MAXIMUM AVAILABLE DESK-TO-EYE DISTANCE FOR STUDENTS IN GRADES ONE AND TWO: REGIONAL NORMS AND STATISTICAL COMPARISON TO DISTANCE USED FOR NEAR POINT SCREENING

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

COLLEGE OF EDUCATION

BY

BETTY J. WARD, B.M., M.Ed.

DENTON, TEXAS

MAY 1989

TEXAS WOMAN'S UNIVERSITY
DENTON, TEXAS

4/17/89
Date

To the Dean of the Graduate School:

I am submitting herewith a dissertation written by Betty J. Ward entitled "Maximum Available Desk-to-Eye Distance for Students in Grades One and Two: Regional Norms and Statistical Comparison to Distance Used for Near Point Screening." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Special Education.

M L Hayes
Major Professor

We have read this dissertation and recommend its acceptance:

Marjorie S Kulle

Jean Pyfer

Donna D. Tynan

Michael Wade

Michael Wade
Dean, College of Education

Accepted

Dean of Graduate Studies and Research

ACKNOWLEDGEMENTS

Many individuals and institutions contribute to the completion of a study. I am grateful to all who helped with this project. My special thanks are extended to

1. dissertation committee members--Professor Marnell Hayes (Chair), Marjorie Keele, M.D.; Professor Jean Pyfer, Professor Donna Tynan, Professor Michael Wiebe, and Professor Wallace Edge (formerly of Texas Woman's University);

2. pilot subject--Amy Wittenauer and her family;

3. participating schools and children;

4. participating furniture manufacturers--American Desk Company and Carter Craft;

5. State respondents knowledgeable about vision screening practices;

6. Staffs at libraries--American Optometric Archives (Chicago); American Seating Company (Grand Rapids); School of Optometry, University of Houston; and Southwest Center for Medical Studies, University of Texas (Dallas);

7. Professionals in other disciplines who gave of their time and expertise for discussions: Gerald Getman, O.D.; Dr. D. G. Ozias, Texas Bureau of Maternal and Child Health; C. A. T. Salerno, Media Specialist;

Copyright © Betty J. Ward, 1989
All rights reserved

Ed Snapp, R.P.T.; Richard Srebro, M.D., Director of Research, Department of Ophthalmology, Southwest Center for Medical Studies, University of Texas (Dallas); Professor David Marshall, Department of Mathematics, Physics, and Computer Science, Texas Woman's University; Mildred Marsh, data entry;

8. Authors who responded to personal correspondence;

9. Beverly Richey Strong, committed typist and word processor extraordinaire; and

10. Ottis Ward, field technician and husband, who gave unstintingly of his patience, and especially of his support, at times of stress and deadlines.

ABSTRACT

Ward, Betty J. Maximum Available Desk-to-Eye Distance for Students in Grades One and Two. Doctor of Philosophy (Special Education), May, 1989, 253 pp., 30 tables, 3 illustrations, 102 titles.

This study establishes maximum available desk-to-eye distance (MA-DED) normative tables for students in Grades 1 and 2 (ages 6 to 9 years) and investigates the effect of age, grade, and sex on available viewing distances while seated at two styles of desks (storage at side or across).

Reports on: target distances used in nearpoint vision screening (TDNPVS), plus lens power used to screen for hyperopia ($+D_{FL}$), and vision screening practices (50 states and District of Columbia).

Significance of the study: supplies criteria for near viewing distances available to students (Grades 1 and 2, ages 6 to 9 years) as bases for generalizability of other research findings and screening results. Statistical findings (two-tailed, $p < .05$) supported three hypotheses: significant differences for independent samples (MA-DED means and TDNPVS, and diopter equivalents [D_S, D_A] of MA-DED means and summed equivalents and plus power used in screening, and significant differences for paired samples (means difference remeasured/measured MA-DED means). MANOVA revealed no effects of grade group or age group per se. Univariate analysis revealed three-way interaction among age group, grade, and style of desk; means differences of Side minus Across not consistent between grades when viewed across age groups.

Conclusions: Present $+D_{FL}$ are too low for mean viewing distances; near viewing distances are shorter than most near screening distances; available viewing distances of boys were usually shorter than those of girls; lower age and grade level are associated with shorter available maximum viewing distances; near visual demands are not constant across age and grade or desk style; viewing distance of across desk is less than viewing distance of side desk;

Application: As viewing distances for near vision screening research or determining generalizability; use individual MA-DED established in classroom or appropriate means of MA-DED.

Key Words: Ages 6 through 9, Near Screening Distances, Near Viewing Distance, Norm Tables, Plus Screening Lens, Vision Screening Practices.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS iv

ABSTRACT vi

LIST OF TABLES xi

LIST OF ILLUSTRATIONS xiv

Chapter

I. INTRODUCTION 1

The Problem 4
Purposes of the Study 4
Statement of Hypotheses 5
Limitations 6

II. REVIEW OF THE LITERATURE 8

Developmental Aspects of the Eye and Vision 9
Investigations by Eye Care Professionals 17
Investigations by Reading Specialists 35
Screening 43
Vision Screening Practices 74
Furniture 76
Handwriting 82
Summary of Review 87

III. METHODOLOGY 89

Subjects 89
Solicitation of Participants 89
School Districts 89
Students 90
Participants 90
School Districts and Schools 90
Students 92
Helpers and Technician 93
Equipment and Instrumentation 94

Chapter		Page
	Procedure	96
	Organization of Testing	96
	Administration of MA-DED Testing	96
	MA-DED Norms	98
	Statistical Analysis	98
IV.	DATA ANALYSIS AND RESULTS	100
	Presentation and Analysis of Data	100
	Retention of Subjects for Data Analysis	108
	Results	110
	Summary	121
V.	SUMMARY, FINDINGS, DISCUSSION, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS	123
	Summary	123
	Findings	125
	Discussion	127
	Commentary	127
	Observations	130
	Conclusions	130
	Implications	132
	Recommendations	134
REFERENCES		138
APPENDIX		
A.	State Publications: Vision Screening Guidelines	147
B.	Sample Teacher Observations	154
C.	Inquiry Respondents	160
D.	Letters	167
E.	Brief Description of the Study	180
F.	Summary Consent Form Reply: Measure/Remeasure	184
G.	Instructions to Local Helpers	186

Appendix		Page
H.	Figure 2. Demonstration of Correct Posture	189
I.	Figure 3. Sample of Target Cross	191
J.	Procedure for Taking the MA-DED Measurement	193
K.	Form for Collection of MA-DED Data	196
L.	Criteria for Measurement Locations and Resulting Locations	198
M.	Criteria for Fit of Chair and Desk	200
N.	Norming of the MA-DED	202
O.	Legend of Acronyms	220
P.	Reply and Response Forms	223
Q.	Tables	226

LIST OF TABLES

Table		Page
1.	Mean Nearpoint Working Distance According to Age Group in Hurst's (1964) Study (in Inches)	29
2.	Inquiry Responses, 1985-86: Frequency of Fogging Lens Power by Grade and Age . .	57
3.	Inquiry Responses, 1985-86: Target Distances Used in Nearpoint Vision Screening (TDNPVS)	60
4.	Manufacturers' Suggested Desk/Chair Heights for Grades 1 and 2	79
5.	Subjects' Ages, Grade Levels, and Ethnic Origins	103
6.	Target Distances and Tests Used to Screen Nearpoint Vision	105
7.	Power of Plus Diopter Lens Used to Screen for Hyperopia by Grade	106
8.	Frequency Distribution of Furniture Used for MA-DED Measurements	107
9.	Retention of Subjects for Data Analysis . .	109
10.	Range of Measured and Remeasured Side and Across MA-DED Scores and Target Distances for Nearpoint Vision Screening (TDNPVS)	111
11.	Range of Diopter Equivalents (+D) of Individual MA-DEDs	112
12.	Maximum Available Desk-to-Eye Distance (MA-DED) Means by Age Span and Desk Style	114

Table		Page

13. Student's T-Tests: Expected and Actual Percentages 115

14. MANOVA of the MA-DED 118

15. Cell Means: Differences Between Across and Side MA-DEDs 119

16. Inquiry Responses, 1985-86: Near Tests and Target Distances 227

17. Inquiry Responses (1985-86): Status of Vision Screening 230

18. Excerpts from TEA Statistical Brief SB81SAR: Annotated Definitions of Terms 235

19. Participating Public Schools: Texas Education Agency Category Analysis, 1985-86 237

20. Participating Parochial School 239

21. Description of Equipment Used in the Study 240

22. Maximum Available Desk-to-Eye Distance (MA-DED) Means by Grade and Desk Style 241

23. Maximum Available Desk-to-Eye Distance (MA-DED) Means by Sex, Grade, and Desk Style 242

24. Maximum Available Desk-to-Eye Distance (MA-DED) Means by Age, Grade, and Desk Style 243

25. Maximum Available Desk-to-Eye Distance (MA-DED) Means by Age, Sex, and Desk Style 244

26. Remeasured Maximum Available Desk-to-Eye Distance (MA-DED) Means by Sex and Desk Style 245

Table Page

27. Remeasured Maximum Available Desk-to-Eye Distance (MA-DED) Means by Grade and Desk Style 246

28. Linear Range of Emmetropic Clear Vision for Given Accommodation, With No Reserve 247

29. Inquiry Responses (1985-86), Screening for Hyperopia by State: Fogging Lens Power at Given Grade(s) or Age(s) 249

30. Inquiry Responses (1985-86): Hyperopia Screening by Grade, Age, Special Conditions or Populations, and Frequency 251

LIST OF ILLUSTRATIONS

Figure		Page
1.	Relationship of Selected Criteria (+D Lens) to Screening Strengths	46
2.	Demonstration of Correct Posture	189
3.	Sample of Target Cross	191

CHAPTER I

INTRODUCTION

There is increasing national and statewide interest in vision screening of school-age children. The belief that vision is a main avenue of learning has led to concern about school children receiving evaluation of their vision by means of vision screening (Petrie, Tumblin, & Miller, 1979). Research has produced data which indicate that it is not so much the mildly to moderately myopic child who demonstrates problems in reading as it is the child who is mildly to moderately hyperopic (Francis, 1973).

Target distances used for screening near vision are based on research findings and conclusions of specialists in the eye care field over the past 100 years or more. Reading and vision researchers have often used these same distances of 14 to 16 inches (33.02 to 40.64 cm) as physical or optical distances created by the use of lens (Bayle, 1942; Gonzalez, 1983; Kruger, 1977). In the United States, these same distances are used as target distances for screening near vision (Petrie et al., 1979; Sloan, 1959). Some vision experts argue, however, not to screen near vision, but to employ only plus or convex lens at far distance to screen for hyperopia. They indicate that the ability of the student to see clearly through the fogging lens is a better indicator of likely difficulty the student will experience in seeing well or comfortably at near work distance (American Association of Ophthalmology, 1971; Committee on School Health, 1977; Doster, 1971).

Information about vision screening practices in the United States has been only summative and is expressed in terms of the areas screened and the names of tests or screening machines used. There has been no inclusion of the near target distances or the plus lens power (Belloc, 1962; Bromberg, Jaycox, Poirier, & Simonse, 1984).

The unit used to measure eye accommodation is the diopter. A target's linear distance from the eye and the dioptric power of accommodation are reciprocal. When one is known, the other may be calculated by using the formula

Diopter = 1.00 m/metric target distance

or

Metric Target Distance = 1.00 m/diopter (Borish, 1970).

Metric target distance is converted to inches by dividing by .0254 m. Because of reciprocity, the necessary accommodation increases as the target distance decreases. The range of clear vision for a given greater diopter also decreases. Normal vision may be thought of as the refractive status which is most commonly found in a population. Emmetropic vision for an individual is the refractive status in which there is present the theoretically perfect relationship between convergence and accommodation for best vision at varying distances. Normal vision at different ages is not necessarily emmetropic.

An emmetrope's linear range of clear vision for the one-diopter difference between +1 D and +2 D is 19.685 inches (50 cm); whereas, the linear range of clear vision for the one-diopter difference between +10 D and +11 D is less than 1/2 inch (0.91 cm). Maximum available nearpoint distance is finite and is limited by four factors: the physical build of the child, the style of the desk being used, the height at which the desk is set, and the height of the chair seat. Posture changes can only shorten the maximum available desk-to-eye distance. A shorter distance increases the power of accommodation which is necessary for the student to continue to see the near stimulus clearly.

Hurst (1964) expressed concern that adult viewing distance criteria or norms were being used to screen or test children's vision. Several investigators in the field of eye care (Hurst, 1964; Rouse, Hutter, & Shiftlett, 1984; Sheridan, 1979) have found that the working distances of primary-age children are often shorter than those of adults. They also found that there may be a range of near work distances, both across their research sample and for a single subject during a sustained time on a single near task.

The Problem

No standards for nearpoint desk-to-eye distance have been found for primary-age children (Grades 1 and 2) which can be used as criteria for comparing the distances used for screening vision or the distances used in research in fields of reading and the vision of primary-age children. Research in these areas has not included data which indicate that the distances used are related to distances available to children during nearpoint tasks in a classroom. Without criteria for available distance while children are seated at classroom furniture, it is difficult to assess the appropriateness of generalizing research findings or pass/fail of vision screening to the classroom situation.

Purposes of the Study

The main purpose of this study was to establish norms for the maximum available desk-to-eye distance (MA-DED) for students in Grades 1 and 2 while seated to write at each of two styles of desks. The second purpose of the study was to test for significant differences. The tests were between means of the Side and Across MA-DEDs and the standards of target distances used for nearpoint vision screening (TDNPVS) as reported by the states and the District of Columbia (the states), and between the dioptric equivalent of the means of the Side and Across MA-DEDs (D_S and D_A) and the standards created (D_{SFL}, D_{AFL}) by adding each dioptric plus power fogging lens reported by the states as being used to screen for hyperopia (D_{FL}) and each D_S and D_A. The diopter is the unit used to measure power of accommodation.

The third purpose of the study was to test for significant differences between the remeasure/measure means of the Side and Across MA-DEDs. The remeasure was done the semester immediately following the measure, fall to spring (Time 1, 4 months) for Grades 1^1 and 2^1, and spring to fall (Time 2, 8 months) for Grade 1^2.

Statement of Hypotheses

The following research hypotheses were tested in this study:

H_1. There is a significant difference between the mean of the MA-DED for each cell as described and each standard distance used as target distance for nearpoint vision screening (TDNPVS).

H_2. There is a significant difference between the mean MA-DED diopters (the mean of the MA-DED for each cell as described when converted to plus diopters of accommodation [D_S, D_A]) and the summed diopters (D_{SFL}, D_{AFL}) of the given plus diopters fogging lens and MA-DED diopters for a given cell.

H_3. There is a significant difference between the remeasure/measure means of the MA-DED across time for the children in Time 1, Grades 1^1 and 2^1 and Time 2, Grade 1^2.

Limitations

The limitations for this study were:

1. the geographic area within Education Service Center Region X of the State of Texas (Collin, Dallas, Ellis, Fannin, Grayson, Hunt, Kaufman, and Rockwall counties);

2. the decision of a district's administrators as to which schools within that district would participate;

3. the number of children enrolled in Grades 1 and 2 who were present the day of measurement and whose parents had given permission for participation;

4. the ethnicity, sex, and grade level of the participating children under age 10 who were present the day of measurement;

5. the response of the administrators, the number of subjects enrolled in the same school at the time of remeasurement, the response of the parents to the request

for remeasurement, and the subjects' presence on the day of remeasurement;

6. the time period in which the study was conducted (three consecutive semesters);

7. the standards used for MA-DED comparisons were near point distances utilized by the individual states in their vision screening methods; and

8. the standards used for D_{SFL} and D_{AFL} comparisons utilized the plus diopters reported by the states as being used to screen for hyperopia and the plus diopters suggested in the literature.

CHAPTER II

REVIEW OF THE LITERATURE

Over the last 100 years, investigators in the field of eye care have conducted research which has resulted in normative data. Replication of these studies to update or extend the findings has involved using the viewing distances found in the earlier research. These distances have become standards for testing the same visual functions.

Viewing distance is a component of all visual tasks, research in vision and reading, vision screening, and a child's performance in the classroom. The visual demand of a task is more than what may easily be apparent. The visual demand varies with changes in the viewing distance and may also vary according to a child's age and visual development.

It is important to look at the normal developmental sequence of the visual system and visual skills. It is also important to look at the viewing distances used in investigations by eye care and reading specialists; to explore for studies which determine the work distance of young students; and to consider vision screening, its components, and its administration. It is equally important to look at school furniture and handwriting and their involvement with near viewing distance.

The review of the literature for this study is divided into six main areas. These are the development of vision, research by eye care professionals, research by reading professionals, vision screening, school furniture, and handwriting.

Developmental Aspects of the Eye and Vision

The refractive status of the eyes is developmental in that it is expected to vary with age in ways than can be predicted. Some investigators consider that at ages 8 to 9 years, a child's vision has completed its major transition and has settled into being predominantly farsighted (hyperopic), predominantly nearsighted (myopic), or properly correlated between the refractive system of the eye and the axial length of the eyeball (emmetropic) (Borish, 1970; Michaels, 1985; Scheie & Albert, 1977). Vision professionals also recognize that an individual's refractive status seldom remains static over a period of time.

In order to differentiate between expected normal vision and abnormal vision, one needs to know the developmental sequence of the maturing visual system. Valadian and Porter (1977) described the refractive capacity of the newborn as being typically hyperopic due to the growth of the eyeball and to the refractive powers of the cornea and lens. They further reported that the tendency toward hyperopia increases slowly through about age 8 as the curvatures of the cornea and lens decrease relative to the growth of the eyeball. The refractive status varies from +0.1 D in newborns to +1.5 D in children at age 8. After age 8, the tendency is growth toward emmetropia, with +0.0 D common at ages 11 to 20. After age 20, there is a tendency toward myopia, which decreases after age 30. Valadian and Porter's statement that "refractive power goes through a developmental cycle" (p. 215) reinforces the need to recognize that changes of refractive status should be expected at all ages in life.

Brent and Arstikaitis (1983) stated that as a child grows, so do the child's eyes, and that after 5 or 6 years of age, hyperopia decreases. Pringle and Ramsey (1982) emphasized that visual problems continue to develop during both the elementary years and adolescence because of growth and the developmental changes that occur. Sheridan (1979) discussed the visual functioning of a child from the age of 2 weeks to 2 to 3 years. She stated that the ability to pay visual and auditory attention at the younger age is confined to nearby environment within 10 to 12 inches from the child's eyes and ears, and is observed to expand spherically over time until the mature range is reached at 2 to 3 years of age. Sheridan also commented that a similar developmental process is observed in young children who are responding to treatment for amblyopia (suppressed vision): near vision, rather than distant vision, improves first.

A child's visual acuity may be spoken of in three ways: an acceptable level of acuity which allows the child to participate in activities appropriate for the child's age; the level of acuity which is expected at a given age; and the age at which emmetropic (20/20) vision is first expected. Opinions among eye care professionals vary. For children under five years of age, 20/40 acuity is acceptable in that it allows them to participate in age-appropriate activities: beyond age five, visual acuity should be 20/20 (Brent & Arstikaitis, 1983). From school age through adolescence, visual acuity should be 20/20 (Pringle & Ramsey, 1982). Keeney (1966) indicated an expectation of 20/20 vision as young as 4 years of age. Borish (1970) indicated that maximum acuity is achieved at approximately age 10. Valadian and Porter (1977) listed an expected acuity of 20/70 at age 2, 20/30 at age 5, and 20/20 at age 7; however, they considered 20/30 to be adquate up to 8 years of age. In Keeney's (1966) opinion, increases in concentration and crowding of the cones, which take place until puberty, underlie the enhancement of central acuity seen during childhood. These changes usually cease at about age 14.

In addition to acuity, other elements of visual functioning are developmental in nature. Pringle and Ramsey (1982) developed a guide for caretakers and health care professionals in which they described the procedure that a caregiver may use to determine the presence of accommodation and control of the eye muscles:

> Ask the child to follow an object, such as the examiner's finger as it is moved to the left, right, up, and down, and close to the child's nose. Binocular motion should be present. If one eye tends to deviate in the opposite direction of the other eye it usually is indicative of weak eye muscles. This is a common problem in children and should be treated immediately. Eye accommodation may be tested with a flashlight. The pupil will constrict when the bright light is brought into focus. (p. 117)

Binocular vision should be apparent at age 4 or 5. Absence of this visual skill at these ages indicates the need to refer the child for professional care (Pringle & Ramsey, 1982).

Stein and Fowler (1982) noted that the child's ability to monitor eye position is "necessary long before reading begins, but to read successfully a new degree of precision is demanded" (p. 332). They found eye dominance to be developmental in nature and that a dominant eye helps to define "visual direction when eye position signals provided each eye disagree" (p. 333).

Borish (1970) referred to the acquisition of a dominant or lead eye as being characteristic of a child's development. He spoke of neurological development at ages common to children in Grades 1 and 2 and its effect on some elements of visual development:

> The child matures neurologically between the ages of 7 to 8, and dominancy is fully established in terms of control, sighting, and function, although in cases of heterophoria, the other eye may assume temporary dominancy. Correct dominancy is restored when the heterophoria is corrected. (p. 436)

Pringle and Ramsey (1982) referred to developmental changes in visual skills and the ages at which they are expected:

> By five years of age, true stereopsis is present. Central acuity is unconditionally entrenched at age six. The gross attention span has lengthened to nearly 20 minutes, and detailed attention extends to about two minutes. The physiological hyperopia of earlier life begins to decrease and emmetropia is established between the ages of nine and 11. (p. 463)

Whittington (1958) perceived visual behaviors or skills to be abnormal when certain elements of normal visual development are missing at the expected ages.

Greater accommodation is required with hyperopia than with emmetropia. Borish (1970) defined accommodation as a function of the converging power of the optical system so that light from a near source is brought to a focus upon the retina. Accommodation is linked with both convergence and pupillary miosis (constriction) through near reaction or near synkinesis. Whenever accommodation occurs, the near synkinesis causes the eyes to converge and the pupils to constrict (Dale, 1982). Dale gave four possible stimuli for accommodation: a blurred image coming to focus behind the retinal plane, disparate retinal images, conscious awareness that a near object is being viewed, or a deliberate attempt to imagine that a near object is being viewed. He spoke of the blurred vision experienced at the near point of convergence: "The blurred zone occurs before the break point when fusional convergence amplitudes are measured. The blurring is due to the induced myopia caused by the increased plus power resulting from accommodation" (p. 69). He also explained that the conscious awareness of a screening machine may result in proximal convergence and cause difficulties in using some of the automatic refractors or screening machines.

As a viewed object is brought closer to the eyes, convergence increases. As convergence increases, the stimulus to accommodate also increases. Convergence can become so great that accommodation is forced to change and the viewed target becomes blurred but remains single. As convergence is increased, the limit of fusional convergence is reached and the visual target appears doubled (diplopia). At this point, the subjective endpoint of convergence is reached. When the full limit is reached, the fusion reflex is lost and one eye moves outward. At this point, the objective endpoint of convergence is reached. With outward movement of the target, the fusion reflex is reintroduced, the eyes converge, and the visual target is perceived as single again. Dale (1982) noted that fatigue or emotional stress can lessen fusional reserve. Convergence is considered deficient when the near point convergence (NPC) distance is greater than 10 cm (approximately 4 inches). Subjective NPC is described as frequently being outside the range of normal NPC, being greater than 10 cm (3.94 inches), or up to 30 cm (11.81 inches) or more (Dale, 1982). The 30 cm remote distance of abnormal NPC is greater than the mean 6-inch working distance Hurst (1964) found for his subjects in Grades 1 and 2.

Dale (1982) explained that in living persons the ever-present gravitational stimulus results in postural reflexes which provide balanced tonus to the extraocular muscles. The position of the eyes using only the minimal tonus is called the functional position of rest and can be demonstrated by suspending fusion while observing the occluded eye, as in the screening cover test. Dale explained the contribution of the child's tonus and nervous system to what appears to be a visual muscle problem: "Tonic innervation is excessive in early childhood but diminishes with age. This probably accounts for the so-called esotropia that develops in children secondary to poor vision in one eye" (p. 76). He stated that the excessive tonic innervation is not present in adults, indicating that with development the excessive innervation may be expected to disappear.

Brent and Arstikaitis (1983) stated that hyperopia begins to decrease at 5 to 6 years of age. Michaels (1985), however, found that the higher the degree of hyperopia at the time of entrance into school, the less likely the chance that a child would outgrow it. He pointed out that expected hyperopia tends to change 2 to 3 years later in boys than in girls, and that "the child who cannot see comfortably cannot read efficiently" (p. 477). Cashell and Durran (1971) explained that the complex coordination of the eyes rests upon a series of conditioned binocular reflexes and becomes fixed by age 8.

Eames (1961) conducted a study of the amplitude of accommodation for school-aged children, with subjects as young as 5 years of age. He was responding to the assertion made by educators that children were entering school and learning to read at a period in their lives when their eyes were not mature enough to cope with the visual demands placed on them by the curriculum. He had found no historical data for a population below 8 years of age.

Eames' (1961) study measured both urban and nonurban subjects. He found the mean amplitude of accommodation to be larger than what he deemed to be the critical diopters of accommodation, that is, greater than +8.00 D. His selection of 8 diopters (the accommodation required for clear viewing at 4.92 inches or 12.5 cm when there is no accommodation in reserve) was somewhat arbitrary. He stated that it allowed for a reserve of accommodation when the child read at 25 cm (9.84 inches, which requires +4 D with no accommodation in reserve). He did not report, however, how this reading distance was related to visual demands in the school. He did find some urban subjects, aged 5, 6, and 7 years, who had less than this amplitude of accommodation. He made no suggestion as to how these individuals would, or could, cope with the visual demands of the curriculum or how the visual demands could be changed to meet their visual development.

Investigations by Eye Care Professionals

Several disciplines have developed investigations which are involved with vision or its use for tasks which are primarily components of school tasks. These tasks are reading and writing, the basic learning of the primary grades. Among the disciplines are the eye care professions of optometry, ophthalmology, and orthoptics.

Eye care professionals have been concerned with elements of the eye and vision which have become a part of eye examinations and vision screening (Borish, 1970). Among the visual elements which are involved in a child's handling of near school tasks are accommodation and convergence (Wold, 1967). These tasks are involved in the clarity and ease with which near vision is sustained. Refinements of both accommodation and convergence occur as the distance of a visual target decreases. When target letters of a given size are brought closer to the eyes, accommodation and convergence increase. Letters whose sizes are kept constant occupy a larger part of the visual field as the distance decreases. This causes them to appear larger and to be discriminated more easily.

For several tests, eye care professionals commonly utilize a chart with lines of letters, numbers, or symbols which become increasingly smaller in size from one line to the next. Letter charts are commonly used for both adults and children who have some reading experience. In order for the use of such a chart to be valid, the chart must be placed at a distance which allows the size of the letters on any of several given lines to occupy the standardized minutes of an arc in a visual field (Borish, 1970).

Some eye care professionals stipulated a distance to be used in testing near vision or the components involved in near vision. In some cases, however, although the test used is named, the distance is not stated (Stein & Fowler, 1982, 1985; Stein, Riddell, & Fowler, 1986), leading the reader to assume that a distance commonly accepted by the eye care profession is involved.

Richards (1973) made no differentiation in techniques or methods in testing visual acuity at far distance and near distance. The only difference was the target distance. The near distance was stipulated as being 14 inches. In speaking of the near distance of specific work and styles of glasses, he mentioned by occupation the variations from 14 inches that may be needed. He indicated that "a careful determination of the distance of various tasks is very helpful" (p. 16). He did not give consideration to the available near distance for children, which may be shorter than that of adults.

Zellers, Alpert, and Rouse (1984) conducted a study to establish normal accommodative facility, that is, the rate at which accommodation can be stimulated and inhibited repeatedly during a specific period of time. Their sample was composed of adults, and their review of the literature left them with the following conclusion: "Unfortunately, a review of the literature shows little agreement on what constitutes a 'normal' accommodative facility finding" (p. 31). The analysis of accommodative facility is, in their opinion, to be included in "the complete evaluation of nearpoint visual skills of nonpresbyopes" (p. 31). The distance used was 40 cm (16 inches). The authors neither excluded nor included children as nonpresbyopes. They referred, however, to two studies of accommodative facility in children 6 to 12 and 6 to 11 years of age in which the near distance was also 16 inches. They did not comment on the usual near work distances of children in copying from the board while seated at their desks, a task involving accommodative facility.

Gilmartin and Hogan (1985) investigated the role of the sympathetic innervation of the ciliary muscle in determining tonic accommodation (TA), that is, determining the resting position of accommodation and convergence under darkroom conditions. They felt that some degree of smooth-muscle tone is retained after a sustained fixation over time and that this accommodative hysteresis will become evident in TA measurements taken immediately afterward. Their concern was based on what is described as simple or school myopia:

> If cognitive stress does indeed induce anomalies of autonomic function, it is conceivable that this, combined with excessive amounts of close work and a predisposition to hysteresis effects, may actually induce manifest myopia. Simple or "school" myopia may fall in this category, and most ophthalmic practitioners will be familiar with the depressing prospect of an initial -1 D correction at 10 or 11 years of age, progressing to, and stabilizing at, around -3 D at 12-13 years of age. (p. 92)

The -D refractive status indicates a degree of myopia or nearsightedness. They found a nonlinear hysteresis effect, which they felt was enhanced by the association with a high level of concurrent parasympathetic activity during a nearpoint fixation. They did not indicate whether the distance for the near point was a standardized distance or one established for the individual. A standardized distance would likely have been 14 to 16 inches (Borish, 1970; Rosner, 1982).

The emmetropic individual is required to converge and accommodate simultaneously as binocular vision is maintained at near distance. The act of converging the eyes brings about some degree of accommodation. Mason (1962) found that convergence dominates and controls accommodation. He described the linkage between accommodation and convergence in a perfectly balanced emmetrope:

> To look at an object 1 m away, the eyes converge 1 M.A. and accommodate 1.0 D. When looking at an object 1/2 m away, the eyes converge 2 M.A. and accommodate 2.0 D, and so on. The efforts of convergence and accommodation are equal and therefore in perfect balance. . . . The amount by which he [the patient] is able to alter his accommodation is, of course, his relative amplitude of accommodation for the convergence being exerted during the test. Beyond the limits of the relative amplitude the patient has a choice of clear vision with diplopia or single but blurred vision. He cannot have both. (pp. 586, 587)

He spoke of plus lenses not always relaxing accommodation. This is of concern in screening children for hyperopia.

Daum (1984) studied the effect of using prismatic lens to improve convergence insufficiency. He described convergence insufficiency as a syndrome in which

> . . . (1) the angle of exodeviation is generally latent, and at a distance is much smaller than that at near; (2) the AC/A ratio is low; (3) the positive vergence at near is generally insufficient to compensate for the angle of deviation; (4) the nearpoint of convergence value is receded; (5) the accommodative amplitude is reduced by about 1 D from the minimum level for the age; (6) the stereopsis threshold is normal; and (7) suppression, if present, is likely to be intermittent in nature. (p. 21)

Convergence insufficiency adversely affects accommodation and may affect visual ability or comfort at near distance.

Convergence of the eyes at the distance a child uses for reading is required in order for the child to use binocular vision. Letourneau, Lapierre, and Lamont (1979) completed a study designed to show the possible relationship between convergence insufficiency and school achievement for subjects in Grades 3 through 6, ages 7 to 14 years. Near point of convergence (NPC) was measured from the bridge of the nose. Subjects were observed as the penlight target was moved toward the eyes. The subjective NPC was reached when the subject judged the object viewed to appear doubled, and the objective NPC was reached as one eye began to diverge. The target was then moved away from the eyes to the points of recovery. The points at which binocular vision was regained were judged both objectively by the examiner as both eyes again focused on the object, and subjectively when the target was again seen as a single object. The investigators found no significant correlation between convergence insufficiency and school achievement. The data were not presented in a form which allows comparison of break and recovery points for individuals, but the group's three ranges for break (< 10 cm, 10 to 15 cm, and > 15 cm) and recovery (< 15 cm, 15 to 20 cm, and > 20 cm) were presented. Since no maximum and minimum points were given by Letourneau et al., the distances must be inferred from the midranges. The break midrange was from approximately 4 to 6 inches, and the recovery midrange was from approximately 6 to 8 inches. The recovery range distances were greater than the mean working distances found by Hurst (1964) for students in Grades 1 and 2.

Although the study by Letourneau et al. (1979) involved diplopia, there is no indication that the authors investigated coping mechanisms that a child might have developed to avoid diplopia. Borish (1970) discussed suppression of vision as a means of avoiding diplopia. Suppression cannot always be determined by observing movement of the eye, nor can it always be recognized subjectively by the viewer. Letourneau et al. (1979) did not determine and eliminate subjects who might have developed suppression to avoid diplopia. Failure to exclude these subjects could have an effect on the correlation of convergence insufficiency and reading achievement. They dealt with this possibility by stating: "In this study no distinction was made between children who suppressed and those who did not. It may well be that children who suppressed were not impaired in reading, while those who did not suppress were" (p. 22). Suppression of one eye affects accommodation. The nonfixating or nondominant eye is usually the suppressed eye.

When one eye is suppressed, only monocular vision is being used. The amplitude of accommodation is not the same for monocular and binocular vision. Monocular amplitude is generally considered to be less than binocular amplitude because convergence is lacking (Borish, 1970).

The discussion by Letourneau et al. (1979) stipulates that testing for voluntary convergence should include sustained convergence. To test children's sustained convergence, the authors suggested use of the drop test. In this test, an object is used as a stimulus, first at a distance at which the child can focus. The object is then brought toward the child while focus is maintained:

> When the fixation object has been brought to the reading distance, the patient is asked to maintain convergence after the fixation object has been taken away; it is probably better to measure voluntary convergence this way to evaluate accommodative and fusional convergence. (p. 22)

The linear distance to be used as the reading distance was not defined. The reading distance may have been a standardized distance. Borish (1970) used 16 inches as the standard near distance in his chart of convergence when discussing esophoria and exophoria. He described the adult reading range as 13 to 16 inches. The reading distance could be established for the individual by means of the reading cards used in evaluating vision for possible lens correction (refraction). The reading distance for a child might be the individual's desk-to-eye distance, the Harmon distance from the child's knuckle to elbow, or the child's working distance. Rosner (1982) spoke of a child's Harmon distance (the distance from the point of the elbow to the middle knuckle on the back of the fisted hand) as being as short as 9 inches. Hurst (1964) found that some students in first and second grade had working distances as short as 4 and 5 inches. Sheridan (1979) found that the self-selected reading distances of most children ranged between 10 and 12 inches. The maximum length of a child's reading distance at a desk is limited and can be determined only by measuring the space while the child is seated at a desk.

Difficulties are inherent in using tests which involve a child's judgment of when an object is seen with blurred or diplopic vision, such as the tests by Letourneau et al. (1979). These difficulties are clarified in the discussion by Davis (1959) when he described orthoptic training for children with esotropia, a condition in which only one eye fixes on the target and the other eye turns inward. During the time of therapeutic training, the child learns to recognize when both eyes are gazing at the stimulus and to distinguish when seeing blurred, doubled, or single images.

Davis described the necessity for the patient to pass through a stage of blurred vision while the eyes are straight. He felt that a child, as a rule, has no problem tolerating 20/100 vision during outside activities. Later, the child is taught that blurred vision is unsatisfactory, and he must learn to see more clearly while keeping the eyes straight. Special devices are required to train near vision and involve the child in near tasks, such as drawing, writing, and coloring at the child's near work distance. Davis did not discuss determination of the work distance.

The near tasks employed by Davis (1959) for training deviant convergence at near distance can be considered typical for young students and are part of their occupation as students. Eye care professionals have conducted studies focused on meeting the visual demands of adult occupations (Fox, 1973; Waters, 1952). Students in school should be considered workers who share the common environment of working while seated at their desks. The occupational distance for near work by the student may vary from class to class during the day due to changes in the size and style of furniture at which the student is seated while working. The viewing distance may also vary from year to year due to the student's physical growth. Additionally, there may be forced differences of viewing distance brought about by the task, the illumination and luminance of the environment, and the use of one or both hands at the same time to complete the task. The distance may also be varied as the angle between the lower arm and the upper arm changes with use of the hands (Harmon, 1958).

The yearly difference which results with growth does not occur in the adult, although adult viewing distance may change due to postural variations that often come about with age. Investigations to determine the mean working distance for given adult occupations have been pursued. Borish (1970) reported that the distance span commonly used for evaluating the needed strength of bifocal lenses (14 to 16 inches) is considered the adult reading distance. Hurst (1964) was concerned that the adult reading-working distance was used for evaluation of children's vision. He had found the mean working or vocational distance for 86 children in Grades 1 and 2 to be 5.7 inches.

Waters (1952) researched several vocations which involve near work, the typical vocational distances, and the sizes of the visual fields. For adults engaged in general or full desk work, he gave the visual fields as 12 x 18 inches and the work distance as 10 to 16 inches. For those involved in special desk work, the visual field was cited as 18 x 30 inches and the work distance as 12 to 28 inches.

Fox (1973) also discussed vocational distances. He referred to 14 to 18 inches as the most common vocational distances for general usage. The near work distances he cited ranged from 5 inches for tool and dye makers to 20 inches for punch operators. He did not include students of any age among his subjects.

Waters' (1952) data show that as viewing distance shortens, the visual field decreases. The shortest viewing distance in Waters' data is 10 inches. Children, being shorter than adults, are likely to have an even shorter viewing distance. Consequently, their working fields may be smaller than those of adults. This may be of concern in terms of the peripheral visual field for reading (Ikeda & Saida, 1978).

Hurst's (1964) investigation in 1961 involved determination of the near working distances of 692 Canadian children, aged 60 through 180 months (5 through 15 years), in 35 classes, Grades K-8. He determined working distance range for reading while holding a book and while writing at a desk, the habitual working distance for each condition, and the mean habitual work distance for ages and grades. Hurst found the writing distance to be approximately 2 inches shorter than the reading distance for children in the primary grades. He found that neither of the mean working distances fell within one standard deviation ($\pm$ 3 cm) of the mean Harmon distance (Harmon, 1958) determined for male subjects and that their writing and reading distances were shorter than their elbow-to-knuckle Harmon distances. The mean nearpoint working distances in Hurst's study are presented in Table 1.

Table 1

Mean Nearpoint Working Distances According to Age Group in Hurst's (1964) Study (in Inches)

Task by Gender	Age in Months (Midpoint Interval)			
	65	75	85	95
Eye-to-desk				
Girls	7.2	6.3	6.7	7.3
Boys	6.9	6.2	7.7	6.9
Eye-to-Book				
Girls	---	8.0	8.1	10.0
Boys	---	7.1	8.6	9.0

NOTE: From "Vision and Reading Achievement" by William Arthur Hurst, 1964, Canadian Journal of Optometry: Revue Canadienne d'Optomtrie, 25(4), 3-19. Copyright 1964 by the Canadian Association of Optometrists. Adapted by permission of the publisher.

The mean working distances while writing for ages 70 through 89 months (approximately 6 to 8 years) were shorter than were the mean working distances while writing or drawing for the younger ages, 60 through 69 months. The mean working distances became larger for the older ages, 90 through 99 months, returning to approximately the same as those for ages 60 through 69 months. Hurst also pointed out that the mean desk-to-eye distance while writing for one Grade 2 class was 4.5 inches. No age span was indicated for this class.

Hurst (1964) postulated that some factor other than the size of the child affects the working distance. He was concerned about the effect that short working distances, especially those found for primary-age children, can have on children's visual reflexes:

> Working at this distance, vision reflexes are subject to a completely different array of requirements than at 13 to 16 inches, the working distance accepted as normal in all near point tests. For example, when the horizontal phoria, a measurement of the postural balance of the eyes, was correlated with reading achievement at 16 inches, and then compared with the same correlation at 6 inches, the Pearson Product-Moment "r" was found to be opposite. (Hurst, 1967, pp. 52-53)

The negative correlation for both boys and girls at the 16-inch distance was expected by Hurst, but the positive correlation for girls at 6 inches was unexpected. He felt this change in direction of correlation for girls at

6 inches indicated a major change in the postural balance of the eyes. The negative correlation at 16 inches showed that low phorias were related to good readers when reading at this distance. The positive correlation for girls at 6 inches, however, indicated that high phorias produced the good readers when reading was done at so close a distance. Hurst postulated that the girls had a greater adaptive power for the stress situation at 6 inches and stated that the visual stress is many times greater at 6 inches than it is at 16 inches. Hurst (1967) indicated that vision screening and examination of children at the adult nearpoint distances are inadequate in terms of the visual demands which school tasks place on children in Grades 1 and 2. He recommended that further studies establish the normal nearpoint work distances of primary children and investigate how primary children maintain single, comfortable, clear binocular vision at the 6-inch and shorter distances found in his study.

Michaels' (1985) statement helps clarify the difficulty in assessing the adequacy of a child's accommodation in terms of near work distance in a classroom. Michaels stated that only one-half of the relative accommodative amplitude should be used for reading: "The principle is that relative accommodation is equally divided into the amount in use and in reserve" (p. 422). He stressed knowing the exact distance the patient uses in order to meet the visual requirement. He would have the patient measure near viewing distance, and then give the measure to the clinician. The clinician would then use the same distance during the evaluation. Michaels emphasized that faulty vision in a child is seldom recognized by either child or parent. Michaels also indicated that cover/uncover tests should be done at both near and far and at habitual seeing distances. Michaels gave no clues as to how habitual seeing distances are to be determined.

Lebensohn (1958) felt that in persons with uncorrected vision, acuity tests should be done at both 20 feet (standardized far distance) and at reading distance. He did not define reading distance, although he mentioned 14 inches as the viewing distance to be used in a high standard near vision test. He felt that tests at near distance were just as valuable in schools as in industry. He also discussed the favorable effect larger type at a given near distance can have on the ability to read the presented target material.

Awareness that children's vision is developmental and not the same as that of adolescents and adults lends caution to generalizing results of any study to children of primary age until the ages of the study subjects are known. Investigators have used the terms _young_ _subjects_ or _students_ without qualifying the terms. Clarification of these terms is necessary in order to determine if the subjects' ages will allow application of the findings to primary-age children. Similarly, clarification is needed in studies that investigate aspects of vision which are considered part of the physiological changes of nearpoint work when the distance is not stated or is so great that it may not be available to primary-age children.

Inquiry was made of two authors regarding the ages of the subjects or the distances used for their studies. Ehrlich clarified the reason for his use of the term young subjects in his 1987 study which employed a stressful 2-hour nearpoint reading task having a near distance of 20 cm (7.87 inches) as a factor which contributed to the stress. Ehrlich explained that the young subjects were optometry students, ages 18 to 30, with active accommodation of over 10 diopters, as opposed to elderly with reduced amplitude (David Ehrlich, personal communication, July 25, 1988). Ehrlich described the subjects as young because of their degree of active accommodation. The ages of Ehrlich's subjects indicate that his findings should not be applied to primary-age children. Erlich added in his letter, however, a comment which has implications for future studies of children and their vision. "Children's working distance is very important in determining their habitual accommodation

v. convergent 'stress'. It will probably be difficult to measure without disturbing the 'natural posture' which probably varies a great deal during classes and also with tasks" (David Ehrlich, personal communication, July 25, 1988). Ehrlich stated that regardless of the optical correction for even moderate or greater levels of myopia, reading distances of children and adults usually increase with age (David Ehrlich, personal communication, July 25, 1988).

The problem inherent in investigating near vision in children was discussed by Pickwell (1988) in personal correspondence. He explained the reason for the distance used in the investigation (Pickwell, Jenkins, & Yekta, 1987) of binocular functions in adult subjects:

> We chose the working distance of 40 cm [15.74 inches] as that generally used in clinical investigation. Of course it is a nominal distance and even with adults varies from patient to patient, according to their predominant near visual task. It is clearly not an appropriate working distance for young children. (David Pickwell, personal communication, July 20, 1988)

Pickwell explained that the distance of 40 cm is an artifact of the design of the apparatus used. In regard to children's working distance and using the 40 cm distance and apparatus with children in making a clinical assessment, he said:

> We cannot conclude that the apparatus is inappropriate for a clinical assessment, even though children normally work at much closer distance. It is clearly

> an area of study that we would have to consider some time in the future. There are important questions to be answered (David Pickwell, personal communication, July 10, 1988)

The nearpoint distance available to children while working at desks is unknown. Adult reading distances continue to be employed when evaluating elements of vision in children. Therefore, it is not appropriate to generalize the findings of prior studies to classroom situations for childhood populations.

Investigations by Reading Specialists

Reading specialists have shown particular interest in the physiological aspects of vision that can be determined externally during the act of reading. In order for their findings to be generalizable to students in the classroom, the studies need to be examined for an indication of the relationship of the subject's reading distance during the investigation with the subject's available reading distance in the classroom. The distance used in the investigation should not differ significantly from that available or used in the classroom.

In past years, technology allowed reading specialists, as well as eye care professionals, to design investigations which incorporated the act of reading and elements of the visual system thought to be involved in reading problems. Whether or not the distance from the eyes to the target was controlled, reading specialists did not consider distance a factor in these studies (Gilbert, 1940, 1959; Gilbert & Gilbert, 1942; Marr & Kamil, 1981; Spache, 1948). More recently, reading specialists have produced fewer studies which involve reading and vision.

Prior to the 1940s, development of an eye camera permitted reading specialists to use noninvasive techniques to explore eye movements during the act of reading. The interest varied from general (to determine the types of movements used by good readers) to specific (to determine regressive eye movements of readers).

An eye camera photographs a reflection of light from the eye. The changing position of the reflection is traced on film during each fixation and saccadic movement (movement of the eyes as they turn from one fixation point to another). The position of the head must be kept constant. This is done by having the reading card in a holder attached to the camera and the subject's forehead against a brace attached to the camera. There is only one adjustment that can be made: the height of the front of the machine can be raised or lowered in order to accommodate subjects of different heights. An adjustment upward does not change the distance from the subject's eyes to the reading card but can cause the subject's gaze to be at a more downward angle.

Bayle (1942) studied the nature and causes of regressive eye movements in reading. She used an eye camera to photograph the eye movements of thirty-five 9th- and 10th-grade students while they read five selections created to determine the effect of different material content on eye movements. No mention was made of the subjects' reading abilities; however, Bayle stated that 3 of the 35 subjects did so much re-reading that it was impossible to plot the film of their reading. These subjects were removed from the study. Bayle did not mention the physical or optical reading distance created by the eye camera.

Viewing distances used were not mentioned by Tinker (1958) when reporting on earlier studies which involved visual findings conducted by reading specialists. He did not comment on either the presence or the absence of information about viewing distance, although he did discuss the different types of eye cameras used.

Taylor (1962) prepared a script to accompany a filmstrip used to introduce his moving eye camera and its use in eye movement photography. He traced the various devices developed over a period of about 80 years and described how each was used. He concluded with specific instructions for the use of the eye camera produced by Educational Developmental Laboratories, Inc. (EDL), findings which could be disclosed by its use, and applications of those findings. A line drawing of a subject being tested with the device clearly shows that the subject was forced to use a downward gaze: The height of the device which held the visual target was adjustable only at the front, near the subject. The increased triangulation for a taller subject forced the individual to use a more downward gaze than that required by a shorter subject. Instructions for use of the camera did not provide a means for maintaining a constant viewing angle for all subjects. A downward gaze, as opposed to a more straightforward gaze, affects the visual system and accommodation (Borish, 1970).

Photographs in the promotional material provided by EDL for the EDL/Biometric Reading Eye II (1962) show a subject with the reading distance and head movement firmly controlled by bars on three sides of the head. The subject was required to maintain contact with these three bars at all times. There was no indication of lenses imposed between the subject and the visual stimulus, and the visual target was almost straight ahead. As did descriptions in Taylor's (1962) script, this material also did not mention the reading distance, although it was clearly a controlled distance and appeared to be a real, not optical, distance.

Reading specialists have utilized other types of technology which incorporate elements of distance, viewing angle, angle of presentation of stimulus, and sometimes, a controlled exposure time. Often some, but not necessarily all, aspects of these elements which influence accommodation or acuity were reported for each part of an investigation.

Solan's (1962) investigation of visual sensory maturation utilized a tachistoscope. Subjects in regular Grade 1 classes were to identify several digits presented tachistoscopically at different exposure times. Solan concluded that "the tachistoscope exposure testing 3 digits at 0.1 and 0.02 seconds distinguishes at an early level those youngsters whose visual sensory maturation is lagging" (p. 36). Solan did not investigate differences that might be found when using a hand-held tachistoscope as compared to a tachistoscopic projector. The hand-held tachistoscope covers and uncovers the stimulus and is a near visual task of no set distance and no set line of gaze. The tachistoscopic projector blurs and focuses the stimulus and is a far visual task, requiring a more forward gaze. When projected for a group, the distance will vary for different members of the group.

Solan (1962) gave no indication of viewing distance, nor did he indicate the relation of the distance or distances used to near-distance school tasks. The assumption should not be made that his norms can be generalized as indicators for visual sensory maturation appropriate for a child's available or habitual reading distance while seated at a desk.

Rubino and Minden (1973) completed a study of the analysis of eye movements in children with reading disabilities. The 23 subjects were 11-year-old participants at a camp for children with learning disabilities. Eye movements were recorded by an EDL-Biometrix Reading Eye Movement Monitor. Mention is made of proper adjustment of equipment, but no details are given about reading distance, angle of viewing, or use of lens to simulate reading distance.

Stennett, Smythe, Pinkney, and Fairbairn (1973) investigated the relationship of eye movement measures to psychomotor and other skills involved in learning to read. They used numbers, rather than letters or words, and employed an EDL Reading Eye, Model II camera. Although they gave findings and conclusions for eye movements as well as descriptions of equipment and procedures, the authors did not include information on the forced reading distance.

Doehring (1976) completed an investigation of the acquisition of rapid reading responses with 150 children in Grades K-11. The procedure included 7 visual matching, 7 auditory-visual matching, 11 oral reading, and 10 visual scanning subtests. The youngest children did not complete those tests involving multiletter stimuli. All subjects were selected by their teachers as normal readers. For items which required pushing a window which displayed the chosen answer, the stimuli were displayed on a sloping panel approximately 11 3/4 to 15 3/4 inches (30 to 40 cm) from the child's eyes. Items which required reading cards had the cards placed on a stand in front of the child. The author concluded that the results evidenced differences in rates of reading development over a period of years and "differences among such skills in both the rate of acquisition, and the final limits of achievement" (p. 39). The distance for the cards was not given, there was no description of the placement or surface angle of the booklets in which the child underlined a target stimulus, and there was no description given for the fit of the furniture across Grades K-11. Each of these can affect viewing distance.

The study by Ikeda and Saida (1978) concentrated on the span of recognition in reading and the critical width at which readers maintain their best rate of reading. The viewing distance of 1 m was kept constant by the subject's use of a small board attached to the apparatus which is placed in the subject's mouth and on which the subject maintains a bite (a bite board). This procedure kept the light reflection from the pupil in the small area required by the equipment which controlled the text exposure. The authors stated that the fixations suggested preprocessing of letters at the outer edge of the critical span of recognition. They did not discuss the possible effect shorter distances might have had on the findings. Shorter viewing distance can decrease the visual field (Waters, 1952) and change the visual demand of the task (Hurst, 1967).

Research by some reading specialists was found to use distances that were greater than the adult reading range discussed by Borish (1970). Use of an eye camera created a controlled distance that was not given. Different angles of viewing were created as the machine was adjusted for subjects of different heights. Use of hand-held stimuli, such as tachistoscopes, caused variation of the near distance and line of gaze which were not taken into account. In the study which used subjects in Grades K-11, the uncontrolled reading distances were described as 30 to 40 cm (11.41 to 15.74 inches) for all ages (Doehring, 1976). In all the studies, there was no investigation as to the effect that changes of distance might have on the outcome or whether the distance used was related to a young student's near work distance.

Screening

Vision screening is a limited process which surveys certain aspects of vision. The purpose of screening is to identify individuals who may need further vision care and those who do not when judged by predetermined objective criteria (Committee on School Health, 1977; Petrie, Tumblin, & Miller, 1979). Screening is not intended to be diagnostic (Lippmann, 1962; Myrowitz, 1984; Peters, 1984; Petersen, 1974). Ideally, a screening procedure should be fast, simple, inexpensive in terms of equipment and skilled personnel, valid, reliable with a minimum of missed cases and over-referrals, and productive in yielding a worthwhile number of cases (Lippmann, 1962). A screening instrument must be standardized, be based on normative data, and have established criteria that are to be met. In setting the level of the criteria, the intent of the screening must be established. Vision screening is needed for all children and must include a follow-up which ensures that the child who fails any screening will receive professional examination and care to enable that child to function visually in an educational setting (Lippmann, 1962; Myrowitz, 1984; Peters, 1984; Petersen, 1974).

Any screening process is related to the functioning ability of the individual in a given environment. In the case of schools being responsible for screening, the pass criteria of the screening instrument should be those which indicate that the individual has a level of visual functioning which allows that person to benefit appropriately from educational instruction in the school environment according to other abilities (Committee on School Health, 1977; Francis, 1973; Gray, 1963; Lebensohn, 1958). A screening instrument's strength or efficiency is associated with its percentage of positive referrals. A referral is considered positive when a professional examination verifies that a condition does exist which should receive professional care. This verification is based on the eye care professional's viewpoint and subsequent criteria. For many conditions, there may be criteria held in common by most professionals. This results in consistent agreement as to the accuracy of referral when a follow-up examination is given. A negative referral is one for which a professional follow-up examination reveals a condition or degree of problem that, according to the professional's criteria, does not need professional care. Another strength of screening which is seldom known is the percentage of all those screened who were accurately identified as being in need of professional examination and care. False nonreferrals, or failure to refer when a condition exists that needs professional evaluation, can be determined only by giving a complete examination to each person after screening. Few formal studies of screening instruments have included the examinations necessary for this determination (Haag, 1972; Michaels, 1985; Myrowitz, 1984; Peters, 1984; Petrie, Tumblin, & Miller, 1979).

Figure 1 graphically shows the relationship of selected criteria to the screening strengths mentioned. Use of low power fogging lenses to screen for hyperopia is considered a high standard for passing. A low power fogging lens is intended to discriminate between the emmetrope and the individual with a small degree of hyperopia. Use of low power will result in referrals of some students who may be found not in need of care for the degree of hyperopia present (low referral efficiency, high overreferral, and low underreferral). This criterion, however, will identify most of those who are hyperopic (high identification efficiency). When high power fogging lenses are used, only those with a high degree of hyperopia will be identified and referred. Most eye care professionals will agree that the referred individual needed care (high referral efficiency), while other patients with lesser degrees of hyperopia who might also benefit from professional care would not be identified and, therefore, not referred (low identification efficiency, low overreferral, and high underreferral).

For any power of fogging lens, there will be some incidence of correct, incorrect, and lack of identification

High Passing Standard | High Over-referrals | High Identification Efficiency

Correct Referrals

Low Under-referrals | Low Referral Efficiency

Low Power +D Fogging Lens: Identifies mild, moderate, and high degrees of hyperopia

---

High Power +D Fogging Lens: Identifies high-moderate to severe degrees of hyperopia

High Under-referrals | High Referral Efficiency

Correct Referrals

Low Passing Standard | Low Under-referrals | Low Identification Efficiency

Figure 1. Relationship of Selected Criteria (+D Fogging Lens) to Screening Strengths.

and referral. Screening pass/fail criteria established for any visual anomaly can vary across a range. When criteria are set at an extreme at either end of a range, efficiencies of identification and referral similar to those described can result.

When a child fails a screening test, the parent or guardian is notified that that professional examination and care are needed. To be effective, the communication must be followed up to ensure that professional help is received, whether it is implemented by the family, the school, or a social agency (Rosner, 1982).

The success of a screening program involves a degree of public relations. Good public relations rest upon the lay and professional communities' feeling that the cost of the screening program is justified by approved criteria for referral, positive referral, effective identification, and affirmation that the criteria for referral is such that referral is automatic for the conditions and degree of conditions that interfere with the individual's functioning in the environment.

Problems may exist as to the content of a screening instrument, as well as to criteria to be used. Concepts of appropriate content and criteria are affected by different professional training and differing viewpoints of professionals with the same training. Lippmann (1962) also spoke of the difficulty experienced by professionals in agreeing upon criteria levels. The continuing lack of consensus as to the content of vision screening for given grades or ages is explained at least in part by Rosner's (1982) comment: "The professional community itself has not come to grips with the importance or nonimportance of binocular problems" (p. 19).

There is always compromise with regard to screening content and pass/fail criteria because eye care professionals know that there will be both under- and overreferral and under- and overidentification (Haag, 1972; Michaels, 1985; Myrowitz, 1984; Peters, 1984; Spache, 1976). One common compromise is employment of a screening instrument which has criteria for the most common interfering conditions of a degree which may seriously interfere with the individual's functioning in, and benefitting from, the environment. In addition, screening is limited to those conditions for which available care, treatments, aids, or modifications of the environment will benefit the individual (Myrowitz, 1984; Verma, 1984).

The New Mexico Health Manual for Elementary and Secondary Schools (School Nursing Advisory Committee and State Department of Education, State of New Mexico, 1986) offers among its guidelines for screening programs admonitions that the condition being screened must have significant effect on the quality or quantity of the learning process, the condition must be present in the age group being screened, and treatment in the asymptomatic phase must produce a therapeutic result. In the case of vision screening, the term therapeutic results may be applied to the acquisition of learning as well as physical or visual changes which may otherwise develop or occur in the future.

New Mexico's guidelines continue by stipulating that the therapeutic results should be superior to results obtained by delaying treatment. The application of these criteria to learning is supported by statements in other states' guidelines which indicate that students who are in remedial reading classes, are experiencing academic failure, have reading problems, have repeated a grade, or have learning problems should be screened annually, as opposed to the less frequent screening of students without these problems (Arizona, Colorado, Florida, Minnesota, Nevada, New Jersey, New York, North Dakota, South Carolina, Utah, and Wisconsin). (See Appendix A for a listing of states and published guidelines.)

A student being screened may be exhorted to do his or her best or to guess when hesitant in responding (Ohio Department of Health, 1982). Michaels (1980) commented on the effect that strong encouragement by the screener or examiner may have on the result of the evaluation and pointed out that the result may not reflect the accommodative status of the individual during usual daily work:

> We sometimes push and coax our patients into more effort on the clinical test than they are willing to expend at home or on the job. The difference between "easy" and "hard" 20/20 may tip the balance toward an unhappy patient. The effort to see involves attention, accommodation, miosis, and fixation and can produce significant improvement. (1975, p. 171)

When strong encouragement during screening has this effect, the result may be a false nonreferral. Subsequently, a student does not receive a professional evaluation which might result in help that could ease the stress of close work in the classroom.

Doster (1971) discussed the then-new booklet about school vision screening produced cooperatively by the National Society to Prevent Blindness and the American School Health Association. She pointed out that the short time element for reading a near card is not sufficient to allow the child with mild to moderate hyperopia to demonstrate the eye strain which might come about with a longer period of reading, and that near point acuity, therefore, should not be screened. Köhler and Stigmar (1981) considered that various visual conditions which are of a degree to warrant professional care are often accompanied by decreased distance acuity sufficient to cause failure.

Others, however, disagreed: "Research has shown that less than half of the children with clinically significant visual disorders will be identified by use of distance visual acuity alone" (Petrie, Tumblin, & Miller, 1979, p. 3). In his 1982 review of the Orinda Study, in which he was a participant, Peters (1984) expresses the opinion that retinoscopy, cover test, and ophthalmoscopy should be done for the individual child before depending solely on the far distance Snellen for vision screening. He stated that "nearly one-half of all the children with referrable problems, problems that interfere with their educability and their health status, are undetected by Snellen testing and are unknown to children's parents, teachers, or to the children themselves" (p. 362).

Petrie, Tumblin, and Miller (1979) provided a chart showing the percentage of incidence for 15 of the more common visual conditions. The percentage varied according to age spans and across types of conditions. For some conditions, such as hyperopia, squint, and amblyopia, the percentage remained almost static across age groups. The largest variation was found in acuity. Most of this variation was accounted for by the incidence of diagnosed myopia increasing through age 20. Incidence of hyperopia exceeded that of myopia for ages 0 to 9 years, being 6% versus 3% at ages 5 to 9. The trend reversed for ages 10 to

19 years, with myopia being twice as frequent as was hyperopia at ages 10 to 14 years, and myopia almost three times as frequent at ages 15 to 19 years. This reversal of incidence, and the magnitude of increase in incidence of myopia, have probably been the bases for statements that use of only the Snellen far charts for screening is adequate for all school children. When all ages are considered together, this statement appears to be true, but with the incidence of hyperopia being two times that of myopia for ages 5 to 9, there is a need to have other tests in addition to those for far acuity for children of these ages. Acknowledgement of the differences in the incidence of hyperopia and myopia at ages 5 to 9 could provide a basis for vision screening instruments designed for use with primary-age children in order to identify anomalies and elements of vision common or specific to children of these ages.

Verma (1984) discussed vision screening of special populations, of which children are one such group. Vision screening of special populations is the one type of health screening in which it may not be true that all tests remain the same. Verma maintained:

> In a specialized vision screening, the conditions most prevalent in each of the categories should be tested. . . . Because prevalence of pathology in a pediatric population is negligible as opposed to the geriatric population, it is most beneficial to screen for a strabismic condition in a pediatric screening as opposed to a geriatric screening. (pp. 367, 368)

Verma (1984) also felt that in checking refractive error and acuity in children and athletes, retinoscopy must be performed even if visual acuity is normal. "For children and athletes, the concentration [in a screening] is more on functional problems" (p. 369).

Belloc (1962) surveyed all the states, the District of Columbia, and four U.S. territories in order to obtain data concerning vision screening practices. Her published report gives only a summary of information. The 1984 update of a 1967 survey of the 50 states, the District of Columbia, and New York City sponsored by the National Society for the Prevention of Blindness (NSPB) and the American School Health Association (ASHA) also resulted in summarized information with regard to screening practices and content (Bromberg, Jaycox, Poirier, & Simonse, 1984). This report gives types of tests used for visual acuity (Snellen and HOTV), color blindness, stereopsis, muscle balance, and hyperopia. No specific information on near target distance or power of plus lens is made available. The authors commented on the variability of the referral criteria but spoke specifically only to distance visual acuity. They stated that differences in the critical or pass/fail line, in line differences when tested monocularly, and in criteria for different ages are not easily explained. They indicated that criteria variations are expected when different tests are used, but not when the same test is used.

Screening instruments and their content are based on investigations made by vision professionals (Borish, 1970; Wold, 1967). The Snellen distance acuity chart was one of the earliest screening instruments. As early as 1908, Shaw, in his book on school hygiene, provided Snellen letters of the appropriate sizes for a teacher to use in constructing a screening chart. The instructions for screening include having the student stand with toes on the 20-foot line and moving the student closer to or farther from the homemade chart to determine farsightedness or nearsightedness. Shaw (1908) cautioned that in administering the test, "a case of long-sightedness might at first be regarded as short-sightedness because the pupil would be unable to make out the letters of the lowest line at 20 ft. distance" (p. 194). Shaw's purpose for screening was different from that of screening today: The teacher was to seat the child at a distance nearer to or farther from the chalkboard, according to the screening results. Today, the Snellen letter chart is still a part of many vision screening instruments and is the standard against which other screening instruments are compared (Bromberg, Jaycox, Poirier, & Simonse, 1984; Committee on School Health, 1977; Francis, 1973; Rosner, 1982).

Köhler's and Stigmar's (1981) study concerned the dilemma which confronts those who have the responsibility of establishing screening content and pass/fail criteria. They examined the relationship of reading and writing difficulties, as estimated by the teachers, to the objective refractive status of 118 second-grade children in Sweden who had been previously screened extensively at age 4. They found more children with these reading difficulties with approximately +0.5 D and +1.0 D status than with other dioptric status. The only severe reading and writing difficulties indicated were for students in the +1.0 D group. Köhler and Stigmar were concerned about the power of plus lens used to screen for hyperopia. They felt that a +1.5 D lens would overrefer:

> On the other hand, with a +2.0 sphere, too few of the hypermetropic children were detected, i.e., the sensitivity too low. It was obvious that fogging with +2.0 lenses does not induce relaxation of the accommodation enough to reveal most of the hypermetropics in a screening situation. (p. 375)

They stated that factors of age, degree of phoria (an eye's line of sight), as well as hypermetropia, are involved. Their findings indicate a need to use fogging lens of an effective power for students in kindergarten and Grades 1 and 2 because hypermetropia is the most common eye disorder found at ages 4 and 7.

In comparing the visual needs of children to those of adolescents and adults, Goss (1986) expressed the view that "the visual needs of a young child are usually less" (p. 148). This view may be influenced by the large amplitudes of accommodation and convergence that children are thought to have, the visual changes which occur in children between the ages of 5 and 9, and the unknown visual demands of near school tasks for children in the primary grades.

Cashell and Durran (1971) designated 33 cm (12.99 inches) as the normal near reading distance to be used for screening or examination. They cautioned that

> . . . nearpoint may appear normal on first testing, but will recede on further measurement. . . . The nearpoint of accommodation should always be tested three times in succession in all cases of complaining or asthenopic [uncomfortable, painful, and irritable vision] symptoms. The clarity of the near test type will be improved by a small convex lens but will again blur after a few moments. (p. 36)

In addition, Mason (1962) stated that the use of plus (convex) lens does not always ensure relaxation of accommodation. These cautions must be taken into consideration when supporting the use of plus lens of any specific power to completely relax accommodation when screening vision.

Recommendations vary as to the power of plus lens to be used as fogging lens in vision screening. Köhler and Stigmar

(1981) indicated a lens greater than +2.00 D would be needed to relax the accommodation at age 8. Others recommended +2.25 D for all ages (Committee on School Health, 1977; NSPB, 1982) or +2.00 D (Petrie, Tumblin, & Miller, 1979). An inquiry of the 50 states and the District of Columbia was conducted as part of this study. Responses received indicate that fogging lens power used to screen for hyperopia ranges from +1.00 D through +2.50 D (see Table 2).

Table 2

Inquiry Responses, 1985-86: Frequency of Fogging Lens Power by Grade and Age

Power of Fogging Lens (+D)	Grade(s)	Age(s)	Number of States[a]
1.00	9-12	---	1
1.50	6-8	---	1
1.50/1.75	K-12	NS	1
1.50-2.50	K-12	NS	1
1.75	K/1	NS	2
	K-1	NS	1
	1-12	---	1
	3-up	---	1
	4-up	---	4
	NS	6-up	1
	NS	> 7[b]	1

(table continues)

Table 2--continued

Power of Fogging Lens (+D)	Grade(s)	Age(s)	Number of States[a]
1.75-2.25	NS	NS	2
2.00	1/3	NS	1
	1-5	---	1
	2-up	NS	1
	NS	AA	1
2.25	K	---	1
	K-2	---	2
	K-3	---	3
	K-12	NS	1
	1	NS	1
	1-3	NS	1
	NS	> 7[b]	1
VSM-PNS	NS	NS	3
PNS	ANY-TWR	NS	1
PNS	NS	NS	3
No Test	---	---	22

NOTE: [a]Some states report different powers for different grades: total ≠ 51; [b]Once determined, record and do not repeat.

AA = all ages; ANY = any grade; NS = not specified; PNS = power not specified; TWR = if trouble with reading; VSM = vision screening machine; > = older than; / = or.

In terms of screening for aspects of vision which affect functioning in a classroom, researchers' statements reflected concepts which support the inclusion of plus lenses. Francis (1973) studied the correlation of reading problems with visual status. He reported: "The findings of this study indicate that several visual factors--hyperopia, astigmatism, exophoria, and aniseikonia [the impression which reaches consciousness]--appear to be associated with reading disability, while myopia and correction tend to result in reading success and/or progress" (p. 358). Michaels (1980) stated that "the reserve [of accommodation] would clearly need to be greater for prolonged than intermittent reading, and amplitudes are affected by many variables (illumination, acuity, binocularity, depth of focus, etc.)" (p. 573), as well as his opinion that "a child's vision is seldom critical beyond 3 feet" (p. 520). These opinions indicate a need to look at distances involved in vision screening.

Responses to the inquiry also provided information on target distances used for near tests. The target viewing distances used for near tests varied from 10, to 12 through 18 inches. One test distance was given as 60 inches, with no indication of it being considered as near or intermediate distance (see Table 3).

Table 3

Inquiry Responses, 1985-86: Target Distances Used in Nearpoint Vision Screening (TDNPVS)

TDNPVS (in inches)	Number of Tests $n \neq 51$
10	1
12	2
12-14	1
12-18	3
@13[a]	1
13	2
13-14	2[b]
13-16	4
@14	2
14	5
14-16	7[c]
15	1
15-18	1
@16	5
16	4
60	1
at reading position[d]	1
at reading distance[e]	2
at average reading distance[e]	1
at arm's length[b,c]	3
distance not specified[f]	25

NOTE: [a]Approximately; [b]Arm's length = 13 to 14 inches; [c]Used as arm's length, 14 to 16 inches; [d]Distance and angle not given; [e]Distance not specified; [f]Specific test indicated.

Distance is involved in both screening and examination of an individual's vision. Six meters, or approximately 20 feet, is accepted as the testing/screening distance for distant vision. At these distances, light rays are parallel as they enter the eyes and are focused on the retina, and the eyes are straight forward as when viewing a visual stimulus at infinity. It is significant that there is no similar commonality of one or two distances which has been agreed upon for screening or examining near vision. Some of the screening tests which may be used and which incorporate near distance presentation are muscle balance, stereopsis or fusion, and near vision acuity (see Table 16, Appendix Q).

Harwood (1984) conducted a survey of vision screening and the involvement of private optometric practitioners. The responses indicated only the areas of vision function screened and not procedures or tests used. In response to a question about content of vision screening, over one third of the respondents indicated that they did not know about screening programs other than the one in which they were actively involved. Other survey reports did not specify a near distance when discussing near screening (Belloc, 1962; Committee on School Health, 1977) or recommended against near vision acuity tests (NSPB, 1982). Screening machines which are used in some states (see Table 16, Appendix Q) provide simulated or optical near distances: the Telebinocular, 16 inches; the Sight-Screener, 14 inches; and the Ortho-rater, 13 inches (Lebensohn, 1958). Lebensohn cited 10 inches as his choice for near testing distance. He reasoned that passing a near screening of 10 inches

(25.4 cm) indicates that the individual has the reserve of accommodation and convergence which is needed to read comfortably at 14 inches (35.56 cm). The near viewing distances used in the screening machines and the distance chosen by Lebenshohn are all greater than the working distances Hurst (1964) found for primary-age children.

Over the years, and in many states, vision screening has become a responsibility or co-responsibility of schools. Vision advisory committees have been created by states to work with the assigned bureau or department within the state administration to aid in the development of vision screening requirements and standards. Screening is often conducted at schools by trained or certified nonprofessionals, volunteers, or by school personnel, including teachers. Awareness and observation of symptoms are part of several screening instruments. The content of different screening instruments may not be the same, or the criteria for referring a student who fails any given screening instrument may be different from the criteria of another screening instrument.

Screening recommendations often include instructions for teachers to observe and report children who evidence described symptoms (see Appendix B). The combination of teacher observation and the Snellen distance chart is thought by some to be the most efficient screening

(Committee on School Health, 1977; NSPB, 1982). None of the state guidelines provide training for teachers to recognize such symptoms or to be knowledgeable about how and when there will be occasions to observe them. Doster (1971) pointed out the hazard for students when teachers and screeners are not knowledgeable about these symptoms and complaints:

> Vision-screeners, whether they be pediatricians, school nurses, teachers, volunteers or aides, must learn also to observe pupils carefully and to solicit eye complaints, because a small minority of children should be referred to eye specialists even though they pass the acuity and other simple school tests. (p. 665)

The symptoms include physical symptoms that are easily visible, such as crusted or red eyelids; verbal complaints, such as statements that the words become fuzzy or doubled after reading a while; and observed behaviors, such as frequent changing of the viewing distance from very close to relatively far. (See Appendix B for a more complete listing).

Individuals vary greatly in regard to the number of symptoms experienced and to the degree of symptoms, even when visual status is similar or the same. Brent and Arstikaitis (1983) felt that low astigmatism can cause more symptoms than can higher astigmatism. They stated:

> Children with astigmatic errors between 0.50 D and 1.00 D may have more complaints of ocular fatigue than those with higher errors. With mild astigmatism a

> child makes a persistent effort to clear his vision; with higher errors, no such effort is made and the child accepts unclear vision, experiencing less ocular discomfort and fatigue. (p. 37)

Pringle and Ramsey (1982) stated that "the child with hypermetropia up to 4.00 D with normal visual acuity and no ocular symptoms does not usually require glasses" (p. 36). They emphasized the possibility of symptoms: "As school work increases, the need for sustained accommodation increases. Here, even a cycloplegic finding [determination of the refractive status after administration of a drug which paralyzes the muscles of the eye responsible for visual accommodation] as low as +3.00 D may be of significance in the presence of symptoms of ocular fatigue" (p. 37). The purpose of cycloplegic findings is to determine the power of accommodation the individual requires to see clearly at given distances when there is no possibility of latent accommodation. In vision screening, fogging lenses of different plus power, instead of a drug, are used to relax the accommodation.

According to Peters (1984), who was a member of the multidisciplinary Orinda research group, the Orinda study made available for the first time information which indicated that "hyperopia of approximately 1.75 D or more does not decrease with age" (p. 362). A complete vision examination was made of each subject. This made it possible to report on the reliability, true positives, and effectiveness of each screening instrument. The Modified Clinical Technique (MCT) had an effectiveness of 90% or greater in each area. Determination of far acuity using only the Snellen far chart had an effectiveness of 41% in identifying visual problems needing professional care and 71% in identifying true positives. The study reported a reliability of 84% for use of the Snellen far chart alone: it is this figure which is used most often in justifying the limitation of vision screening to the Snellen far chart and teacher observation. True positives indicate the percentage of the entire group who, when given a complete visual examination, had correctly been referred. In this case, the 71% true positives also indicated that screening using only the Snellen far chart failed to refer 29% of those who needed care.

The MCT screens for organic problems, using a hand magnifier and ophthalmoscope; visual acuity, using an acuity chart; refractive problems, using a retinoscope; and binocular coordination problems, using a cover test and a 5 D prism (Peters, 1984). The criteria for pass/fail of the MCT are acuity of 20/40 or less and hyperopia of +1.50 or more. It should be noted that the distances used in different retinoscopies are not identical. For example, the Monocular Estimate Method (MEM) of retinoscopy is intended to be used at a child's customary working distance. The MEM differs from the standard dynamic retinoscopy in one of two ways:

> The testing distance is not the same for all patients; it is determined by the unique characteristics of the patient: his physical size or his preferred reading distance. . . . Testing may be done as close as 9 inches with small children [when the child's Harmon distance is used]. (Rosner, 1982, p. 154)

The distance could be as short as the 6 inches or less which was the working distance found in Hurst's (1964) study.

Other retinoscopic techniques may leave the practitioner a choice of distance, e.g., 14 to 16 inches (Kruger, 1977, 1978; Zellers, Alpert, & Rouse, 1984). In light of Michaels' (1985) position that boys' refractive status changes from an expected condition of hyperopia to one approaching emmetropia 2 to 3 years later than does that of girls, separate criteria should be available for males and females if the eye care professional considers that what is usual at these ages does not need referral.

It is Peters' (1984) contention that two publications seem to have influenced the content of screening requirements. These are the Orinda study report and the Children's Eye Health Guide, developed and published by the National Society to Prevent Blindness (NSPB) (1982). Peters' discussion of the Orinda study indicates that the procedures used have become known as the MCT.

The recommendation in the Health Guide (NSPB, 1982) is for distance acuity using the Snellen chart with full line exposure while a helper uses a pointer to indicate the letter or symbol to be read. Additional tests, classified as low-yield tests, carry the caution that their use might result in overreferrals and that a highly trained, competent screener is required. These optional tests are plus lens of 2.25 D for all ages, muscle balance with target at both 13 to 14 inches and far distance, stereopsis test, and color discrimination in sixth or seventh grades. The near vision acuity test is discouraged because it does not provide for any indication of the degree of accommodation in reserve. In its place is recommended the plus lens test at far distance. The plus lens at far is considered to indicate the greater-than-emmetropic power of accommodation used at the distance at which virtually no accommodation should be required (Borish, 1970).

Borish (1970) defined the standardized arm's length at which the Ishihara color plates are to be viewed as 75 to 100 cm or 30 to 40 inches (rounded up to the next inch). He stated that a closer viewing distance can improve the subject's performance. This distance of 30 to 40 inches as an arm's length is clearly not available to children, and is in contrast to Harmon's arm length from the individual's middle finger knuckle on the back of the fisted hand to the point of the elbow and the 13 to 14 inches and 14 to 16 inches reported by some states as being an arm's length.

The publication, Guidelines for Developing Eye Health Programs for Children (National Association of Vision Program Consultants, [NAVPC] 1981), includes recommendations that are much like those of the NSPB. Exceptions are in the minimum level of screening for school-aged children, which includes plus lens of +2.25 D, eye alignment by cover/uncover or stereoscopic testing at near distance and at 20 feet, and color vision testing advised for elementary grades but urged by Grade 7. The NAVPC guidelines provide for a higher level of screening which limits eye alignment to cover/uncover at near and far distances (eliminates stereoscopic testing) and emphasizes that specially qualified personnel are required to administer this level.

Found among the studies reviewed were descriptions of training vision screeners. Trained screeners are necessary for effective and efficient vision screening. Trained screeners were described as varying from volunteers with a few hours training and volunteers with some college course credit to eye care professionals who carry out a screening that is not an examination (Helveston & Ellis, 1984; NSBP, 1982; Petrie, Tumblin, & Miller, 1979; Trobe, 1975; Whittington, 1958).

Much of the material concerning vision screening has reflected interest in screening preschool children (Hatfield, 1979; Petersen, 1974; Radke & Blackhurst, 1978). The emphasis has become one of preventing development of, or increase in, visual problems which may be prevented, maintained without increase, or decreased as to the adverse impact that the condition may have on the individual's development and learning.

Over the years, there have been efforts to develop new test charts. Eye care professionals have acknowledged the effect of styles of print and the fact that some letters are more easily recognized than others (Committee on School Health, 1977; Henson, 1977; Lebensohn, 1936, 1958; Michaels, 1975; Mehr & Freid, 1976; Potts, 1972; Von Noorden, 1980).

Testing and screening charts are created and standardized to be used at exact distances. Sloan (1959) discussed her newly created vision charts for near distances to be used with both children and adults. She indicated that in order to test at 35 cm (approximately 14 inches) or 40 cm (approximately 16 inches), different charts are required. The visual angle size of the letters must be kept comparable. The need for the different distances is caused by reports which must be recorded in required terminology that indicates the relationship of the near distance to a designated far distance.

Eye care professionals caution that using the full line of print versus covering and providing a window to expose only one letter has an effect termed the crowding phenomenon and influences the result of the screening (Buncie, 1983; Radke & Blackhurst, 1978). Helveston and Ellis (1984) stated that this phenomenon may strongly affect the result for the individual with amblyopia. The exposure of a single letter is less like a normal reading situation than is the exposure of the entire line: "Often a child with functional amblyopia will see the first and last letters correctly on a line but will be unable to correctly identify the central letters for the next several large lines of optotypes" (p. 12). Responses from the states disclosed that some specified one or the other be used, that is, full line or window (Arizona, Kansas).

Research has provided new information for an aspect of vision that is now recognized as critical in some occupations and for individuals with impaired acuity. That aspect is contrast sensitivity. Ginsburg (1984) created a contrast sensitivity screening chart which utilized black bars of different widths positioned at different angles within a white circle. The impact of contrast sensitivity within the classroom must be taken into consideration in terms of the quality of contrast of large print books supplied to the visually handicapped and the quality of contrast for printed or duplicated worksheets which all students are expected to read. Based on Borish's (1970) comments on the effect of distance on perception of color, it is possible that lessened contrast may contribute to a child's viewing distance being different than it would be for reading a visual stimulus with greater contrast.

Hennessey, Iosue, and Rouse (1984) studied accommodative infacility. Questions about symptoms were asked of the 60 male and female subjects, aged 8 to 14 years. Of those examined, questioned, and considered asymptomatic, 60% passed, 20% failed, and 20% were suspect for failing criteria of adequate accommodative facility. The researchers concluded, "It appears that the addition of accommodative facility testing to a vision screening may help identify those symptomatic subjects who would otherwise pass the screening and constitute an underreferral" (p. 183). Findings and symptoms of accommodative infacility have direct bearing on the way a child functions during classroom tasks. A child makes frequent changes of accommodation and convergence as the overhead screen or chalkboard across the room and near desk work alternately are the visual targets.

Adams, Haegerstrom-Portnoy, Brown, and Jampolsky (1984) sought to develop a means to assess visual acuity in schools, industry, aviation, drivers' licensing, and ocular health examination. Adams et al. stated that there is a need for a rapid, simple, and interpretation-free measure of visual acuity to overcome some of the problems of the conventional screening of visual acuity. They listed problems of conventional measurement of visual acuity:

> . . . lack of standardization in lighting, letter form or type, interpretation of the target by the subject, and the response by the examiner as well as possible problems of malingering (false high and false low), problems of learning and memorization in test repetition, and potential errors in recording. (p. 371)

They sought a "measure [which] would allow assessment of vision capabilities without the overlay of 'cortical factors'" (p. 371). Although Adams et al. indicated that they found a lack of standardization in lighting and letter form or type, some screening instruments do designate the degree of illumination of the background and the target (Committee on School Health, 1977; NSPB, 1982; Tansill, 1985).

Present screening instruments may include nearpoint convergence and accommodation. When evaluating nearpoint convergence and accommodation, the presence of fine detail in a target is required. Mason (1962) interpreted the results of an experiment in which he determined that convergence dominates and controls accommodation as demonstrating

> . . . the importance of having fine detail on charts used to measure near distance muscle balance. If the patient does not accommodate fully when presented with fine detail, how much less he may accommodate on a coarse chart is a matter of conjecture. (p. 588)

Other tests also require a target with fine detail. Borish (1970) emphasized the type of target required for a push-up nearpoint convergence test:

> The target, of whatever sort, must be fine enough to indicate diplopia readily and is slowly moved, pushed towards the patient's nose while the patient is requested to report the onset of diplopia. (p. 428)

Cashell and Durran (1971) stated that a target with small detail is required to bring about accommodation effort.

The content of vision screening instruments is not all the same. Different instruments which include the same or similar near tests to screen the same aspect of vision may have variations in target viewing distance. Screening instruments which include the same far test may describe different procedures for administering the test. These differences in procedures can affect a student's screening score.

Explorations of visual demand, such as contrast sensitivity and facility of accommodation, suggest that studies of the content of vision screening instruments should include these, as well as other areas which are sometimes optional in vision screening instruments currently in use. Emphasis is placed on the type of target used for different tests done at near distance, tests for which no standardized target is provided.

Vision Screening Practices

Because the literature review did not reveal any specific data concerning standard distances used for nearpoint vision screening of primary-age children in public schools, it was necessary to obtain the detailed information from each state on an individual basis. An inquiry concerning current screening practices in the 50 states and the District of Columbia was undertaken. Data were collected by letter and telephone from appropriate personnel at the state level for each of the 50 states and the District of Columbia (see Appendix C for respondents).

The provision for vision screening of school-age children ranged from no screening to coverage of acuity, muscle balance, stereopsis or fusion, color blindness, nearpoint convergence, hyperopia, and other areas. There was a lack of standardization in the terms or descriptions given in replies to the inquiry.

The two areas of interest used in this study were the distances used for presenting targets for nearpoint screening and the power of plus diopter (+D) fogging lens used to screen for hyperopia. The specified target distances used in nearpoint vision screening varied from 10 to 18 inches, with the exception of 11 inches. The power of +D lenses ranged from +1.00 D through +2.50 D. The critical pass/fail line sometimes varied according to the +D power or the grade being screened. Consideration of critical line was not a part of this study.

Several states included teacher/screener observation of student appearance and behaviors and student complaints as part of the screening process. Most guidelines included lists of symptoms or complaints (see Appendix B). Notably missing were provisions to train teachers to employ effectively their own observations of the listed symptoms of eye or vision problems or to educate parents to recognize the symptoms and the child's need for professional care.

Responses to the inquiry clearly indicate that there is no uniformity among the states regarding requirement of vision screening of school-age children (see Table 17, Appendix Q). Among the states which recommended or required vision screening, there was no uniformity as to the tests to be included in a screening instrument. Among the states that screened the same areas of vision or used the same tests, such as the cover/uncover test, there was no uniformity of the target distance. The factors which contribute to the lack of uniformity were not investigated.

Furniture

In 1908, Shaw discussed the effect of school furniture upon the posture and growth patterns of children, their handwriting, and their lines of sight while writing. He maintained that the recommended writing position could be maintained only when the "desk is of exactly the right height for the pupil sitting at it" (p. 213). He indicated that providing "seats and desks with proper slant and adjustable not only as to height but also as to minus distance" (p. 215) would constitute a great advance. He advocated use of furniture with these advantages, along with the use of vertical-slant writing. Vertical-slant writing has the slant, but not the letter formation, of manuscript writing presently used in Grades 1 and 2.

A classroom attended by every school child at least once each week, such as a music room, is supplied with only one set of furniture. The sizes of desks, chairs, or combination desk-chairs must be of a size that serves children in every grade level. The logical solution is to have chairs large enough to fit the larger children. The result is that the furniture is so large that the younger students must climb into it. For classrooms which are used for only one grade level, the situation is improved. A review of catalogs provided by manufacturers of school furniture disclosed that desks and chairs are available in a variety of styles and in sizes that are suggested for specific grade levels.

The 1985 catalogues of the American Desk Manufacturing Company (Temple, Texas) and Carter Craft, Division of Smith Systems (Plano, Texas) were sources of information regarding different styles and designs of chairs and desks for use in this study. Listed chair sizes referred to the distance of the chair seat from the floor. Most chairs were not adjustable, but were available in several sizes. A chair's height was cited as the distance of the crest of the seat from the floor. The dimensions from the front to the back and across the seat varied and were specific according to the chair's height. Traditional chairs have the seats parallel to the floor. The Balans chair, designed by A. C. Mandal of Denmark and offered in this country by Carter Craft, is the only adjustable chair shown in the school furniture catalogue. Its cost of over $250 precludes its use in most public schools.

Desks are manufactured in four designs. Of concern in this study were the two with attached storage facilities. These desks are produced in sizes appropriate for primary-age children. The distinguishing feature of these desks is the placement of the storage facility, which affects the height of the desk top from the floor. The side desk has a large top which covers the student's legs; the storage facility is set at the right or left side. This desk also comes in a design for two students, with both storage facilities in the center. The across desk has book-box storage which extends from side to side immediately under the desk top. The book box is described as being 5 inches in height. When each of these styles is adjusted to the same clearance above a child's knees, the side desk will have a shorter overall height than will the across desk. The difference in height may have an effect on the child's viewing distance.

Both Carter Craft and the American Desk Manufacturing Company recognize that students in any given grade are varied in size. As an aid to schools, they include in their catalogues information which suggests sizes, and percentage of those sizes, appropriate for specific grades. The recommendations match a desk size with a chair approximately 10 inches lower than the desk top when the desk is adjusted to its lowest setting. While not identical, information from the two companies indicate similar sizes and percentages of those sizes for Grades 1 and 2 (see Table 4).

Table 4

Manufacturers' Suggested Desk/Chair Heights for Grades 1 and 2

Furniture/ Suggested Distribution	Manufacturer's Suggested Size (Inches)				
	American Desk			Carter Craft	
Chair	11.5	11.5	13.5	11.5	13.5
Grade 1	---	50%	50%	50%	50%
Grade 2	---	---	100%	---	100%
Desk/Table	21.0	22.0	23.0	21.5	23.5
Grade 1	---	50%	50%	50%	50%
Grade 2	---	---	100%	---	100%

The stipulated size of a desk is the height of its lowest setting. The desks are adjustable for an increase of 6 to 8 inches in height, in increments of 1 inch. Chairs are not adjustable; therefore, the suggested 10-inch space between chair seat and desk top cannot be maintained. Without going into the classroom and measuring the current heights of desks, there is no way to determine the heights of work surfaces being used by students, regardless of the desk sizes ordered. In addition, the students may not be using chairs that are one of the two recommended heights or that allow the 10-inch differential in space.

The fit of a chair and desk is affected by several factors. The size of available furniture pieces and the styles of desks are basic. The size of the child and the height of the thighs above the floor when seated affect the height setting for the desk. A child's preference of desk and chair size may influence choice of size and the adjustment of the desk. Young children may feel that using a taller desk indicates that they are more mature. Although children change in size during a school year, it is unusual for desk and chair assignments to be changed or for desks to be readjusted frequently. Given the fact that the child's physique and the size of the furniture at which the child works affect nearpoint viewing and working distances, it would follow that the available desk-to-eye distance for any child will vary during the year, will vary among children, and will allow a child a limited range of desk-to-eye distance during any given task.

Mandal (1984) stated that "school children have a visual distance of approximately 20 cm to 40 cm [8 to 16 inches]" (p. 48). He traced the history of the design of chairs and desks and the skeletal model used to determine sizes. He found no consideration for the downward gaze that is required for viewing material on the desk. His Balans chair and slanted desk are the result of his interest in reducing stress on the body while the child is seated for work at a desk.

Although persons interviewed at the manufacturing companies cited in this study could not give a scientific bases for the furniture sizes recommended, past studies have provided data for functional measurements of reach at different types of work stations and of body parts for Grades K-12 school children (Martin, 1954). Martin's study was a joint effort of the U.S. Office of Education, the University of Michigan, and the National School Service Institute. The study was based on an awareness that the growth patterns and norms for children had changed across the years. There has been no update of this information. The striking aspect of Martin's study is the design of two measuring stations which were staffed by a trained crew and allowed 55 different measurements to be taken and recorded for an individual within 4 minutes. From these measurements, the dimensions of other body parts were calculated.

One use intended for information from Martin's (1954) study was as an aid to manufacturers in deciding upon the sizes of chairs and desks to manufacture and recommend for given grades. Interviews of personnel at manufacturing companies and of a school purchasing agent who was ordering furniture to equip a new elementary building did not indicate that any such scientific data were the basis for recommending or ordering desks and chairs of given sizes for specified grades. The manufacturers reported making and offering sizes that are requested by the schools. The schools order what is currently considered satisfactory in their districts (R. Barnes, Advertising Department, American Desk Manufacturing Company, Temple, Texas, personal communication, May 8, 1985; J. Siebenthal, Purchasing Agent, Carrollton-Farmers Branch ISD, Carrollton, Texas, personal communication, February 20, 1984; H. Taylor, General Manager, Carter Craft Division, Plano, Texas, personal communication, May 23, 1985). It was not possible to determine what influenced the first order of furniture in the district, which was made many years earlier.

Handwriting

Handwriting texts adopted for use in the State of Texas often incorporate the following lessons among others in their curricula: teaching the child to utilize specific paper position, hand grasp of the writing instrument, and sitting posture. Each of these elements alone, as well as in combination, has an effect on nearpoint visual distance. The size of the child's desk, chair, and the appropriate fit of the furniture to the child's size and physique affect the demands of a nearpoint visual task. The material presented to teachers in terms of children's writing posture and viewing distance were reviewed in several of the handwriting texts offered for adoption by school districts in Texas. In Grades 1 and 2, all texts use manuscript writing (printing).

Photographs or line drawings of children posed as if writing at desks or tables were used in some of the handwriting texts to provide examples of described writing posture, paper position, and grasp of the pencil. For the primary grades, similar models of writing at a chalkboard also were provided. In every text examined, there were discrepancies between the description in the text and the illustrations or photographs. The discrepancy of the hand and arm position in relation to the position of the paper is widespread (Barbe et al., 1987; King, 1987; Johnson, 1987). There were also discrepancies in the distance from the chalkboard (Barbe et al., 1987; Bell, Davidson, & Veal, 1978) as described and illustrated.

Posture affects the distance of a student's eyes from the visual target. In the handwriting texts, the authors describe the writing posture children should use. Several authors are not specific, but indicate some element of posture, such as "hips touching the back of the chair, back not touching" (Barbe et al., 1987, p. vi); "The children should be expected to maintain a healthful, yet comfortable, position for <u>all</u> written work. The necessary factors to keep in mind are a comfortable, relaxed position, room to write, and eyes not too close to work" (Bell et al., 1978,

p. 4); "The children should be encouraged to sit with their feet flat on the floor and their backs straight. Bodies may be inclined forward slightly from the hips" (Foerster, 1979, p. 7); and "If one shoulder is higher than the other as a child writes, it is an indication that a desk of different height should be used" (Townsend, 1978, p. 8). Townsend also indicates that a chair of correct height allows the feet to rest on the floor. King (1987) is the only author who stipulates a viewing distance:

> If pupils are taught to assume upright, healthful postures and to hold papers in correct position, the position of the head should not cause trouble. Heads should be reasonably erect so that the eyes will be far enough from the writing to permit a clear view. This is about 12 inches. (p. T8)

Johnson (1987) spoke to posture, height of the writing surface, and the position of the arms in relation to the body and the height of the writing surface:

> Children should sit with both feet on the floor and with hips to the back of the chair. The children should lean forward slightly but not slouch. The writing surface should be smooth and flat and at a height which allows the upper arms to be perpendicular to the surface and the elbows to be under the shoulders. The children should not reach up to or slouch down to the writing surface. (p. T52)

Thurber (1987), the author of the only text which uses a slanted printing style, recommended a healthful posture, with no details given.

Photographs in the various texts show the height of the desks or tables from being slightly above the waist to being even with the armpit (Barbe et al., 1987; Bell et al., 1978; Foerster, 1979; Johnson, 1987; King, 1987; Thurber, 1987; Townsend, 1978). Only one text provides the suggestion that a child monitor his or her own visual distance. This is to be done by asking, "Are my eyes far enough away from my work?" (Bell et al., 1978, p. 5). No criterion is given for judging what distance is far enough away.

Harmon (1949) examined the relationship of the physical environment of the classroom to "children's distortions of writing, drawing, and other educational performances" (p. 1). The physical environment included lighting, seating, and work surface equipment.

Research by Harmon (1949) dealt with the interaction and cross-effect of trunk, head, and neck with vision. Over a 3-year period, 160,000 elementary school children in over 4,000 Texas classrooms were measured, and the physical environment was evaluated, as well as was its impact on the growth and development of the students. The physical environment and body condition of the students included lighting (illumination and luminance of the surrounding environment), restraining seating equipment, functional visual difficulties, postural defects, and other health problems. Harmon examined the relationship among all of these factors, as well as their effect on children's distortions of writing, drawing, and other educational performances.

Harmon's early study (1949) seems outdated on the surface because of the advent of air-conditioned classrooms, some without windows, and use of fluorescent lighting. The increase in school population in some geographic areas, however, has resulted in the use of portable buildings. These buildings usually have windows and produce the same problems of illumination and luminance that Harmon investigated in 1949. The pendulum has completed its swing and brought us to the same position of earlier days: Where the child sits, the type of furniture used, and the child's position in relationship to illumination and luminance affect posture.

In a 1958 report, Harmon emphasized the interaction and use of the same nervous pathways for holding the body balanced in a relationship with the body's gravitational system and in "balancing the body with centers of visual attention" (p. A-18). As the viewing and work distance became shorter, the organic stresses produced by body-balancing reflexes were intensified. Harmon felt that "80% of a child's time in school is devoted to such tasks" (p. A-19) and that these tasks were those "where the actions of the body-balancing reflexes are at maximum intensification" (p. A-19). Harmon's (1965) address emphasized that awareness of position in space is based on gravitational reflexes and also establishes a foveal axis.

Instructions given in the teachers' manuals that accompany handwriting texts indicate that the authors are aware that viewing distance and posture at a desk can affect a child's ability to work effectively. Discrepancies between the descriptions of posture, paper position, use of the arms, and fit of furniture and the representation of these factors as presented in illustrations intended to model these elements indicate difficulty in attaining the true maximum desk-to-eye distance.

Summary of Review

No studies which established the maximum available desk-to-eye distance for students in Grades 1 and 2 were found. In view of Hurst's (1964) findings that work distances for primary-age students were less than half of the standard distance given as adult reading distance by Borish (1970) and that the target distance used in near vision screening varied across tests and among similar testing across states, it was of interest to determine the maximum available desk-to-eye distance (MA-DED) for students in Grades 1 and 2 and to test for significant differences between means of the MA-DED and each target distance used in nearpoint screening (see Table 3).

Studies concerning the use of plus diopter (+D) fogging lens (FL) to screen for hyperopia disclosed that different powers are used, as did responses to the inquiry of the 50 states and the District of Columbia (the states) (see Table 2). In view of these differences, it was of interest to test for significance of differences between the dioptric equivalent of each Side or Across MA-DED means (D_S or D_A) and the sum of each D_S or D_A and each fogging lens power (D_{SFL} or D_{AFL}).

No studies were found which indicated the effect that growth might have on the available desk-to-eye distance of primary-age children. In view of this apparent lack, it was of interest to test for significant differences between measured and remeasured MA-DED means at each style of desk for two adjacent semesters, fall to spring (Time 1) and spring to fall (Time 2).

CHAPTER III

METHODOLOGY

Subjects

Solicitation of Participants

School Districts

Texas Education Service Center Region X was contacted to obtain the list of all districts within its region and the names of their superintendents. Each district's administrative officer was contacted by letter to request the district's participation (see Appendix D for a sample letter). All districts which agreed to participate were included. The local participating districts made the decision regarding how many and which of the elementary schools would participate. The names of the principals were obtained from the districts, and each principal was contacted by both telephone and letter (see Appendix D for a sample letter). The participation of a parochial school in Dallas, Texas, was solicited through contact with its principal. (Hereinafter, the terms districts and schools refer to both public and nonpublic school jurisdictions and individual schools.)

Students

Materials soliciting voluntary participation in the study were sent to the parents and guardians (hereinafter referred to as parents) of all students enrolled in Grades 1 and 2 in the participating schools. Included were a letter from each principal which stated the district's participation in the study and a letter from the investigator which requested parental consent for the child to participate (see Appendix D for a sample letter), a brief description of the study (see Appendix E), and two copies of a parental permission form (Appendix F) appropriate for use with studies involving human subjects. One copy of the permission form was to be returned; the other was to be kept by the parent. A student qualified as a subject when a properly executed consent form was returned.

Participants

School Districts and Schools

All public school districts within the geographic area served by Texas Educational Service Center Region X were invited to participate in the study. Subsequently, 9 public school districts in 6 counties participated in the study. A parochial school invited to participate in the study was also within the geographic area of Region X and became a participant in the study.

The participating public school districts represented 5 of the school district categories established by the Texas Education Agency (TEA, 1986) (see Table 18, Appendix Q for a list of TEA categories). The categories are based on Standard Metropolitan Statistical Areas as defined by the U.S. Bureau of the Census. The TEA does not have a comparable category system for parochial schools.

Both of the Coppell ISD (Dallas County) elementary schools, Pinkerton Elementary and Lee Elementary, took part in the study. The Coppell ISD is in TEA Category 3, Suburban--Fast Growing. Three of the Carrollton-Farmers Branch ISD (C-FBISD) (Dallas County) elementary schools, Blanton Elementary, Central Elementary, and Country Place Elementary, took part in the study. The C-FBISD is in TEA Category 4, Suburban--Stable. Hartmann Elementary of the Wylie ISD (Collin County) took part in the study. The Wylie ISD is in TEA Category 5, Non-Metro (1,000+ Average Daily Attendance [ADA]). Ferris Elementary of Ferris ISD (Ellis County) also took part in the study. The Ferris ISD is in TEA Category 6, Non-Metro (town). Five participating districts are in TEA Category 7, Rural. These districts are Community ISD (Collin County), Savoy ISD (Grayson County), Pottsboro ISD (Grayson County), S and S (Southmayd and Sadler) Consolidated District (Grayson County), and Celeste ISD (Hunt County). Each district has one elementary school which bears the name of the district. Community Elementary is located near Nevada, Texas. Celeste, Pottsboro, and Savoy elementary schools are located in the communities from which they take their names. The consolidated district, S and S, serves two communities as well as the surrounding rural area, and has its elementary school located in Southmayd. The parochial school, St. Phillip's School, is located in an inner-city minority neighborhood in Dallas, Texas. Classes range from preschool through Grade 3. The TEA did not provide category information on parochial schools. (See Table 19, Appendix Q for additional information about the public school districts, and Table 20, Appendix Q for additional information about the parochial school.)

Students

The measured sample included all students enrolled in Grades 1 and 2 whose parents had returned correctly completed forms granting permission for the child's participation, whose forms were returned within the stipulated number of school days, who were present at the time of measurement, and who were within the upper age limit established for the design (< 10 years old). There was no lower age limit set for the study. There was no exclusion of subjects from any category of educational placement.

The distribution of boys and girls was a result of the number of boys and girls who became participants in the study and were present at the time of measurement at their schools. The data form provided for identification of five ethnic groups: Aleut/Native American, Anglo, Asian/Oriental, Black, and Hispanic. The ethnic categories were taken from the registration forms used in the C-FBISD.

The birth months of the subjects in both the measure and remeasure groups were dispersed among the 12 months of the year. The dispersion of birth months across the 12 months indicates little to no bias in age from unequal numbers of subjects measured at different times within the school or from an unequal number of subjects in the first and second semesters of each grade. The dispersion of birth months, however, is a result of the birth month of the students enrolled in the school who became participants. The number of measured subjects with birthdays in a single month ranged from 72 through 115.

Helpers and Technician

Each principal was asked to nominate local personnel to serve as helpers in the study. These individuals were contacted, employed and scheduled, and instructed in their role of gathering and entering data from registration records, distributing and gathering parental permission letters, recording permission data, escorting children from the classrooms to the place of measurement, and recording the dictated data as the MA-DEDs were taken (see Appendix G for instructions to helpers). All local helpers were paid an hourly wage for their services.

The investigator instructed the lead local helper regarding the responsibilities of the helpers and provided printed instructions. The helpers were monitored by the investigator and the technician in order to ensure compliance with the research design.

A mature male technician was trained in the procedures to present the task to the subjects, take the MA-DED measurements, and supervise the local helpers. The technician had the authority to adjust the testing schedules in order to comply with the immediate needs of the individual schools.

Equipment and Instrumentation

Chairs of three sizes (11 1/2, 13 1/2, and 15 1/2 inches) and two styles of desks (side storage and across storage) in each of the two sizes recommended by the manufacturers for use in Grades 1 and 2 were used to seat the students for testing (see Table 21, Appendix Q for description of furniture). These were available without cost to the study through the participation of the American

Desk Company of Temple, Texas, and Carter Craft of Plano, Texas.

An illustration which appeared in handwriting texts for both Grades 1 and 2 (Figure 2, Appendix H) was used to demonstrate correct posture and pencil grasp. A photocopy of the illustration was placed on the back of the technician's clipboard, to be shown to each student. A Number 2, sharpened pencil with a length of at least 6 inches was used by the students to point to the target.

The target (Figure 3, Appendix I) for placing the point of the pencil was the intersection of the 3/4-inch arms of a cross (+) printed in black ink on an 8-1/2 x 11 inch sheet of white, unlined paper. Multiple copies were printed so that replacement targets were identical. A sheet was affixed to each desk within marked borders which kept the bottom of the sheet at the edge of the desk and the intersection of the cross at the center of the desk top area above the leg space. The marked borders ensured that replacement sheets were in the same position on the desks as were the originals.

The maximum available desk-to-eye distance (MA-DED) was measured by the technician. The end of a tape measure was placed at the center of the bridge of the nose between the student's eyes and stretched tautly to the placement of the pencil point. The distance was then rounded to the nearest

1/8 inch (0.32 cm). (See Appendix J for a more detailed description of the methods and procedures for taking the MA-DED measurement.) The data were recorded on a form created for the study (Appendix K).

Data on birth date, grade level, and ethnicity were obtained from enrollment cards or other office records. Ages were calculated by the examiner and were rounded to the nearest full month.

Procedure

Organization of Testing

Schedules and building locations for the MA-DED measurements were established by consultation with each school principal (see Appendix L for criteria and subsequent locations). More choices were available to the earlier responding districts and schools.

Administration of MA-DED Testing

The subjects were brought to the measurement location in groups of three. The technician instructed the group of subjects as to their role, showed the illustration as a model, and demonstrated taking the MA-DED measurement on himself. After the group procedure, one subject sat in each of the chairs for the technician to judge the best fit. The best-fit chair was taken to each desk in turn where the subject sat in the best-fit chair for the technician to judge the best-fit desk. The subject was seated in the best-fit chair at the best-fit side and across desks in turn while the individual protocol was followed. The technician reviewed the procedure with each individual while the child was seated at each desk for measurement. The technician took both the trial and final MA-DED measurements on each subject. For subjects who had difficulty in following the instructions or in maintaining posture while the final measurement was taken, the individual portion of the protocol (showing the picture, demonstrating, taking trial and final measurements) was repeated up to two times. If difficulty persisted, the results of the third time were recorded as the MA-DED. (See Appendix J for comprehensive procedure.)

The MA-DED task for each subject was to sit at the desk and chair which were judged by the technician to be the best fit for the student's physical proportions (see Appendix M for fit criteria), assume the writing posture demonstrated by the child in the provided illustration, grasp the pencil in a writing grasp, and place the point of the pencil at the intersection of the target cross (Appendix I) which was affixed to the desk. The subject was to hold that position while the MA-DED was measured.

MA-DED Norms

The MA-DED norms presented in this study were derived from the groups which participated. The _n_ means and standard deviations for described cells are found in Table 12, Chapter IV and Tables 22 through 25, Appendix Q. (For a complete description of the norming procedures and process, see Appendix N). Norm tables are established for each style desk for age, grade, sex by grade, age by grade, and age by sex.

Statistical Analysis

The data obtained from this study were subjected to the following statistical procedures (Norušis, 1985):

1. A student's _t_-Test (two-tailed, independent samples) was used to test for significant differences ($p < .05$) between the Side or Across MA-DEDs for age, grade, and sex cells and for each member of the set of target distances used for nearpoint vision screening as reported by the states and the District of Columbia.

2. A student's _t_-Test (two-tailed, independent samples) was used to test for significant differences ($p < .05$) between the diopter equivalent of each Side and Across MA-DED mean (D_S or D_A) for age, grade, and sex cells and for the sum of each member of the set of +D fogging lens

used to screen for hyperopia (D_{FL}) and each Side and Across diopter equivalent (D_{SFL} or D_{AFL}).

3. A student's t-Test (two-tailed, paired samples) was used to test for significant differences ($p < .05$) between the means of remeasured/measured Side and Across MA-DED.

4. The multiple analysis of variance (MANOVA) was used to test for significant interaction among the variables of age, sex, grade, and desk style.

CHAPTER IV

DATA ANALYSIS AND RESULTS

Presentation and Analysis of Data

The primary purpose of this study was to establish normative tables of the maximum available desk-to-eye distance for students in Grades 1 and 2 who were less than 10 years of age. Additionally, this study analyzed the significant differences between the mean lengths of the Side or Across MA-DEDs and the target distances used in nearpoint vision screening. A second analysis was of significant differences between the diopter equivalent of the Side and Across MA-DED means (D_S, D_A) and the sum of D_S or D_A and each power of plus lens used as fogging lens (D_{FL}) to screen for hyperopia ($D_S + D_{FL} = D_{SFL}$, or $D_A + D_{FL} = D_{AFL}$). A third analysis was of the significant differences between the means of the remeasured Side MA-DED and measured Side MA-DED and between the means of the remeasured Across MA-DED and measured Across MA-DED. The multiple analysis of variance (MANOVA) procedure examined the interaction between the variables of age, grade, and sex for the measure and remeasure Side and Across MA-DEDs (8 x 4 x 2 design).

Univariate procedures were completed to determine which variables contribute to the overall differences.

The measured sample included both males and females whose parents had returned correctly completed forms granting permission for the child's participation. There was a total of 1,135 subjects in Grades 1 and 2. Of these, 510 were males and 625 were females. Their ages ranged from 6 years, zero months (6-0) through 9 years, 11 months (9-11). One district had subjects older than 9-11: In Grade 2^2, there was one boy 10 years old, one girl 11 years old, and one girl 12 years old. These subjects were excluded from the study by the age limitations.

No data were available on the registration cards to indicate a student's age at time of entry into school, that is, Grade 1 or kindergarten, nor were there any data to indicate that a student had been retained. There were, however, subjects in both Grades 1 and 2 whose ages were within the Old 9 age span of 9 years, 6 months (9-6) through 9 years, 11 months (9-11). The youngest subjects in first grade, first semester (Grade 1^1) were within the Young 6 age span of 6 years, zero months (6-0) through 6 years, 5 months (6-5). The youngest subject in Grade 2 was in the Old 6 age span, 6 years, 6 months (6-6) through 6 years, 11 months (6-11). The oldest students in Grades 1^1 were within the Old 8 age span (8-6 through 8-11).

The subjects in one district (C-FBISD) were described by the administration as being all students enrolled in mainstream classes. In addition to regular students, the mainstream classes included mildly and moderately handicapped special education students who were mainstreamed with assistance given as direct service to them or as support service to their teachers on a demand basis, slow learners (IQ between 70 and 85) who had the same assistance as the mainstreamed special education students, students in special classes for the gifted and talented (IQ of 140 or higher, plus other qualifying criteria), and students in classes for intensive language development to acquire the English language. Other districts included all students enrolled in classes designated as Grades 1 and 2. There was no exclusion of any category of educational placement, but there was no indication that self-contained, severely handicapped students were among the subjects.

There was a pool of 1,712 subjects enrolled in Grades 1 and 2 in the 13 schools. Of these students, 1,135 became subjects in the study. The percentages of the subjects in grade levels 1^1 and 2^1 were almost equal, each being between 17% and 18%. The percentages of subjects in grade levels 1^2 and 2^2 were also close in value, being 33.57% and 31.98% (see Table 5).

Table 5

Subjects' Ages, Grade Levels, and Ethnic Origins

Subject Group	Percentage of the Sample $\underline{N}$ = 1,135
Age	
6 years old	23.61
7 years old	48.11
8 years old	26.17
9 years old	2.11
Grade Level	
1st Grade	
1st Semester	17.36
2nd Semester	33.57
Total	50.93
2nd Grade	
1st Semester	17.09
2nd Semester	31.98
Total	49.07
Ethnic Origin	
Anglo	78.02
Hispanic	10.86
Black	7.06
Asian/Oriental	3.71
Aleut/Native American	0.35

There was representation of each of the five ethnic groups: Anglo, Asian/Oriental, Hispanic, Aleut/Native American, and Black. The percentage of the sample in minority, non-anglo groups was 21.98%, ranging from 0.35% (Aleut/Native American) to 10.86% (Hispanic). The incidence of representation was based on the ethnicity of the students who participated in the study and were present during the time of measurement at their schools.

Measurements were made during 7 of the 9 school months. No measurements were made in December or May. The times of measurement were scheduled by the principals.

The design of the study set the upper age limit at 9 years, 11 months. There was no lower age limit set. There was, however, no subject younger than 6 years, zero months (6-0) at the time of measurement. The resulting age span was from 6-0 through 9-11.

The analyses involved two types of standards: linear target distance used in nearpoint screening and plus diopter power. The diopter standards (D_{SFL} and D_{AFL}) utilized both the diopter equivalent of the MA-DED means and the diopter power used to screen for hyperopia. The near target distances as reported by the states (10 and 12 to 18 inches) and their frequencies of use are shown in Table 6. The powers of plus lens used to screen for hyperopia and the grades at which they are used as reported by the states (+1.00 D through 2.25 D) are shown in Table 7. Not all states screen for near vision, nor do all screen for hyperopia. Near tests and the distances reported as being used for each test are shown in Table 16, Appendix Q.

Table 6

Target Distances and Tests Used to Screen Nearpoint Vision

Distance	Test Used	N
12-13"	Corneal Light Reflection	1
12-14"	Near Acuity	1
12-18"	Cover/Uncover	1
	Corneal Light Reflection	2
13-14"	Corneal Light Reflection[a]	1
13-16"	Near Acuity	1
	Near Point Convergence[b]	1
	Muscle Balance	1
	Worth Dot Test	1
14-16"	Near Acuity	1
	Worth Dot Test	1
	Cover/Uncover[c]	2
15-18"	Cover/Uncover	1
60"	Worth Dot Test	1
Reading Position[d]	Cover/Uncover	1
Reading Distance[d]	Cover/Uncover	1
	Near Phoria	1
Average Reading Distance[d]	Strabismus	1
	Cover/Uncover	1
At Arm's Length	Cover/Uncover[c]	1
	Corneal Light Reflection[a]	2
20'	Fogging Lens[e]	26
DNS	Vision Screening Machine[f]	23

NOTE: [a]Arm's length defined as 13" to 14"; [b]And move inward; [c]Arm's length defined as 14" to 16"; [d]Measure distance not given; [e]Reported by some as a near vision score; [f]Reported by Lebensohn (1958): Telebinocular, 16 inches; Sight Screener, 14 inches; Ortho-rater, 13 inches.

Table 7

Power of Plus Diopter Lens Used to Screen for Hyperopia by Grade

Power of +D Lens	Grade(s) Used
1.00	9-12
1.25/2.25	K,1-3,4-8
1.50	6-8
1.50/1.75	K-12
1.50-2.50	1-4,6,8,10,12
1.75	K-1,1-12,3-UP,4-UP GNS
1.75/2.25	> 7[b]
1.75-2.25	GNS
2.00	1/3,1-5,2-UP,GNS
2.25	K,K-2,K-3,1,1-12
VSM-PNS	GNS
NS	ANY-TWR, NS

NOTE: [a]Some states use more than one power. [b]Years of age.

ANY = any grade; GNS = grade not specified; PNS = power not specified; TWR = if trouble with reading; VSM = vision screening machine.

There were three sizes of chairs and two sizes of each style of desk used in the study. Table 8 presents data for the number of subjects for each desk and chair size.

Descriptions of the criteria for fit of the furniture is given in Appendix M.

Table 8

Frequency Distribution of Furniture Sizes Used as Best Fit for MA-DED Measurements

Furniture Size	Number of Students per Size	
	Measured	Remeasured
Chair		
11 1/2 inches	214	15
13 1/2 inches	461	60
15 1/2 inches	460	76
Total	1,135	151
Side Desk		
19 3/4 inches	801	99
22 inches	334	52
Total	1,135	151
Across Desk		
23 5/8 inches	669	75
26 1/4 inches	466	76
Total	1,135	151

During the measure trial, fit for the best-fit chair was low for 0.53% of the subjects, high for 3.08% of the students, and appropriate for 96.39% of the children. For the best-fit side desks, the resulting fit was short for 0.97%, tall for 78.18%, and appropriate for 20.85% of the children. For the best-fit across desks, the resulting fit was short for 0.09%, tall for 83.17%, and appropriate for 16.74% of the subjects. During the remeasure trial, the percentages for best fit were: (a) chair, 0.00% low, 1.34% high, and 98.66% appropriate; (b) side desk, 0.00% short, 91.39% tall, and8.61% appropriate; and (c) across desk, 0.00% short, 91.39 % tall, and 8.61% appropriate. Intervening factors which might affect fit, such as body build or physique and posture, were not investigated.

Retention of Subjects for Data Analysis

From a sample pool of 1,712 students, 1,135 subjects met all criteria for inclusion in the analysis of data for this study. The criteria for retention were that the parent return a properly completed consent form, the student be present at the time of measurement, the student be under 10 years of age, and data entry be complete for the variable being analyzed. The data entry error rate was < 1%. Of the pool of 1,712 subjects, 75.18% returned consent forms by the deadline (see Table 9). Three students were excluded by the upper age limit set in the study design. In Grade 2[2], one boy was 10 years old, one girl was 11 years old, and one girl was 12 years old. There was no lower age limit. Data are complete for 1,135 subjects.

Data were collected on the number of students who took home parent packets for measure and remeasure phases of the study. Table 9 shows the number of students retained for data analysis in each phase.

Table 9

Retention of Subjects for Data Analysis

Criterion	Measure Total N = 1,712 n	%	Remeasure Total N = 173 n	%
Parent Packets				
Not returned	425	42.82	18	10.40
Incorrect	5	0.29	0	00.00
Consent				
Yes	1,159	67.70	153	88.44
No	123	7.18	2	1.16
Overage	3	0.18	0	00.00
Attendance on day of measurement				
Measured	1,139[a]	66.53	152[b]	87.86
Absent	17	0.99	1	0.58

NOTE: [a]Data incomplete on 4; [b]Includes one retainee; [c]13.35% of measured subjects were remeasured.

Follow-up letters and duplicate forms were sent to parents who did not return the initial packet. After follow-up letters were sent, 24.82% of the measure pool did not have returned packets. There was a wide variation across classrooms and teachers in the percentage of forms returned and consent granted. These ranged from 100% return and 100%

consent granted to less than 25% of each. The contributing variables were not investigated, but among the variables would be teacher influence and clarity of communication to the parents. The clarity of communication could be influenced by the reading levels of the parents, as well as a limited ability to communicate in English. The pool included students in classes to learn English, whose home language was not English.

Subjects were remeasured at two schools. Of the possible remeasure pool of 194 measured subjects, 173 (89.18%) were still enrolled and became the pool of remeasured subjects. This loss of measured subjects is accentuated by the lapse of time (4 and 8 months). The adjacent semesters for Time 1 were over a long holiday at the end of the calendar year. The adjacent semesters for Time 2 were over the summer and end of a school year.

Subjects were classified within five ethnic categories: Anglo, Asian/Oriental, Hispanic, Aleut/Native American, and Black (see Table 5). The number in each category is not controlled but is a result of student enrollment, parental consent, and student presence on the day of measurement.

Results

Subjects' Side and Across MA-DED individual scores (viewing distances) were determined and ranked for each style of desk. The range of individual MA-DEDs and the upper and lower limits of the MA-DEDs and the near screening target distances for the measured and remeasured trials are shown in Table 10.

Table 10

Range of Measured and Remeasured Side and Across MA-DED Scores and Target Distances for Nearpoint Vision Screening (TDNPVS)

Desk Type/ Trial	MA-DED (inches)			TDNPVS (inches)	
	Range	Upper Limit	Lower Limit	Upper Limit	Lower Limit
Side Desk					
Measured (N = 1,135)	11.500	19.875	8.375	18	10
Remeasured (N = 151)	7.375	16.375	9.000	18	10
Across Desk					
Measured (N = 1,135)	9.875	16.500	6.625	18	10
Remeasured (N = 151)	8.00	15.250	7.250	18	10

The individual MA-DED scores subsequently were used to establish the Side and Across MA-DED means. The TDNPVS of 10 to 18 inches, in increments of 1 inch, became the set of standards used in testing for significant differences between MA-DED means and the standard distances (Hypothesis

One). The means of the MA-DED at each style desk are also used to test for significant differences between the means of the measured and remeasured MA-DEDs (Hypothesis Three).

Diopter differences were used to test Hypothesis Two. Individual MA-DED scores were converted to diopter equivalents by first changing inches to metric distance (1 inch = .0254 m) and then applying the formula D = 1/metric distance. The range of individual diopter equivalents is shown in Table 11.

Table 11

Range of Diopter Equivalents (+D) of Individual MA-DEDs

Desk Type (N = 1,135)	Range	Diopter Equivalents	
		Upper Limit	Lower Limit
Side Desk	+2.72 D[a]	[4.70]	[1.98]
Across Desk	+3.55 D[a]	[5.94]	[2.39]

Note: [a]Range equals upper limit minus lower limit. Reciprocity limits application of D = 1/m to a single point of viewing distance.

The display of the range of individual diopter equivalents shows greater variation than is apparent when only means are displayed.

In developing the diopter equivalents of the MA-DED means, the means were first rounded to the nearest 1/8 inch. This number was then converted to diopter equivalents by utilizing the formula D = 1/metric distance. The set of standards used in the test of significant differences for Hypothesis Two were unique for each cell. Each set was created by summing a D_S or D_A and the incremental powers (+0.25 D), in turn, across the range of plus fogging lenses (D_{FL}) reported by the states as being used to screen for hyperopia ($D_{SFL} = D_S + D_{FL}$; $D_{AFL} = D_A + D_{FL}$). The reported +D fogging lens ranged from 1.00 D through 2.50 D. The range of diopter equivalents and the range of the MA-DED scores cannot be shown on the same table giving upper and lower limits because reciprocity results in the upper limit of the MA-DEDs converting to the lower limits of the diopter equivalents, and the lower limit of the MA-DEDs converting to the upper limit of the diopter equivalents.

Presentation of the mean scores of the MA-DED at each style of desk for the different age spans (6-month, 1-year, 2-year, 3-year, and 4 year) are shown in Table 12. The presentation includes the means of the MA-DED, standard deviations, and number of subjects for the described cells, and may be used as a norm table. The remainder of the norms are presented in Appendix Q (Tables 22-27).

Table 12

Maximum Available Desk-to-Eye Distance (MA-DED) Means by Age Span and Desk Style

Age Span	Side Desk n	Side Desk Mean	Side Desk SD	Across Desk n	Across Desk Mean	Across Desk SD
			Six-Month			
Young 6[a]	41	12.948	1.745	41	11.415	1.890
Old 6[b]	227	12.905	1.563	217	11.231	1.617
Young 7	281	13.398	1.681	281	11.832	1.525
Old 7	265	13.730	1.646	265	12.052	1.607
Young 8	230	14.320	1.768	230	12.404	1.659
Old 8	67	14.349	1.454	67	12.597	1.551
Young 9	18	14.097	2.559	18	12.729	1.757
Old 9[c]	---	---	---	---	---	---
			One-Year			
6 Years	268	12.911	1.589	268	11.259	1.659
7 Years	546	13.559	1.671	546	11.939	1.568
8 Years	297	14.327	1.700	297	12.447	1.653
9 Years	24	13.797	2.623	24	12.266	2.000
			Two-Year			
6-7 Years	814	13.347	1.671	814	11.715	1.629
8-9 Years	321	14.287	1.785	321	12.434	1.662
			Three-Year			
6-8 Years	1,111	13.608	1.659	1,111	11.932	1.608
7-9 Years	867	13.829	1.707	867	12.150	1.603

(table continues)

Table 12--continued

Age Span	Side Desk			Across Desk		
	n	Mean	SD	n	Mean	SD
			Four-Year			
6-9 Years	1,135	13.612	1.756	1,135	11.919	1.669

NOTE: [a]Year plus zero to 5 months; [b]Year plus 6 to 11 months; [c]Fewer than 10 subjects per cell.

All hypotheses were subjected to statistical analyses. Hypotheses One and Two were tested utilizing an independent-samples student's *t*-Test (two-tailed, $p < .05$). Hypothesis Three was tested utilizing a paired-samples student's *t*-Test (two-tailed, $p < .05$). Table 13 illustrates the analysis of data for each student's *t*-Test.

Table 13

Student's T-Tests: Expected and Actual Percentages

Hypothesis/ Number of Tests Run	Expected %	Actual %
Independent Samples (two-tailed, $p < .05$)		
H_1. Side and Across MA-DED Means ($N = 376$, Grades 1-2)	89.00	92.169

(table continues)

Table 13--continued

Hypothesis/ Number of Tests Run	Expected %	Actual %
H2. + Diopters (Equivalent of Side and Across MA-DED means) (N = 2,632, Grades 1-2)	89.00	95.080
Paired Samples (two-tailed, $p < .05$)		
H3. Remeasure/Measure MA-DED Mean Differences (Side and Across) Time 1 and Time 2 (n = 151, Grades $1^1, 1^2, 2^1$	89.00	98.368

The basis for decisions regarding rejection or failure to reject Hypotheses One, Two, and Three is the relationship of the expected proportion of the tests that are significant and the actual proportion of the tests that are significant.

Hypothesis One states:

> There is a significant difference between the mean of the MA-DED for each cell as described and each standard distance used as target distance for nearpoint vision screening (TDNPVS).

The actual proportion of student's t-Tests that were significant (two-tailed, Independent Samples, $p < .05$) is 92.169%, which is greater than the expected 89% significant proportion. Therefore, Hypothesis One is supported.

Hypothesis Two states:

> There is a significant difference between the mean MA-DED diopters (the mean of the MA-DED for each cell as described when converted to plus diopters of accommodation [D_S, D_A]) and the summed diopters (D_{SFL}, D_{AFL}) of the given plus diopters fogging lens and MA-DED diopters for a given cell.

The actual proportion of student's *t*-Tests that were significant (two-tailed, independent samples, *p* < .05) is 95.080%, which is greater than the expected 89% proportion. Therefore, Hypothesis Two is supported.

Hypothesis Three states:

> There is a significant difference between the remeasure/measure means of the MA-DED across time for the children in Time 1, Grades 1^1 and 2^1 and Time 2, Grade 1^2.

The actual proportion of student's *t*-tests that are significant (two-tailed, paired samples, *p* < .05) is 98.368%, which is greater than the expected 89% proportion. Therefore, Hypothesis Three is supported.

Results of tests of significance in the MANOVA procedures must be statistically significant before there is cause to examine univariate results. The univariate results determine the variables which contribute the most to overall differences (Norušis, 1985).

Two analyses of variance (ANOVAs) were performed for effects of age, grade, and sex (8 x 4 x 2 design) for the Side and Across MA-DED means using MANOVA procedures

(SPSS-X). The first analysis includes the repeated measure factor, retesting on both the Side and Across MA-DEDs, thus being a true multivariate analysis of variance. The second analysis deletes the measurement factor and examines the difference between the Side and Across MA-DED measures, thus being a univariate analysis of variance (see Table 14).

Table 14

MANOVA of the MA-DED

Source of Variation	Wilks	Approximate F	Hypothesis df	Error df	Significance of F
Age Group	.823	1.768	14.00	242.00	.044
Grade	.905	3.093	4.00	242.00	.017
Sex	1.000	.029	2.00	121.00	.971
Age Group x Grade	.910	.976	12.00	242.00	.472
Age Group x Sex	.979	.315	8.00	242.00	.960
Grade x Sex	.997	.095	4.00	242.00	.984
Age Group x Grade x Sex	.982	.363	6.00	242.00	.902
Measure	.993	.423	2.00	121.00	.656
Age Group x Measure	.884	1.101	14.00	242.00	.358
Grade x Measure	.972	.853	4.00	242.00	.493
Sex x Measure	.975	1.547	2.00	121.00	.217

(table continues)

Table 14--continued

Source of Variation	Wilks	Approximate F	Hypothesis df	Error df	Significance of F
Age Group x Grade x Measure	.884	1.279	12.00	242.00	.232
Age Group x Sex x Measure	.965	.540	8.00	242.00	.826
Grade x Sex x Measure	.955	1.397	4.00	242.00	.236
Age Group x Grade x Sex x Measure	.935	1.376	6.00	242.00	.225

The difference between the Side and Across MA-DEDs is computed as $D_A - D_S$. All of the resulting mean differences are of negative value. This indicates that the Side MA-DED is larger in value than is the Across MA-DED (see Table 15).

Table 15

Cell Means: Difference Between Across and Side MA-DEDs

Age Group/Grade	Mean	SD	n
Young 6			
Grade 1[1]	-1.651	1.739	29
Grade 1[2]	-1.250	1.113	12

(table continues)

Table 15--continued

Age Group/Grade	Mean	SD	n
Old 6			
Grade 1[1]	- .895*	1.402	82
Grade 1[2]	-2.126*	1.356	144
Grade 2[1]	-3.250	.000	1
Young 7			
Grade 1[1]	-1.129*	1.354	64
Grade 1[2]	-1.873*	1.751	154
Grade 2[1]	- .826*	1.154	46
Grade 2[2]	-2.434*	1.414	17
Old 7			
Grade 1[1]	-1.133*	1.286	15
Grade 1[2]	-1.530*	1.617	42
Grade 2[1]	- .900*	1.354	74
Grade 2[2]	-2.215*	1.207	134
Young 8			
Grade 1[1]	-1.563*	1.488	5
Grade 1[2]	-2.244**	1.724	22
Grade 2[1]	- .967*	1.243	53
Grade 2[2]	-2.194**	1.722	150
Old 8			
Grade 1[1]	- .375	0.000	1
Grade 1[2]	-2.854*	1.530	6
Grade 2[1]	-1.098*	1.142	14
Grade 2[2]	-1.837**	1.368	46
Young 9			
Grade 1[1]	-5.500	0.000	1
Grade 1[2]	-1.000*	.835	4
Grade 2[1]	-1.163*	2.153	13
Old 9			
Grade 1[1]	-1.938	1.503	2
Grade 1[2]	-1.625	.707	2
Grade 2[1]	-2.500	1.061	2

(table continues)

Table 15--continued

Age Group/Grade	Mean	SD	n
Total Sample	-1.692	1.565	1,135

NOTE: Cells with n = 1 were not tested.

*Means which differ significantly.
**Means which differ from other means of smaller value but do not differ from each other.

The second analysis of variance shows a significant F-ratio only on the three-way interaction among age, grade, and desk style (Side or Across). This effect was investigated further by univariate tests. The grades means are found to differ significantly for the following age groups: Old 6 (6 years, 6 months through 6 years, 11 months) through Young 9 (9 years, zero months through 9 years, 5 months). The interaction significance is due to the mean difference between Side and Across MA-DEDs not being consistent between grades when viewed across age groups. Therefore, Hypothesis Three is accepted.

Summary

Analysis of the data reveals that there are significant differences between the means of the Side and Across MA-DEDs and the target distances used for nearpoint vision screening

(TDNPVS). Thus, Hypothesis One is not rejected. A mean may be shorter than some of the TDNPVS, or equal to or longer than others. There are significant differences between the diopter equivalents of the means of the MA-DED for each style of desk and the D_{SFL} and D_{AFL} (sum of each MA-DED diopter equivalent and each power of +D fogging lens used to screen for hyperopia). Thus, Hypothesis Two is not rejected. There are significant differences between the remeasure and measure means of the MA-DED involving the three-way interaction of age, grade, and style of desk. The means difference between the Side and Across MA-DEDs is not consistent between grades when viewed across the different age spans. Therefore Hypothesis Three is not rejected.

CHAPTER V

SUMMARY, FINDINGS, DISCUSSION, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

This study investigated the maximum available desk-to-eye distance (MA-DED) for students in Grades 1 and 2 while seated in best-fit chairs at best-fit desks with storage beneath the desk top at the side or across. The study established normative tables for the Side and Across MA-DEDs for Grades 1 and 2 and for the ages of the subjects, 6 through 9 years. Relationships between the MA-DEDs and age, grade, and gender were analyzed.

The study is significant in that it provides criteria of near viewing distance available to students in Grades 1 and 2 or age 6 through 9 years while seated to work at desks. This criteria can be used to examine the generalizability of findings in reading and vision studies to a child's classroom situation. The criteria also allow examination of past studies to determine the appropriateness of generalizing these past findings of vision screening and vision examination to a classroom situation.

The study analyzed data from 1,135 students enrolled in Grades 1 and 2 in 13 public schools and 1 parochial school within the geographic boundaries of Education Service Center Region X in Texas.

To obtain the maximum available desk-to-eye distance (MA-DED) data, each subject was measured from the bridge of the nose to the pencil point placed on the target while assuming a good writing posture at each of the two styles of desks. The target point was in the center of the desk area above the leg space. The best-fit chair and best-fit desk (both side and across) were established for each student prior to measurement.

The remeasure and measure of Side and Across MA-DEDs were taken in adjacent semesters. Time 1 was for 4 months, fall to spring; Time 2 was for 8 months, spring to fall.

The data analyses utilized the student's *t*-test (two-tailed, independent samples, $p < .05$) for Hypotheses 1 and 2 and the student's *t*-test (two-tailed, paired samples, $p < .05$) for remeasure/measure for Hypothesis 3. The Multivariate Analysis of Variance (MANOVA) procedures of SPSS-X were utilized to determine significant interaction among age, grade, sex, and desk style factor on the MA-DED. MANOVA simultaneously tests the interaction between the age spans, grade levels, and sex, and measure and remeasure MA-DEDs.

The following hypotheses were tested:

1. There is a significant difference between the mean of the MA-DED for each cell as described and each standard distance used as target distance for nearpoint vision screening (TDNPVS).

2. There is a significant difference between the mean MA-DED diopters (the mean of the MA-DED for each cell as described when converted to plus diopters of accommodation [D_S, D_A]) and the summed diopters (D_{SFL}, D_{AFL}) of the given plus diopters fogging lens and MA-DED diopters for a given cell.

3. There is a significant difference between the remeasure/measure means of the MA-DED across time for the children in Time 1, Grades 1^1 and 2^1 and Time 2, Grade 1^2.

Findings

The following findings resulted from the study:

1. There were significant differences between the means of the Side and Across MA-DED and each of the target distances used in screening nearpoint vision (TDNPVS) for 92.169% of the tests at $p < .05$. The linear means of the Side and Across MA-DEDs varied from the TDNPVS distances of 10 and 12 to 18 inches in that the means were equal to some and shorter or longer than others. The high percentage of

tests of differences that were significant support Hypothesis One.

2. There were significant differences between the diopter equivalent of the means of the Side and Across MA-DEDs and each sum of a standard plus lens and a Side or Across MA-DED diopter (D_{SFL}, D_{AFL}) for 95.080% of the tests at $p < .05$. The high percentage of tests of differences that were significant support Hypothesis Two.

3. There were significant differences between the means of the remeasure Side and Across MA-DEDs and the measure Side and Across MA-DEDs across time for 98.368% of the tests at $p < .05$. Hypothesis Three is supported.

Further statistical analysis of the interaction between the MA-DED measure and remeasure, age spans, grade levels, and sex were made using the MANOVA procedures of SPSS-X. The F-ratios for grade and age span were significant at $p < .05$. Examination of the means shows that the MA-DED values, both Side and Across, increase with age and by grade.

The results of the second analysis show a significant F-ratio only on three-way interaction among age span, grade level, and MA-DED type (Side versus Across). This effect was investigated by tests of simple main effects. Grades were found to differ significantly across age span, from young 6-year-olds (6-0 through 6-5) through young

9-year-olds (9-0 through 9-5). The interaction is significant because the mean difference between Side and Across MA-DEDs is not consistent between grades when viewed across age spans. Using $D_A - D_S$, the resulting mean differences were negative in value, indicating that the Side MA-DED is larger in value than the Across MA-DED.

Discussion

Commentary

A review of the data reveals the following additional outcomes:

1. The mean value of the Side and Across MA-DEDs for boys is shorter than that of the total sample, although the standard deviation for boys is greater than that for the total sample or for girls.

2. In Grades 1^2 and 2^1, the remeasured means and standard deviations are in the same direction in terms of the relationship to the measured means and standard deviations for each desk style. That is, the shorter remeasured means are associated with smaller standard deviations (when compared to the measured means and standard deviations of the same grades), and the longer remeasured means are associated with larger standard deviations (when compared to the measured means and standard deviations of the same grades).

3. In Grade 1[1], the remeasured means and standard deviations are in opposite directions in terms of the relationship to the measured mean and standard deviation for each desk style. That is, the shorter remeasured mean is associated with a larger standard deviation (when compared to the measured mean and standard deviation of the same grade).

4. The range of the Side MA-DED means is 1 5/8 inches larger than that of the Across MA-DED means. Examination of the data reveals that most of the difference is seen in the upper limit of the Side MA-DED means being longer than that of the Across MA-DED.

5. Examination of the grade-by-sex means of the Side and Across MA-DED means reveals that the means of the boys are shorter than those of the girls in 13 of the 14 cells in which there are both boys and girls to contrast. The lesser means for boys are in all 7 of the contrasted cells for Side MA-DED means, and in 6 of the 7 contrasted cells for the Across MA-DED means.

6. The values of the shortest Side and Across MA-DED means (by grade and desk style, and by grade by sex by desk style) range from 11.076 to 12.600 inches. The diopter equivalents of these shortest MA-DED means are +3.50 D and +3.00 D (rounded to the nearest +0.25 D). The shortest

MA-DED means found are for 6-year olds at side desks in Grade 1^1 and at across desks in Grade 1^2.

7. The values of the longest Side and Across MA-DED means (by grade and desk style, and by grade by sex by desk style) range from 14.654 to 12.691 inches. The diopter equivalents of these longest MA-DED means are +2.75 D and +3.00 D (rounded to the nearest +0.25 D). The longest MA-DED means found are for 8-year olds at side desks in Grade 2^2, and for 9-year olds at across desks in Grade 2^2.

8. The diopter equivalents of the shortest MA-DED means at either style of desk are greater than the strongest +D lens reported as being used to screen for hyperopia by +0.50 D and +1.00 D.

9. The diopter equivalents of the longest MA-DED means at either style of desk are greater than the strongest +D lens reported as being used to screen for hyperopia by +0.25 D and +0.50 D.

10. The pattern of boys having MA-DED means shorter than those of girls should be coupled with Michael's (1985) statement that the expected change in refractive status toward being less hyperopic is seen 2 to 3 years later in boys than it is in girls.

Observations

It was observed during the testing that the type of footwear had an effect on the distance of the thigh and knee from the floor, thus influencing the height of the chair and desk which were the best fit. The footwear differed as to thickness of sole when jogging or athletic shoes were compared to the thinner leather or plastic soles of nonathletic shoes. Cowboy boots have higher heels than do other styles of footwear, and have enough heel height to affect the knee and thigh height to a greater degree than do the thick soles of athletic shoes. There were no data kept as to the style of footwear worn by the subjects, and all subjects had the best-fit chair and desk established without removing footwear. All types of footwear were observed being worn by both boys and girls.

Conclusions

The following major conclusions result from an analysis of the findings of this study. These conclusions, it is felt, can be generalized to students in Grades 1 and 2 or of ages 6 through 9 years for both boys and girls.

1. Tables of maximum available desk-to-eye distance means (MA-DEDs) are now available as normative tables to serve as criteria of the near viewing distance of students while working at school desks.

2. The maximum available desk-to-eye distance at side and across desks for most students are different from the target distances used in nearpoint vision screening, and are usually shorter than the target distances reported as being used.

3. The strength of plus lens appropriate to use when screening for hyperopia should be related to the individual's maximum available desk-to-eye distance for the desk style being used in the classroom. When the individual's measured MA-DED is not available, a MA-DED mean may be used. The means appropriate, in descending order, are: age-by-grade-by-sex-by-desk style; grade-by-sex-by-desk style; age-by-grade-by-desk style; age-by-desk style; or grade-by-desk style. The desk style of the means used should match the desk style used in the classroom.

4. There are significant differences in the MA-DEDs across time. At each grade level, the style of desk and the child's age are correlated with differences in the value.

5. The visual demand of the Side and Across MA-DEDs is greater for younger students, or students in the lower grades, than it is for older students or students in the higher grades, due to the relationship of viewing distance and the dioptric accommodation for a given distance.

6. The maximum available desk-to-eye distance (MA-DED) is shorter at the across desk than at the side desk,

resulting in a greater near visual demand while working at the across desk.

7. The shorter means of the Side and Across MA-DEDs for boys (as compared to those for girls) is associated with a greater variance in the individual MA-DEDs for boys than in those of girls.

8. The length of the Side and Across MA-DEDs are expected to increase as students become older and advance in grade level, resulting in decreased visual demand while working at a desk.

9. It is appropriate to compare the viewing distance available to a student while seated to read or write at a desk in the classroom to the target distance used in nearpoint vision screening, in order to determine the appropriateness of generalizing a nearpoint screening pass/fail to the classroom situation.

10. The style of desk and fit of chair and desk have an effect on a child's viewing distance while working at a desk.

Implications

Specific implications exist for individual professionals and professional organizations who advise or establish the content of vision screening practices for a state or school district, who design or create new screening instruments, who screen the vision of school children, or who examine children's vision. There are also specific implications which exist for teachers and reading professionals who instruct reading, investigate elements of reading, or develop methods of reading instruction for students in Grades 1 and 2 or for ages 6 through 9 years.

1. When near vision screening is part of a routine vision screening, near target distance less than or equal to the maximum available desk-to-eye distance for the student when seated at his or her own school desk should be employed.

2. When vision screening includes the use of +D (convex) lens, the power used should be related reciprocally to the near viewing distance as determined by individual measurement or by use of an appropriate MA-DED measure.

3. State vision advisory committees should be aware of the mean MA-DED for the different styles of desks for different grades and ages in conjunction with the visual refractive status that is considered to be normal, or is expected, at a given grade or age. They should base their recommendations upon the visual demands which result from these factors.

4. Eye care professionals should not assume that the results of past investigations which have become the basis for vision screening standards and the distances used in

vision examinations are appropriate in terms of the minimum visual demand made upon children in Grades 1 and 2, or ages 6 through 9 years.

5. Eye care professionals should not assume that investigative findings will be the same at the traditional near distances and at a mean MA-DED or an individual MA-DED distance.

6. The maximum available desk-to-eye distance is not necessarily the work distance of students in these grades or of these ages. Work distances are likely to be shorter than the MA-DEDs and to vary during a task.

7. Teachers should not assume that all children learn to read equally well at all distances. Some children may need a greater distance than the desk environment allows.

8. Schools should not assume that size and fit of chair and desk do not affect the visual demand of a near task while the student is working at a desk. It is important for each student to be working at a best-fit chair and desk all of the school year.

Recommendations

Recommendations for future studies are as follow:

1. investigation of the ability of primary-age children to utilize different visual distances as a developmental aspect of vision as established by means at

given ages and grades, and by longitudinal studies of individuals over the age span commonly found in the primary grades;

2. determination of working or vocational distances for various tasks involving reading, writing, or both, under various conditions. The conditions should include those of varying work surfaces or no work surface, such as holding a book to read when not at a work surface. The conditions should also include the stress of various academic tasks in which a student has varying levels of achievement and skill, such as handwriting during a spelling test as compared to handwriting during composition or a formal writing lesson, or drawing;

3. investigation of the interaction or correlation of the various factors in the determination of working distances, whether of main effects or of intervening variables such as gender, age, posture, or physique;

4. replication of earlier investigations by eye care professionals of the visual elements directly involved in near school tasks, such as facility and amplitude of accommodation and contrast sensitivity at the original, MA-DED, and Hurst's working distances, as well as when working at these distances for varied lengths of sustained time;

5. correlative studies of complete individual refractive status (utilizing rounding to the nearest ± 0.25 diopter) and academic achievement and facility or ease of academic performance, as well as intervening variables such as sex, age, and grade;

6. determination of the individual's ability to sustain working on academic tasks at the various distances or the effect of forced maintenance of various working distances on academic output, as well as effect on the individual's attitude toward completing the work;

7. investigation of different rates of learning, especially in areas of lowered academic achievement, when working under varied conditions of working distance (even far distance for reading), illumination (such as spot-lighted reading material), and various time exposures which do not involve covering/uncovering or blurring/ focusing of the stimulus;

8. determination of the pass/fail rate for vision screening when the targets used for tests of nearpoint vision screening are at distances equal to or shorter than the appropriate age, grade, and sex means of the MA-DED (Side or Across) which match the desk style used in the child's classroom;

9. determination of the hyperopia screening pass/fail rate when the power of +D lens is the diopter equivalent of

the child's measured MA-DED, an appropriate MA-DED mean, or the child's habitual working distance; and

10. studies in which the findings of the earlier described determinations, studies, and investigations are correlated with the child's academic mastery, when academic mastery equates to the grade level at which the child ranks in the 50th percentile or higher.

REFERENCES

Adams, A. J., Haegerstrom-Portnoy, G., Brown, B., & Jampolsky, A. (1984). Predicting visual resolution from detection thresholds. American Journal of Optometry and Physiological Optics, 61(6), 371-376.

American Association of Opthalmology. (1971). Identification of school children requiring eye care: A report to educators and physicians. Washington, DC: Author.

Barbe, W. B., Lucas, V., Wasylyk, T. M., Hackney, C. S., & Braun, L. A. (1987). Zaner-Bloser handwriting: Basic skills and application, Book Two (Teacher's Edition) (Rev. ed.). Columbus, OH: Zaner-Bloser.

Bayle, E. (1942). The nature and causes of regressive movements in reading. Journal of Exceptional Education, 11(1), 16-36.

Bell, M. E., Davidson, E., & Veal, R. C. (1978). I learn to write: Transition teacher's guide (3rd ed.). New York: McCormick-Mathers.

Belloc, N. B. (1962). School vision screening in the United States. The Sight-Saving Review, 32(4), 194-198.

Bierman, A. (1978). The Harmon distance. Pennsylvania Optometrist, 38(1), 15.

Borish, I. M. (1970). Clinical refraction (3rd ed.). New York: Professional Press Books.

Brent, H. P., & Arstikaitis, M. (1983). Correction of refractive errors. In J. S. Crawford & J. D. Morin (Eds.), The eye in childhood (pp. 33-38). New York: Grune and Stratton.

Bromberg, J., Jaycox, S., Poirier, R. D., & Simonse, A. (1984). Results of the NSPB/ASHA Vision Screening Requirement Survey. New York: National Society to Prevent Blindness.

Carrollton-Farmers Branch Independent School District. (1986). Registration card. Carrollton, TX: Author.

Cashell, G. T. W., Durran, I. M. (1971). Handbook of orthoptic principles (2nd ed.). Edinburgh: Churchill Livingston.

Cochran, W. G. (1983). Planning and analysis of observational studies. (Edited posthumously by L. E. Moses and F. Mosteller.) New York: John Wiley and Sons.

Committee on School Health. (1977). A guide for health professionals. Evanston, IL: American Academy of Pediatrics.

Dale, R. T. (1982). Fundamentals of ocular motility and strabismus. New York: Grune and Stratton.

Daum, K. M. (1984). Convergence insufficiency. American Journal of Optometry & Physiological Optics, 61(1), 16-22.

Davis, W. J. G. (1959, February). Accommodative esotropia. Southern Medical Journal, 158-162.

Doehring, D. G. (1976). Acquisition of rapid reading responses, 41(2). Society for Research in Child Development (Monograph series no. 165). Chicago: University of Chicago Press.

Doster, M. E. (1971). Vision screening in schools--Why, what, how and when? Clinical Pediatrics, 10(1), 662-665.

Eames, T. (1961). Accommodation in school children aged five, six, seven, and eight. American Journal of Ophthalmology, 51(6), 1255-1257.

Ehrlich, D. L. (1987). Near vision stress: Vergence adaptation and accommodative fatigue. Ophthalmic and Physiological Optics, 7(4), 353-357.

Foerster, L. M. (1979). Handwriting to communication. Austin, TX: Bensom.

Fox, S. L. (1973). Industrial and occupational opthalmology. Springfield, IL: Charles C. Thomas.

Francis, L. J. (1973). The relationship of eye anomalies and reading ability, and an analysis of vision-screening programs (Vols. 1 & 2). Unpublished doctoral dissertation, University of Northern Colorado, Greeley.

Gilbert, L. C. (1940). Effect on silent reading of attempting to follow oral reading. Elementary School Journal, 40, 614-621.

Gilbert, L. C. (1959). Influence of interfering stimuli on perception of meaningful material. California Journal of Educational Research, 10(1), 15-23.

Gilbert, L. C., & Gilbert, D. W. (1942). Reading before the eye-movement camera versus reading away from it. Elementary School Journal, 42, 443-447.

Gillie, J. C. (1962). Aberrant vergence movements in heterophoria and heterotropia. Transactions of the International Ophthalmic Optical Congress, 1961 (pp. 596-605). London: Crosby, Lockwood and Sons.

Gilmartin, B., & Hogan, R. E. (1985). The role of the sympathatic nervous system in ocular accommodation and ametropia. Ophthalmic and Physiological Optics, 5(1), 91-93.

Ginsburg, A. P. (1984). A new contrast sensitivity vision test chart. American Journal of Optometry and Physiological Optics, 61(6), 403-407.

Gonzalez, C. (1983). Strabismus and ocular motility. Baltimore: Williams & Wilkins.

Goss, D. A. (1986). Effect of bifocal lenses on the rate of childhood myopia progression. American Journal of Optometry and Physiological Optics, 63(2), 135-141.

Gray, L. (1963). Teaching children to read (3rd ed.). New York: Ronald Press.

Haag, J. H. (1972). School health program. Philadelphia: Lea and Febiger.

Harmon, D. B. (1949). The coordinated classroom. Grand Rapids, MI: American Seating Company.

Harmon, D. B. (1965). Restrained performance as a contributing cause of visual problems. Chula Vista, CA: College of Optometric Vision Development.

Harmon, D. B. (1958). Dynamic theory of vision (abstract). Duncan, OK: Optometric Extension Program Foundation.

Harwood, L. (1984). Vision screening and the private practitioner--A status report. American Journal of Optometry and Physiological Optics, 61(6), 364-366.

Hatfield, E. M. (1979). Methods and standards for screening pre-school children. The Sightsaving Review, 49(2), 71-83.

Hennessey, D., Iosue, A. A., & Rouse, M. W. (1984). Relation of symptoms to accommodative infacility of school-aged children. American Journal of Optometry and Physiological Optics, 61(3), 177-183.

Henson, D. B. (1983). Optometric instrumentation. London: Butterworth's.

Hurst, W. A. (1964). Vision and reading achievement. Canadian Journal of Optometry, 25(4), 3-19.

Hurst, W. A. (1967). A basis for diagnosing and treating learning disabilities within the school system. Canadian Journal of Optometry, 29(2), 46-59.

Ikeda, M., & Saida, S. (1978). Span of recognition in reading. Vision Research, 18(10), 83-88.

Johnson, B. K. (1987). HBJ Handwriting (Teacher's Edition). Orlando, FL: Harcourt, Brace and Jovanovich.

Keeney, A. H. (1966). Development of vision. In Frank Falkner (Ed.), Human Development (pp. 459-464). Philadelphia: W. B. Saunders.

King, F. M. (1987). Palmer method: Grade two. Naples, FL: A. N. Palmer.

Köhler, L., & Stigmar, G. (1981). Testing for hypermetropia in the school vision screening programme. Acta Ophthalmologica, 59(3), 369-377.

Kruger, P. B. (1977). Changes in fundus reflex luminance with increased cognitive processing. American Journal of Optometry & Physiological Optics, 54(7), 445-451.

Kruger, P. B. (1978). The effect of accommodative changes on the brightness of the fundus reflex. Journal of the American Optometric Association, 49(1), 47-49.

Lebensohn, J. E. (1936). Scientific and practical considerations involved in the near-vision test with presentation of a practical and informative near-vision chart. American Journal of Ophthalmology, 19(2), 110-117.

Lebensohn, J. E. (1958). Visual acuity tests for near-implications and correlations. American Journal of Ophthalmology, 45(4), 127-133.

Letourneau, J. E., Lapierre, N., & Lamont, A. (1979). The relationship between convergence insufficiency and school achievement. American Journal of Optometry and Physiological Optics, 56(1), 18-22.

Lippmann, O. (1962). Eye screening. Archives of Ophthalmology, 68(5), 692-706.

Mandal, A. C. (1984). The correct height of school furniture. Physiotherapy, 70(2), 48-53.

Marr, M. B., & Kamil, M. L. (1981). Single word decoding and comprehension: A constructive replication. Journal of Reading Behavior, 13(1), 81-86.

Martin, W. E. (1954). The functional body measurements of school-age children. Joint project of U.S. Office of Education, University of Michigan and National School Service Institute. Chicago: National School Service Institute.

Mason, T. S. (1962). Clinical aspects of convergence and accommodative efforts. Transactions of the International Opthalmic Optical Congress, 1961 (pp. 585-595). London: Crosby, Lockwood and Son.

Mehr, E. B., & Freid,A. N. (1976). Techniques, instruments, cases. American Journal of Optometry and Physiological Optics, 53(6), 314-317.

Michaels, D. D. (1975). Visual optics and refraction (1st ed.). St. Louis: C. V. Mosby.

Michaels, D. D. (1980). Visual optics and refraction (2nd ed.). St. Louis: C. V. Mosby.

Michaels, D. D. (1985). Visual optics and refraction (3rd ed.). St. Louis: C. V. Mosby.

Myrowitz, E. (1984). A public health perspective on vision. American Journal of Optometry and Physiological Optics, 61(6), 359-360.

National Association of Vision Program Consultants (NAVPC). (1981). Guidelines for developing eye health programs for children. Washington, DC: Author.

National Society to Prevent Blindness. (1982). Children's eye health guide. New York: Author.

Norušis, M. J. (1985). Advanced statistics guide. New York: McGraw-Hill.

Peters, H. B. (1984). The Orinda study. American Journal of Optometry and Physiological Optics, 61(6), 361-363.

Petersen, R. A. (1974). Vision screening and the detection of amblyopia in children. The Sight-Saving Review, 44(2), 85-88.

Petrie, V. E., Tumblin, J. C., & Miller, S. C. (1979). The American Optometric Association guidelines on vision screening. St. Louis: American Optometric Association.

Pickwell, D., Jenkins, T., & Yekta, A. A. (1987). The effect on fixation disparity and associated heterophoria of reading at an abnormally close distance. Ophthalmic and Physiological Optics, 7(4), 345-347.

Potts, A. M. (1972). The assessment of visual function. St. Louis: C. V. Mosby.

Pringle, S. M., & Ramsey, B. E. (1982). Promoting the health of children. St. Louis: C. V. Mosby.

Radke, E., & Blackhurst, R. T. (1978). Preschool screening of vision: The Michigan experience. Sight-Saving Review, 48(3), 99-105.

Richards, R. D. (1973). Ophthalmologic disorders. Flushing, NY: Medical Examination Publishing.

Rosner, J. (1982). Pediatric optometry. Boston: Butterworths.

Rouse, M. W., Hutter, R. F., & Shiftlett, R. (1984). A normative study of the lag in elementary school children. American Journal of Optometry and Physiological Optics, 61(11), 693-697.

Rubino, C. A., & Minden, H. A. (1973). An analysis of eye movements in children with a reading disability. Cortex, 9(2), 217-220.

Scheie, H. G., & Albert, C. M. (1977). Textbook of ophthalmology (9th ed.). Philadelphia: W. B. Saunders.

Shaw, E. R. (1908). School hygiene. New York: MacMillan.

Sheridan, M. D. (1979). The clinical assessment of visual competency in babies and young children. In V. Smith & J. Keen (Eds.), Visual handicap in children (Clinics in Developmental Medicine #73) (pp. 6-15). Lavenhem, Suffolk, U.K.: Lavenham Press.

Sloan, L. L. (1959). New test charts for the measurement of visual acuity at far and near distances. American Journal of Optometry, 48(6), 807-813.

Solan, H. A. (1962). Visual processing training with the tachistoscope: A rationale and grade one norms. Journal of Learning Disabilities, 2, 30-36.

Spache, G. (1976). Investigating the issues of reading disabilities. Boston: Allyn and Bacon.

Stein, J. F., & Fowler, M.S. (1982). Diagnosis of dyslexia by means of a new indicator of eye dominance. British Journal of Ophthalmology, 66(1), 332-336.

Stein, J. F., & Fowler, M.S. (1985). Effect of monocular occlusion on visuomotor perception and reading in dyslexic children. The Lancet, 2(8446), 69-73.

Stein, J. F., Riddell, P. M., & Fowler, M. S. (1986). The Dunlop Test and reading in primary school children. British Journal of Ophthalmology, 70(4), 317-320.

Stennett, R. G., Smythe, P. C., Pinkney, J., & Fairbairn, A. (1973). The relationship of eye movement measures to psychomotor skills and other elemental skills involved in learning to read. Journal of Reading Behavior, 5(1), 1-13.

Tansill, B. C. (Ed.) Walsh and Hoyt's clinical neuro-ophthalmology (4th ed.). Baltimore: Williams and Wilkins.

Taylor, S. E. (1962). Eye-movement photography. Huntington, NY: Educational Development Laboratories.

Taylor, S. E. (1965). Eye movements in reading: Facts and fallacies. American Educational Research Journal, 2, 187-202.

Thurber, D. N. (1987). D'Nealian handwriting, Book One: Teacher's Edition (2nd ed.). Glenview, IL: Scott, Foresman.

Tinker, M. A. (1958). Recent studies of eye movement in reading. Psychological Bulletin, 55(4), 215-231.

Townsend, R. M. (1978). Writing on, Grade two: Imaginary line handwriting series. Austin: Steck-Vaughn.

Trobe, J. D. (1975). Problems of eye care delivery. Survey of Ophthalmology, 20(3), 205.

Valadian, I., & Porter, D. (1977). Physical growth and development from conception to maturity. Boston: Little, Brown.

Verma, S. (1984). Vision screening of specialized populations. American Journal of Optometry and Physiological Optics, 61(6), 367-370.

Von Noorden, G. K. (1980). Burian-Von Noordon's binocular vision and ocular motility (2nd ed.). St. Louis: C. V. Mosby.

Waters, H. B. (1952). The new approach to optical dispensing. Culver City, CA: Murray and Gee.

Westheimer, G. (1978). On screening with the Snellen chart. The Sightsaving Review, 48(1), 40.

Whittington, T. H. (1958). The art of clinical refraction. London: Oxford University Press.

Wold, R. M. (1967). The spectacle amplitude of accommodation of children ages six to ten years. American Journal of Optometry, 44(10), 642-664.

Zellers, J. A., Alpert, T. L., & Rouse, M. W. (1984). A review of the literature and a normative study of accommodative facility. Journal of the American Optometric Association, 55(1), 31-37.

APPENDIX A

STATE PUBLICATIONS: VISION SCREENING GUIDELINES

State Publications: Vision Screening Guidelines

(Recommended or Mandated)

State	Guideline(s)
Alabama	Code of Alabama, Statute 16-19-1, et seq., 1975, no guidelines, Alabama Department of Public Health
Alaska	Statute Article 2, Sec. 14.30.127, 1982, to be implemented (only excerpt received), Department of Health and Social Services
Arizona	Guidelines for Vision Screening for Handicapped Children, (1983), Arizona Department of Health Services, and Guidelines for Recommended School Vision Screening Program, 1969, Revised 1980, Arizona Department of Health Services
Arkansas	Vision and hearing screening guidelines and regulations, Arkansas Department of Health (no year)
California	A Guide for Vision Screening in California Public Schools, 1984, California State Department of Education
Colorado	Colorado School Health Guidelines, 2nd ed., 1986, Colorado Department of Health
Connecticut	Connecticut Legislation and Regulations, Sec. 10-214-5, Department of Education (only excerpt sent)

State	Guideline(s)
District of Columbia	Vision Screening Policy and Procedures, Revised 1984, 1985-86, Department of Human Services
Florida	School Health Services, 1983, Department of Health and Rehabilitative Services
Georgia	Training Manual for Vision Screening of Children, Revised 1976, no date, but after 1972 legislation, Georgia Department of Human Resources; Rules and Regulations for Eye, Ear, and Dental Examinations of Children Entering Public Schools, Chapter 290-531, July 31, 1974
Hawaii	Vision and Hearing Screening Program, School Health Services Branch, Department of Health; Part IX, Vision Screening and Education, Hawaii revised Statutes (HRS), no date given
Idaho	A School Health Manual for Idaho, 1970 (under revision), Department of Health and Welfare
Illinois	Vision Screening Guide. (1984). Springfield, IL: Illinois Department of Public Health and Illinois Society for the Prevention of Blindness
Indiana	Senate Enrolled Act 201 (1986), to be implemented, State Board of Health
Iowa	Letter: Department of Health and Department of Public Instruction
Kansas	Vision Screening Guidelines, 1983, Bureau of Maternal and Child Health, Kansas Department of Health and Environment

State	Guideline(s)
Kentucky	Administrative Regulations 704 KAR 4:020, Section 2, 1983, Kentucky Department of Education
Louisiana	Guidelines for Vision Screening, 1985, School Nurse Program, Department of Education
Maine	State School Code 693, Section 5,8, 1983; Recommendations of the School Health Advisory Committee, no date, Department of Educational and Cultural Services
Maryland	Vision Screening Manual, 1982, Maryland Department of Health and Mental Hygiene, and Public School Law, Section 7-403
Massachusetts	Instructions for the Massachusetts Vision Test, Grades K-3; Instructions for the Massachusetts Vision Test, Grades 4-12, Titmus Optical versions, 1986, Massachusetts Department of Public Health, Division of Family Health Services, Vision and Hearing Section; Massachusetts General Law Chapter 7, Section 57
Michigan	Vision Technician's Manual, 1982, Michigan Department of Public Health
Minnesota	Pre-School and School Vision Screening Manual, 1980, Minnesota Department of Health
Mississippi	Referral to Placement Process, Module H: Vision Screening Training, Mississippi Department of Education, For 1986

State	Guideline(s)
Missouri	Handbook for the School Health Nursing Program, 1985, Missouri Department of Elementary and Secondary Education
Montana	<u>Administrative Rules of Montana: 16.10.1117 Health Supervision and Maintenance (7)</u>, 1986, Department of Health and Environmental Services
Nebraska	<u>Health Services in Nebraska Schools--Policies and Procedures, 1985</u>, Department of Education; Nebraska School Laws, 1967, Sec. 79-4, 133
Nevada	Revised Statutes 392.420, 1981, Department of Human Resources
New Hampshire	<u>School Health Services Manual, New Hampshire State Department of Education, 1980</u>, Division of Instruction
New Jersey	<u>Guidelines for School Health Services</u>, 1986, Department of Education
New Mexico	New Mexico Health Manual (1986), Department of Education, and letter: State General Consul
New York	<u>Vision Screening Tests</u>, 1981, The State Education Department; New York State Education Law, Article 19, Section 105 (year not given)
North Carolina	<u>Child Health Manual</u>, 1985, Division of Health Services, North Carolina Department of Human Resources

State	Guideline(s)
North Dakota	School Health Nursing Manual, 1985, Division of Community Health Nursing, North Dakota State Department of Health
Ohio	Policies Recommended for Vision Conservation Programs for Children and Vision Screening Guide, 1982, Ohio Department of Health
Oklahoma	Letter: State Department of Education
Oregon	Excerpts sent from Oregon Administrative Rules and Guidelines 851-22-705, 1983, Oregon Department of Health
Pennsylvania	Pennsylvania Code, Section 23.4; Public School Code of 1940, Section 1402(a)(11), Revised 1981, Department of Education, or Pennsylvania School Nurses Guide, no date given, Division of School Health, Department of Health
Rhode Island	Rules and Regulations for School Health Programs, amended 1980, Department of Health/Department of Education; Outline of Procedures for Visual Appraisal School, 1978, being revised
South Carolina	Outline of Procedures for Visual Appraisal - School: State Department of Education, Department of Health and Environmental Control
South Dakota	Letters: State Department of Health and Department of Education and Cultural Affairs

State	Guideline(s)
Tennessee	Tennessee Rules, Regulations, and Human Standards, 1985, Tennessee Department of Education; Letter: Department of Education, 1985
Texas	Basic Vision Screening, 1981, Texas Department of Health, Bureau of Maternal and Child Health; Children Vision Screening Act, 1979; Special Senses and Communication Disorders, adopted rules, 1984
Utah	Standards for Visual Acuity Screening Programs of Utah School Children, 1984, Utah Department of Health; Utah Code, Title 53, Chapter 22, 1983-84
Vermont	Excerpt from Vision Screening; Vermont School Health Services, (1986). Montpelier, VT: Department of Education
Virginia	State Code 22.1-273, 1981, Commonwealth of Virginia, Department of Education
Washington	Washington State Administrative Code, Chapter 248, 148-140, (1983 ed.), Olympia: Superintendent of Public Instruction
West Virginia	Handbook for School Health Services, 1985, Office of Education Program Development, Department of Education; School Laws of West Virginia, Section 18-5-17
Wisconsin	Children's Eye Health Guide, National Society to Prevent Blindness, Wisconsin Department of Public Instruction
Wyoming	Letter: Department of Education

APPENDIX B

SAMPLE TEACHER OBSERVATIONS[1]

---

[1]Items 1-47 are from the Student Evaluation Manual--Revised (pp. 14.10, 14.11) by the Tennessee State Department of Education, 1985, Nashville: Tennessee State Department of Education, Psychological Services. Adapted by permission.

Items 48-70 are from the Oregon Vision Screening Administrative Rule by the Oregon Department of Education, Salem: Oregon Department of Education, Student Services and Special Education, 700 Pringle Parkway SE, Salem, OR. Adapted by permission.

Items 71-94 are from the Preschool and School Vision Screening Manual, 1980, Minneapolis: Minnesota Department of Health, P.O. Box 8441, Minneapolis, MN 55440. Adapted by permission.

Items 95-104 are from the South Carolina Outline of Procedures for Visual Appraisal--School (under revision), 1986. Columbus, SC: South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbus, SC 29201. Adapted by permission.

Sample Teacher Observations

Name ______________________________ DOB ______________

School ________________ Grade _____ Teacher______________

To Teachers: Please complete the following checklist. Your observations will be an important part of the functional vision assessment. Place a check ( ) in the space beside each behavior you have observed.

CHARACTERISTICS OF VISION DIFFICULTIES

A. Appearance of the Eyes

____ 1. Eyes crossed--turning in or out--at any time
____ 2. Reddened eyes
____ 3. Watering eyes
____ 4. Encrusted eyelids
____ 5. Frequent sties

B. Behavior Indications of Possible Vision Difficulty

Near

____ 6. Frowning or scowling while reading or writing
____ 7. Thrusting head forward or tilting to one side
____ 8. Covering or closing one eye habitually
____ 9. Unusual fatigue after completing a visual task
____ 10. Holds reading materials at an unusual angle
____ 11. Turning head so as to use one eye only
____ 12. Bending over to see material
____ 13. Constantly shifting position
____ 14. Easily distracted
____ 15. Holds reading material 6" or less from eyes
____ 16. Eyes 6" or less from paper when writing
____ 17. Writes unusually large
____ 18. Writes unusually small
____ 19. Difficulty copying letters and/or numerals accurately from textbook to paper
____ 20. Difficulty copying letters and/or numerals from chalkboard to paper
____ 21. Difficulty completing assignments in allotted time

_____ 22. Leaves out parts of assignments put on top, bottom, or side of board
_____ 23. Difficulty reading and completing dittoed materials
_____ 24. Difficulty reading and completing xeroxed materials
_____ 25. Uses finger or marker to guide eyes
_____ 26. Unduly sensitive to light
_____ 27. Begins writing in center of page or does not use complete line for writing
_____ 28. Unable to distinguish colors

Distance

_____ 29. Squinting or scowling when reading from board
_____ 30. Thrusting head forward or moving forward
_____ 31. Falling more frequently than other students
_____ 32. Difficulty locating wall clock from 20' distance
_____ 33. Unable to tell time when hands are on any of the larger numbers
_____ 34. Unable to tell time when hands are between larger numbers
_____ 35. Fails to see distant objects readily visible to others
_____ 36. Unable to accurately estimate locations of objects, hence, frequently runs into them
_____ 37. Walks with extreme caution, looking closely or feeling with the foot for a step up or a step down or for small obstructions

Peripheral

_____ 38. Startles when approached from side; if so, indicate which side or if from both sides
_____ 39. Frequently loses objects outside of central line of vision
_____ 40. Bumps into objects on either side
_____ 41. Turns head while traveling
_____ 42. Begins writing in center of page or does not use complete line for writing

C. Complaints Associated with Using the Eyes

_____ 43. Headaches
_____ 44. Nausea or dizziness
_____ 45. Burning or itching of eyes
_____ 46. Blurring of vision at any time
_____ 47. Words or lines running together

D. Child Complaints

____ 48. Pain in the forehead or temples
____ 49. Dizziness or nausea following close eye work
____ 50. Definite dislike of reading or other close work

E. Symptoms Based on Appearance of the Child

____ 51. Watering of eyes while reading
____ 52. Lids often red
____ 53. One eye tends to turn inward or outward when tired
____ 54. Frowning
____ 55. Excessive blinking
____ 56. Wrinkling of the forehead
____ 57. Obvious deviation of the eye in any direction

F. Behavior

____ 60. Rubs eyes frequently
____ 61. Tries to brush away a blur
____ 62. Sees the blackboard with difficulty
____ 63. Holds the book close to the eyes
____ 64. Sits with poor posture when reading
____ 65. Inattention and symptoms of fatigue while reading
____ 66. Stumbles or trips over objects
____ 67. Squints in bright light
____ 68. Continually tries different positions and angles during close work
____ 69. Shuts or covers one eye when reading
____ 70. Frequently moves book closer or further from eyes while reading

Parents and teachers have the advantage of observing a child several hours a day and, therefore, are in a position to detect vision difficulties. The following signs and symptoms of vision problems should be reported to the person responsible for referral and follow-up and considered in the assessment of the child's vision status. Any child manifesting one or more of these behaviors consistently should go through the screening process. Refer if the problem persists after discussing the problem with the parent and/or teacher, even though the child may pass the screening.

G. External Abnormalities

____ 71. Any observed problem or change in the whites, lids, lashes, pupils, or area around the eye

H. Complaints of Visual Distress

_____ 72. Sensitivity to light
_____ 73. Burning or itching of eyes or lids
_____ 74. Blurring or seeing double
_____ 75. Words or lines running together
_____ 76. Words jumping
_____ 77. Headache
_____ 78. Nausea or dizziness

I. Behaviors

_____ 79. Rubbing eyes frequently
_____ 80. Blinking frequently when reading or watching movies
_____ 81. Frowning or scowling when reading
_____ 82. Closing or covering an eye when reading or watching movies
_____ 83. Abnormal posture when doing close work
_____ 84. Squinting
_____ 85. Thrusting head forward or backward while looking at an object
_____ 86. Avoiding close work
_____ 87. Abnormally short attention span
_____ 88. Tilting head to one side
_____ 89. Placing head close to book or desk when reading or writing
_____ 90. Dislike for tasks requiring sustained visual concentration
_____ 91. Losing place while reading
_____ 92. Using finger or other devices to keep place while reading
_____ 93. Moving head rather than eyes while reading
_____ 94. Poor eye-hand coordination

J. Appearance of the Eyes

_____ 95. Eyes appear to wander when child tries to focus
_____ 96. Pupils of the eyes are of different sizes
_____ 97. Eyes that involuntarily move constantly
_____ 98. Drooping eyelids

K. Visual Behavior

_____ 99. Facial distortions, constant rubbing of the eyes, tilting of the head when seeing
_____100. Frequently changes the distance of reading material from near to far

____101. Inattentiveness during reading; cannot read for long periods without tiring; reads more poorly as time span increases

____102. Tendencies towards reversals of letters and words or confusion of letters and numbers with similar shapes

____103. Constant loss of place in a sentence or on a page

____104. Poor spacing in writing

APPENDIX C

INQUIRY RESPONDENTS

Inquiry Respondents

State	Response Date	Respondent
Alabama (AL)	05/19/86	W. Holcomb Kerns Assistant Legal Counsel Department of Public Health
Alaska (AK)	05/03/86	Rita Schmidt Chief Division of Public Health Section of Family Health Department of Health and Social Services
Arizona (AZ)	12/06/85	Elizabeth J. Field, M.P.H. Vision Program Manager Office of Maternal and Child Health Division of Family Health Services Arizona Department of Health Services
Arkansas (AR)	05/13/86	Fred R. Beggs Director Hearing, Speech, and Vision Services Arkansas Department of Health
California (CA)	11/20/85	James R. Smith Deputy Superintendent Curriculum and Instructional Leadership California State Department of Education
Colorado (CO)	05/22/86	Victoria Hertel, R.N., M.S., S.N.P. School Health Nursing Consultant Colorado Department of Health
Connecticut (CT)	10/31/85	Elaine F. Brainerd Consultant School Health Services Department of Education
Delaware (DE)	11/07/85	Edith P. Vincent State Supervisor Health Education/Services Department of Public Instruction
District of Columbia (DC)	11/20/85	Floretta Dukes McKenzie Superintendent of Schools Chief State School Officer District of Columbia Public Schools
Florida (FL)	11/20/85	Ralph D. Turlington Commissioner State of Florida Department of Education
Georgia (GA)	05/21/86	Adam Roche, Jr. Acting Program Manager Child and Adolescent Health Program Georgia Department of Human Resources

State	Response Date	Respondent
Hawaii (HI)	10/14/86	Francis M. Hatanaka Superintendent Department of Education
	04/04/88	Dorothy Colby Supervisor School Health Support Services Section Department of Health Family health Services Division School Health Services Branch
Idaho (IH)	05/13/86	Carole A. Hesse, M.P.H. Supervisor Crippled Children's Service Department of Health and Welfare
Illinois (IL)	05/20/86	Michael R. Larson, M.S. Coordinator Vision and Hearing Program Division of Health Promotion and Screening Department of Public Health
Indiana (IN)	01/28/86 05/20/86	Raymond Handley Consultant for the Visually Impaired Division for the Handicapped State Board of Health
Iowa (IA)	11/12/85	Robert D. Benton, Ed.D. Commission of Public Instruction Department of Public Instruction
	05/16/86	Paul F. Carlson Acting Commissioner of Public Health Iowa Health Department
Kansas (KS)	11/05/85	Gorin Rutherford Hearing Conservation Specialist Bureau of Community Health Department of Health and Environment
Kentucky (KY)	10/23/85	Dianne H. Caines Director Unit for Health and Psychological Services Kentucky Department of Education
	12/04/85	Kathleen Stevenson, R.N. President Kentucky School Nurses Association
Louisiana (LA)	11/06/85 05/08/86	Edia Harris Section Chief School Nurse Program Bureau of Student Services Department of Education
Maine (ME)	10/25/85	Mary E. Spencer, R. N., M.S. School Nurse Consultant Department of Educational and Cultural Service

State	Response Date	Respondent
Maryland (MD)	11/12/85	Mary K. Albrittain Chief Pupil Services Branch Maryland State Department of Education
	12/13/85	Bella Caplan, R.N., M.S. Nurse Consultant in Pediatrics Preventive Medicine Administration Department of Health and Mental Hygiene
Massachusetts	12/03/85	Cheryl Haug-Simons Project Director Health and Human Development Bureau of Student, Community, and Adult Services Department of Education
Michigan (MI)	05/20/86	Karen Schrock Chief Eastern Regional Division Bureau of Community Services Department of Public Health
Minnesota (MN)	06/13/86	Don Newman Supervisor Hearing and Vision Conservation Program Minnesota Department of Health
Mississippi (MI)	10/31/86	Charles E. Saul, Ed.D. Educational Technologist State Department of Education
Missouri (MO)	11/14/85	Marla J. Baigi Supervisor State and Federal Programs Department of Elementary and Secondary Education
	10/21/86	Arthur L. Mallory Commissioner of Education
Montana (MT)	05/19/86	Eleanor A. Parker DHES Counsel Legal Division Department of Health and Environmental Sciences
Nebraska (NB)	10/29/85	Stan Carlson Administrator School Assistance and Support Nebraska Department of Education
Nevada (NV)	06/11/86	Lisa Singer Acting Manager Special Children's Clinic Health Division Department of Human Resources
	10/14/86	Eugene T. Paslov Superintendent of Public Instruction Department of Education
	01/25/89	Dr. Kevin Crowe Director of Planning, Research, and Evaluation Nevada Department of Education

State	Response Date	Respondent
Nevada (NV) (continued)	01/25/89	Sandra Fairburn, R.N. Supervisor of Rural Nurses Health Division Nevada Department of Human Resources
New Hampshire (NE)	12/09/85	Muriel C. Desrosiers, R.N., Ed.D. FASHA School Health Consultant Special Education Bureau Department of Education
New Jersey (NJ)	11/04/85	Joel Bloom Assistant Commissioner Division of Genral Academic Education Department of Education
	12/04/85	Jane DeMaio, R.N.
	12/14/85	Education Program Specialist Bureau of Student Behavior and Development Division of General Academic Education Department of Education
New Mexico (NM)	05/22/86	Florenceruth J. Brown Deputy General Counsel Office of General Counsel New Mexico Health and Environment Department
	01/25/89	Walt Youngblood Deputy Division Director of Public Health State of New Mexico
New York (NY)	11/13/85	Arlene Sheffield Director School Health Demonstration Program Bureau of Health and Drug Education and Services The State Education Department
North Carolina (NC)	11/05/85	Tina Fisher, R.N., M.P.H. Nursing Consultant School Unit Maternal and Child Care Section Division of Health Services North Carolina Department of Human Resources
North Dakota (ND)	05/19/86	Stephen L. McDonough Director Division of Maternal and Child Health Preventive Health Section North Dakota State Department of Health
Ohio (OH)	05/28/86	James F. Quilty, Jr., M.D. Chief Division of Maternal and Child Health Department of Health
Oklahoma (OK)	10/29/85	Dean Niles Director RESC Section Oklahoma State Department of Education

State	Response Date	Respondent
Oregon (OR)	10/14/86	Les Adkins Director Student Services and Special Education Oregon Department of Education
Pennsylvania (PA)	11/05/86	Paula Hower Clausen Legislative Analyst Office of Legislative Programs Department of Health
Rhode Island (RI)	05/13/86	Estelle A. Tetreault, M.S. Specialist Health Regulations Department of Health
South Carolina (SC)	05/21/86	Maryellen Hatfield, R.N., M.N. Associate State Director Public Health Nursing Nurse-Consultant-School Health Division of Children's Health South Carolina Department of Health and Environmental Control
South Dakota	05/21/86	Carol Job Health Services Assistant Administrator Community Health Nursing Program South Dakota Department of Health
Tennessee (TN)	11/12/86	Gloria Matta Consultant Psychological Services Division of Special Programs Tennessee State Department of Education
Texas (TX)	11/12/85 04/25/86 05/20/86	Douglas K. Ozias, Ph.D. Director Vision, Hearing, and Speech Services Bureau of Maternal and Child Health Texas Department of Health
Utah (UT)	05/15/86	Jan Robinson, R.N., M.S., C.P.N.P. Child Nursing Consultant Family health Services Division Utah Department of Health
Vermont (VT)	03/18/88	Shirley M. Reid Consultant Guidance and Health Services Department of Education
Virginia (VA)	10/31/85	Jeane L. Bentley Associate Director Health, Physical Education, and Driver Education Department of Education
Washington (WA)	11/12/85	Judith A. Maire, M.N., C.R.N. Health Services Supervisor Division of Special Services and Professional Programs Office of Superintendent of Public Instruction

State	Response Date	Respondent
West Virginia (WV)	10/29/85	Lenore Zedosky Coordinator School Health Services and Health Education Office of Educational Program Development Department of Education
Wisconsin (WI)	11/04/86	C. Ernest Cooney Children's Vision Screening Specialist Division for Handicapped Children and Pupil Services Bureau for Children with Physical Needs Department of Public Instruction
Wyoming (WY)	10/28/85	Audrey Cotherman Deputy State Superintendent of Public Instruction Department of Education

APPENDIX D

LETTERS

[Sample Letter of Inquiry to States]

(DATE)

(INSIDE ADDRESS)

Dear (NAME OF ADMINISTRATOR):

Currently, I am engaged in a doctoral study at Texas Woman's University (Denton, Texas) which includes utilizing information from each state. The study incorporates references to mandatory or suggested vision screening that is provided to students in Grades 1 and 2 who are enrolled in public, private, parochial, or proprietary schools.

I will appreciate receiving information that states the conditions under which the screening is done, the instrument used, the distances used for each type of screening, power of +D lens to screen for hyperopia, and other specific information which is included in the guidelines for vision screening in your state.

If this information is more properly obtained from a different governmental agency, I would appreciate your referring this request to that agency.

In case there is a charge for receiving a copy of the material, I will immediately forward payment upon receipt of the statement.

A copy of the results of this survey may be obtained by including a request for a copy in your response. A copy will then be sent when the study is complete.

Thank you for your help.

Sincerely,

Betty Ward
706 Ridgedale
Richardson, Texas 75080
Phone: 214/783-1413 (recorder)

[Sample Letter to Superintendents]

(DATE)

(INSIDE ADDRESS)

Dear (SUPERINTENDENT'S NAME):

I am involved in research that relates to the screening of nearpoint vision. The study requires public school children in Grades 1 and 2 as subjects. In order to have the children available, the participation of school districts in ESC Region X, such as yours, is needed.

Enclosed is a resume of the study, and the complete description of it in order that you, and the members of the research committee and of the the school board, can determine what is involved. Although there is no <u>immediate</u> benefit to the subjects, the outcome of the study has the potential of benefitting all children in the future who receive nearpoint vision screening.

Texas' present time constraints within the classroom have been taken into consideration. The research design has been constructed so as to impinge as little as possible upon instructional time and classroom procedures.

If more information is needed, or wanted, please contact me at the address/phone below, or check the statement on the form.

I greatly appreciate my request being thoughtfully considered, and look forward to working with your school district in establishing the Maximum Available Desk-to-Eye Distance norms (MA-DED) for students in Grades 1 and 2.

Sincerely,

Betty Ward
Texas Woman's University
Vision screening Research Project
706 Ridgedale
Richardson, Texas 75080
(214)783-1413 (recording available)

[Sample Letter to Principals]

(DATE)

(INSIDE ADDRESS)

Dear (PRINCIPAL'S NAME):

Thank you for cooperating in my doctoral study being done at Texas Woman's University, which allows the first and second grade students in your building to be participants in the research.

Enclosed is a sample letter that the principals have been having us enclose with the letter and form sent to the parents. If you, too, would like for this, or a similar letter, to be enclosed, please return the signed letter to me, as well as the school letterhead. I will then add the proper title, etc., below your name, insert the contact phone number, format it with your letterhead, and have it printed.

We will also have prepared the number of envelopes for your enrolled students in grades 1 and 2 (plus a few extra). The material to the parents will already be inserted when the envelopes are delivered to your building. This will be done about 2 weeks before the date of measurement. This allows for any follow-up that is needed for parents who do not respond within the designated number of days.

In order to make as little time demand on the school staff as possible, we like to use a local person--perhaps from the PTA or similar organization--to help us. We offer $3.50 per hour. This can be done either as a fund-raising activity for the parent organization, or by an individual. The individual will need to deliver the envelopes to the rooms and collect the returned forms. Data from the AGR cards will need to be entered onto our form for each child. There is a column to indicate the parent's response, so that only the "yes" students will participate. This filling in of the data will need to be done before the day of measuring.

We also will want the local helper to be available to escort the students to and from the classroom and the location in the building where the measurement is being done. Our experience has been that the maximum number of students that are measured in 1 day is about 50. The number may vary according to how well the children follow the directions, and how expeditiously the children can be gotten from and returned to the classrooms. Our "yes" answers have been running about 65% of the parents solicited. This may help give you an idea of how long we need to be in your building.

Please send us the number of students you have enrolled in grades 1 and 2, the school phone number, the name of the person to contact as the helper (and how to contact her), and the signed letter that you would like enclosed with the letter and form from me.

Thank you very much for your interest in the study and your cooperation. We are looking forward to working with your students and staff.

Sincerely,

Betty Ward
Vision Screening Research Project
Texas Woman's University
706 Ridgedale
Richardson, TX 75080
(214) 783-1413 (recorder)

[Sample Follow-Up Letter to Principal]

(DATE)

(INSIDE ADDRESS)

Dear (PRINCIPAL'S NAME):

Please share my thanks with the staff and faculty members who made it possible for the students in grades 1 and 2 at Blanton to be included in the Vision Screening Research Project study.

While I also appreciate the cooperation of the parents who made it possible, I cannot contact each of them. But if the opportunity arises, please pass on my thanks to them, too.

As an expression of my appreciation, please place the fruit bowl in the lounge (lounges?) for the staff and faculty--to include all, although all did not have students who took part in the study.

My special thanks to you for making Mr. Ward feel so welcome, and being so helpful while he was there.

Sincerely,

Betty Ward
706 Ridgedale
Richardson, Texas 75080
Vision Screening Research Project
Texas Woman's University (Denton)

[Sample Letter to Teachers and Staff: Measure]

Dear Teachers and Staff:

Thank you for cooperating in my doctoral study. We are trying to have the procedure done in a way that will interrupt the least with your daily routine and activities.

The children will take home a letter and 2 copies of the parent consent form: 1 is to be completed and returned, and the other is to be kept by the parent. It is very important that ALL returned forms be kept. My field assistant, Ottis Ward, will retain all of the returned forms to be filed in our records, as is required by the University.

Your principal will be working with us to determine in which order the children will be gotten from the classrooms. A helper will come for a group of 3. We can return them in a group, or let each one return alone as his or her measurement is completed. Please let us know your preference.

A helper will have filled out the data sheets from the AGR cards. She will also keep track of which children return a form giving or denying consent for the child to be included in the study. Only those whose parents have returned a "yes" consent will be among those measured.

It will take about 15 minutes to get the children, do the measuring, and have them start to return to the classroom.

The helper will also determine who did not return any form, and will have a letter, addressed to the parents of the child, that the child is to carry home. This will be brought to your room the first day the measurements are made.

We are also providing a small reward to be given to each student who returns a form, regardless of the parent's reply. The office will have supplied us with the number of students in your classroom, so that we should have enough rewards in your package.

Individuals on the state level of the department which deals with vision screening in the schools have expressed the opinion that the information obtained by this study can have an impact on the vision screening of all school children in the future. Our thanks to you for helping make it possible.

We appreciate so much your cooperation, that of the District (and especially that of Dr. Thacker), the children, and the parents.

Sincerely,

Betty Ward
Doctoral Candidate
Texas Woman's University
Denton, Texas
706 Ridgedale
Richardson, TX 75080
(214) 783-1413 (recorder)*

*If there are any questions, please feel free to call and leave a message. I will get back with you.

[Sample Letter to Teachers and Staff: Remeasure]

Nov. 15, 1987

Dear Teachers:

Those of you who were teachers in grades 1 and 2 last year in ____________ Elementary will remember that the District took part last spring in the Vision Screening Research Project, which involves my doctoral study. We appreciated so much the cooperation of the District, the parents, and you, the teachers.

At this time, we are doing phase 2 of the study. This involves the repeat measurements of the children now in grades 1 and 2 who were among those measured last spring.

Since it does not involve all the children in your classes, the local helper will bring to your room on Wednesday, Nov. 18, letters already addressed to the parents of the children involved in the repeat measurement. It will also have the child's name on the envelope. These will need to be sent home on that day.

The children are asked to return the signed forms within 3 school days--by Monday, Nov. 23. The helper will be coming by to pick them up each day. It IS necessary that all forms returned be gotten to us: The research requires that all the forms be kept on file by us.

Because of the Thanksgiving holiday, the measurements will be done on Monday and Tuesday, Nov. 30 and Dec. 1. The procedure will be as it was last spring. The helper will come by for the next 3 students on her list, take them with her to be measured, then they will return to your room. The timing for this will be worked around your schedule. Please let the helper known your needs in regard to your schedule.

Followup letters will be sent out on Monday, Nov. 30, to those who have not returned the form sent home. (Good research design requires this.) However, in some classes, the rate of return has been 100%, so that no followups were required!

We appreciate your help and cooperation, very much. We try to have the procedure such that it will disturb your routine as little as possible.

Sincerely,

Betty Ward
706 Ridgedale
Richardson, Texas 75080
(214)783-1413

Please call if you have any questions. BW

[Sample Suggested Principal's Letter to Parents]

Dear Parents:

Our school district is cooperating in a doctoral study which is being conducted at Texas Woman's University by Betty Ward. We feel that the result of the study can be of benefit to children in the future. In order for your child to participate, we must have on file the completed form which gives your approval.

The study will require very little time during one school day, and should not cause much disruption.

If you have any questions about the study or about your child being a participant in the study, please call me at ____________________.

We encourage you to have your child take part in the study.

Sincerely,

[Sample Letter to Parent or Guardian]

(DATE)

Dear Parent or Guardian:

We are asking your permission to have your child, ___(CHILD'S NAME_____________, participate in our research study. The purpose of the study is to collect data to create norms.

The created norms will allow the distances used for vision screening to be compared to the distance children have from their eyes to the desk. These comparisons will result in a determination of whether or not a Pass or Fail on different vision screening tests can be appropriately generalized to the classroom situation for children in grades 1 and 2.

The taking of the measurement of the distance between the bridge of the nose to the desk has <u>no</u> basic risk to the child. Although there is no direct benefit to the child at the time of measuring, there is the likelihood that the study results can benefit all children who will in the future receive vision screening.

Please complete and return the attached form within the next three (3) school days.

Thank you for your cooperation.

Sincerely,

Betty Ward
Doctoral Candidate
Texas Woman's University
Denton, Texas

If there are any questions, please call (214) 783-1413, or write:

Betty Ward
Vision Screening Research Project
706 Ridgedale
Richardson, Texas 75080

[Sample Follow-Up Letter to Parent or Guardian]

Dear Parents:

Earlier this month, a letter and permission form were sent home with the students in grades 1 and 2. They were asking you to give permission for your child to be included in a doctoral study being done at Texas Woman's University by Betty Ward.

The research assistant will be at your building this week to take the measurements. I know that forms can become misplaced and not get returned to the school. So, enclosed is a copy of the material sent. Please sign the form indicating whether or not you want your child included in the group being measured. A "yes" reply must be on file in order for your child to be among those who will help create a nearpoint vision screening distance which will be applicable to classroom vision tasks.

The measurement will be of the space from their eyes to the surface of the desk. It is of no hazard to the child. Taking the measurement should take only about 5 minutes. This should be of very little disruption of the instructional time during the school day.

If there are any questions, please call me in the evening and I will be happy to discuss it with you and to answer your questions (783-1413, with recorder).

I appreciate so much your signing the form and returning it to the school tomorrow.

Sincerely,

Betty Ward
Vision Screening Research Project
Texas Woman's University
706 Ridgedale
Richardson, Texas 75080

APPENDIX E

BRIEF DESCRIPTION OF THE STUDY

Maximum Available Desk-to-Eye Distance for Students in Grades 1 and 2

Regional Norms and Statistical Comparison to Distances Used for Nearpoint Vision Screening

By Betty Ward

The distance used to screen nearpoint vision is based on the accommodation convergence/accommodation ratio (AC/A). The AC/A is the nearest point at which accommodation has been established for clear nearpoint vision. Because no norms have been established for the distance which children have available during the usual nearpoint school tasks which involve both reading and writing, there have been no studies which relate the distance of nearpoint visual screening to the distance of nearpoint school tasks.

Establishing the maximum available desk to eye distance (MA-DED) norms will provide the criteria which are needed, but at present do not exist.

The tradition of using the AC/A distance for nearpoint vision evaluation and screening has developed since the early studies around 1850 first established the distances found for the AC/A. The range for the AC/A extends well past 30 inches out from the eye. From the mean of the AC/A the standard 13-16 inches used for nearpoint vision screening has been established. The "Pass" of the nearpoint vision screening done at 13-16 inches has been generalized to mean that the child who passes the screening can handle the nearpoint visual tasks of the school environment.

According to present day research standards such a generalization would not be accepted. Studies have not been done which demonstrate the similarities of the AC/A distance and the nearpoint distance available to a student during a nearpoint academic task in the school environment. Therefore, no statistical comparisons have been made.

A review of the literature in the fields of eye care, vision screening, investigations of eye movements and other related eye-reading variables during the act of reading, and research in the field of reading has shown that there is a need to have available the norms for the MA-DED. Distance, whether controlled or not, has not been considered a variable in the studies. Often the controlled distance (even up to 47 inches) was greater than that used for nearpoint vision screening. This means that the findings cannot properly be generalized to children. Until the MA-DED norms are available for comparisons, no generalizations can properly be made to children in the lower grades.

The subjects are to be drawn from among the students enrolled in districts within the geographic boundaries of Education Service Center (ESC) Region X.

Desks and chairs will be supplied by the manufacturers of school furniture who have plants in Texas. The styles of desks shall include those with storage facilities under the desk top and above the thighs, and those without storage area above the thighs. Having storage facilities above the thighs shortens the MA-DED. Many schools use this type of desk. The desks and chairs will be of the sizes purchased for use in Grades 1 and 2, as indicated by the furniture manufacturers. Subjects are to be seated at a chair whose seat is no higher than the bend in the back of knee, and at a desk adjusted at its lowest setting. Attached to the desk will be a paper positioned as shown in the manuscript handwriting texts. The paper will be marked with a cross as the visual target.

While seated at the proper chair and desk, and holding a pencil, the subject will be shown a picture of the correct writing posture taken from the handwriting text. The subject will be told, "Sit like this, and put the pencil on the middle of the cross as if you are going to write your name." Once positioned, the subject will be shown the picture again, and asked, "Are you sitting like this?" With the subsequent posture held, the technician will place non-stretchable tape at the center of the bridge of the nose of the subject, and at the point on the paper. Retaining his hold on the tape, the technician will read the MA-DED distance in both inches and centimeters. This distance is the MA-DED distance for this subject at this desk.

Statistical comparisons will be made. Findings of no significance will allow the generalizations of the past to stand. Findings of significant differences will indicate the need for future studies, which may include the determination of new distances for nearpoint vision screening. The new distances may be based on the MA-DED findings.

A survey is being made of all the states to determine the vision screening mandated, or the guidelines for vision screening, with the distance for nearpoint screening included. Communication with the education and health departments has revealed that there is an interest in having the MA-DED information available to them. Several of the states at present have an advisory committee studying possible changes in vision screening.

The need for the MA-DED norms is readily apparent and urgent.

APPENDIX F

SUMMARY CONSENT FORM REPLY:

MEASURE/REMEASURE

Summary Consent Form Reply: Measure/Remeasure

Study Title: Maximum Available Desk-to-Eye Distance for Students in Grades One and Two: Regional Norms and Statistical Comparison to Distance Used for Nearpoint Screening

Investigator: Betty Ward, Texas Woman's University, Denton

Date Sent: __________ Please return within 3 school days.

The study involves measuring the distance between the bridge of the child's nose and the pre-positioned target on the desk. There is considered to be no risk involved to the child. However, should there be an injury to the child, Texas Woman's University is not responsible for any compensation for such injury.

I understand that all information that is obtained which can be identified with the child is to remain confidential by the name being removed from the records at the completion of the study. The result of the study may be published without identifying the child by name, but by a number only.

Participation in this research study is completely voluntary. Refusal to have my child participate will involve no penalty. When I give my consent for my child to participate in the study, I understand that I can withdraw my consent and discontinue my child's participation at any time.

I understand that I am to keep the attached copy of this form as my copy of this document. I understand that I am making a decision as to whether or not my child is to participate in this study by having the distance measured between the bridge of his/her nose and the pre-arranged target on the desk. My signature and the checked item indicate my decision after having read and understood the information.

Date ________________ Child ____________________________

I am ____ am not ____ willing for my child to participate in the research study described above.

Relationship to the child: Parent Guardian (Circle 1)

Signed: ____

APPENDIX G

INSTRUCTIONS TO LOCAL HELPERS

Instructions to Local Helpers

Data Sheets and Letters Home

1. Data sheets will be delivered on Monday. Before the forms are returned, do the following:

   A. List the students for each teacher's class on a separate data sheet. Write the teacher's name and class designation (i.e. 2C) on each. If a class requires two sheets, write the same information on each sheet, with the word "continued" also on the second sheet. Clip the two sheets together.

   B. Put the following information (gathered from the AGR or similar office file card): name, sex, birth date, grade, and ethnic group.

   In filling out the Ethnic column on the data sheets, use the prefix "L" when the student is enrolled in an ILD class.

   LA = ILD Anglo (includes European)
   LO = ILD Asian or Oriental
   LH = ILD Hispanic
   LB = ILD Black
   LL = ILD other--such as Arabic, etc.

   C. At the top fill in the date(s) the information was gathered. Sign your name in the "By" space.

2. The envelopes containing the forms for the students to take home will be delivered on Monday. These will be bound in groups of 20.

   Prepare groups of these envelopes according to the number of students in each teacher's class (Grades 1 and 2). Place a paper on the front of each group with the teacher's name written on it. Deliver the packet to the teacher. Each child is to take one home.

3. There will be a small reward furnished for each child who returns a form--whether it is blank, completed correctly or incorrectly. Count out the number of awards for each teacher's class and deliver them along with the envelope.

4. Each of the 3 school days following the forms being taken home, go by each class to collect the returned forms. ALL RETURNED FORMS, letters, etc., must be saved and turned in to Mr. Ward.

   Mark each returned form with the teacher's name and the class designation (i.e. 2C).

   Keep the forms grouped according to the teacher and class.

5. Mark the data sheet in the Parent Permission space Y or N according to the correctly filled out form. LEAVE BLANK the parent permission space when the returned form is marked incorrectly or is blank. ALL RETURNED FORMS, even those that are blank, must be saved and returned to Mr. Ward.

6. On Friday afternoon, prepare a list by student name and teacher of those students who have not returned a form. Give this information to Betty Ward by telephone (214-783-1413, recorder). Follow-up packets will be prepared for those students.

7. Follow-up packets are to be delivered to the students' teachers on the first day of measuring.

   Each envelope is to have written on it, "To the Parents of ________________" (write the student's name). The student is to take this envelope home the first day of measuring.

8. Each day of measuring, check with the teachers for additional returned forms. Mark the data sheets Y or N in the parent permission space according to #5 above.

APPENDIX H

FIGURE 2. DEMONSTRATION OF CORRECT POSTURE

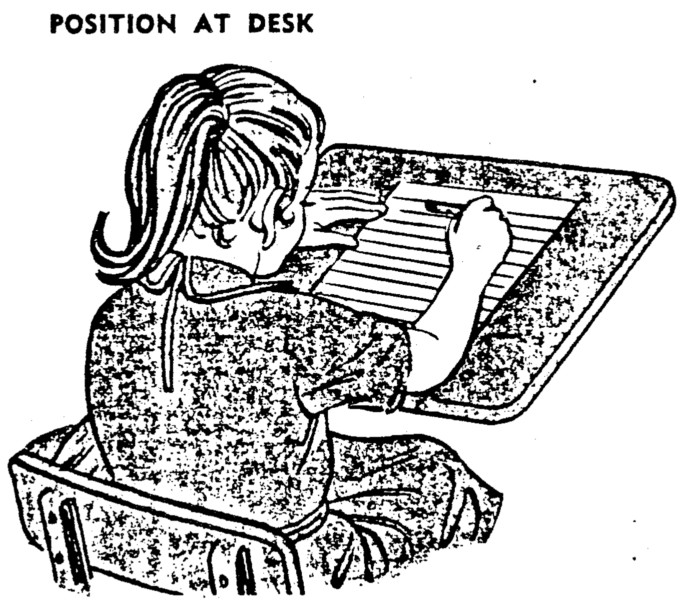

Figure 2. Demonstration of Correct Posture.

SOURCE: From Writing On, Imaginary Line Handwriting Series by R. M. Townsend, 1978, Austin, TX: Steck-Vaughn Company. Copyright 1978 by Steck-Vaughn Company. Reprinted by permission of the publisher.

APPENDIX I

FIGURE 3. SAMPLE OF TARGET CROSS

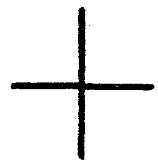

Figure 3. The Target Cross.

The page containing the target cross was affixed to each desk so that the intersection of the arms of the cross was in the measured center of the portion of the desktop above the leg space. For the side desk, this was off the center of the desktop because not all of the space under the desk was available as leg space: the storage space is located under one side of the desk top. For the across desk, the target was in the center of the desktop because all of the space was available as leg space. The desk was marked so that a replacement page, if needed, could be affixed very quickly in the same position.

APPENDIX J

PROCEDURE FOR TAKING THE MA-DED MEASUREMENT

Procedure for Taking the MA-DED Measurement

1. The helper brings a group of three subjects to the measurement location, where they are seated in the waiting area.

2. The technician introduces himself and explains the study. The explanation includes a demonstration of taking the MA-DED on himself: this is done by placing the end of the tape on the bridge of his nose and holding the tape tautly stretched downward.

3. One subject is led to the chairs and sits by turn in each whil the technician judges the best-fit chair and dictates its size and fit to the helper.

4. The best-fit chair is brought to each side desk in turn. The subject is seated with the chair positioned by the technician so that the edge of the desk is approximately half-way between the subject's knees and trunk. The technician judges the best-fit side desk and dictates the size and fit to the helper.

5. With the subject seated at the best-fit desk, the model picture is displayed, a short explanation is given, and a demonstration is made again. The subject is asked which is his or her writing hand and is given the pencil. A trial MA-DED is taken on the subject.

6. The subject is told that the real MA-DED will now be taken. All the steps are repeated. For the subjects who correctly follow the instructions of holding the pencil as if to write, seem to be sitting in a writing posture, and who remain still while the end of the tape is placed on the nose and pulled tautly to the point of the pencil placed on the target, this is the recorded MA-DED. The measurement is dictated to the helper, using the nearest 1/8 inch. This procedure is completed at the side desk before determining the best-fit across desk.

7. For the subject who has difficulty holding the pencil as if to write, a blank sheet may be placed over the target and the subject asked to write the first letter of his or her name. The subject is then told to hold the pencil in the same manner as the pencil is placed on the target.

8. For a subject who has difficulty in either following the instructions or remaining still while the measurement is taken, the display of the picture, demonstration, and instructions may be repeated up to a maximum of two times. The third time of taking the "real" MA-DED, the measurement is recorded, even if the subject is still having difficulty complying.

9. The explanation to the subjects must include the following: "Hold the pencil like you do when you write;" "Here is a picture of a girl in her very best writing position. Sit like the girl in the picture;" "Place the point of the pencil where the lines cross;" and "Sit as still as a statue while I measure the distance from the bridge of your nose to where the point of the pencil is touching the paper."

10. Each child and group is thanked and is either sent back to join their classmates or taken back, according to the plan determined for the school.

APPENDIX K

FORM FOR COLLECTION OF MA-DED DATA

SCHOOL DISTRICT ______________________

DATE DATA GATHERED ______________________ **BY** ______

STUDENT NAME Last, First	SEX B G	PAR. PER. Y/N	REPEAT MSR. √	ID NO. 1-1000	BIRTH DATE m/d/yr	AGE yr/mos	GRADE 1^1 1^2 2^1 2^2	ETHNIC GROUP Anglo As/Or Hisp. AI/NA Black	CHAIR HEIGHT 11-1/2 13-1/2 15-1/2 inches
					/ /				
					/ /				
					/ /				

TEA CATEGORY OF DISTRICT ______________________

large city, suburban, rural or small town

CHAIR FIT Yes low high	WRITING HAND R L	"SIDE" DESK HEIGHT 19-3/4 22 inches	"SIDE" DESK FIT Yes short tall	"SIDE" DESK MA-DED inches/mm	"ACROSS" DESK HEIGHT 23-5/8 26-1/4 inches	"ACROSS" DESK FIT yes short tall	"ACROSS DECK MA-DED inches/cm	DATE MSRD m/d/yr	MSRD BY
								/ /	
								/ /	
								/ /	

APPENDIX L

CRITERIA FOR MEASUREMENT LOCATIONS AND RESULTING LOCATIONS

Criteria for Measurement Locations

1. Easily accessible to students in Grades 1 and 2.
2. Out of a line of traffic.
3. Quiet.
4. Adequate lighting.
5. Equipment can be left set up overnight or for the duration of measurements.
6. Allows ease of setting up the equipment.
7. Has available additional chairs and desks for the group of children to wait and receive instruction and for the helpers to sit and write.
8. Does not disrupt the routine within the school.

Resulting Locations

1. Hallway
2. Storage room (old equipment)
3. Book room
4. Stage in the cafetorium
5. Unused classroom
6. Different classrooms during periods in a day
7. School clinic

APPENDIX M

CRITERIA FOR FIT OF CHAIR AND DESK

Criteria for Fit of Chair and Desk

Chair

The best fit chair is an appropriate fit when the chair height allows the child's thighs to rest on the chair with feet flat on the floor when seated well back in the chair. The chair fit is low when the chair height does not allow the thigh to rest on the chair when the child is seated well back in the chair with feet flat on the floor. The chair fit is high when the chair height does not allow the child's feet to be flat on the floor when seated well back in the chair.

Desk

The best fit desk is determined while the subject is seated in the best fit chair at each desk, in turn, with the edge of the desk approximately half-way between the subject's knees and the trunk of the body. In an appropriate fit, the under surface of the desk is approximately 2 inches from the surface of the thighs. In a short fit, the distance between the undersurface of the desk and the surface of the thighs is less than approximately 2 inches. In a tall fit, the distance between the undersurface of the desk and the surface of the thigh is approximately 3 or more inches.

APPENDIX N

NORMING OF THE MA-DED

Norming of the MA-DED

The MA-DED norms presented in this study were derived from the groups which participated. The sample pool was drawn from students enrolled in Grades 1 and 2 in schools within the geographic boundaries of Educational Service Center Region X in the State of Texas.

Region X serves eight counties: Collin, Dallas, Ellis, Fannin, Grayson, Hunt, Kaufman, and Rockwall. All public school districts and one parochial school within the region were invited to participate in the study. Nine public school districts and one parochial school became participants, with a total of 13 schools participating.

The Texas Education Agency (TEA) places public school districts in categories based on the Standard Metropolitan Statistical Areas (SMSA) as defined by the U.S. Bureau of the Census: Urban, Other Central, Suburban (stable in growth or fast-growing student enrollment), Non-Metro (with a town of 1,000+ population), Non-Metro (with a town of $\leq$ 1,000 population), and Rural (see Table 18, Appendix Q). The TEA does not classify or categorize the school districts according to size of enrollment, but according to the economic base of the taxing district. All seven categories of schools are found in Region X: This is not true for all

Education Service Centers in Texas. The categories used in this study are described more fully in the TEA Statistical brief SB81SAR (see Table 19, Appendix Q), October 8, 1961, which was still in use in 1986. This brief provides, among other information, data on the refined average daily attendance (ADA) and the minority percentage of the ADA. The report also provides information on the tax base.

Category 3, Suburban-Fast Growing, is represented by Coppell ISD. Both of its elementary schools took part in the study. Category 4, Suburban-Stable, is represented by the Carrollton-Farmers Branch ISD (C-FBISD), which chose to have three of its elementary schools take part in the study. Category 5, Non-Metro (1,000+), is represented by the Wylie ISD. Category 6, Non-Metro (Town) is represented by the Ferris ISD. Category 7, Rural, is represented by 5 districts which took part in the study.

There was no determination of the comparison of the parochial school, St. Phillip's, to other schools, public, private, or parochial. The TEA did not provide category information for parochial schools. St. Phillip's enrollment for kindergarten through Grade 3 is 100% minorities, with Black as the predominant ethnic group. St. Phillip's School, located in a Dallas inner-city minority neighborhood, draws students from outside the immediate vicinity.

The size of the ADA for districts may vary widely, especially in the suburbs. In Category 3, Suburban-Fast Growing, nearly 50% of the category ADA is found within one of the 10 school districts. In Category 4, Suburban-Stable, nearly 50% of the category ADA is found within 2 of the 11 districts.

The TEA does categorize the schools as to urban or suburban districts. Of the nine participating districts and the parochial school, only the parochial school is in a large urban center (Dallas). The largest of the participating districts (C-FBISD) is composed of two industrialized suburbs which have a combined population of over 60,000 people. Two of the districts (Coppell ISD and Wylie ISD) lie in the second outlying ring of Dallas suburbs, and are contiguous with suburbs that touch Dallas. These two districts are in towns which have populations of less than 15,000 people, have smaller industrial/business bases than does Dallas, and are located 20 or more miles from the center of Dallas. A fourth district (Ferris ISD) is in a town which is over 35 miles from the center of Dallas and on a major interstate highway. The remaining districts which participated in the study are in small towns, may serve one or more municipalities, and are surrounded by rural areas from which their enrollments are drawn.

In this study, 21.98% of the 1,135 subjects measured were minorities, or non-anglos. Of the 13 schools participating in the study, 3 had no minorities among the measured subjects, 1 had 100% non-anglo pupils, and 2 had over 50% non-anglo students. The other 6 schools ranged from 2.74% to 20.80% non-anglo populations.

Subjects were remeasured at two schools. Of the remeasured subjects, 30.46% were non-anglo. For Time 1, there was 15.69% non-anglos, and for Time 2 there was 61.24% non-anglos.

The minority labels used in this study were those found on the enrollment cards of the Carrollton-Farmers Branch ISD. The percentages of minorities in this study are as follow: Anglo, 78.02%; Hispanic, 10.86%; Black, 7.06%; Asian/Oriental, 3.71%; and Aleut/Native American, 0.35%.

The 1,135 subjects included 510 boys and 625 girls. There were 197 students from first grade, first semester (Grade 1^1); 381 from first grade, second semester (Grade 1^2); 194 from second grade, first semester (Grade 2^1), and 363 from second grade, second semester (Grade 2^2).

The bias toward the second semester of each grade is an outcome of the election by schools with larger enrollments to schedule the measurements later in the school year. Most schools wanted to avoid scheduling measurements at the start of the year and during the weeks preceding the administration of the statewide achievement tests. Data for the study were gathered in the months of September, October, November, January, February, and March; in the fall of 1987; and in the spring and fall of 1988.

Remeasurement was made of groups at two schools. Time 1, fall to spring, was a 4-month interval (October 1987 to February 1988). Grades 1^1 and 2^1 were remeasured in Time 1. Time 2, spring to fall, was an 8-month interval (March 1987 to November 1987). Grade 1^2 was remeasured during Time 2.

The age span established for the study had no lower limit set, in order to allow for the possibility of young ages if there were a difference of policy among the districts regarding the earliest age at which a student is allowed to enroll in Grade 1. An upper age limit was set at $<$ 10 years old. No subjects younger than 6 years, zero months were found in the study. The resulting age span is from age 6 through age 9.

No formal determinations were made of either family socioeconomic status or occupation of head of household. In the 9 participating public school districts, 6 had only one elementary school, thus ensuring that 100% of the districts' enrollments in Grades 1 and 2 was available to the study. A 7th district had two elementary schools: Both participated in the study, ensuring that inclusion of 100% of that district's first- and second-grade enrollment was available to the study. An 8th district had two elementary schools. One of them participated in the study. The largest district in the study had 3 of its 15 elementary schools take part in the study. In this last district, the administrator responsible for determining the schools to be included stated that he, on his own initiative, selected the 3 schools from that district which, in his opinion, would best represent the high, middle, and low socioeconomic and head of household levels and include regular students, students enrolled in special education, ESL (English as a second language), and LEAP (IQ $\geq$ 140 and other qualifying criteria) classes as well as mainstreamed special education and low-achieving students who received only supportive help on demand. The parochial school is located in a low-income, inner-city, minority neighborhood, and draws its students from the surrounding vicinity as well as from other areas.

The Maximum Available Desk-to-Eye Distance (MA-DED)

The MA-DED distances are indicators of the distances within which children in Grades 1 and 2 must work during their nearpoint tasks. The students need to have a reserve of accommodation and convergence while working at these distances. The MA-DED mean distances, based on linear measurement, are for each age group, each grade span, and each age group within a grade span, as well as by sex. The maximum desk-to-eye distance was selected as an indication that a child's working distance while writing is at or within this distance, and cannot be greater than the maximum distance available. The work distance while holding a book and reading at the desk is also at or within this distance.

Equipment

The equipment used for the study included chairs, desks, a pencil, the prepared target, a nonstretchable measuring tape marked in eighths of inches and in centimeters, an illustration of a child writing at a desk, and forms for recording data. The chairs of the three sizes suggested in the manufacturer's catalogues for use in Grades 1 and 2 were 11 1/2, 13 1/2, and 15 1/2 inches tall (height of seat from the floor). The fit of the chairs was recorded as yes, low, or high. Of the measured subjects, fit was recorded as yes for 96.3%, low for 0.53%, and high for 3.08%. There was no allowance made for the need of a footstool for a dwarf child; the chair fit was high for her. (See Appendix M for a description of fit criteria.)

The two styles of desks were one with across and one with side storage. The side desk had storage at the side of the work area; whereas, the across desk had storage underneath the full width of the working surface. The side desks were described in the catalogue as having lowest adjustments of 19 1/2 to 21 1/2 inches tall (height of working surface from the floor), but in actuality, the lowest possible adjustments were 19 3/4 and 22 inches. The across desks were described as being 21 1/2 and 23 1/2 inches tall, but the actual lowest adjustments were 23 5/8 and 26 1/4 inches. The fit of the desks was recorded as yes, short, or tall. Of the measured subjects, the desk fit was recorded as yes for 21.0%, short for 0.7%, and tall for 77.9%. (See Appendix M for a description of the fit criteria.)

Procedure

To construct the MA-DED table for the maximum available desk-to-eye distance at side desk and across desk, measurement of each subject was made at each style of desk using the following steps:

1. Best-fit chair was determined from among the three sizes suggested for use in Grades 1 and 2 by chair manufacturers.

2. One best-fit desk was determined from two side-storage desks, and one best-fit desk was determined

from two across-storage desks from among the sizes suggested for use in Grades 1 and 2 by desk manufacturers.

3. Each subject was seated in the best-fit chair at the best-fit desk and instructed to "sit like the child in the illustration," to hold the pencil as if to write, and to place the point of the pencil on the intersection of the target cross.

4. The illustration was shown again to the subject, and a demonstration of taking the MA-DED and a trial MA-DED measurement were made for each subject.

5. Instructions, demonstration, and trial measurement were repeated up to two additional times for subjects who were unable to follow directions or maintain the illustrated posture and pencil grasp.

6. The MA-DED measurement from the bridge of the student's nose to the placement of the pencil point on the intersecting arms of the target was taken.

7. The MA-DED was recorded on the measurement in which the subject followed the directions and held the posture and position during the measurement, or on the third time.

The means and standard deviations of the Side and Across MA-DEDs were computed for each 6-month, 1-year, 2-year, 3-year and 4-year age group. These values are presented in Table 12, Chapter IV. The values for the remeasured Side and Across means and standard deviations for grade or sex are presented in Tables 26 and 27, Appendix Q. The cells which have an n smaller than the number of variables being studied are excluded from the findings. Smaller age groups in which $n < 5$ are excluded from the findings. The subjects excluded in these findings are included in the cells for larger age spans with $n \geq 5$, thus not being lost to the study.

Cells for grade levels allowed the inclusion of all subjects (see Table 22, Appendix Q). Separate means and standard deviations for boys and girls for each grade group are given in Table 23, Appendix Q. Separate means and standard deviations for each 1-year age-by-grade group are given in Table 24, Appendix Q. Separate means and standard deviations for age-by-sex are given in Table 25, Appendix Q.

Interpretation of the MA-DEDs

The MA-DED scale has only a quantitative interpretation. It contains means and standard deviations for five age spans: 6-month (young and old 6, 7, 8, and 9), 1-year (ages 6, 7, 8, and 9); 2-year (ages 6 and 7, and 8 and 9); 3-year (ages 6 through 8 and 7 through 9); and 4-year (ages 6 through 9). The age spans include subjects of those ages who are in any one of the four grade levels: Grades 1^1, 1^2, 2^1, and 2^2 (see Table 12, Chapter IV). The scale also contains means and standard deviations for grade levels (see Table 22, Appendix Q). Each grade span includes all subjects younger than 10 years old who were enrolled in each grade level or span (1^1, 1^2, 2^1, 2^2, 1^{1+2}, 2^{1+2}, and $1^{1+2} - 2^{1+2}$). Additional scales are provided for sex by grade, age by grade, and age by sex (see Tables 24-26, Appendix Q).

Statistical Properties of the Scale

Standard Error Measurement

The standard error of measurement (se_m) is a function of the reliability coefficient and the variability of scores for a particular age group. It provides an indication of the confidence in making judgments about the true maximum available desk-to-eye distance for children of ages or in grades shown on the scale. The se_m or standard deviation (SD) indicates the limits of a band of error around a MA-DED measurement. Table 12, Chapter IV and Tables 22-25, Appendix Q present the standard deviations of the MA-DED measurements. The standard deviation of ± 1.745 for the Side MA-DED mean at age Y6 indicates that the chances are about 95 in 100 that this mean is within ± 1.745 inches of the true measurement. The true measurement is the average of measurements which would be obtained for a child if the child were measured many times and if other effects could be ruled out. The lower the standard deviation, the more reliable the measurement.

The standard deviation of the MA-DED varies across the age groups, across grade levels and spans, and across styles of desks. The range of measured means also varies across age groups, grade levels and spans, and sex for both styles of desks (see Table 12, Chapter IV and Tables 22-25, Appendix Q).

<u>Stability</u>

It is difficult to assess the reliability of the MA-DED across time because of the possible effect of physical growth. Therefore, remeasurement was made of two groups from fall to spring (Time 1), a period of 4 months, and spring to fall (Time 2), a period of 8 months, for a total of 151 children (105 anglo; 46 non-anglo) (see Tables 26 and 27, Appendix Q). Tests were made for significant differences between the means for each Time group. The absolute differences of means (in inches) for the Side MA-DED were 0.0156 (Grade 1[1]) and 0.0486 (Grade 2[1]) for Time 1 and 0.4618 (Grade 1[2]) for Time 2. The absolute differences of means for the Across MA-DED was 0.7474 (Grade 1[1]) and 0.2893 (Grade 2[1]) for Time 1, and 0.0892 (Grade 1[2]) for Time 2. The variation in the lengths of Time 1 and Time 2 was affected by the summer vacation and the end of the school year intervening in Time 2, and the measurement schedule. The schedules were arranged by the principals to be compatible with other activities at each facility.

Differences Between the Side and Across MA-DEDs

The size of the difference between the Side and Across MA-DED means which is required for statistical significance is small. An examination of the absolute difference found to be significant was approximately 1/2 inch or less in length. The dioptric equivalent of this absolute difference varies according to the distance of the target from the eyes. The linear range equivalent of the one-diopter difference between two and three diopters for the emmetrope (individual with normal vision) is 7 inches (20 to 13 inches) but is only 1/2 inch (5 to 4 1/2 inches) for the one-diopter difference between eight and nine diopters. The dioptric accommodation range required for the 2-inch reading range difference in Borish'2 (1970) 16- to 14-inch reading range is +0.34 D, but the dioptric accommodation reading range required for the 2-inch difference between 6 and 4 inches is 3.34 D (Hurst, 1964).

Intercorrelation with Other Measurements

There have been no other measurements made of the maximum available desk-to-eye distance for children in Grades 1 and 2. Hurst (1964) determined the working distances of children in Grades K-8 when writing and when reading a book at their desks. It is not appropriate to compare the maximum available distance to the working distance.

General Measuring Considerations

The MA-DED was developed for use with children aged 6 through 9, or in Grades 1 and 2. The scale might also be applied, however, to children in grades other than Grades 1 and 2 or of ages other than 6 through 9 when both the height and weight of the individual falls within the height and weight norms of children in Grades 1 and 2 or the height and weight norms of children aged 6 through 9. This could be considered because the child would be of a size or physique similar to that of the target population. The study cited a child's size or physique as affecting the size of best-fit chair and desk, which in turn was considered to affect the maximum available desk-to-eye distance.

Standard Procedures

When the MA-DED is to be made for a child in Grades 1 or 2 or of an age within the 6 to 9 year span, the conditions should be the same in regard to the placement of the target, type of target, and the presentation of an illustration depicting writing posture appropriate for the style of writing being used in the classroom. The intention of the MA-DED scale is to provide a minimum standard against which near viewing distances used in designing investigations which employ reading or writing at a desk, screening vision, or examination of vision and determination of possible optical aids may be compared. In the case of examination and determination of optical aid, however, it may be most appropriate to determine the individual's working distance at his or her school desk and employ that distance in evaluating the need for optical aid for near distance work.

Intended Use of the MA-DED

The MA-DED scale provides a standard that can be used to determine whether the near viewing distances used in past investigations and norms of visual elements were appropriate for Grades 1 and 2 and ages 6 through 9 years. If the difference between the viewing distance used and the MA-DED for a given age or grade is significant, there is a need to establish norms of the visual element using a distance no greater than the maximum available desk-to-eye distance for the given age or grade. The availability of the MA-DED scale also provides one standard for near viewing distance that can be utilized in designing reading experiments. A MA-DED might be the only viewing distance used, or one of several reading distances used in replication of earlier studies which incorporated greater reading distances, with the intention to determine if the same findings will result at viewing distances equal to, shorter than, or longer than the appropriate MA-DED.

Validity of the MA-DED

The internal validity of the study was viewed in terms of an individual's desk-to-eye distance being different for Side and Across MA-DEDs and not in terms of the significance between the means. In the raw data, 21 of the 1,135 subjects had no difference between the Side and Across MA-DEDs, and 110 subjects had an Across MA-DED which was longer than the individual's Side MA-DED.

The time lapses for Time 1 and Time 2 were not the same, although each group had the remeasurement made the semester immediately following the semester of measure. Time 1 was fall to spring, a period of 4 months. Time 2 was spring to fall, a period of 8 months across the summer vacation and the end of the school year.

External validity could not be controlled. It is felt, however, that the external validity is good due to the procedure followed:

1. All public school districts within the geographic boundaries of Education Service Center Region X were invited to become participants.

2. All elementary schools within a participating district were eligible to become participants.

3. Parents of all students enrolled in Grades 1 and 2 in the participating schools were asked to grant permission for their children to become participants.

4. A parochial school in an inner-city neighborhood was included in the study.

5. No educational placement excluded a student as a subject.

6. No lower age limit was set, and the upper age limit (< 10 years) was set high enough to include retained students.

7. There was representation of each of the five ethnic groups.

Therefore, it is felt that each student enrolled in the public schools within the geographic boundaries of Region X had equal opportunity to become a subject in the study. The inclusion of all students given permission to participate indicates that the findings may be generalized to the larger target population of students who are enrolled in Grades 1 and 2, or are of the ages of the subjects, that is, 6 through 9 years of age.

APPENDIX O

LEGEND OF ACRONYMS

Legend of Acronyms in Tables

1^1 = Grade 1, first semester
1^2 = Grade 1, second semester
2^1 = Grade 2, first semester
2^2 = Grade 2, second semester
@ = about, approximately
/ = or
+D = plus diopters
AA = all ages
AC = all children
ANY = any grade
AR = administrative rule
ARP = all students with reading problems
BC = with behavior change
CB = complete battery
CH = local choice
D_A = diopter equivalent of Across MA-DED
D_{AFL} = sum of D_A and D_{FL} lens to screen for hyperopia
DE = driver's education
D_{FL} = lens used to screen for hyperopia
DGG = failed screening, but didn't get glasses
D_S = diopter equivalent of Side MA-DED
D_{SFL} = sum of D_S and D_{FL} lens to screen for hyperopia
EG = even grades
FL = fogging lens: used to screen for hyperopia
FPS = failed past screening
FSLY = failed screening last year
G = guidelines
GNS = grade not specified
HR = high risk cases
HRM = high risk: mentally retardation, Down's Syndrome, cerebral palsy, deafness, diabetes
K = kindergarten
L = legislated
LD = learning disability
LP = learning problems, including dyslexia or reading difficulties
M = mandatory
MA-DED = maximum available desk-to-eye distance
MCT = modified clinical technique
MEM = monocular estimate method of retinoscopy
MVT = Massachusetts Vision Test
N = no
NE = new enrollees

NI = not implemented
NPSE = nonpublic, certified regular, or special education facility
NPVS = near point vision screening
NS = not specified
NSHI = no screening of hyperopia indicated
OG = odd grades
P = by policy
PNS = power not specified
R = recommended
RG = by regulations
RPG = repeating a grade
RT = referred by teacher
SC = special conditions
SE = special education
SF = scholastic failure
SN = Snellen, far only
SP = special populations
R = self-referred
T1 = Time 1 (4 months) remeasured Grade 1^{1} and 2^{1}
T2 = Time 2 (8 months) remeasured Grade 1^{2}
TDNPVS = target distance used for nearpoint vision screening
TWR = if trouble with reading
UG = ungraded classes
VSM = vision screening machine
WG = wear corrective lenses (glasses)
Y = yes
YR = years of age

APPENDIX P

REPLY AND RESPONSE FORMS

[Principal's Reply Form]

Maximum Available Desk to Eye Distance (MA-DED) Research

School ____________________ Principal ______________

School District ______________ School Phone ____________

Scheduled measurement date _____________________________

Number of 1st graders _____ No. of Classrooms (1st) _____

Number of 2nd graders _____ No. of Classrooms (2nd) _____

Name of persons to contact concerning employment as helper:

______________________________ Phone ______________

______________________________ Phone ______________

Location for the 4 desks and 3 chairs to be used for the measurement of the MA-DED:

____

____

____

We would like to borrow 4-5 chairs or desks to use for the helper, the Field Assistant, and the children to sit in while they are waiting.

Address of the building, and directions for getting there:

____

____

____

____

Thank you for your help and cooperation.

Betty Ward
Doctoral Candidate
Texas Woman's University
Denton, Texas
706 Ridgedale
Richardson, TX 75080
(214) 783-1413 (recorder)

School: 323-6600 or 6601
call can be
returned after
3:45 p.m.

[Principal's Response Form]

Date______________________

The ____________________________ School District
(please check the ones which apply)

_____will be a participant in the MA-DED study.

_____wants more information on the MA-DED study.
Please contact by _____ mail _____ phone

Name____
Address____
____

Phone _____-____________________

_____contact the following persons to schedule the MA-DED study in the buildings: Grades 1 and 2

Name_____________________________Title_________________
School____
Address____
____

Phone _____-____________________

Name_____________________________Title_________________
School____
Address____
____

Phone _____-____________________

Name_____________________________Title_________________
School____
Address____
____

Phone _____-____________________

Name_____________________________Title_________________
School____
Address____
____

Phone _____-____________________

_____ will not be a participant in the MA-DED study.

APPENDIX Q

TABLES

Table 16

Inquiry Responses, 1985-86: Near Tests and Target Distances

Test	Distance (in inches)	State	N
Corneal Light Reflection	DNS	GA,MO[a],NC	3
	12-13	TX[a]	1
	12-18	CO	1
	13	MI	1
	@13	MD	1
	13-14	FL[a]	1
	13-16	LA	1
	at arm's length (14-16)	KS,MN	2
Cover/Uncover Cover Alternating Cover	DNS	GA,MO[a],NH[a],TX[a]	4
	reading position[d]	CA	1
	12	NC	1
	12-18	CO	1
	13	LA	1
	13-14	Fl[a]	1
	14	DE,NJ[a],NM	3
	@14	MD	1
	14-16	MI	1
	at arm's length (14-16)	MN	1
	14-20	KS	1
	15	OH	1
	15-18	DC	1
	16	TN	1
	at reading distance	SC	1
Muscle Balance	DNS	AR,DE,IL,NH,NJ[a],NC, PA,TX[a],VT,WV	10
	14	NM	1
	16	OH	1

(table continues)

Table 16--continued

Test	Distance (in inches)	State	N
Near Acuity	DNS	AZ[a],CO,MI,VT,WV	5
	12-14	OH	1
	13-16	KS	1
	14/16	TN	1
Near Phoria	DNS	IL,TX[a],VT	3
	16	OH	1
	at reading distance	MI	1
Near Point Accommodation	14[a]	CA	1
Near Point Convergence	5-8[a]	NH	1
	10[c]	CA[a]	1
	12-16[c]	KS	1
	13-16[c]	LA	1
Plus Diopter Fogging Lens	far distance	AZ,AR,CA[ah],CO,DE FL,Il,IN,KS[h],LA, MD[h],MA[h],MI,MN[ah],MS, NE[a],NH,NJ[ah],NM[a],NY[i], OH[h],PA[h],SC[h],TN,TX[a], VT,WY	27
Strabismus	average reading distance	AZ	1
Titmus Fly	DNS	AZ,CO,NM,TN	4
	16	DE,KS	2
	@16	MD	1

(table continues)

Table 16--continued

Test	Distance (in inches)	State	N
Worth Dot Test	DNS	KS,NJ[a]	2
	13-16	TN	1
	@14	DE	1
	14-16	MD	1
	60[a]	MN	1
	intermediate distance[e]	TN	2
Vision Screening Machine[g]		AZ[a],AR,CT[a],DE[ah], FL[ah],GA[ah],HI[h],IL, KS[ah],LA,MD[ah],MA, MI[a],MN[ah],MO[ah],NH[a], NJ[ah],NC,ND,PA[a],TN[a], TX[a],VT[a],WV[a]	24

NOTE: [a]Optional; [b]Criteria near distance; [c]Starting distance, move inwards; [d]Distance and angle not specified; [e]No equivalent distance given; [f]Near distance varies among screening machines; [g]Some states limit use to far setting; [h]Limited as to age and grade; [i]After passing far tests.

Table 17

Inquiry Responses (1985-86): Status of Vision Screening

State	Status of Vision Screening	Near Tests	Grades Screened	Special Population(s)	Special Condition(s)
AK	L[a]	NS	---	---	---
AL	L,P	NS	AC	---	---
AR	RG,G	Y	NI	---	---
AZ	R,G	Y	K/1 3,4,6,8 10,12	SE	LD
CA	L,G	Y	K/1 3,6,9/10	---	NE,RT
CO	L,G	Y	K-2 3,5,7,9	SE	NE,RT RPG,DGG HR
CT	L	N	K-6,9	---	---
DC	NS,G[b]	Y	K,1,3,6 8,10,UG	---	NE,RT
DE	NS,G[b]	Y	K/1,3/4 5,8,10/11	SE	NE,RT DE
FL	L,G[b]	Y	K-3,5/6 7/8,9/10 11/12	---	NE,RT BC,LD
GA	L,G[b]	Y	M:(K/1) R:(3) 5/6,8/9 10/12	---	NE
HI	L,G[b]	N	K-3,4-6 7,10	SE	---

(table continues)

Table 17—continued

State	Status of Vision Screening	Near Tests	Grades Screened	Special Population(s)	Special Condition(s)
IA	CH	CH	---	---	---
ID	R,G[a],CH	NS	1,3,5,7 9,11	---	NE,RE RT,RS
IL	L,G[b]c	Y	(K/1,5,9)[e]	SE[e]	NE,RT
IN	L[b],G	MCT[b]	1,3,8	---	NE,RT
KS	L,G[a]	Y	K-1,3,5 7,9,11	SE	NE
KY	RG	CH	K/1	---	NE
LA	L,G[b]	Y	K,1,3,5 7,9,11	---	RT,NE
MA	L,G[b]	Y[b],MVT	K-4,6 (7,9,11) or (8,10,12)	---	NE,SE RT,BC
MD	L,G	Y	K/1,4 5/6,9	NPSE	NE,SE
ME	L,G[b]	NS	K,1,3,5 7,9,11[e]	---	RT,NE RS
MI	L,G[b]	Y	1,3,5,7 (9-11)/DE SN:EG	---	SRD
MN	R,G[b]	Y	K,1,3-5 7,10	SE	NE,HR
MO	R,G[b]	NS	K,1,3,5 7,(9-11)10	SE	NE,RT

(table continues)

Table 17—continued

State	Status of Vision Screening	Near Tests	Grades Screened	Special Population(s)	Special Condition(s)
MS	RG,G,CH	CH	1, 4CH R:(1-12)	—	—
MT	R[b],CH	NS	CH	—	—
NC	L,P,G	Y	K-3 5,8,11	—	RT
ND	R	Y	K-6	DE	NE,RT LD,BC
NE	L	NS	AC	—	NE,RT
NH	R,G[b]	Y	K-12	—	—
NJ	R,G,[ab],CH	Y[d]	K/1,2,5 8,10/11	DE	LP,HR,RT NE,SF
NM	R,G	Y[b]	K,(6-12)[e] SN:(1-5	SE	NE
NV	L[b],CH	CH	K,4,7,8 10	SE,NE	RT,FSLY RPG,NE
NY	L,G[b]	NS	K-12	DE,SE	SR,NE,RT HR,LP
OH	L,G[b]	Y	R:([K/1]/3) 5,7,9	—	RT,NE
OK	CH	CH	—	—	—
OR	AR,G	N	K-8,10,12	—	—
PA	L,G,CH	Y	AC	—	ARP
RI	L,G	Y	AC	—	RT,NE

(table continues)

Table 17—continued

State	Status of Vision Screening	Near Tests	Grades Screened	Special Population(s)	Special Condition(s)
SC	R,G	Y	K,OG	SE	NE,RPG,PB FPS,HR
SD	CH	CH	CH	---	---
TN	L,G	Y	K,1-3[g] 4-8[h]	---	---
TX	L,G[b],AR	R	K/1,3,5 7,9	SE	NE,RT
UT	L,RG	N	R:(K,3,7) O/DE	DE,SE	RR,ARP
VA	L,R,G	N	R:(K,3,7 10)	---	NE,RT
VT	L,G[b]	Y	K-3,5,7 9/10	SE	SR,HR,NE RPG,FSLY RT,WG
WA	L	N	K,1,3,5 7,10	---	NE,RT
WI	L,AR,CH	NS	K-2,5,8 10/11	DE	SF,NE,RT RPG,HRM,LP
WV	L,R,G[b]	Y[b]	R:(1,2,3 5,7,10)	SE	NE
WY	R[be]	NS	P,1-2	---	---

NOTE: [a]Not yet funded or implemented; [b]Optional; [c]Limited as to age and/or grade; [d]Chicago's version accepted; [e]Students enrolled in public, private, parochial, or independent schools; [f]Recommended; [g]Sent only proposed changes.

AC = all children; AR = administrative rule; ARP = all students with reading problems; BC = with behavior change; CB = complete battery; CH = local choice; DE = driver's education; DGG = failed screening, didn't get glasses; EG = even-numbered grades; FPS = failed past screening; FSLY = failed screening last year; G = guidelines; HR = high risk cases; HRM = high risk: mental retardation, Down's syndrome, cerebral palsy, deafness, diabetes; K = kindergarten; L = by legislation; LD = learning disabiltiy; LP = learning problems, including dyslexia or reading difficulties; MCT = modified clinical technique; MVT = Massachusetts Vision Test; N = no; NE = new enrollees; NI = not implemented; NPSE = nonpublic, certified regular or special education facility; NS = not specified; OG = odd-numbered grades; P = by policy; PB = premature birth; R = recommended; RG = by regulations; RPG = repeating a grade; RT = referred by teacher; SC = special conditions; SE = special education; SF = scholastic failure; SN = Snellen, far only; SR = self-referred; UG = ungraded classes; Y = yes; WG = wears glasses; > = older than; / = or; - = through.

Table 18

Excerpts from TEA Statistical Brief SB81SAR:

Annotated Definitions of Terms

Category Number	District Category	Description
1	Major Urban	The largest school district(s) located within the central city of each of the state's six largest Standard Metropolitan Statistical Areas (SMSA's), (i.e. Austin, Corpus Christi, Dallas/Fort Worth, El Paso, Houston, and San Antonio). SMSA's are defined by the U. S. Bureau of the Census.
2	Other Central City	Districts which are considered by TEA to be the "most central" to the state's remaining SMSA's.
3	Suburban-Fast Growing	Generally, suburban districts of 1,000 or more refined ADA which grew at least five percent (5%) from 1970-75 and some smaller suburban districts which displayed rapid growth for the same period.
4	Suburban-Stable	Suburban districts which are similar to those in the previous category but which do not demonstrate high ADA growth rates.
5	Non-Metro With 1000+ ADA	Districts which have 1,000 or more refined ADA and which are not included in the previous categories.

(table continues)

Table 18--continued

Category Number	District Category	Description
6	Non-Metro With Town	Districts which have less than 1,000 ADA and which encompass a town having a population of approximately 1,000 or more.
7	Rural	Districts which have less than 1,000 ADA and which have no central town within their boundaries.

Table 19

Participating Public Schools: Texas Education Agency Category Analysis, 1985-86

Name of School District (ISD)	TEA Category[a]	Refined Average Daily Attendance	Percentage of Minorities	Highest Tax Category[b]	Density[c]	Number of Participating Schools
Carrollton-Farmers Branch	Suburban--Stable	13,389	20-30	business	100+	3
Celeste	Rural	369	< 10	land	5-20	1
Community (Nevada)	Rural	747	10-20	resident	20-100	1
Coppell	Suburban--Fast Growing	1,554	10-20	land	20-100	2
Ferris	Non-metro (town)	1,061	50-75	resident	5-20	1
Pottsboro	Rural	862	< 10	resident	5-20	1
S and S Consolidated (Southmayd and Sadler)	Rural	589	< 10	oil & gas	< 5	1

(table continues)

Table 19--continued

Name of School District (ISD)	TEA Category[a]	Refined Average Daily Attendance	Percentage of Minorities	Highest Tax Category[b]	Density[c]	Number of Participating Schools
Savoy	Rural	289	< 10	business	5-20	1
Wylie	Non-metro (1,000+ ADA)	1,777	< 10	resident	20-100	1

NOTE: [a]See Table 18, Appendix Q for a description of TEA categories; [b]As determined by the State Property Tax Board; [c]Number of students per square mile.

Table 20

Participating Parochial School

Name	Enrollment	Minority Percentage	Density (City)[a]	Grades Taught
St. Phillip's School	116	100[b]	100+	Preschool 1 - 3

NOTE: [a]Based on Texas Education Agency report for the City of Dallas, Texas.

[b]The minority percentage for the City of Dallas is 75+.

Table 21

Description of Equipment Used in the Study

Chair	Desk
American Desk Manufacturing Company Temple, Texas 76501	
0506-F20-13-DOO Quadraline 11 1/2"	1308-W02-10-D-00 Jr. Exec. Adj. RH 22-29" side book box
0506-F50-13-D-00 Quadraline 13 1/2"	1107-LOD-00-V-00 Open Front 22-29" Quadraline Open Front
1610-ARD-13-D-DO Student Chair Duraline 15 1/2"	1020-WOO-23-D-00 Utility Table 23 in. Non-adjustable walnut
Carter Craft Division Smith System Manufacturing Company P. O. Box 415, Plano, Texas 75074	
SMO2001 (15 1/2")	SMO1310 RH
SMO2002 (13 1/2")	SMO1330 21-29" Side Book Box
SMO2003 (11 1/2")	SMo1330 21-29" Open Front

Table 22

Maximum Available Desk-to-Eye Distance (MA-DED) Means by Grade and Desk Style

Grade Level	Side Desk			Across Desk		
	N	Mean	SD	N	Mean	SD
			Single Semester			
1^1	197	12.749	1.453	197	11.619	1.572
1^2	381	13.456	1.774	381	11.493	1.627
2^1	194	13.308	1.358	194	12.384	1.576
2^2	363	14.441	1.704	363	12.305	1.640
			Full Grade			
1^{1+2}	578	13.215	1.665	578	11.536	1.608
2^{1+2}	557	14.046	1.584	557	12.333	1.618
			Total			
1^{1+2} + 2^{1+2}	1,135	13.623	1.625	1,135	11.927	1.613

Table 23

Maximum Available Desk-to-Eye Distance (MA-DED) Means by Sex, Grade, and Desk Style

Grade Level	Side Desk			Across Desk		
	N	Mean	SD	N	Mean	SD
			Boys			
1^1	73	12.673	1.24	73	11.505	1.45
1^2	180	13.305	1.82	180	11.389	1.69
1^{1+2}	253	13.122	1.65	253	11.423	1.62
2^1	79	13.231	1.44	79	12.405	1.58
2^2	178	14.287	1.76	178	12.209	1.72
2^{1+2}	257	13.460	1.66	257	12.270	1.68
1-2	510	13.545	1.66	510	11.851	1.65
			Girls			
1^1	124	12.693	1.56	124	11.607	1.64
1^2	201	13.598	1.74	201	11.609	1.56
1^{1+2}	325	13.253	1.67	325	11.608	1.59
2^1	115	13.371	1.32	115	12.388	1.60
2^2	185	14.625	1.68	185	12.414	1.62
2^{1+2}	300	14.144	1.54	300	12.404	1.61
1-2	625	13.681	1.61	625	11.990	1.60

Table 24

Maximum Available Desk-to-Eye Distance (MA-DED) Means by Age, Grade, and Desk Style

Grade(s)	Side Desk N	Side Desk Mean	Side Desk SD	Across Desk N	Across Desk Mean	Across Desk SD
			Age 6			
Grade 1[1]	113	12.600	1.45	113	11.502	1.68
Grade 1[2]	153	13.134	1.66	153	11.076	1.63
Grade 2[1a]	---	---	---	---	---	---
Grade 2[2a]	---	---	---	---	---	---
All	268	12.911	1.59	268	11.259	1.66
			Age 7			
Grade 1[1]	79	12.866	1.42	79	11.736	1.39
Grade 1[2]	196	13.599	1.79	196	11.800	1.54
Grade 2[1]	120	13.138	1.35	120	12.266	1.51
Grade 2[2]	151	14.205	1.64	151	11.965	1.71
All	546	13.599	1.67	546	11.939	1.57
			Age 8			
Grade 1[1a]	---	---	---	---	---	---
Grade 1[2]	29	14.246	1.86	29	11.793	1.62
Grade 2[1]	67	13.593	1.37	67	12.599	1.70
Grade 2[2]	196	14.654	1.66	196	12.543	1.58
All	297	14.326	1.70	297	12.447	1.63
			Age 9			
Grade 1[1]	---	---	---	---	---	---
Grade 1[2a]	---	---	---	---	---	---
Grade 2[1a]	---	---	---	---	---	---
Grade 2[2]	15	14.033	2.73	15	12.691	1.82
All	24	13.797	2.62	24	12.266	2.00

NOTE: [a]No central tendency statistics available; fewer than 10 children.

Table 25

Maximum Available Desk-to-Eye Distance (MA-DED)

Means by Age, Sex, and Desk Style

Age	Side Desk N	Side Desk Mean	Side Desk SD	Across Desk N	Across Desk Mean	Across Desk SD
6 Years						
Boys	107	12.833	1.46	107	10.896	1.60
Girls	161	12.965	1.62	161	11.493	1.65
Total	268	12.911	1.59	268	11.259	1.66
7 Years						
Boys	224	13.415	1.60	224	11.882	1.53
Girls	322	13.661	1.58	322	11.986	1.57
Total	546	13.599	1.67	546	11.939	1.57
8 Years						
Boys	163	14.236	1.63	163	12.385	1.63
Girls	134	14.434	1.54	134	12.528	1.55
Total	297	14.326	1.70	297	12.447	1.63
9 Years						
Boys	16	13.055	2.72	16	12.196	2.17
Girls	8	15.281	1.26	8	12.406	0.43
Total	24	13.797	2.62	24	12.266	2.00

Table 26

Remeasured Maximum Available Desk-to-Eye Distance (MA-DED) Means by Sex and Desk Style

Sex	Side Desk			Across Desk		
	N	Mean	SD	N	Mean	SD
			Time 1 and Time 2			
Boys	66	12.939	1.47	66	11.941	1.66
Girls	85	13.154	1.56	85	11.878	1.64
Both	151	13.060	1.52	151	11.906	1.65

Table 27

Remeasured Maximum Available Desk-to-Eye Distance (MA-DED) Means by Grade and Desk Style

Grade	Side Desk			Across Desk		
	N	Mean	SD	N	Mean	SD
			Time 1			
1^1	48	12.518	1.51	48	11.326	1.70
2^1	54	13.220	1.21	54	12.234	1.42
$1^1 + 2^1$	102	12.890	1.35	2	11.807	1.55
			Time 2			
1^2	49	13.416	1.70	49	12.112	1.71
			Time 1 and Time 2			
$1^1 - 2^1$	151	13.060	1.52	151	11.906	1.65

Table 28

Linear Range of Emmetropic Clear Vision for Given Accommodation, With No Reserve

Plus Diopters Accommodation	Plus Diopters ± .25 Range	Linear Range Centimeters	Linear Range Inches
1.00	0.75-1.25	133.00-80.00	52.49-31.50
1.25	1.00-1.50	100.00-66.67	39.37-26.25
1.50	1.25-1.75	80.00-57.14	31.50-22.50
1.75	1.50-2.00	66.67-50.00	26.25-19.69
2.00	1.75-2.25	57.14-44.44	22.50-17.50
2.25	2.00-2.50	50.00-40.00	19.69-15.75
2.50	2.25-2.75	44.44-36.36	17.50-14.32
2.75	2.50-3.00	40.00-33.33	15.75-13.12
3.00	2.75-3.25	36.36-30.77	14.32-12.11
3.25	3.00-3.50	33.33-28.57	13.12-11.25
3.50	3.25-3.75	30.77-26.67	12.11-10.50
3.75	3.50-4.00	28.57-25.00	11.25- 9.84
4.00	3.75-4.25	26.67-23.53	10.50- 9.26
4.25	4.00-4.50	25.00-22.22	9.84- 8.75
4.50	4.25-4.75	23.53-21.05	9.26- 8.29
4.75	4.50-4.00	22.22-20.00	8.75- 7.87
5.00	4.75-5.25	21.05-19.05	8.29- 7.50

(table continues)

Table 28--continued

Plus Diopters Accommodation	Plus Diopters ± .25 Range	Linear Range Centimeters	Linear Range Inches
5.25	5.00-5.50	20.00-18.18	7.87- 7.16
5.50	5.25-5.75	19.05-17.39	7.50- 6.85
5.75	5.50-6.00	18.18-16.67	7.16- 6.56
6.00	5.75-6.25	17.39-16.00	6.85- 6.30
6.25	6.00-6.50	16.67-15.38	6.56- 6.06
6.50	6.25-6.75	16.00-14.81	6.30- 5.83
6.75	6.50-7.00	15.38-14.29	6.06- 5.62
7.00	6.75-7.25	14.81-13.79	5.83- 5.43
7.25	7.00-7.50	14.29-13.33	5.62- 5.25
7.50	7.25-7.75	13.79-12.90	5.43- 5.08
7.75	7.50-8.00	13.33-12.50	5.25- 4.92
8.00	7.75-8.25	12.90-12.12	5.08- 4.77
8.25	8.00-8.50	12.50-11.76	4.92- 4.63

Table 29

Inquiry Responses (1985-86), Screening for Hyperopia by State: Fogging Lens Power at Given Grade(s) or Age(s)

State	Fogging Lens Power	Grade(s)	Age(s)
AL	NHSI	---	---
AK	NHSI	---	---
AR	1.75	NS	NS
AZ	1.75	K-1[a]	NS
CA	1.00	9-12	NS
	1.50	6-8	NS
	2.00	1-5	NS
	2.25	K	NS
CO	PNS[b]	NS	NS
CT	NHSI	---	---
DE	1.75	3-up	NS
	2.25	K-2	NS
DC	NHSI	---	---
FL		1.75-2.25	NS
	2.00	2-up	NS
GA	SM-PNS	NS	NS
HI	NHSI	---	---
ID	NHSI	---	---
IL	1.75	K/1,5,9	NS
IN	NHSI	---	---
IA	NHSI	---	---
KS	1.75	4-up	NS
	2.25	K-3	NS
KY	1.75	---	---
LA	1.50/1.75	NS[c]	NS
ME	NHSI	---	---
MD	1.75	NS	after age 7[d]
	2.25	NS	after age 7[d]
MA	1.75	4-up	NS
	2.25	K-3	NS
MI	1.75	1-12	NS
MN	1.75	4-up	NS
	2.25	1-3	NS
MS	2.00	NS	AA
MO	NHSI	---	---
MT	NHSI	---	---

(table continues)

Table 29--continued

State	Fogging Lens Power	Grade(s)	Age(s)
NE	PNS	NS	NS
NV	PNS	NS	NS
NH	1.50-2.50	1-4,8 10,12	NS
NJ	PNS[e]	NS	NS
NM	2.25	1-12	NS
NY	2.25	1	NS
NC	SM-PNS	NS	NS
ND	NHSI	---	---
OH	2.00	1/3	NS
OK	NHSI	---	---
OR	NHSI	---	---
PA	2.25	K-2	NS
RI	---	---	---
SC	1.75	K/1	NS
SD	NHSI	---	---
TN	1.75-2.25	NS	NS
TX	SM-PNS[b]	NS	---
UT	NHSI	---	---
VT	2.25	K-3	---
	1.75	4-up	---
VA	NHSI	---	---
WA	NHSI	---	---
WV	SM-PNS	3-up	NS
WI	NHSI	---	---
WY	PNS	any, if trouble with reading[b]	ns

NOTE: AA = all ages
NHSI = no hyperopia screening indicated
NS = not specified
PNS = +D power not specified, but hyperopia screening is indicated
SM-PNS = screening machine, +D power not indicated
[a]special education students at all grade levels
[b]optional
[c]failure criteria varies according to grade
[d]do not repeat once determined and recorded
[e]reported as near-vision score
[f]referred by teacher, any grade

Table 30

Inquiry Responses (1985-86): Hyperopia Screening by Grade, Age, Special Conditions or Populations, States, and Frequency

Grade	Age	Special Conditions or Populations	Fogging Lens Power +D	States	N
K	NS	NS	2.25	CA[a]	1
K/1	NS		1.75	IL[a],SC	2
K-1	NS	SE-AG	1.75	AZ	2
K-2	NS	NS	2.25	DE[a],PA	2
K-3	NS	NS	2.25	KS[a],MA[a] VT[a]	2
K-12	NS	NS	2.25	NM	1
1	NS	NS	2.25	NY	1
1/3	NS	NS	2.00	OH	1
1-3	NS	NS	2.25	MN	2
1-5	NS	NS	2.00	CA[a]	1
1-12	NS	NS	1.75	MI	1
2-up	NS	NS	2.00	FL[a]	1
3-up	NS	NS	1.75	DE[a]	1
3-up	NS	NS	VSM-PNS	WV	1
4-up	NS	NS	1.75	KS[a],MA[a] MN[a],VT[a]	4

(table continues)

Table 30--continued

Grade	Age	Special Conditions or Populations	Fogging Lens Power +D	States	N
5,9	NS	NS	1.75	IL[a]	1
6-8	NS	NS	1.50	CA[a]	1
9-12	NS	NS	1.00	Ca[a]	1
ANY[c]	NS	ITWR[c]	PNS	WY	1
NS	> 7[b]	NS	1.75	MD[a]	1
NS	> 7[b]	NS	2.25	MD[a]	1
NS	NS	NS	PNS,O	CO	1
NS	NS	NS	PNS	NE,NV,NJ[d]	3
NS	NS	NS	1.75-2.25	FL[ae],TN	2
NS	NS	NS	1.50-2.50	NH	1
NS	NS	NS	1.75	AR	1
NS	NS	NS	2.00[d]	MS	1
NS	NS	NS	1.50/1.75[f]	LA	1
NS	NS	NS	VSM-PNS	GA,NC	2
NHSI	NHSI	NHSI	NHSI	AL,AK CT,DC HI,ID IN,IA KY,ME MO,MT ND,OK OR,RI SD,TX UT,VA WA,WI	22

NOTE: [a]State has more than one power of fogging lens; [b]Once determined and recorded, do not repeat; [c]If trouble with reading; [d]Fogging lens discontinued in 1987; [e]Recorded as a near vision score; [f]Other power has specified grade; [g]Alternate power.