation of the material taught by each modality was randomized among the subjects. Each subject was taught for thirty minutes or until he mastered the task. If a subject could not learn the syllables within thirty minutes, he was dropped from the experiment and the subject whose name appeared next on the randomized list for that group was used as a replacement so that the number of subjects in each of the two groups remained at fifteen. Twenty-four hours later each subject was tested for retention. In order to minimize teacher variable, the researcher acted as instructor for all subjects. The data collected consisted of two scores for each subject: the Acquisition Score, or the number of trials needed to master the task, and the Retention Score, of the number of words retained after twenty-four hours.

The data from this investigation seemed to indicate that poor readers did not learn best by the kinesthetic modality. A need for further study was indicated. Modality preference did appear to be important enough to make a difference in how well individuals learn and retain words, and, although the mode of presentation seemed more important for poor readers, it appeared to be sufficiently important for good readers to warrant consideration for them also. Finally, modality preference was found to be an individual matter. No mode of presentation was significantly superior for good readers or for poor readers as a group. For this reason, Cooper recommended that future studies attend to the learning of individuals rather than to that of groups.

In another study Daniel and Tacker (1974:255-258) sought the effects of presenting consonant-vowel-consonant trigrams to subjects by means of the visual and the auditory modalities. Subjects were classified as having visual preference, auditory preference, or no preference on the basis of their responses on selected subtests of the ITPA and of the Detroit Tests of Learning Aptitude. Lists of trigrams were presented to all three groups in both of the modes, but the three groups learned differently under each mode. The auditory group did better when trigrams were presented auditorially and less well when they were presented visually. The visual group excelled in recalling those trigrams given visually and scored lower on those presented aurally. The no preference group did equally well

using both presentations and their scores fell between the scores of subjects with a preference when the presentation was made in the preferred modality and the same subjects when the presentation was made in the non-preferred mode. The researchers concluded that, "a child's preference for modality of stimulus input is an important variable which influences learning." (Daniel and Tacker, 1974:257)

A study by Dauzat (1970) investigated the effectiveness of four learning modalities in teaching word recognition to disadvantaged and non-disadvantaged second graders. A random sample of 20 children for each group was taken from a total of 529 pupils in the second grade. Using a two-way analysis of variance of the results of the Mills Learning Methods Test, she found that in general the visual method was best for all subjects, and that the kinesthetic method was least effective. However, no best method of teaching word recognition to disadvantaged children was found.

Only one study was found which included a consideration of any modality other than the visual, the auditory, and the kinesthetic-tactile. McCracken (1974:6) claimed that previous studies had ignored two learning modes, namely the sapiditory and the olfactory. He attempted to remedy this by establishing a sapiditory treatment group in his study comparing the effectiveness of several modality approaches in beginning reading instruction. While other groups saw, heard, and traced words at fourteen reading levels, the sapiditory group ate the words composed by ligaturing Alpha-bits letters into a

tasteless, transparent parallelepiped. The groups appeared to learn equally well under each of the eleven modality treatments. However, a technical difficulty invalidated the scores of the control group.

A study by Rosner investigated the relationship between specific perceptual skills and language arts and arithmetic achievement. Using correlations between achievement scores on the Stanford Achievement Test and the results of the Auditory Analysis Test and the Visual Analysis Test, Rosner concluded (1973:64) that there were significant relationships between reading achievement and auditory perception, and between arithmetic achievement and visual perception. While conceding that replication studies were needed to support his findings, he maintained that a consideration of the perceptual skills of individual children should be a major component in the design of instructional programs.

Daniel and Tacker (1974:257) shared this view, stating that "a child's preference for modality of stimulus input is an important variable which influences learning."

Williams and Williams (1972) have proposed several hypotheses concerning children's verbal learning and comprehension in the aural and visual modes. These included the existence of a relationship between mode and the type of material being taught, a grade-by-mode interaction in which children in one grade were found superior in one mode and those in a higher grade functioned more effectively in another mode, and a mode-to-immediacy of response relationship. There

was evidence to support the hypothesis that prose materials are best presented aurally and that there are complex interactions between modality and the length of time material was remembered. Nevertheless, the inconclusiveness of the results led the investigators to recommend further study of the precise parameters of modal preference.

According to Linder and Fillmer (1971) research on the effects of visual and auditory presentation of information and on early sensory experience indicated that (1) modal preference was affected by cultural and social background, (2) modal preference (visual or auditory) changed with maturational level, (3) the type, complexity, and the extensiveness of the information determined the appropriate modality for its presentation, (4) there was a hierarchy of sensory modalities moving from concrete meaning to abstract meaning, (5) auditory deficits were more common than visual deficits, and (6) children of low socioeconomic levels had deficits in all language development.

SUMMARY

In general the findings were inconclusive and, at times, somewhat contradictory; however, some of the points on which the findings of two or more studies agreed were:

1. There was a single modality which was most effective for any given individual.

2. The kinesthetic method was the least effective one for the teaching of reading.

3. There seemed to be no best mode for teaching reading to "poor readers" as a group.

4. There seemed to be a relationship between preferred mode and (a) the type of material to be learned and (b) the maturation or age of the students.

Among the points on which findings were contradictory were:

1. The modality chosen for instruction facilitated the learning and retention of words.

2. An approach using a combination of modalities, as opposed to one which emphasized a single modality, was most effective.

3. A single modality existed which was best for teaching all members of a group.

Chapter 3

PROCEDURES USED IN THE STUDY

BACKGROUND

The study was conducted in four schools located in and operated by the Catholic Diocese of Baton Rouge. School A had an enrollment of approximately 515 students and a faculty of 22. Parents of students in the school represented a cross section of socio-economic levels, but the majority fell into the middle income group. The school enrollment was about 9 percent black. School B had an enrollment of approximately 360 students and a faculty of 14. The parents of most of these students were in the lower and middle socio-economic level, and the enrollment was about 12 percent black. School C had an enrollment of approximately 650 students and a faculty of 29 regular members. Parents of the students in this school were primarily in the middle income group although some had higher than average incomes. The school population was 6 percent black. School D had an enrollment of approximately 350 students and a faculty of 15. Parents of its students represented a cross section of socio-economic levels, but the majority were in the lower income group. The school was about 35 percent black.

SELECTION OF SAMPLE

A number of factors influenced the selection of the classes used in the study. Since all teaching was done by a single individual, it was necessary to arrange the teaching schedule to allow for travel among the schools, while coordinating it with the existing schedules of the classes eligible for inclusion; that is, the fourth grade classes in the schools of the Catholic Diocese of Baton Rouge. In addition, the assistance of the Diocesan Superintendent was requested in selecting classes which would be representative of the overall population of the schools in the system. Within these constraints, one fourth grade class in each of the four schools was selected. The classes were approximately equal in size, the smallest consisting of twenty-nine students and the largest of thirty-five.

ASSIGNMENT OF TREATMENTS

A random drawing was used to assign the modality treatments to the selected classes. The names of the participating schools were placed in one envelope and the letters A, B, C, and D in another. Each letter represented a modality treatment as follows: "A"--Visual Treatment; "B"--Auditory Treatment; "C"--Kinesthetic-Tactile Treatment; "D"--Visual-Auditory-Kinesthetic-Tactile Treatment. The name of each school was randomly paired with a letter to determine the treatment to be used for pupils in the class from that school.

Subsequently, the treatment groups and the schools were identified by letter. Thus "School A" or "Group A" refers to the school in which or to the subjects for which the visual treatment was used; "School B" or "Group B" refers to the school in which or to the subjects for which the auditory treatment was used; and so on.

INSTRUMENTATION

In the absence of testing instruments which would provide an adequate sampling of the desired behaviors, it was necessary to develop and validate tests to measure achievement of the unit objectives. The five major objectives were analyzed to yield fifteen supporting objectives, all stated behaviorally. A pre-test and a post-test were developed consisting of thirty-one items each with at least one item measuring achievement of each of the supporting objectives. These tests, together with a list of the objectives, were sent to the jury of experts in elementary mathematics whose names appear in the appendix. A form was included on which each expert was to indicate his opinion of the validity of each test item for the objective it was intended to measure.

All items were scored as valid by each of the members of the jury, but, based upon their suggestions, several revisions were made in wording and in format in the interest of clarity. The directions for Items 28 through 31 were amended by adding the words "as indicated" to the original direction, "add or subtract." In the final form of

the tests this direction read, "Add or subtract as indicated." For Items 30 and 31, the blanks provided for the students' responses were revised from "_____, _____, _____." to "_____ + _____ + _____."

One member of the jury indicated that the term "dekameter" used in the original draft of the tests is a variant of "decameter." However, the original spelling was retained.

An attitude scale was constructed to measure reactions to the unit. Items were included which investigated attitudes toward the metric system in general, toward the modality used in the presentation, and toward the instruction received during the unit. For the second of these, four variant forms were used so that the wording of this item on the attitude scale matched the modality experience of each of the treatment groups. In addition, nine irrelevant items were included on each form of the scale in an effort to increase the honesty of the responses. Each form of the scale consisted of twelve items, only three of which were to be scored. On each item the student was to indicate his feelings by marking one of three simple drawings of faces which represented enjoyment, indifference, and displeasure.

Prior to its use in the study, the attitude scale was submitted to a panel of fourth grade teachers who were asked to rule on the suitability of each item for use by fourth grade students.

Since their replies indicated substantial agreement that the items were acceptable for these students, no revisions were made in wording of the items. However, at the suggestion of one of the members of the panel, students were familiarized with the meanings conveyed by each "face" prior to the use of the scale. The names of those serving on this panel are given in the appendix. Items were randomized on each of the forms of the scale prepared for students.

INSTRUCTIONAL PROCEDURES

A preliminary conference was held with the principal of each of the participating schools and with the teacher of each of the selected classes. Among the main points agreed upon were the specific beginning and ending time of instruction for each class. The instructional period for each group was forty minutes in length. Classroom teachers were also requested to avoid giving any other instruction in the content of the metric unit during the weeks the study was in progress, and all agreed not to use the results of the pre-test in determining any student's mathematics grade. The principal and the teacher in each school were given a brief description of the activities which would be used in the particular modality treatment assigned to the class from that school. They were informed of the two specific prerequisites to the unit which the investigator hoped each participating student would possess; namely, the abilities to: (1) add and subtract whole numbers without regrouping, and (2) distinguish between the printed and the cursive

form of the letters "h" and "k" and be able to produce distinguishable forms of these letters in either manuscript or cursive writing. Since the study was to be conducted with fourth grade students no difficulty was expected to arise from any student's inability to meet these prerequisites. Student responses on the pre-test and on activities during instruction in the unit verified that all were able to perform adequately on both of the prerequisites.

Activities were developed in the visual, the auditory, and the kinesthetic modalities to enable students to achieve mastery of the objectives of the unit. These activities were used for the first three presentations.

The visual presentation made use of a flannel board, an overhead projector, the chalkboard, and printed worksheets. The auditory presentation used rhymes and songs, listening games, and verbal sequencing. In the kinesthetic-tactile presentation, students handled metric manipulatives, traced textured symbols with their fingers, and physically moved the distances studied. The fourth presentation was constructed from approximately equal numbers of activities selected from the other three presentations.

Each class was taught for forty minutes each day from March 19, 1974 through April 4, 1974. The pre-test was administered to all groups on March 18, 1974. On April 5, 1974, the attitude scale and the post-test were administered to all groups.

Because it was expected that few of the subjects would have had prior experience with the terminology of the metric system, and in an effort to reduce the anxiety associated with taking a test on material the subjects had had no opportunity to master, the pre-test was read to the students one item at a time at intervals which allowed them to write their responses. This procedure was suggested by Ebel's (1965:204) caution that a case of "jitters" is a real handicap in taking a test. Students were also informed that the pre-test results would not be used for grading purposes.

Subjects were familiarized with the attitudes represented by each of the "faces" shown on the attitude scale before these scales were distributed. This scale was designed to allow subjects to record their impressions independently. It had been judged suitable for fourth grade students by a panel of fourth grade teachers, and the directions printed at the top of the sheet indicated that a student could ask for help if he found any word which he did not understand. These directions were read aloud to the subjects. The regular classroom teacher was available to give this help, but no requests for assistance were made by the subjects.

Subjects were allowed to proceed independently in recording their responses on the post-test and were permitted to take as much time as was needed. All students completed this test within twenty minutes.

STATISTICAL PROCEDURES

For purposes of analysis of the data each student was assigned a number within his group and his pre-test and post-test were paired with this number. Neither the student's name nor any other form of identification was placed on the attitude scale.

An analysis of covariance was determined from the scores on the post-tests. An analysis of variance was performed on the results of the attitude scales. Calculations were performed on a statistical calculator provided by the Department of Education at Louisiana State University.

Chapter 4

PRESENTATION AND ANALYSIS OF DATA

INTRODUCTION

In this chapter the two types of data generated by the study are reported and analyzed. Data in the cognitive aspect of the study resulted from scores made by subjects on a pre-test and on a post-test. For the affective phase of the study data were obtained from subjects' responses to an attitude scale.

The data presented in Table 1 show the number of subjects in each of the treatment groups for the cognitive and for the affective phases of the study.

Table 1

Number of Subjects in Each Treatment Group for the Cognitive and for the Affective Phases of the Study

	Group A	Group B	Group C	Group D	Total
Cognitive	34	29	34	28	125
Affective	34	30	34	28	126

In each of Groups A and C, thirty-four subjects were included in both phases of the study. One student in Group B and one in Group D were excluded from the cognitive part of the study because these students were absent at the beginning of the study and did not return to school until more than half of the three week teaching period had elapsed. However, since the attitude scales were not identified, the scales marked by these students were included in the calculations for the affective part of the study. The attitude scale of one student was invalidated because of failure to provide responses to all items on the scale including one of those which was to be scored.

Therefore for Group B, the number of students included is twenty-nine in the cognitive aspect of the study but thirty in the affective. For Group D, the number of students included is twenty-eight for both areas, since the invalidated attitude scale cancelled out the student included only in the affective part of the study.

THE COGNITIVE ASPECT OF THE STUDY

In order to determine whether a true difference existed among the means of the scores obtained by the various groups, the scores were subjected to an analysis of covariance. According to Garrett (1966:295), "analysis of covariance represents an extension of analysis of variance to allow for the correlation between initial and

final scores. . . . Through covariance analysis one is able to effect adjustments in final or terminal scores which will allow for differences in some initial variable."

The scores from which these calculations were made are shown in Tables 2, 3, 4, and 5. The data in Table 2 are the scores achieved by subjects in Group A on the pre-test and on the post-test, the differences between the scores of each subject, and the means of the pre-test and the post-test scores. The data in Table 3, 4, and 5 give the same information for the students in Groups B, C, and D, respectively. All differences shown in these four tables are positive.

Means for the pre-test ranged from 13.618 for Group A to 10.724 for Group B. The same two groups also achieved the extreme scores on the post-test. The mean score for Group A on the post-test was 28.971, while that for Group B was 22.862.

The total variance of the pre-test and post-test scores was analyzed to identify that portion of the variance attributable to differences among the groups themselves and that portion due to individual differences within the groups. The results of this procedure are shown in Table 6.

Under the heading "df" are given the degrees of freedom available among means, within groups, and as a total. The column headed "SS_X" shows the squares of the sums of the pre-test (X) scores. The squares of the sums of the post-test (Y) scores are given under the heading "SS_y." The column marked "S_{xy}" shows the sum found by

Table 2

Pre-test and Post-test Scores of Subjects in Group A (Visual Treatment)

Student Number	Pre-test	Post-test	Difference
1.	17	31	14
2.	15	31	16
3.	12	19	7
4.	16	25	9
5.	12	30	18
6.	12	31	19
7.	14	29	15
8.	8	28	20
9.	16	25	9
10.	16	24	8
11.	14	30	16
12.	13	27	14
13.	11	31	20
14.	14	31	17
15.	14	29	15
16.	13	31	18
17.	13	30	17
18.	13	29	16
19.	13	30	17
20.	15	29	14
21.	15	29	14
22.	14	31	17
23.	13	31	18
24.	14	28	14
25.	18	28	10
26.	13	24	11
27.	13	31	14
28.	17	31	14
29.	11	31	20
30.	12	29	17
31.	14	31	17
32.	12	31	19
33.	16	31	15
34.	10	29	19
Means	13.618	28.971	

Table 3

Pre-test and Post-test Scores of Subjects in Group B (Auditory Treatment)

Student Number	Pre-test	Post-test	Difference
1.	9	25	14
2.	15	31	16
3.	13	28	15
4.	8	19	11
5.	8	14	6
6.	13	27	14
7.	9	29	20
8.	7	18	11
9.	9	20	11
10.	12	19	7
11.	14	26	12
12.	10	28	18
13.	9	29	19
14.	13	24	11
15.	12	18	6
16.	9	17	8
17.	14	29	15
18.	10	16	6
19.	10	30	20
20.	7	19	12
21.	11	20	9
22.	11	18	7
23.	11	24	13
24.	15	24	9
25.	10	25	15
26.	7	20	13
27.	12	21	9
28.	11	18	7
29.	12	28	16
Means	10.724	22.862	

Table 4

Pre-test and Post-test Scores of Subjects in Group C
(Kinesthetic-Tactile Treatment)

Student Number	Pre-test	Post-test	Difference
1.	15	31	16
2.	10	26	16
3.	12	31	19
4.	19	31	12
5.	15	31	16
6.	14	30	16
7.	7	25	18
8.	13	29	16
9.	15	31	16
10.	15	31	16
11.	16	29	13
12.	15	30	15
13.	14	26	12
14.	11	27	16
15.	15	30	15
16.	15	30	15
17.	10	30	20
18.	12	30	18
19.	15	31	16
20.	14	30	16
21.	13	26	13
22.	13	28	16
23.	14	31	17
24.	13	26	13
25.	8	19	11
26.	16	27	11
27.	14	31	17
28.	18	27	9
29.	12	31	19
30.	12	31	19
31.	13	23	10
32.	13	26	13
33.	13	30	17
34.	11	24	13
Means	13.353	28.500	

Table 5

Pre-test and Post-test Scores of Subjects in Group D
(Visual-Auditory-Kinesthetic-Tactile Treatment)

Student Number	Pre-test	Post-test	Difference
1.	12	29	17
2.	10	31	21
3.	8	30	22
4.	14	31	17
5.	14	24	10
6.	16	30	14
7.	14	31	17
8.	15	28	13
9.	13	30	17
10.	18	31	13
11.	13	31	18
12.	9	31	22
13.	12	30	18
14.	7	15	8
15.	9	21	12
16.	10	24	14
17.	7	18	11
18.	12	26	14
19.	15	26	11
20.	13	27	14
21.	9	26	17
22.	9	26	17
23.	11	18	7
24.	12	21	9
25.	15	22	7
26.	16	30	14
27.	17	30	13
28.	10	28	18
Means	12.143	25.679	

adding the products of the pre-test (X) scores and the post-test (Y) scores of each group. The "$SS_{y.x}$" column gives the sum of the squares of the post-test (Y) scores as adjusted by the pre-test (X) scores, and the "$MS_{y.x}$" column shows the mean squares of the post-test scores as adjusted by the pre-test scores. The values in this last column represent the adjusted variance of the post-test scores.

Table 6

Analysis of Covariance of Test Scores

Source of Variation	df	SS_x	SS_y	S_{xy}	$SS_{y.x}$	$MS_{y.x}$
Among Means	3	161.98	741.94	346.197	244.48	81.49
Within Groups	120	953.02	2728.06	775.803	2096.52	17.47
Total	123	1115.0	3470.0	1112.0	2341.0	-

$$F_{y.x} = \frac{81.49}{17.47} = 4.6646$$

For df 2/120
F at .05 level = 2.68
F at .01 level = 3.94

The variances of the post-test (Y) scores were adjusted to correct for variability in the pre-test (X) scores, and the F ratio for these adjusted variances was computed by dividing the variance among the groups by the variance within the groups. This operation yielded an F ratio of 4.6646, which is greater than the critical ratio at either the .05 or at the .01 level of confidence. Thus the null hypothesis was rejected.

Because the F ratio does not indicate precisely which mean or means differs significantly from another mean, the t test for adjusted means was applied.

The data reported in Table 7 present the unadjusted means of the post-test scores for each group and the means as adjusted by the achievement on the pre-tests.

Table 7

Unadjusted and Adjusted Means of Post-test Scores

Group	Unadjusted Mean Score	Adjusted Mean Score
A	28.971	28.028
B	22.862	25.314
C	28.5	27.7727
D	25.679	25.9366

The data presented in Table 8 indicate the differences between each of the six pairs of means possible among the four groups.

The data in Table 8 indicate that the differences between the means of two pairs of groups meets the test of significance at the .05 level.

The difference between the means of Groups A and B is shown in Table 8 as 2.714. This difference is significant at the .05 level of confidence.

The difference between the means of Groups B and C, shown in Table 8 as 2.4587, meets the test of significance at the .05 level.

Table 8

Significance of the Difference Between Adjusted Means of Post-tests

	B	C	D
A	2.714*	0.2553	2.0914
B	-	2.4587*	0.6226
C	-	-	1.8361

*Significant at the .05 level of confidence.

The differences between the means of Groups A and C, Groups A and D, Groups B and D, and Groups C and D are less than their respective t values at the .05 level of confidence. At this level there are no significant differences in achievement among these four pairs of groups.

THE AFFECTIVE ASPECT OF THE STUDY

The responses provided by subjects on the attitude scale were converted to numerical values and these were analyzed for variance to determine the significance of the differences among the scores of the four treatment groups. Only three items on the attitude

scale were scored, namely, Items Three, Seven and Eleven. The other items included were irrelevant to the study. On each item a response indicating a favorable attitude was scored as "+1." A neutral attitude was computed as "0," and an unfavorable attitude as "-1." From these a total score for each student and a composite score for each treatment group were derived.

Analysis of Data for Item Three

Item Three, intended to measure the students' feelings about the metric system, read, "I feel like this about learning to use the metric system to measure things." A summary of the scores recorded by each of the groups and the algebraic sum of these scores for each group are given in Table 9.

Table 9

Summary of Scores for Item Three of the Attitude Scale

	+1	0	-1	Sums
A (N=34)	31	2	1	30
B (N=30)	24	5	1	23
C (N=34)	33	1	0	33
D (N=28)	26	2	0	26

The data presented in Table 9 indicate that most of the students responded positively to this item of the attitude scale. In Group A a total of three students responded indifferently or negatively. In Group B six students recorded indifferent or negative responses. In Group C only one response was not positive, and in Group D there were two indifferent responses.

The data presented in Table 10 show the results of the analysis of the variance of the scores given by subjects on Item Three.

Table 10

Analysis of Variance of Scores for Item Three of the Attitude Scale

Source of Variation	df	SS	MS	SD
Among Means	3	7.6164	2.5388	-
Within Groups	122	8.8284	0.0724	0.2693
Total	125	16.4444	-	-

$$F = \frac{2.5388}{0.0724} = 35.066$$

For df 3/122
F at .05 level = 2.68
F at .01 level = 3.94

Under the heading "df" in Table 10 are shown the degrees of freedom available among groups, within groups, and as a total. The column marked "SS" gives the sums of the squares of the scores on

Item Three, and that marked "MS" shows the mean square of these scores. The standard deviation of the scores is shown in the "SD" column.

The data in Table 10 indicate that the F ratio is 35.066, which is far greater than the critical ratio for the .01 level of confidence. The null hypothesis that no significant differences exist among the scores of the four groups was rejected.

Tha data in Table 11 indicate the differences between the means of each of the six comparisons possible among the four groups for Item Three.

Table 11

Significance of the Difference Between the Means of Item Three of the Attitude Scale

	B	C	D
A	0.1157	0.0882	0.0462
B	-	0.2039**	0.1619*
C	-	-	0.0420

*Significant at the .05 level.

**Significant at the .01 level.

The difference between the means of Groups B and C, shown in Table 11 as 0.2039, meets the test of significance at the .01 level.

The difference between the means of Groups B and D, shown in Table 11 as 0.1619, meets the test of significance at the .05 level.

The differences between the means of Groups A and B, Groups A and C, Groups A and D, and Groups C and D are less than their respective t values at the .05 level of confidence. At this level there are no significant differences in the responses given by these four pairs of groups.

Analysis of Data for Item Seven

Item Seven attempted to measure students feelings about the modality presentation which they had experienced in the study. On the attitude scale this item appeared in four variant forms so that its wording matched the modality treatment used with each of the respective groups. The form given to the group taught visually read, "I feel like this about having many things to look at to help me learn the metric system."

A summary of the scores recorded by each group on Item Seven, and the algebraic sums of these scores for each group are given in Table 12.

The data in Table 12 show that in Group A twenty-six of the students responded to this item positively while eight did not. In Group B seventeen subjects responded positively and a total of thirteen did not. For Groups C and D there were three indifferent responses each.

Table 12

Summary of Scores for Item Seven of the Attitude Scale

	+1	0	-1	Sums
A (N=34)	26	8	0	26
B (N=30)	17	11	2	15
C (N=34)	31	3	0	31
D (N=28)	25	3	0	25

The data presented in Table 13 show the results of the analysis of the variance of scores on Item Seven.

Table 13

Analysis of Variance of Scores for Item Seven of the Attitude Scale

Source of Variation	df	SS	MS	SD
Among Means	3	3.2928	1.0983	-
Within Groups	122	23.0316	0.1888	0.4345
Total	125	26.3254	-	-

$$F = \frac{1.098}{0.1888} = 5.8157$$

For df 3/122
F at .05 level = 2.68
F at .01 level = 3.94

The data in Table 13 indicate that the F ratio for Item Seven is 5.8157, which is greater than the critical ratio for the .01 level of confidence. The null hypothesis for the scores on this item was rejected.

The data in Table 14 indicate the differences between the means of each of the six comparisons possible among the four groups for Item Seven.

Table 14

Significance of the Difference Between the Means of Item Seven of the Attitude Scale

	B	C	D
A	0.2647*	0.1471	0.1282
B	-	0.4118**	0.3929**
C	-	-	0.0189

*Significant at the .05 level.

**Significant at the .01 level.

The difference between the means of Groups A and B, shown in Table 14 as 0.2647, meets the test of significance at the .05 level of confidence.

The differences between the means of Groups B and C and Groups B and D, shown in Table 14 as 0.4118 and 0.3929 respectively, meet the test of significance at the .01 level of confidence.

The differences between the means of Groups A and B, Groups A and C, Groups A and D, and Groups C and D are less than their respective t values at the .05 level of confidence. At this level there are no significant differences in the responses given by these four pairs of groups on Item Seven.

Analysis of Data for Item Eleven

Item Eleven of the attitude scale attempted to measure the subjects' feelings about the methods employed and the general management of the class during the metric unit. It read, "I feel like this about how the teacher helped me learn the metric system."

A summary of the scores recorded by each group on Item Eleven and the algebraic sums of these scores for each group are given in Table 15.

Table 15

Summary of Scores for Item Eleven of the Attitude Scale

	+1	0	-1	Sums
A (N=34)	32	1	1	31
B (N=30)	21	7	2	19
C (N=34)	33	1	0	33
D (N=28)	26	2	0	26

The data in Table 15 show that in Group A thirty-two students responded positively while a total of two did not. In Group B twenty-one students responded positively while a total of nine did not. In Groups C and D there were one and two indifferent responses respectively.

The data presented in Table 16 show the results of the analysis of the variance of scores on Item Eleven.

Table 16

Analysis of Variance of Scores for Item Eleven of the Attitude Scale

Source of Variation	df	SS	MS	SD
Among Means	3	2.1766	0.7255	-
Within Groups	122	15.5297	0.1273	0.3568
Total	125	17.7063	-	-

$$F = \frac{0.7255}{0.1273} = 5.6991$$

For df 3/122
F at .05 level = 2.68
F at .01 level = 3.94

The data in Table 16 indicate that the F ratio for Item Eleven is 5.6991, which is greater than the critical ratio for the .01 level of confidence. The null hypothesis for the scores on Item Eleven was rejected.

The data in Table 17 indicate the differences between the means of each of the six comparisons possible among the four groups for Item Eleven.

Table 17

Significance of the Difference Between the Means of Item Eleven of the Attitude Scale

	B	C	D
A	0.2785**	0.0588	0.0168
B	-	0.3373**	0.2953**
C	-	-	0.0420

**Significant at the .01 level.

The differences between the means of Groups A and B, Groups B and C, and Groups B and D, shown in Table 17 as 0.2785, 0.3373, and 0.2953 respectively, all meet the test of significance at the .01 level of confidence.

The differences between the means of Groups A and C, Groups A and D, and Groups C and D are all less than their respective t values at the .05 level. At this level there are no significant differences in the responses given by these three pairs of groups on Item Eleven.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

The purpose of this study was to compare the effectiveness of presentations structured in four learning modalities. These presentations were used to teach a unit on linear measurement in the metric system to fourth grade students. The subjects were pupils in one fourth grade class in each of four schools within the Catholic Diocese of Baton Rouge. Each class was taught by one of the four modality presentations. Each of the subjects provided scores from three instruments, a pre-test and a post-test in the cognitive part of the study, and an attitude scale in the affective part.

The results of the post-tests were analyzed by the use of an analysis of covariance procedure to determine whether significant differences in achievement existed among the four groups. The results of the attitude scale were analyzed for variance to determine whether there were significant differences among the four groups in their attitudes toward the metric system, the modality used in the presentation, and toward the teaching methods employed and the general management of the class.

CONCLUSIONS

Consideration of the data compiled during this study appeared to justify the following conclusions:

1. There was a difference in favor of Group A, significant at the .05 level, between the achievement of unit objectives by the students in Group A, taught by the visual approach, and those in Group B, taught by the auditory presentation.

2. There was a difference in favor of Group C, and significant at the .05 level, between the achievement of unit objectives by students in Group B, taught by the auditory approach, and those in Group C, taught by the kinesthetic-tactile presentation.

3. There were no significant differences between the achievement of unit objectives by students in Groups A and C, Groups A and D (taught by the visual-auditory-kinesthetic-tactile presentation), Groups B and D, and Groups C and D.

4. Attitudes toward the metric system as measured by responses to Item Three of the attitude scale differed significantly at the .05 level between students in Groups B and D. The attitudes expressed by students in Group D were more favorable.

5. There was a difference, significant at the .01 level, between the attitudes toward the metric system expressed by students in Groups B and C. Proportionally more students in Group C gave favorable responses.

6. There were no significant differences in attitude toward the metric system between the responses given by students in the following pairs of groups: Groups A and B, Groups A and C, Groups A and D, and Groups C and D.

7. Attitudes toward the respective modality presentations as measured by responses to Item Seven of the attitude scale differed significantly at the .05 level between students in Groups A and B. Proportionally more students in Group A responded favorably.

8. Attitudes toward the respective modality presentations differed significantly at the .01 level between students in Groups B and C, and between students in Groups B and D. In both cases proportionally fewer students in Group B gave favorable responses.

9. There were no significant differences in the responses to Item Seven between the following pairs of groups: Groups A and C, Groups A and D, and Groups C and D.

10. Attitudes toward teaching methods and class management as revealed by responses to Item Eleven of the attitude scale differed significantly at the .01 level between students in Groups A and B, between students in Groups B and C, and between students in Groups B and D. In each case proportionally fewer students in Group B responded favorable.

11. There were no significant differences in responses to Item Eleven between the following pairs of groups: Groups A and C, Groups A and D, and Groups C and D.

RECOMMENDATIONS

1. The study appears to reinforce the conclusion reached by Daniel and Tacker (1974:258) that "a pragmatic need exists for a rapid and reliable screening test for the identification of children with strong modality preference" in order to facilitate further research.

2. Since there is some evidence that modality preference may be related to content, additional studies are needed to determine the effects of modality preference upon the learning of mathematics.

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APPENDIX A

February 14, 1974

Brother Felician Fourrier, S.C.
Superintendent of Schools, Diocese of Baton Rouge
1800 South Acadian Thruway
P. O. Box 2080
Baton Rouge, Louisiana 70821

Dear Brother Felician:

As you are aware, I am a doctoral student at LSU in Baton Rouge. My dissertation will investigate some outcomes of instruction in the linear metric system structured in four learning modalities. The unit will be taught to fourth grade students. Students will be given both a pre-test and a post-test on the content of the unit. Additionally, the students' reactions to the instruction experienced during the study will be assessed by an attitude scale administered at the close of the unit. An analysis of co-variance among the four treatment groups will be made for the cognitive aspect of the study and an analysis of variance for the affective.

It is highly desirable that the study be conducted in schools which are representative of the entire population of students in the Catholic Schools in the Diocese of Baton Rouge. I understand that the schools which you named for me at our last meeting will fulfill this requirement, and that their participation is mutually agreeable to all concerned.

The unit will require three weeks teaching time. The most suitable time for this from my standpoint is March 18, 1974 through April 5, 1974.

If all of the above meets with your approval, I shall contact the principals of the cooperating schools to work out further details.

Thank you for allowing me the opportunity to conduct this study in the Catholic Schools of the Baton Rouge Diocese. You will, of course, be provided with a copy of the results.

Sincerely,

Jocelyn Marie Rees

APPENDIX B

PARTICIPATING CLASSES IN THE CATHOLIC DIOCESE OF BATON ROUGE

School	Principal	Teacher
Holy Family	Sister M. Damien, M.S.C.	Mrs. James Charleville
Sacred Heart	Sister Jane, C.S.J.	Mrs. Mary Allen
Saint Anthony	Mrs. Guy Gauthier	Mrs. Gayle Hamersley
Saint Aloysius	Sister Marina, F.I.	Mrs. Don Mitchner

APPENDIX C

MEMBERS OF VALIDATION JURY

Dr. Houston T. Karnes, Head
Department of Mathematics
Louisiana State University
Baton Rouge, Louisiana

Dr. Sam Adams
Department of Education
Louisiana State University
Baton Rouge, Louisiana

Mrs. Olympia Boucree
Supervisor of Mathematics
New Orleans Public Schools
New Orleans, Louisiana

APPENDIX D

February 16, 1974

Dear

As you know from our conversation, my dissertation will investigate some of the outcomes of instruction in the linear metric system structured in four learning modalities. The unit is planned for presentation to fourth grade students. They will be given both a pre-test and a post-test on the content of the unit. Since this material has not in the past been a part of the elementary mathematics curriculum, it is not possible to use standardized tests as instruments of evaluation. Instead, I plan to use tests which I have constructed. My dissertation committee has agreed that these tests can be validated by submitting them to a jury of experts in elementary mathematics and securing their positive judgments that the test items are valid for the objectives which the unit seeks to achieve.

Since when we spoke you agreed to serve as a member of the validation jury, I am enclosing copies of the unit objectives, the pre-test and the post-test, and an evaluation form upon which to indicate your judgment of the validity of the test items.

Each test item is keyed to a particular objective. Underlining has been used on your copy to indicate what information the student will be asked to supply. Material given in parentheses will not appear on student forms of the test.

Please return these materials to me at your earliest convenience. A self-addressed envelope is enclosed.

Thank you for your assistance.

Sincerely,

Jocelyn Marie Rees

Enclosures

APPENDIX E

PRE- AND POST-TEST EVALUATION FORM

Objective	Test Item	Pre-Test		Post-Test		Comments
		Valid	Not Valid	Valid	Not Valid	
IA.	1.					
IB.	2.					
IB.	3.					
IB.	4.					
IB.	5.					
IB.	6.					
IC.	7.					
IC.	8.					
ID.	9.					
II.	10.					
II.	11.					
II.	12.					
IIIA.	13.					
IIIA.	14.					
IIIB.	15.					
IIIB.	16.					
IIIC.	17.					
IIID.	18.					
IIID.	19.					
IIIE.	20.					
IIIE.	21.					
IIIF.	22.					
IIIF.	23.					
IIIF.	24.					
IIIF.	25.					
IVA.	26.					
IVB.	27.					
VA.	28.					
VA.	29.					
VB.	30.					
VB.	31.					

Date _____ Signed _____

APPENDIX F

PRE-TEST AND KEY

Objective		Test Items
IA.	1.	Circle the word which tells how you could measure the distance of an auto race. (kilometer) decimeter centimeter
IB.	2-6.	Circle the words that are metric measures. (Credit given for correctly marking or not marking each term.) inch (meter) ton (centimeter) yard
IC.	7.	Circle the word that stands for the longer distance. (hectometer) decimeter
IC.	8.	Circle the word that stands for the shorter distance. (meter) kilometer
ID.	9.	Circle the word you would use to talk about something this long. hectometer (centimeter) dekameter
II.	10-12.	Copy the correct abbreviation beside each word. km hm dkm m dm cm 10. centimeter cm 11. kilometer km 12. dekameter dkm

Objective		Test Items
IIIA.	13-14.	Complete these equations.
		13. 1 dekameter = __10__ meters
		14. __1__ kilometer = 10 hectometers
IIIB.	15-16.	Copy the correct word in each blank.
		kilometer hectometer dekameter meter decimeter centimeter
		15. 1 __meter__ = 10 decimeters
		16. 1 hectometer = 10 __dekameters__
IIIC.	17.	Circle the digits. (Credit given only if the entire item is correct.)
		(6) 10 (0) (5) 38
IIID.	18-19.	Complete these equations.
		18. 7 meters = __70__ decimeters
		19. 4 kilometers = __4000__ meters
IIIE.	20-21.	Complete these equations.
		20. 51 dekameters = __510__ meters
		21. 6283 meters = __623,300__ centimeters
IIIF.	22-25.	Complete these equations.
		22. 40 dekameters = __4__ hectometers
		23. 600 decimeters = __6__ dekameters
		24. 3500 centimeters = __35__ meters
		25. 7240 meters = __724__ dekameters
IVA.	26.	Complete this equation.
		264 meters = __2__ hectometers + __6__ dekameters + __4__ meters

Objective		Test Items
IVB.	27.	Copy the correct word in each blank. You may need to use some words more than once.

kilometer hectometer dekameter
meter decimeter centimeter

836 centimeters = 8 meters +
3 decimeters + 6 centimeters

VA. 28-29. Add or subtract. Be sure to give your result a name.

28.
23 dekameters
+35 dekameters
58 dekameters

29.
87 centimeters
-42 centimeters
45 centimeters

VB. 30-31. Add or subtract. Then copy your result on the next line and rename it.

30.
315 meters
+262 meters
577 meters

577 meters = 5 hectometers +
7 dekameters + 7 meters

31.
795 decimeters
-334 decimeters
461 decimeters

461 decimeters = 4 dekameters + 6 meters +
1 decimeter

APPENDIX G

POST-TEST AND KEY

Objective		Test Items
IA.	1.	Circle the word which tells how you could measure the length of a new pencil. kilometer meter (decimeter)
IB.	2-6.	Circle the words that are metric measures. (Credit given for correctly marking or not marking each term.) foot (dekameter) pound mile (meter)
IC.	7.	Circle the word that stands for the longer distance. centimeter (kilometer)
IC.	8.	Circle the word that stands for the shorter distance. meter (decimeter)
ID.	9.	Circle the word you would use to talk about something this long. _____ kilometer (decimeter) meter
II.	10-12.	Copy the correct abbreviation beside each word. km hm dkm m dm cm 10. hectometer hm 11. decimeter dm 12. centimeter cm

Objective		Test Items
IIIA.	13-14.	Complete these equations.
		13. __1__ meter = 10 decimeters
		14. 1 hectometer = __10__ dekameters
IIIB.	15-16.	Copy the correct word in each blank.
		kilometer hectometer dekameter meter decimeter centimeter
		15. 1 __dekameter__ = 10 meters
		16. 1 decimeter = 10 __centimeters__
IIIC.	17.	Circle the digits. (Credit given only if the entire item is correct.)
		46 (0) (7) (4) 10
IIID.	18-19.	Complete these equations.
		18. 5 dekameters = __500__ decimeters
		19. 3 decimeters = __30__ centimeters
IIIE.	20-21.	Complete these equations.
		20. 46 kilometers = __4600__ dekameters
		21. 532 meters = __5320__ decimeters
IIIF.	22-25.	Complete these equations.
		22. 300 decimeters = __3__ meters
		23. 1000 centimeters = __1__ dekameter
		24. 330 meters = __33__ dekameters
		25. 49,000 decimeters = __49__ hectometers
IVA.	26.	Complete this equation.
		341 dekameters = __3__ kilometers + __4__ hectometers + __1__ dekameter

Objective		Test Items
IVB.	27.	Copy the correct word in each blank. You may need to use some words more than once.

kilometer hectometer dekameter
meter decimeter centimeter

673 decimeters = 6 dekameters + 7 meters +
3 decimeters

VA. 28-29. Add or subtract. Be sure to give your result a name.

28.
314 kilometers
+265 kilometers
579 kilometers

29.
79 decimeters
-43 decimeters
36 decimeters

VB. 30-31. Add or subtract. Then copy your result on the next line and rename it.

30.
136 meters
+243 meters
379 meters

379 meters = 3 hectometers + 7 dekameters +
9 meters

31.
758 dekameters
-346 dekameters
412 dekameters

412 dekameters = 4 kilometers +
1 hectometer +
2 dekameters

APPENDIX H

MEMBERS OF THE ATTITUDE SCALE COMMITTEE

Mrs. Jon L. Branton
Fourth Grade Teacher
Mayfair Elementary School
Baton Rouge, Louisiana

Mrs. Robert W. Crain
Fourth Grade Teacher
Beechwood Elementary School
Baton Rouge, Louisiana

Mrs. William B. Gatipon
Fourth Grade Teacher
St. Joseph Academy
Baton Rouge, Louisiana

APPENDIX I

February 10, 1974

Dear

As I explained to you in our conversation, my doctoral dissertation will include the use of an attitude scale designed to measure the reactions of fourth grade students toward instruction which they will have received in the use of the linear metric system. A copy of the proposed scale is enclosed. It would be most helpful to me if you would evaluate it in terms of its acceptability for use with fourth grade students.

For your information, the directions on the scale will be read to the subjects. Only the first three items on the scale will be scored for the study. The others are "dummy" items intended to make desirable responses less obvious to the students. In the form used in the study the order of the items will be randomized.

Because the study is a comparison of four methods of presentation of the content unit, the only identification necessary will be the treatment group to which each student belongs. These groups will be designated A through D. The attitude scale for each group will be identified by a difference in the wording of Item 2. Item 2A will be used on the form for Group A; Item 2B on the form for Group B; etc.

If you wish (although this is not at all necessary), you may have some of your students read the form since none of them will be involved in the actual study. Should you choose to do this, please keep in mind that we are not concerned at this time with the attitudes shown by their responses, but only with their ability to understand the scale and to do what is required in making their responses.

Please indicate on the enclosed form your opinion concerning the acceptability of each item. If you believe that an item is not satisfactory, kindly indicate briefly your reason and any suggestions you may have for improving it.

Kindly affix your signature in the place provided and, in the lower left hand corner give your name and school as you wish it to appear in the credits of the dissertation.

Please return this material to me at your earliest convenience. A self-addressed envelope is enclosed. Thank you for your assistance in this project.

Sincerely,

Jocelyn Marie Rees

Enclosures

APPENDIX J

EVALUATION OF PROPOSED ATTITUDE SCALE

Item	Acceptable	Not Acceptable	Comments
1.			
2A.			
2B.			
2C.			
2D.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

Any other comments or suggestions? _____

_____

_____

Signed _____

Name _____

Fourth Grade Teacher at _____

THANK YOU!

APPENDIX K

PROPOSED ATTITUDE SCALE

IIRECTIONS:

This is NOT a test. Do NOT put your name on this paper.

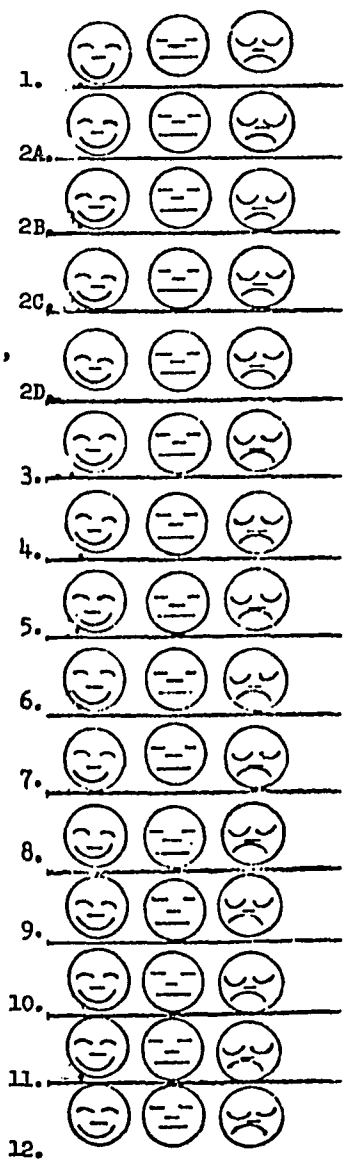
Read each sentence carefully. Put an X on the face which shows how you feel about what the sentence says.

An answer is correct if it tells how YOU feel.

If you cannot read any word or sentence, you may ask your teacher to read it to you.

When you have finished, please wait quietly until the papers are collected. Thank you.

1. I feel like this about learning to use the metric system to measure things.
2A. I feel like this about having many things to look at to help me learn the metric system.
2B. I feel like this about having many things to listen to to help me learn the metric system.
2C. I feel like this about doing many things with my hands and body to help me learn the metric system.
2D. I feel like this about using things to look at, to listen to, and to do with my hands and body to help me learn the metric system.
3. I feel like this about how the teacher helped me learn the metric system.
4. I feel like this about learning how to read new words.
5. I feel like this about how we learn to spell new words.
6. I feel like this when we study about other people and other countries.
7. I feel like this when the class plays games outdoors.
8. I feel like this when we study about plants and animals or planets and space.
9. I feel like this when my teacher asks me to do some pages in a workbook.
10. I feel like this when the class sings together.
11. I feel like this about learning to spell words such as "metric" and "kilometer."
12. I feel like this about learning to read words such as "centimeter" and "hectometer."



APPENDIX L

ATTITUDE SCALE, FORM A

DIRECTIONS:

This is NOT a test. Do NOT put your name on this paper.

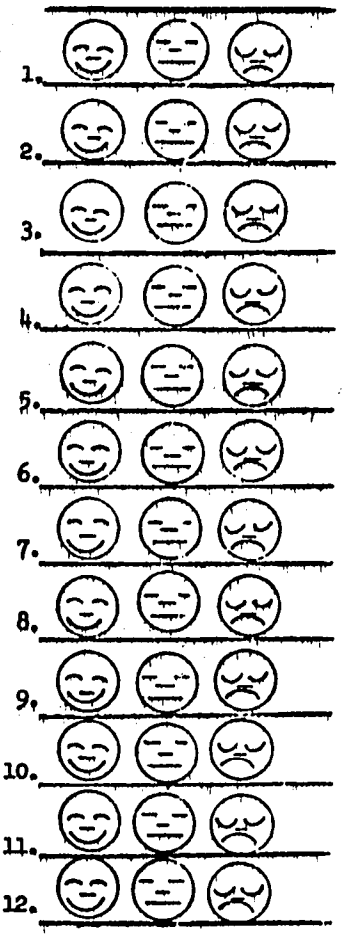
Read each sentence carefully. Put an X on the face which shows how you feel about what the sentence says.

An answer is correct if it tells how YOU feel.

If you cannot read any word or sentence, you may ask your teacher to read it to you.

When you have finished, please wait quietly until the papers are collected. Thank you.

1. I feel like this when my teacher asks me to do some pages in a workbook.
2. I feel like this when we study about other people and other countries.
3. I feel like this about learning to use the metric system to measure things.
4. I feel like this about learning how to read new words.
5. I feel like this about learning to spell words like "metric" and "kilometer."
6. I feel like this when we study about plants and animals or planets and space.
7. I feel like this about having many things to look at to help me learn the metric system.
8. I feel like this about how we learn to spell new words.
9. I feel like this about learning to read words such as "centimeter" and "hectometer."
10. I feel like this when the class sings together.
11. I feel like this about how the teacher helped me learn the metric system.
12. I feel like this when the class plays games outdoors.



APPENDIX M

ATTITUDE SCALE, FORM B

DIRECTIONS:

This is NOT a test. Do NOT put your name on this paper.

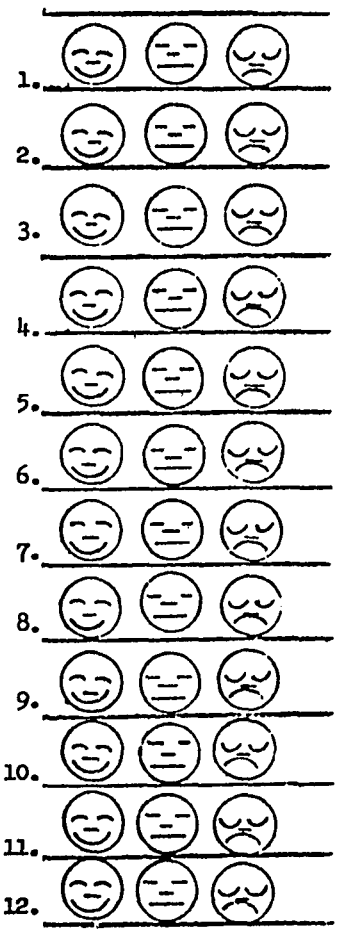
Read each sentence carefully. Put an X on the face which shows how you feel about what the sentence says.

An answer is correct if it tells how YOU feel.

If you cannot read any word or sentence, you may ask your teacher to read it to you.

When you have finished please wait quietly until the papers are collected. Thank you.

1. I feel like this when my teacher asks me to do some pages in a workbook.
2. I feel like this when we study about other people and other countries.
3. I feel like this about learning to use the metric system to measure things.
4. I feel like this about learning how to read new words.
5. I feel like this about learning to spell words like "metric" and "kilometer."
6. I feel like this when we study about plants and animals or planets and space.
7. I feel like this about having many things to listen to to help me learn the metric system.
8. I feel like this about how we learn to spell new words.
9. I feel like this about learning to read words such as "centimeter" and "hectometer."
10. I feel like this when the class sings together.
11. I feel like this about how the teacher helped me learn the metric system.
12. I feel like this when the class plays games outdoors.



APPENDIX N

ATTITUDE SCALE, FORM C

DIRECTIONS:

This is NOT a test. Do NOT put your name on this paper.

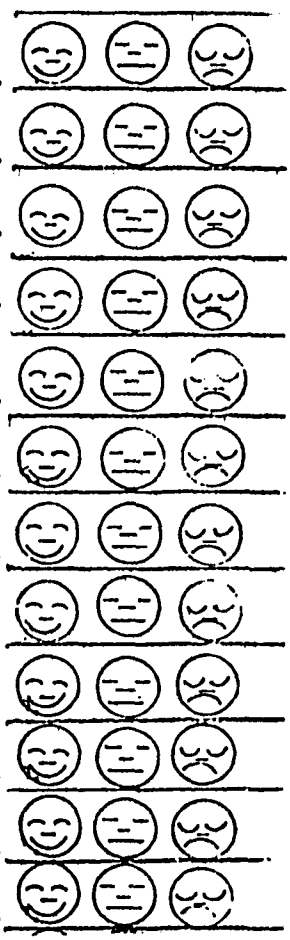
Read each sentence carefully. Put an X on the face which shows how you feel about what the sentence says.

An answer is correct if it tells how YOU feel.

If you cannot read any word or sentence, you may ask your teacher to read it to you.

When you have finished please wait quietly until the papers are collected. Thank you.

1. I feel like this when my teacher asks me to do some pages in a workbook.
2. I feel like this when we study about other people and other countries.
3. I feel like this about learning to use the metric system to measure things.
4. I feel like this about learning to spell words like "metric" and "kilometer."
5. I feel like this about learning to read new words.
6. I feel like this when we study about plants and animals or planets and space.
7. I feel like this about doing many things with my hands and body to help me learn the metric system.
8. I feel like this about how we learn to spell new words.
9. I feel like this about learning to read words such as "centimeter" and "hectometer."
10. I feel like this when the class sings together.
11. I feel like this about how the teacher helped me learn the metric system.
12. I feel like this when the class plays games outdoors.



APPENDIX O

ATTITUDE SCALE, FORM D

DIRECTIONS:

This is NOT a test. Do NOT put your name on this paper.

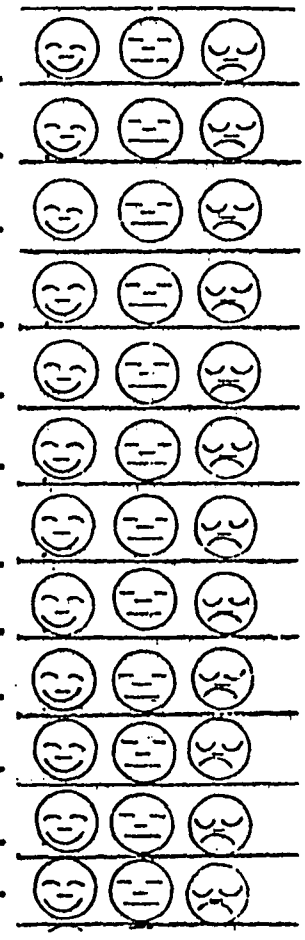
Read each sentence carefully. Put an X on the face which shows how you feel about whet the sentence says.

An answer is correct if it tells how YOU feel.

If you cannot read any word or sentence, you may ask your teacher to read it to you.

When you have finished please wait quietly until the papers are collected. Thank you.

1. I feel like this when my teacher asks me to do some pages in a workbook.
2. I feel like this when we study about other people and other countries.
3. I feel like this about learning to use the metric system to measure things.
4. I feel like this about learning how to read new words.
5. I feel like this about learning to spell words like "metric" and "kilometer."
6. I feel like this when we study about plants and animals or planets and space.
7. I feel like this about using things to look at, to listen to, and to do with my hands and body to help me learn the metric system.
8. I feel like this about how we learn to spell new words.
9. I feel like this about learning to read words such as "centimeter" and "hectometer."
10. I feel like this when the class sings together.
11. I feel like this about how the teacher helped me learn the metric system.
12. I feel like this when the class plays games outdoors.



VITA

Jocelyn Marie Rees was born in New Orleans, Louisiana, on January 26, 1931. She attended John Dibert Elementary School and graduated from Eleanor McMain High School in 1947. She began her studies in elementary education at Loyola University in New Orleans but subsequently transferred to Southwestern Louisiana Institute (University of Southwestern Louisiana) in Lafayette.

Her teaching career began at St. Maurice Elementary School in New Orleans in 1950. During the following years she taught in elementary and secondary schools in New Orleans, Lafayette, and Gonzales, Louisiana, and in Pascagoula, Mississippi. Concurrently she attended University of Southwestern Louisiana on a part time basis and earned a Bachelor of Arts Degree in elementary education from that institution in 1960.

She continued teaching in elementary and secondary schools in Louisiana and from 1962 to 1967 served as principal of St. Michael High School, a junior senior high school in Crowley, Louisiana. Meanwhile she continued her studies in summer sessions at Catholic University of America in Washington, D.C., from which institution she received a Master of Arts Degree in educational administration in 1970.

Since 1967 she has been employed in the junior high schools of East Baton Rouge Parish in Louisiana.

EXAMINATION AND THESIS REPORT

Candidate: Jocelyn Marie Rees

Major Field: Education

Title of Thesis: SOME COGNITIVE AND AFFECTIVE OUTCOMES OF MODALITY STRUCTURED INSTRUCTION IN THE LINEAR METRIC SYSTEM

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

April 14, 1975