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The Effectiveness of a Structured Handwriting Program

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Abstract

The purpose of this study was to assess the use of a structured multi-sensory handwriting program with grade one students. This study utilized a multiple-group time series design and included a pre-test. A standardized assessment of handwriting skills, the *Minnesota Handwriting Test* was used for this baseline measurement and subsequent measurements throughout the school year. Two experimental classes received instruction using the *Handwriting Without Tears* method and a control class used traditional methods. Subsequent testing of handwriting skills was conducted each month from December until June. A one-way Analysis of Variance was used to compare the results. The experimental classes using the structured multi-sensory handwriting program improved significantly in handwriting skills specifically, in overall printing skills, alignment of letters on the baseline and size of letters in comparison to the control class. The girls in both experimental classes mirrored the above results and demonstrated improvement in overall printing skills, alignment and size when compared to the girls in the control class. The boys in the experimental classes demonstrated significant changes in the areas of legibility and spacing. Although the experimental classes demonstrated more improvement than the control class in overall handwriting skills, the students in the control class were faster writers. Further research including an assessment of handwriting skills into grade two would be helpful to further explore the speed and legibility issue and consolidation of handwriting skills. A longitudinal study would assist in exploring handwriting issues.

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An Assessment of a Structured Handwriting Program

CHAPTER I

Introduction

Occupational therapists receive frequent referrals for children who have not mastered the skill of handwriting. These children have difficulty keeping up with schoolwork, produce illegible work and lack confidence in their abilities in the classroom. Sometimes the method of handwriting instruction or a lack of handwriting instruction has contributed to the child's difficulty in learning to print and write. (Rubin & Henderson, 1982).

Printing and cursive handwriting instruction used to be an important part of the elementary school curriculum. In recent years, handwriting instruction has become more incidental. Although some teachers still use formal methods of teaching handwriting with emphasis on the mastery of the basic motor and perceptual skills, many have adopted whole language curriculum. The whole language approach to reading and writing integrates the teaching of handwriting with the teaching of other literacy skills so there is no separate handwriting curriculum (Alston & Taylor, 1987). Until now, there has been little empirical evidence supporting one method of handwriting instruction over another (Graham

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& Weintraub, 1996; Rubin & Henderson, 1982). This is a study of one particular handwriting program entitled *"Handwriting Without Tears"*.

The following terms associated with printing, writing and handwriting are used interchangeably throughout this paper:

Handwriting: The motor and perceptual task of printing or cursive writing.

Manuscript printing: Upper and lower case letters in the printed form.

Cursive Handwriting: Upper and lower case letters in the joined script form.

Writing: A task that requires the integration between handwriting and cognitive processes for communicating ideas on paper.

Handwriting is the perceptual-motor skill involved in the process of writing. The problems that, school age children encounter in learning the skill of handwriting include inconsistent spacing between letters and words, difficulty writing on the baseline, inefficient letter formation, letter reversals, inconsistent letter size, decreased legibility and slow handwriting speed (Alston & Taylor, 1987, Tseng & Cermak, 1993).

Handwriting has remained a necessary skill as children spend at least half of the school day employed in paper and pencil tasks (McHale & Cermak, 1992). Despite the introduction of computers and word processors printing or cursive writing is the primary means for taking notes, generating ideas on paper and communicating what children have learned (Amundson & Weil, 1996).

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Children learning the process of writing, can be slowed down by inefficient handwriting. Slow and inefficient handwriting skills can impact on the cognitive skills of planning and content generation involved in the process of writing (Graham, 1992). Children with poor handwriting skills have been graded less favourably on essays and tests than children with neat, legible handwriting (Briggs, 1970 & 1980, Sloan & McGinnis, 1978). In order for children to effectively engage in the activity of writing, they must be able to easily and automatically handwrite their ideas on the page so that it can be read with ease by them and others. The need for proficiency in the basic skill of handwriting should not be underestimated (Tseng, 1998).

Background to the Problem

Occupational therapists assessing and treating children with handwriting difficulties require an awareness and understanding of the methods used to teach handwriting in the classroom. Teachers are using many methods and the methods can vary from school to school and within the same school depending on a teacher's approach (Alston, 1985; Rubin & Henderson, 1982).

Occupational therapists often choose multi-sensory approaches for remediating handwriting difficulties of children who have identified fine motor, visual motor and sensori-motor problems. A multi-sensory approach to handwriting remediation utilizes the various sensory experiences to assist the child's nervous system to integrate information for producing a satisfactory motor output.

The motor output targeted in handwriting remediation is legible handwriting.

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In a multi-sensory program, all sensory systems can be utilized including the olfactory, gustatory, visual, proprioceptive, tactile and auditory senses with the goal of sending information through a variety of channels, to the child's nervous system (Admunson, 1992). The multi-sensory approach reinforces learning on various body system levels to include the motor system, sensory system, cognitive system and perceptual system. This study assesses the effectiveness of one structured multi-sensory handwriting program.

Purpose of the Study / Research Question

The purpose of this study is to assess a multi-sensory structured handwriting program. Specifically the question is:

Is there a difference between the handwriting skills of grade one students taught using a multi-sensory handwriting program and those of students in a control group which did not use this approach?

Specifically, three areas will be examined. These areas include:

- Will the subjects in the experimental group demonstrate an overall improvement in handwriting skills? Is the improvement significant when compared to the control group?
- Will the subjects in the experimental group demonstrate improvement in each of the five areas of handwriting skills being evaluated to include: Legibility, Form, Size, Spacing and Alignment? Is the improvement significant when compared to the control group?

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- Is there a difference in the improvement of handwriting skills between the boys and the girls? Is the improvement significant when compared to the control group?

Rationale

There is a limited amount of research literature on the effectiveness of any given method of handwriting instruction for school age children. Very few countries have a national handwriting policy (Graham, 1992). Teachers are guided by the knowledge that students must develop legible handwriting, but they are left to develop their own methods for teaching handwriting skills.

Teachers consider legible handwriting an essential skill for their pupils to posses (Rubin & Henderson ,1982). However, some teachers spend little time teaching formal handwriting skills and there are inconsistencies in the methods of instruction used across the grades for the same students. Hagin (1983) suggests that handwriting training may be a gap in the current education of teachers. He points out that handwriting is one of the most poorly taught components in the elementary school curriculum. Poor or inefficient teaching may be a reason for children's failure to acquire the complex skills of handwriting (Rubin & Henderson, 1982).

Teaching handwriting is full of decisions regarding how to initiate the instruction, how to teach pencil grip, posture, and other factors that influence handwriting (Graham & Miller, 1980). For example, Rubin and Henderson (1982)

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suggests that teachers must decide whether to start with manuscript or cursive handwriting, when to transfer from one to another, what style of printing and cursive writing to teach, and whether or not to allow poor writers to continue printing or not. Although most teachers would describe precisely what they do and when, few could cite the sources of their decisions (Rubin & Henderson, 1982, p.18). Rubin and Henderson (1982) report that "the success with which writing is learned depends not only upon the motivation and ability of the child but also on the methods and ability of the teacher" (p. 23).

Teachers use various approaches to teaching handwriting and are often unsure of their own abilities and skills when teaching it. They are given little guidance on which approach to use for handwriting instruction. Students, as a result, are taught handwriting using different handwriting methods which vary among grades and between schools. It is likely that students are taught several different methods of handwriting from SK to grade four. Therefore, illegible handwriting may be a result of the mechanisms by which children are taught (Rubin & Henderson, 1982).

The structured multi-sensory approach to handwriting instruction *Handwriting Without Tears* (Olsen, 1997), appears to have the potential to assist all children in learning printing and cursive handwriting in the classroom. It has the potential to offer teachers a method for handwriting instruction that provides specific structure and guidance in how to teach the skill. This research is an examination of this program.

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CHAPTER II

Literature Review

Introduction

This chapter summarizes major findings, conclusions, and theories on handwriting and handwriting instruction. Various handwriting approaches will be introduced and discussed in terms of the theory behind the method and the implied assumptions from which the methods were developed. Specifically, the *Handwriting Without Tears* approach to handwriting instruction will be described and related back to the literature on handwriting instruction.

The Development of Handwriting Skills

Children follow a sequence of developmental milestones associated with the development of handwriting skills. This sequence moves from a preprinting stage to the handwriting stage. Children at approximately 10-12 months of age can make scribbles on the paper. Usually, by age 2, children can imitate horizontal, vertical, and circular marks on the paper. At approximately age 3, children can copy a vertical line, horizontal line and circle when given a prompt. At about ages 4-5

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years, children can copy a cross, right oblique line, square, left diagonal line, left oblique cross, some letters and numerals, and they may be able to print their own names. By around ages 5-6 years, children can copy a triangle, print their names, copy most lower case and upper case letters (Amundson & Weil, 1996, p. 525).

Ziviani (1995) reports that the usual developmental sequence of graphomotor (drawing, writing) skills is that drawing precedes writing. Children when given tools at an early age, smear paint, scribble with crayons and draw (Amundson & Weil, 1996). The scribbles, pictures letters and words produced on the paper is the end result of the process of integrating varied developmental functions (Benbow, 1992).

The Pencil Grip

With the introduction of a writing tool, children must be able to manipulate the tool to produce an image on the paper. The development of pencil grasp in young children follows a fairly predictable course in children who are developing as expected. Development of pencil grasp occurs from proximal (trunk muscles) to distal (arm muscles), global or whole arm muscles to differentiated or fine hand muscles (Erhardt, 1994).

The muscles of the hand or the intrinsic muscles are used to guide and grade the movement of the fingers and thumb when manipulating and gripping small objects like pencils and crayons. These small hand muscles allow the fingers to spread out and come together (Hanft & Marsh, 1993) The larger muscles of the

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forearm that cross the wrist and attach to the small bones in the hand are known as the extrinsic muscles. Their function is to move the fingers and the thumb in larger hand movements for example flexing all fingers or fisting, or using a power grip (Hanft & Marsh, 1993). Good hand function is dependent on the balance between the intrinsic and extrinsic muscle of the hand and forearm. The small intrinsic muscles permit the thumb and index and middle finger to flex and straighten, and complete rotary strokes with a pencil to print or cursive write (Hanft & Marsh 1993).

Children just starting to grasp a crayon at the earliest age of two, hold the crayon with a palmar-supinate grasp, with the wrist slightly supinated, the hand fisted , and the shoulder motion predominating (Erhardt, 1994). Between the ages of two and three, shoulder stability is developing and the beginning of elbow mobility is observed in the digital-pronate grasp, when the pencil is held by the fingers with the wrist pronated.

Starting at age three, the emergence of the tripod posture is noted in the hand when holding a pencil or crayon. The tripod grasp is characterized with the wrist in slight extension, holding the pencil between the distal phalanges of the thumb and index fingers and the radial side of the middle finger (Amundson, 1992). The tripod posture is static at first, with some wrist mobility, but the control of the movement based in the shoulder and elbow, with the arm moving as a unit.

At age four, the dynamic tripod posture is developing and begins to be perfected. The shoulder, elbow, and wrist provide stability allowing the interphalangeal joints to perform very fine individuated movements (Erhardt, 1994).

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The dynamic tripod grasp allows for increased speed, sustained and most dextrous control of the pencil in the hand (Connolly, 1973). The development of an efficient grasp for handwriting is very desirable. An efficient grip allows the pencil to be controlled as a skilled extension of the hand (Benbow, Hanft, & Marsh., 1992, p.23).

The establishment of definitive hand dominance appears to correlate with the developing mature dynamic tripod posture used by four to six year-olds. Completely integrated hand dominance may not develop until eight or nine (Erhardt, 1994, p. 14). However, most children between ages 4.5 and 6.5 years develop dynamic tripod grasps when using a pencil (Schneck & Henderson, 1990).

The lateral tripod grasp is another pencil grasp commonly used by children characterized by the pencil being stabilized against the radial side of the middle finger, with the index finger on top of the pencil and the thumb adducted and braced over or under anywhere along the index finger (Schneck & Henderson, 1990, p. 896). The lateral tripod grasp was observed to be one of the most commonly used grasps along with the dynamic tripod grasp. However, as age increased, the use of the lateral tripod grasp began to decrease (Schneck & Henderson, 1990). The findings of Schneck and Henderson (1990) indicate that variability of pencil grasp does exist in children without handwriting and motor difficulties. Also, the use of the lateral tripod grasp can be expected to decrease in older children up into adulthood. Myers (1992), indicates that further research is needed in order to determine whether or not the lateral tripod grasp is a desirable grasp. After studying the lateral tripod grasp in adults, Bergman (1990) concluded that the

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lateral tripod grip may be used by young children however, it is not an efficient grasp for handwriting.

Two other dynamically efficient grasps have been identified by Benbow et al. (1992) They are the "quadripod" grasp and the "adapted tripod" grasp. The quadripod grasp is characterized by a similar hand posture for the dynamic tripod grasp, except four fingers are placed on the shaft of the pencil. Benbow (1990) reports that approximately one half of all children use this grasp. The "adapted tripod grasp" is characterized by placing the pencil between the index and middle finger resting in the space between the upper part of the fingers. The pencil is grasped by the thumb, index and middle finger pads similar to the tripod grasp. The web space is round and open similar to the dynamic tripod grasp posture.

Regardless of the type of grasp, one of the most important components of an effective pencil grasp is the rounded open web space in the hand between the thumb and the index finger (Long et al , 1970; Benbow et al., 1992). This allows for opposition of the fingers and the thumb so that objects can be manipulated freely with the finger tips (Benbow et al, 1992). Another important consideration of an efficient pencil grasp is the dynamic ability of the grasp or movement of the fine muscles of the hand. This allows for simple flexion and extension movements of the wrist and fingers to make vertical pencil strokes while the horizontal wrist action moves the hand across the paper (Benbow et al., 1992).

Zivianni (1983 , 1987) suggested that the presence of an atypical pencil grip in the absence of other difficulties, does not predict poor handwriting. Children

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with handwriting difficulties however, frequently use less typical grasps. Pencil grip must be considered along with other findings when assessing children who have handwriting difficulties. It has been found that children with decreased proprioceptive-kinesthetic finger awareness along with handwriting difficulties generally used less efficient grasps than children who demonstrated average proprioceptive-kinesthetic finger awareness (Schneck, 1991). As handwriting requirements increase throughout the grades, children with atypical grasps may have difficulties with fatigue limiting handwriting production (Ziviani & Elkins, 1986).

Ziviani and Elkins (1986) suggested that less emphasis should be placed upon the most desirable grasp pattern and more emphasis placed on underlying factors that may be contributing to poor handwriting performance. Ziviani (1995) sums the issues up in this way:

- Mechanically the dynamic tripod grip offers a high level of precision and control. If a child is young enough, and has not developed a fixed writing posture, then the dynamic tripod grasp should be encouraged.
- Variations of the dynamic tripod grip do not, of themselves contribute to handwriting difficulties. If the grip adopted allows for intrinsic muscles action and some opposition, then it may be acceptable for the task.
- Differentiation should be made, however, between a modified version of the dynamic tripod grip that is developmentally immature. The

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latter requires intervention because it may indicate that the child has not developed the necessary prerequisites to progress to a mature hold (p.186).

The Developmental Foundations of Handwriting

The developmental functions of handwriting include the sensori-motor, fine motor, visual perceptual and language foundations. The sensori-motor foundations of handwriting include proprioceptive /kinesthetic awareness, bilateral integration, posture and balance, shoulder/ wrist stability and mobility, tactile sensation, and motor planning. The fine motor foundations of handwriting include thumb development, hand arches, in-hand manipulation, motoric separation of the hand, eye-hand coordination, and laterality. The visual perceptual foundations of handwriting include visual memory, visual discrimination, spatial organization and position in space. The language foundations that impact on handwriting include visualization, vocabulary, auditory discrimination and syntax/ grammar (Benbow et al., 1992). The language foundations necessary for writing are beyond the scope of this paper and therefore have not been addressed.

The Sensori- Motor Foundations

At the sensori-motor level, children must have a unconscious sense of arm and body movement as well as the position of their body in relation to the writing surface (Benbow et al., 1992). Children must be able to use one hand to hold the

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pencil and move the pencil to write while the other hand holds the paper in place. They must be able to maintain an efficient and proper posture at their desk. Children must be able to sense where the pencil is on the paper and provide enough pressure to make letters and words on the page and guide the excursion or movement (Benbow et al., 1992). Initially, children rely heavily on visual input to assist with letter formation, however, as the kinesthetic memory of letters develop, children rely on proprioceptive and kinesthetic input when handwriting. This increased awareness allows handwriting speed to improve (Ziviani, 1995).

Fine Motor Foundation

A child must be able to hold the pencil efficiently in the hand to write for brief and longer periods in the classroom. When the child has this fine motor foundation, the hand maintains the position on the pencil to allow for skilled movements of the fingers for handwriting. The fingers must be able to assist with pencil pressure on the paper. The child must be able to hold the pencil and move the pencil into the grasp for writing. If a child makes a mistake and wants to use the eraser on the pencil, the child is able to easily turn the pencil to the eraser side and back to the lead side. Eye movements guide the action of the hand during the writing task. The child must have developed a superiority of skill and function of one hand over the other (Benbow et al., 1992). Exner (1990) identified gender related differences in the area of in-hand manipulation which is a fine motor component of handwriting. She noted that four year old girls were ahead of four year old boys in in-hand

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manipulation skills. The four year old boys in this research compared similarly to the three year old boys and girls in the area of in-hand manipulation (Exner, 1990). These gender differences for in-hand manipulation could impact on handwriting development in boys and girls.

Visual Perceptual Foundation

Children must be able to discriminate the letters of the alphabet. They must be able to recall shape and form of letters and numbers when writing (Benbow et al., 1992). Children must be able to recognize that letters are the same size and to space letters appropriately to make words on the page (Benbow et al., 1992).

Boys and girls have been studied for differences in performance of design copying or visual motor areas which is a component of visual perception and fine motor skills. Judd, Siders, Siders, and Atkins (1986) found that boys demonstrated decreased skills when compared to girls in grade one in the rate of production of symbols and accuracy of copying symbols. The authors suggest that differences may be related to information processing of symbols at that age (Judd et al., 1986).

Karapetsus and Vlachos (1997) identified that children's ability to copy designs develops specifically between ages 7 and 12. They reported that boys demonstrated decreased abilities in design copying when compared to girls at younger ages. The authors hypothesized that different rates of human cerebral hemispheric maturation and especially myelinization of the corpus callosum and the lateralization of the hemispheres may be part of the reason which leads girls to

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exhibit better performances in certain developmental stages (Karapetsus & Vlachos, 1997).

Handwriting Instruction

Rubin and Henderson (1982), reported that a variation in the practical aspects of teaching exists in the areas of handwriting instruction. Often teachers must determine within their own classrooms, how often handwriting instruction should occur, and how long a teaching session should last. Some other issues that teachers of handwriting must reach decisions on include the child's readiness, selection of writing tools, use of lines, and whether to start with upper or lower case letters. These issues have all been subject of research and published opinion.

Handwriting Readiness or Pre-Printing Skills

Some controversy exists as to when children are ready for formal handwriting instruction (Amundson & Weil, 1996, p. 525). Alston and Taylor (1987) suggest that children should master readiness skills before being introduced to handwriting instruction to decrease frustration and limit the development of poor handwriting habits. Other authors have suggested that handwriting instruction should be postponed until after the child is able to master the first nine figures in the Developmental Test of Visual Motor Integration (VMI) (Beery, 1982, Benbow et al., 1992). Weil and Admunson (1994) found that children who were able to copy the first nine forms on the VMI were able to copy significantly more letters than were the

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children who could not copy the first nine forms. The results of the investigation into the relationship between visual motor skills and handwriting skills of children in kindergarten indicate that most children in kindergarten who are typically developing will be ready for handwriting instruction at the later end of the school year (Weil and Amundson, 1994).

Lamme (1979) suggested six prerequisites that children must have before handwriting instruction begins. These include (1) small muscle development; (2) eye-hand coordination; (3) the ability to hold utensils or writing tools; (4) the capacity to smoothly form basic strokes such as circles and lines; (5) letter perception, visual discrimination; (6) orientation of written language including right / left discrimination.

Writing Tools

Lamme and Ayris (1983) investigated the effects of five writing tools on the handwriting legibility of 798 first grade students to find that the type of writing tool did not impact on legibility. The use of the large primary pencil did not produce more legible work than the No. 2 pencils for beginning handwriters and teachers noted the children's attitudes toward writing were more positive when using felt-tipped pens rather than pencils.

Amundson (1992) points out that during handwriting remediation, occupational therapists utilize a wide variety of tools for handwriting activities. This as part of a multi-sensory approach to handwriting. Writing tools include magic

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markers, felt-tipped pen, crayons, wipe-off boards, grease markers, chalk, and erasable ink pens. Pencil grips added to pencils, markers and pens may also be useful.

Use of Lines

Weil and Amundson (1994) found that kindergarten children who are developing as expected would benefit from using unlined paper until they have learned the correct sequence, order and direction of strokes necessary for letter formation. A study conducted by Hill, Gladden, Porter, and Cooper (1982) on variables affecting the transition from the use of wide lined paper to normal spaced paper for printing, indicated that second grade students made more correct letter strokes using wide spaced paper than when using normal-spaced paper. Space and size did not affect performance in third grade students. Therefore, the transition from wide-spaced paper to normal-spaced paper may be appropriate during the second grade (p.53).

Bailey (1988) reviewed the literature on various aspects of handwriting related to ergonomics, assessment and instruction. She concluded that there is evidence to support the notion that lines on the writing paper provide the novice writer with structural guidance which will improve letter formation and legibility (p. 69). The lines improve the organization of work, especially for younger children (Waggoner et al., 1981; Leung et al., 1979; Hill et al., 1982).

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Upper Case and Lower Case Letters

Should beginning students be taught upper case or lower case letter forms? In Stennett, Smythe, Hardy and Wilson's (1972) study, children from kindergarten to grade three were given a printing test during the last week of May and early June. The children were given a stimulus letter and asked to copy it as carefully and accurately as they could. The children copied all 26 upper-case and 26 lower-case letters. If the letter was readable without the reader knowing the stimulus, it was "acceptable". The results indicated that the children found lower-case letters more difficult to copy. By the end of grade 2, children had mastered the upper-case letters. By the end of grade three, children were still having some difficulty copying lower-case letters.

The lower case letters that were easier for the kindergarten children to complete were the relatively simple letters involving a single stroke (o,l,c,s) which are the same in both the upper and lower case forms. These children had the most difficulty copying the letters that were more complex, required more than one stroke and more visual motor control (r,u,h,t).

Summary of Handwriting Foundation Skills

The research, then, suggests the following basic information on handwriting instruction. Children follow a sequence of developmental milestones in the visual motor and fine motor areas associated with the development of handwriting skills. Handwriting is the end product of the integration of a number of skills that include

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sensori-motor, fine motor, visual perceptual and language foundations. In children who are developing typically, the foundational skills of handwriting are in place and integrated to a level for handwriting instruction to begin at age 6 or around the latter half of the senior kindergarten school year. There is some evidence that upper case letters are easier than lower case letters for younger children to form. It is also suggested that children start to print using lines, moving from wider lines to normal sized lines in grade two.

Handwriting Instruction Methods

Although handwriting is a necessary skill, teachers are not consistent in the approach they use to teach it. With the introduction of computers, the adoption of the whole language approach to writing, and the availability of various commercial methods for handwriting instruction, teachers are varied in their philosophies and approaches to handwriting instruction.

Teachers have had little formal training in the area and they are not confident in how to teach the skill of handwriting (King, 1961). Instructional practices for handwriting are based on traditional procedures rather than on research findings and tends to be based on personal opinion (E. Askov, Otto & W. Askov,1970; Manning,1988).

Handwriting Programs

One traditional approach to handwriting, introduces manuscript printing first

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using a ball and stick method. This is initiated by teaching the children basic strokes: vertical lines, horizontal lines, circles and diagonal lines. Once the basic strokes are mastered, children are taught how to put them together to form letters. Letters are usually introduced in alphabetical order from A-Z. Letters are given a letter group name identified by the use of basic strokes i.e. backward circle letters, curve line letters, straight line letters and slant line letters. Letters are formed starting on the baseline or on the middle line. Specific letter formation may not be encouraged as long as the letter is legible (Zaner Bloser, 1976).

One of the earliest alternative methods for teaching handwriting was introduced and studied by Furner in the late 1960's. Furner (1969a, 1969b, 1970) developed a program of instruction for grades one through grades three which emphasized the development of a perception of letters and their formation through the guided examination of the letter formation process, development of verbal descriptions by the children during letter formation procedures, and handwriting practice based on the verbalizations. The self-analysis of errors was also used in the program.

In her three year longitudinal study, Furner emphasized the need to learn each procedure so that the children had an understanding of why they were learning it. This was to increase the children 's motivation and sense of the importance of their learning. The children were introduced to letter forms on various sensory and cognitive system levels so that they had many types of exposures to the stimulus. The children where given demonstration on the actual

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letter formation process several times. They were guided to verbalize a description of the process involved in forming the letter and to practice this when printing. They were provided with a multi-sensory approach utilizing the visual, the auditory and the kinesthetic sensory systems along with an auditory and cognitive approach.

Letters were placed in groups related to the way in which they were formed. This was to emphasize transfer of learning in both perceptual and motor aspects of handwriting. During the instructions for letter formation, children were given terms used to differentiate various aspects of the development of perception of the letter formation.

Teachers in the study were given daily lesson plans which characterized the experimental method. This method was compared to commercially available handwriting materials. The outcomes of the study indicated that the experimental method of instruction, which emphasized verbalization of procedures and multiple sensory stimuli to develop perception of the letter formation and handwriting task, was effective in teaching handwriting. The quality of handwriting was maintained without deterioration at a functional level over the course of the study.

At the end of the study, individual letter formation errors were analyzed to determine the extent of letter form errors in the experimental and control groups. Children from both groups were randomly selected and given a test to determine letter form errors. In grade one, the children in the experimental group printed with more correct letter formation skills than those in the control group (Furner, 1970,

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p.67). According to Furner (1970), correct letter formation is essential to quality of handwriting.

In grade two, the children in the experimental group printed with more correct letter formation skills than those in the control group, and demonstrated a statistically significant improvement. The experimental method was found to be effective in developing and maintaining accurate perceptions of the handwriting task to act as the basis of motor execution. In grade three, the experimental group continued to demonstrate significant differences in the correct letter formation skills. This also carried over into cursive writing (Furner, 1970).

In the early primary years quality of letter form may impact on the speed as some letters are more difficult to form when learning. Once the skill becomes more automatic, the speed will increase. This finding was identified by Furner (1970) at the grade three level for the experimental group.

This research implies that handwriting instruction that builds perception of letters and their formation as a guide for motor practice, rather than emphasizing the motor practice, appears more effective in teaching handwriting skills that last. Inversely, current programs which stress copying or tracing as the primary means of instruction does not build on these perceptual abilities.

Furner's research introduced the idea of using several processes to learn the skill of handwriting. Emphasis on the visual, auditory, kinesthetic and motivational or mediational skills provides the learner with a variety of experiences and reinforcers to use in developing the complex skill of handwriting.

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In 1978, a new type of manuscript alphabet, the D'Nealian was developed (Trap-Porter et al., 1984). The letters of the alphabet are written with a slant and show more resemblance to the cursive letter form. Most of the D'Nealian letters are formed with a continuous stroke. Supporters for using this style of manuscript writing suggest that transition to cursive letter forms is easier using D'Nealian as all that is required in the cursive form is the joining stroke (Alston, Taylor, 1987).

Trap-Porter et al., (1984) conducted a study to test the effect of training under two manuscript alphabets, D'Nealian and Zaner-Bloser (ball and stick style) in grade one handwriting instruction. Eleven grade one classes participated in the study in six schools in Ohio. Inclusion criteria for student participation in the study was: a) interest and cooperation of teachers and principals, b) formal handwriting instruction only in manuscript letters had been given to the students, and c) previous training in writing the D'Nealian Manuscript alphabet or the Zaner-Bloser alphabet had occurred (Trap-Porter, 1984).

The children were given instruction on use of the lines, as well as how to slant the paper when writing in the cursive form. They were then asked to figure out how to "write" each letter on the model sheet which had numbers and arrows which explained the cursive form of the letter. Students were told to make each letter look just like it did on the model letter sheet including the same size and shape (p. 344). The number of correct strokes made by each student was analyzed. An analysis of variance was performed based on the type of instruction (Zaner-Bloser and D'Nealian) and sex differences in the number of correct cursive strokes (Trap-Porter

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et al, p. 345). The results indicated that the first grader's production of cursive letters was not enhanced in the students who learned the D'Nealian method of manuscript instruction.

In another comparison of the transition to cursive handwriting between the D'Nealian and Zaner-Bloser manuscript instruction methods, Farris (1982) compared cursive handwriting performance of students in the second grade who had learned to print using one of the two methods. In this study students who had been taught the traditional method using the Zaner-Bloser materials outperformed the D'Nealian students.

In Graham's (1992), review of the literature on handwriting instruction, he concluded that the ease in transition to cursive handwriting purported to be associated with the D'Nealian method was not supported in the literature (p. 8). Although, the continuous stroke has been said to be more rhythmical, faster and directionally consistent than traditional manuscript, Graham (1992) was unable to find conclusive evidence in the literature to substantiate the benefit of one type of script over another.

One study by Oglesby(1982) looked at 12 underachieving students in second grade. The students were randomly assigned into two groups. One group received nine weeks of D'Nealian instruction, while the other group received nine weeks of Zaner-Bloser instruction. Every three weeks, the students were assessed for quality in the areas of letter formation, legibility, and spacing, by four teachers. The overall results favoured the D'Nealian method but the study was limited by the

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omission of information regarding reliability of assessment and assessors and a small sample size.

Graham (1992), reported that Duvall (1985) assessed handwriting methods using a variety of criteria to look specifically at the difficulty of the different manuscript handwriting methods. She found that using the D'Nealian method, children would have to change direction more often and do more retracing of lines and make more strokes that occur with increased age and maturity. On the other hand, the Zaner-Bloser manuscript method requires children to pay more attention to visual information such as position and intersection of strokes.

In 1998, Ziviani and Watson-Will, conducted a study which investigated speed and legibility of modern script and the beginner's alphabet which recently had been established in the curricula of most Australian schools compared to previous print and cursive styles. A comparison between speed and legibility in boys and girls was also investigated. Modern cursive differs from the traditional "ball and stick" style in two ways. First, transition from print to cursive form occurred with the introduction of joiners (Ziviani, Watson-Will, 1998). Second, the script shape is oval in appearance when compared to the round shape of the ball and stick style. The lines are also slanted rather than vertical which was thought to facilitate the transition from print to cursive. The letters in print are formed using a continuous stroke method. The continuous stroke method is thought to reduce the tendency for reversals and promote faster, more automatic writing (p.60).

The outcome of the study suggests that young children write at similar

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speeds and that older children demonstrate faster speeds when writing. Girls are able to maintain a higher level of legibility than boys. Overall, the study reports that this script facilitates writing speed. It is also noted that during the primary years, legibility is emphasized by the children over speed, indicating that quality is the precursor to speed (p.64).

Many teachers do not ascribe to any particular handwriting program. The whole language philosophy for the process of writing, encourages teachers to teach handwriting skills within the activity of writing when a particular child needs the skill for the completion of the work (Edelsky, 1990). Handwriting is taught sporadically, with advice and practice given only on an individual, as needed basis (Graham,1992). Teachers using this approach believe that writing conventions, such as letter formation, are best learned by using them naturally and in concert with each other (Graham, 1992, p. 4).

Principles of Effective Handwriting Curriculum

Whatever the program used, formal handwriting instruction occurs in grade one and is reinforced in grade two. In grade three, children are taught cursive handwriting (Graham, 1980). In kindergarten, children are asked to trace letters and practice printing their names. However, formal instruction on proper letter formation generally does not occur in this grade. The change in emphasis of writing as a process rather than a product has influenced handwriting instruction (Farris, 1991). This occurred primarily with the introduction of the whole language

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approach to teaching Language Arts.

Whatever the program, some basic guidelines for teachers have been outlined by researchers. Furner (1970) suggested that effective handwriting programs should utilize multi-sensory stimuli and verbalization of letter formation for increasing quality, letter formation and speed. She recommended that a perceptual method of handwriting instruction be used in the elementary school program and suggested the following instructional methods.

1) Encourage the child to identify the problem for each lesson. This will develop an appropriate "mental set" and motivation for learning.
2) Guide children to observe letter formation through demonstration of procedure.
3) Provide many guided exposures to letter formation in order to build perception.
4) Encourage a mental response from each child regarding the letter formation in conjunction with the motor response.
5) Use multi-sensory stimulation to include visual, auditory, and kinesthetic modalities.
6) Allow the child to evaluate and self correct against a desired model.
7) In practice, emphasize comparison and improvement rather than writing numerous samples.
8) Demonstrate a consistent style, and keep it consistent throughout the grades.

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9) Set clear and attainable expectations of the expected quality and speed.

Graham (1980), discusses handwriting curriculum and reports that the handwriting product should be easy to learn, read and write. Achieving fluency of handwriting is a primary goal for handwriting instruction. Letters should be introduced in groups that share common formational characteristics (p. 5). Letters must be over learned first and then practiced in the context of writing. When teaching manuscript letters he recommended an alphabet with oval shape letters rather than the more difficult circle and slant letters.

Graham (1980) highlighted the following principles and conditions that should be used when teaching handwriting.

1. Instruction should be direct rather than incidental.
2. Instruction should be individualized to meet the needs of all students.
3. The handwriting program should be planned, monitored and modified based on ongoing assessment of student's needs, and skills.
4. A variety of methods and techniques that are flexible and adaptable should be used.
5. Handwriting lessons should occur in short daily periods.
6. Skills should be over learned in isolation before being applied to assignments.
7. Work expectations should be outlined to facilitate the student's best effort. Have high standards.

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8. Positive attitudes are necessary of the teacher and students toward handwriting instruction.
9. The atmosphere should be pleasant, promoting motivation through incentives, reinforcement, success, and enthusiasm.
10. Teachers are to model using the same style. Practice is necessary.
11. Students should be encouraged to self-evaluate and actively participate in initiating, conducting and evaluating the remedial program.
12. The teacher should assist in helping students maintain a consistent, legible handwriting style throughout the grades.

Furner (1970) and Graham (1980) identify essential considerations for the development of an effective handwriting curriculum which has the potential to teach children to be fluent printers. Once children learn to handwrite efficiently, they can concentrate on getting their ideas down on paper. If handwriting is taught in a manner that is consistent, and provides structure for both the teacher and student, it may assist in the development of automatic efficient skills. These principles are evident in the *Handwriting Without Tears* method of handwriting instruction.

The *Handwriting Without Tears* Method

Handwriting Without Tears (Olsen, 1997) is a teaching method for children in the regular classroom as well as for children with special needs. It emphasises and utilizes a multi-sensory approach. The author considers it a total method

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"which takes a child from pre-printing skills to a mastery of cursive writing" (Olsen, 1997, p. 2). The structured handwriting teaching method starts with a basic rule in printing that emphasises all letters starting at the top. Letters are taught in letter formation groups. The lessons are designed to meet a variety of learning styles to assist children who are visual, auditory, tactile, and kinesthetic learners. The sequence of instruction is based on developmental abilities of children and fine motor development. Children progress through the program at their own rate of competency (Olsen, 1997).

Like Furner's method of handwriting instruction, the *Handwriting Without Tears* method uses a multi-sensory approach that encourages children to learn through movement, perception and cognition. The teacher demonstrates the letter formation through movement and verbalizations. The children then imitate and verbalize and learn says and stories about letter formation. As they practice printing, they verbalize the letter formation rules. Children are encouraged to "feel" the movement when forming a letter. They are asked to look at a letter and describe the movement needed for forming letters based on stories and rules. The students are encouraged to form the letters using the identified movements on the chalkboard, in the air or on paper. Through this process, good handwriting habits are developed (Olsen, 1997).

The *Handwriting Without Tears* program incorporates many rules that are used to teach children consistency when learning to print and write. When teaching the letter formation for printing and writing, the program emphasizes imitating,

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copying, and independent practice. Sovik's (1980) research supports the use of demonstration and imitation according to developmental cybernetics theory. In developmental cybernetics the child begins to track the behaviour of another person at an early age in learning different kinds of skills. He identifies that compared to a static model of presentation, a dynamic display of the model to be copied should improve the quality of children's reproduction of the model.

The *Handwriting Without Tears* program encourages the mastery of good handwriting habits using specific rules. An example of a rule is that children always start at the top when forming upper case and lower case printed letters (Olsen, 1997). The children learn a song about this in order to reinforce this first lesson.

Handwriting readiness activities are always reinforced. Children are provided with exercises to prepare themselves posturally and physically for handwriting instruction and practice. Children are instructed on proper pencil grasp and No. 2 HB pencils are always used. The program teaches children to use two lines for printing and writing rather than using paper with the broken midline. This program also includes adjustments for the left handed child.

The *Handwriting Without Tears* program is sequenced from kindergarten to grade six. At the pre-printing and printing level in kindergarten, children use wood pieces to manipulate, "feel" and make letters. In kindergarten, children use the blackboard to learn directionality and vertical down strokes. Then letters are introduced and taught in capitals (upper case form) in a specified order and practised using "gray boxes" which children use to visually guide them when

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forming capital letters on paper for the first time. Once the children demonstrate consistent letter formation from memory, they start to print the alphabet and familiar words on a wide line with a top line and bottom line. They continue to print in capital letters until the letter formation is mastered (see Appendix A).

Once upper case printing has been mastered, children move on to learning lower case printing in grade one using *My Printing Book*, a grade one workbook. This book emphasizes what the children already know about forming capital letters. The teaching of lower case manuscript starts by utilizing letters from upper case that have the same letter formation in the lower case form. As the children master the letter formation they progress through the program (see Appendix A).

Two letter groups are used in the *Handwriting Without Tears* program. These letter groups include letters that are formed using the same movement of the pencil on the paper. Letter formation occurs in a continuous stroke pattern. For curved shaped letters, the oval shape is used rather than the circle shape. All letters are vertical rather than slanted.

The first is the "magic C" letter group which consists of letters which begin on the top line with a C stroke (c, a, d, g). The second group is the "diver" group. All these letters begin with a down stroke and then come up and over (p, r, h, b, m, n). These groups are introduced in an appealing way which children find motivating (Olsen, 1997). To encourage acquisition, skills are reinforced using practice sheets. During handwriting practice using *My Printing Book*, children are asked to practice letters twice rather that practicing a whole line of the same letter.

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Berninger et al.(1997) supports this practice in their work on teaching handwriting for use within the writing process. In their approach, children print letters one to three times only. They identified that in traditional methods where children were asked to print letters many times, habituation of poor letter formation may result. Limiting this type of practice, encourages children to follow the rule for proper letter formation.

Once printing has been mastered children are introduced to the cursive handwriting component. Cursive handwriting is usually taught in grade three. By that time children have matured and developed better eye hand coordination and longer attention spans (Olsen, 1997).

Handwriting Without Tears, cursive handwriting program employs a vertical cursive script (see Appendix A). Olsen (1997) reports that vertical cursive is easier to learn, read, and write. Olsen (1997) indicated that children will develop slanted cursive as their personal style naturally. Developmentally, children initially learn on the vertical plane. Once the vertical plane has been mastered and developed children are then able to reproduce diagonal lines. Olsen notes that some children have difficulty learning slanted cursive because of the diagonal component to this type of handwriting. In the cursive handwriting program, Olsen (1997) strongly suggests that all children learn vertical style first. If a person is going to slant their handwriting it will occur naturally. When comparing this program to other handwriting cursive programs, Olsen's *Handwriting Without Tears* letters appear vertical and only essential strokes are used. The handwriting has a simple clean

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appearance and is easier to read (Olsen, 1997).

The *Handwriting Without Tears*, cursive handwriting program has 22 letters that end on the baseline and 4 letters that end higher on the line. This is a rule that the children are taught and it is reinforced throughout the program. The first letters introduced are c, a, d, g. These letters are formed in cursive writing using the "magic C" initial stroke like in the manuscript form. Then the h, p, t, letters are taught as they are familiar letters to children in the cursive form. Next, the letters that are slightly or very different from printing are introduced. These letters all end on the baseline and are easily joined. They include e, l, f, u, y, i, j, k, r, s, letter groups. Once the children have mastered these letters and are consistent with using them, the "Tow Truck" letters are next. There are only 4 letters which end like a "Tow" (higher up from the line) they are, b, o, w, v (Olsen, 1997, p. 5). These "Tow Truck" letters do not have an "in-stroke" (Olsen, 1997, p. 5). After the "Tow Truck" letters are mastered, 2 more letters are added. These letters are the m, and n. Another rule is introduced when these letters are taught, "When M or N are joined to a "Tow Truck" letter, the letter is used in the printed form" (Olsen, 1997, p. 5). Once these letters are practised and mastered, the x, z, and q, letters which are less frequently used are taught.

Children may learn any of these letters in a different order if they need to use them to write a name or for some other reason. Olsen (1997) suggests that a child is taught needed letters individually. Cursive capital letters are taught last. Due to the fact that they are used less frequently these letters must be practised and

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drilled.

The *Handwriting Without Tears, My Printing Book* (grade one workbook), *Printing Power* (grade two workbook), *Cursive Handwriting* (grade three workbook), and *Cursive Success* (grade four workbook) are all written with step by step directions in the corresponding teacher's manuals. The workbooks and teacher's manuals include instructions and stories for forming letters. The teacher employs these stories when teaching letter formation to the children. The stories are reinforced for the children in the workbooks using the letter formation sample and pictures.

Summary

There is limited empirical evidence suggesting the use of one method of handwriting instruction over another. Controversy exists as to how and when to teach children to print the manuscript alphabet. Authors have suggested that children should start handwriting instruction when they are able to copy a diamond. It is also suggested that teachers utilize a method of handwriting instruction that incorporates the use of multiple senses and multiple modes of instruction rather than copywork. Authors suggest the use of regular pencils, teaching students how to grasp, using lines, teaching upper case letters before lower case letters and teaching manuscript letters before cursive letters.

The *Handwriting Without Tears* method of handwriting instruction offers teachers a consistent structured method. It incorporates the use of multiple senses

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and multiple modalities as a means to teach children to print. The program provides teachers with a method to teach grasp, prepare the child's posture, and provide a context to discuss, evaluate and reinforce letter formation.

The purpose of this study is to assess the effectiveness of the *Handwriting Without Tears* method of handwriting instruction in teaching grade one children to print. This method will be compared to handwriting instruction that is presently being used in the grade one program.

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CHAPTER III

Methodology

Research Methodology: Multiple- Group Time Series Design

The study followed a multiple-group time series design and included a pre-test. This particular design was chosen because it allows for comparison of change within and between sample groups and observation of the naturally occurring dependent variable over time. Here the dependent variable was the student's printing ability.

With a time series design, a pattern of progress can be monitored and studied along a continuum as a result of the observations or measurements over time. When analyzing the pattern of results, one can infer the effect of the intervention on the dependent variable. By having a control group within the study, the pattern of the dependent variable in students who were not given the experimental intervention can be evaluated and conclusions can be drawn from the observations and measurement (Wiersma, 1991). In this case, both the control group and the experimental group were grade one classes. The experimental group received the *Handwriting Without Tears*- printing program, while the control

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group received the traditional method of printing instruction which was the ball and stick method, eclectic approach. Both groups were pretested before the intervention began and were retested at four week intervals throughout the school year. The experimental intervention was implemented throughout the school year as was the traditional method of instruction provided to the control group.

Random sampling did not occur as the experimental and the control groups under study were intact as a classroom group at the start of the study. With the lack of randomization of subjects, there were potential problems in the internal validity and external validity of the results. When using this design, building in as much control as possible into the study is beneficial. For increasing internal validity, the researcher needed to establish the degree of equivalence between the groups (Weirsma, 1991, p. 136)

A pretest can help to provide some information to determine the similarities between the experimental and the control groups. The use of a pretest aids in checking the extent of group similarity (Weirsma, 1991, p.140). In this case, the control group started at a different level from the experimental group so the pretest scores were used for statistical control for generating gain scores (Weirsma, 1991). This study design using multiple groups and a pretest, allowed for analyzing group results by comparing the magnitude of change between groups, and the amount of change within subjects of each group. It also lent itself to making more detailed comparisons of the data (Weirsma, 1991). With greater similarity between the groups, the researcher can be more confident when drawing conclusions from the

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results (Weirsma, 1991). In this study, the control class and the experimental classes started at different levels of skills. This finding was also mirrored for the girls. For the classes and the girls, a comparison of the magnitude of change was needed in order to make comparisons between classes. However, the boys in the study in both the experimental classes and the control class, started at the same level of skill. With the boys starting at the same level, direct comparisons between groups can be made from the pre-test scores to the post-test scores.

The time series design, using multiple groups and a pretest, is an established method of applied clinical and educational research. It lends itself to educational research when using intact classrooms. The pretest will assist with providing statistical evidence about the similarities between the experimental and the control groups. The baseline data gathered from the pretest demonstrates performance without treatment. The results gained by observation and measurement every four weeks over a period of time, will assist in determining the effect from the intervention on the dependent variable. The use of a control group allows for comparison between the groups while holding the dependent variable constant throughout the study.

Subjects

The subjects were students in three grade one classes at two elementary schools in a Northern Ontario City (population 118, 000). The choice of classes was limited as few teachers were trained in the *Handwriting Without Tears* program

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for printing instruction, so two classrooms at one school were chosen to be the experimental group. These classrooms were located in a neighbourhood school in a residential suburban area of the city. One grade one classroom at another school was chosen to be the control group. This school was also located in a residential suburban neighbourhood and the teacher was interested in handwriting instruction.

The subjects in the experimental group were kept as intact classes. Class 1 included 22 students, 14 girls and 8 boys. Class 2 included 25 children, 11 girls and 14 boys. Class 3 included 26 students, 13 girls and 13 boys. All students in these grade one classrooms were potential subjects for the study. The students who did not return a signed consent form were excluded. A total of 63 subjects, 37 girls and 25 boys, were given parental consent to participate in the research. In Experimental Class 1, one boy did not participate. In Experimental Class 2, three children were excluded from the study including two boys and one girl. In the control class, eleven children did not participate including 10 boys and one girl. The numbers in the analysis varied as children were absent from some monthly test periods but present for the others. All the children included in the study, completed a pretest sample. If a pretest sample was not available the student was excluded from the study.

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Independent Variable

The independent variable is the handwriting instruction methods of the *Handwriting Without Tears* program using the printing workbook titled, *My Printing Book* and the *Printing Teachers' Guide* that outlines and describes the teaching methods of the printing program. Handwriting instruction using the *Handwriting Without Tears* program was implemented by two grade one teachers trained in this method of printing instruction. The teachers followed the *Printing Teachers' Guide* and developed lesson plans utilizing the methods outlined in the book.

Dependent Variable

Printing improvement in the students represented the primary dependent variable under study. Several other variables related to the overall printing skills were measured for improvement. These variables included; Legibility, Form, Alignment, Size and Spacing. The *Minnesota Handwriting Test* (MHT) (Reisman, 1993) was the instrument chosen to evaluate printing skills of the subjects.

Hypothesis of Study

There are four hypotheses generated from the problem statement. During and following printing instruction in grade one:

1. The subjects will demonstrate an increase in overall scores on the *Minnesota Handwriting Test* (MHT) compared to the baseline measurement.

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2. The subjects in the experimental group will demonstrate a greater increase in handwriting test scores than the control group.
3. The subjects in the experimental group will demonstrate significantly more improvement in each of the five areas of handwriting skills specifically being evaluation on the MHT to include: Legibility, Form, Alignment, Size and Spacing.
4. There will be a difference in the improvement of handwriting skills between the boys and the girls in the experimental group and the control group.

Instrumentation

The printing skills of the grade one classes were evaluated using the research version of the *Minnesota Handwriting Test* (MHT). This evaluation tool is a norm-referenced test that is sensitive to small changes in the performance of younger students (Reisman, 1993, p. 43). It was designed for handwriting assessment of grade one and grade two students primarily for use by occupational therapists. This test can identify students with handwriting difficulties as well as document treatment effectiveness in improving handwriting skills. Because of the need for classroom administration of the tool, rather than individual testing, an assessment tool that was easily administered in a group was favourable. The MHT is easily administered to children in a classroom setting in a relatively efficient manner.

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Administration of the MHT

The children are asked to copy words from a near point sample (a sample at the desk as opposed to the blackboard). Words used for completing the sample are from the sentence, "the quick brown fox jumped over the lazy dogs". This sentence is mixed up and printed on the top of the page. The students are asked to copy the words, the "same size as the example" and to "write as you usually do when you are trying to use good handwriting" (Reisman, 1993 p. 43). The words are mixed up to eliminate memorization by fluent readers, ensuring that all students read each word before they print it. The students are given 2.5 minutes to copy the sample. After the time is up, the students are asked to put their pencils down. This ends the timed part of the test. The students are then asked to circle the last letter that they completed and finish the rest of the sample. The rate score is measured by counting the words completed in the 2.5 minutes. The quality of the sample is measured according to legibility, form, alignment, spacing and size. This criteria is used to evaluate the quality of the entire finished sample.

Scoring Criteria

Analysis of the samples included scoring for quality of handwriting (printing), based on criteria outlined in the MHT. Five different categories were included in the scoring to include legibility, form, alignment, size and spacing. All letters in the sample were scored individually. Each letter is given 1 point score for each category. A maximum point score for each letter is 5 points. A maximum total

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point score on the MHT is 170. Overall, the lowest test scores on the MHT demonstrated poorer skills in printing. On the other hand, the highest test scores indicated better skills in printing.

Legibility. To receive one point score for legibility, the letter must be recognizable out of context. It must include all strokes needed to complete the letter and contain no reversals or rotations (p for b). The letter must not look like another letter requiring interpretation. Legibility is weighted more heavily than the other categories. If a letter loses it's point for legibility, it scores 0 for the other four categories (Reisman, 1993). The maximum point score for the Legibility category on the MHT is 34.

Form. To receive one point score for form, the quality of print is present. For example, lines that should be curved should not have sharp points. Lines that should be curved are not straight or pointed. Gaps or line extensions greater than 1/16" cannot be present (Reisman, 1993). The maximum point score for the Form category on the MHT is 34.

Alignment. This criterion refers to the position of the letters on the bottom line. To receive one point score, the letter must rest within 1/16" of the bottom line or baseline (Reisman, 1993, p. 46). The maximum point score for the Alignment category on the MHT is 34.

Size. To receive one point score for size, all parts of the letter must be within 1/16" of the lines that should be touched by the letter (baseline or middle dotted line). Letters cannot be too big or too small based on the scoring criteria (Reisman,

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1993). The maximum point score for the Size category on the MHT is 34.

Spacing. This criterion includes both letter and word spacing in the test sample. Letter spacing requires "daylight" between letters but not more than 1/4" between letters. Word spacing requires more "daylight", to include 1/4" or more between words. Enough space should be allowed to eliminate overlap between letters however, letters in words should not be split by the space (to look like two words). Words should not "run into" each other looking like one word rather than two (Reisman, 1993). The maximum point score for the Spacing category on the MHT is 34.

Reliability

Reliability studies demonstrated interrater reliability for two experienced scorers of twenty handwriting samples reached r= 0.99 for total test scores with a range by category from r=0.90 for form to r=0.99 for alignment and size (Reisman, 1993, p. 48). For another rater who was inexperienced, 20 samples were scored and compared to the experienced raters. The correlation obtained on the total test scores was r=0.98 with a range in category from r=0.87 to r=0.98 (Reisman, 1993, p. 48).

Another inexperienced rater achieved 86% agreement with a second rater on 15 samples. These inexperienced raters used the printed directions and learned the scoring independently (Reisman, 1993, p. 49). Reisman (1993) postulated that the high reliability between raters may be attributed to the precise

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directions and ruler measurement of samples. This limits the amount of subjective input into the evaluation of handwriting.

Intrarater reliability of the MHT was studied to determine the consistency of scoring within individual raters. Three raters ranging in experience using the MHT scored 20 samples. They re-scored the same samples five to seven days later. The two experienced raters achieved 98.5% - 98.7% (Reisman, 1993, p. 49). The inexperienced rater achieved 96.4%.

Test re-test reliability did not achieve as high scores as the other reliability studies. Reisman (1993) attributes this lower correlation to possible differences in test conditions or student's motivation and attention to task in two testing periods (p. 52). The correlation for total accuracy scores was r=0.72 with a between school range of r=0.58 - 0.94 (Reisman, 1993, p. 50). Reisman (1993) recommended that " therapists using the MHT in the evaluation process consult the classroom teacher to verify whether a handwriting sample is an accurate representation of a particular student's performance" (p. 51).

The researcher for this study engaged an evaluator to score the MHT and completed a similar interrater and intrarater evaluation between the researcher and the evaluator. The evaluator was a university student, who had no formal training in handwriting instruction. She was unaware of which students were in the experimental classes and which students were in the control class. Both the researcher and the evaluator were inexperienced in scoring the MHT. In order to test interrater reliability, the researcher and the evaluator used the first set of ten

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samples provided with the MHT. This was used in order to discuss the differences in scoring and determine the cohesion of the interpretation of the scoring between the researcher and the evaluator. Following scoring and discussion of the first ten samples, the second ten samples were used for analysis of interrater reliability. The researcher and the evaluator achieved a Pearson Product - moment correlation of $r= 0.9933$, $p<.001$. This agreement was statistically significant.

The evaluator scored all handwriting samples for the study. After scoring all samples, she randomly picked ten samples to re-score. She was unaware of the first score for each sample. The intrarater reliability analysis achieved a Pearson Product - moment correlation $r=0.9912$, $p<.001$, between 1st scores and 2nd scores. Therefore, interrater and intrarater reliability for the evaluator achieved statistical significance.

Validity

Data on the validity of the MHT was not available. However, a study completed by Reisman (1990) which looked at children who were referred to occupational therapy for handwriting intervention, determined that children who scored the lowest on the MHT from a sample of second grade students (N=565) were the children that required handwriting intervention according to teachers and occupational therapists. The differences among four groups of students; regular classroom, no special education, mainstreamed students who received special education for part of the day, students in the regular classroom with handwriting

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difficulties, and mainstreamed students receiving special education and occupational therapy, were statistically significant (Reisman, 1990, p. 851). This study identified that students with poorer handwriting scored the lowest on the MHT in a large sample.

Procedure

The procedure for the present study consisted of the following steps:

Pre-Test : October 1997 (Mid-Month)

Intervention: Ongoing printing instruction (October - December)

Test Period: December 1997 (Mid-Month)

Intervention: Ongoing printing instruction (December - January)

Test Period: January 1998 (Mid-Month)

Intervention: Ongoing printing instruction (January - February)

Test Period: February 1998 (Mid-Month)

Intervention: Ongoing printing instruction (February - March)

Test Period: March 1998 (Mid-Month)

Intervention: Ongoing printing instruction (March - April)

Test Period: April 1998 (Mid-Month)

Intervention: Ongoing printing instruction (April - May)

Test Period: May 1998 (Mid-Month)

Intervention: Ongoing printing instruction

Final Test Period: June 1998 (Mid-Month)

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Pre-test

During the middle of October, the teachers for the experimental classes and the control class administered the *Minnesota Handwriting Test.* The researcher provided the teachers with the administration procedures and test sheets. The instructions were clearly identified for the teachers. All students provided the handwriting sample on the same day. It was not determined whether the sample took place in the morning or the afternoon. Handwriting instruction occurred in each of the study classrooms on a limited basis in September and beginning of October. The experimental classrooms were reviewing the uppercase letters while the control group were starting lowercase letters.

Subsequent Test Periods

Starting in December 1998, the researcher went into the three classrooms to administer the *Minnesota Handwriting Test.* The first test period was completed in the middle of December. Subsequent test periods were in the middle of each month to include January, February, March , April, May and June.

During the test periods, the children remained seated at their desks. They used their own pencils for the session. The students were given the instructions, asked if they had any questions and then were told to begin printing. At the same time as they began the sample, the timer was started. At 2.5 minutes, the children were asked to stop and put their pencils down. Once they all stopped, they were asked to circle the last printed letter and continue until they were finished.

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The experimental groups were taught using doubled lined paper not the triple lined paper that was used on the MHT. Because of this difference, and disadvantage, it was decided that another sample would be completed. This other sample, was not brought into the test for scoring or statistical analysis. It was used for observation only.

In June, all subjects in the three classrooms were asked to do an extra handwriting sample. This sample was completed on regular blue lined paper that the children use in the classroom, the type usually present in their Hilroy exercise books. The children completed the sample " The red baseball team won the game". Samples were not used for statistical analysis, but for observation.

Ongoing Printing Instruction

The teachers were asked, using a questionnaire, to identify their experience in teaching handwriting, and the process that they used in their handwriting instruction sessions.

The teachers in all three classes taught printing on an ongoing basis throughout the school year. The teachers in the experimental group taught the children using the *Handwriting Without Tears* program while the teacher in Class 3 used the more traditional ball and stick method.

All three teachers have taught printing at the present grade 1 level for many years. The teachers in Class 1 and Class 2 had recent training in the *Handwriting Without Tears* method of handwriting instruction. The Class 1 teacher was using

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it for the first time. While, the Class 2 teacher used *Handwriting Without Tears* for the last third of the previous school year. Both Class 1 and Class 2 teachers had a teacher's manual to use as a guide. The teachers in Class 1 and Class 3 had formal instruction on teaching handwriting to students in Teachers' College where they learned the Zaner Bloser (ball and stick) Method . All three teachers have followed (Class 1 and Class 2) or are following (Class 3) the Board of Education's curriculum guidelines which were developed in the 1970's and 1980's. The teacher in Class 2 did not receive any formal instruction for handwriting teaching except the training for *Handwriting Without Tears*.

The teacher in Class 1 reported teaching the children handwriting four to five times per week at the beginning of the school year. These were then gradually lessened to one session per week during the later third of the school year. Incidental teaching of printing occurred throughout the year as needed during the day. Verbal instruction and letter correction was included in the incidental teaching. With more complicated letters, incidental teaching occurred using the blackboard for teaching and practice.

The teacher of Class 2 conducted formal printing instruction sessions using the *Handwriting Without Tears* program, until April 1998. In April, printing was reinforced incidentally. Printing was taught throughout the day on an as need basis with reinforcement of letter formation. Incidental teaching usually occurred in journal writing and seat work.

In the experimental groups, the children were taught the capital letters first,

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and then moved on to the lowercase letters by November 1997. The lowercase letters were then taught throughout the school year. The children started printing using their individual workbooks entitled *My Printing Book.* This book utilized double lines, the bottom (bumping line) and the top line (starting line). The children started with wider lines and were using smaller width lines by the end of the year. Transition to the regular exercise book lines was taught at the end of the school year.

The teacher of Class 3 taught formal handwriting sessions throughout the school year using the Ball and Stick Method. The teacher reported that lowercase letters were taught first, then the capital letters. The teacher used four lines to orient letter placement during instruction at the beginning of the school year. In the spring, the children were switched to three lines and were taught to reduce the size of their printing.

Group Similarities and Differences

Classes - Baseline Measurement

Tables 1 through 3 display the mean, standard deviation and number of students for each class at the baseline measurement for total test scores and category test scores. Baseline measurements from the October samples on the *Minnesota Handwriting Test* (MHT) showed that the control class started with different abilities than the experimental classes (see Table 1). An analysis of variance was conducted to statistically determine the differences between the

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classes at the start of the study. It was determined statistically $F(2,55)= 6.77$, $p<0.002$, that the control class (Class 3) was different from the experimental classes (Class 1 and 2). That is, Class 3 performed significantly better on the *Minnesota Handwriting Test* than both the experimental groups, at the baseline test period for total test score. The mean for the control group, in all categories, was considerably higher than those of the experimental group (see Table 1). The standard deviation from the class norm was also consistently lower, which means that the control group consisted of students whose handwriting skills varied less widely than those in the experimental groups. Therefore, the control group started with better handwriting. Because of this statistical difference between the experimental and the control classes, it was essential to utilize change scores for comparisons between the classes.

Girls - Baseline Measurements

The results above was mirrored by the girls in the experimental classes and the control class. Baseline measurements from the October samples on the *Minnesota Handwriting Test* showed that the girls in the control class started with different abilities than the experimental classes (see Table 2). An analysis of variance was conducted to statistically determine the differences between the classes at the start of the study. It was determined statistically $F(2,35)=11.02$, $p<0.000$, that the girls in the control class (Class 3) were different from the girls in the experimental classes (Class 1 and 2). Therefore, the girls in the control group

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started with better handwriting. Refer to Table 2 to review the means and standard deviations of the girls in these classes.

Boys- Baseline Measurements

Baseline measurements from the October samples on the MHT showed that the boys in the control class and the experimental classes started with similar abilities at the start of the study. An analysis of variance was conducted on the means of the boys in the control class and experimental classes. It was determined statistically $F(2,19)=0.1334$, $p<0.876$, that the boys in the control class and the experimental classes were the same (see Table 3). Therefore the boys in the control group and the experimental groups started with the same handwriting skills.

Use of Gain Scores

Because of the statistical differences between the experimental classes (Class 1 and 2) and the control class (Class 3), it was essential to utilize change scores to allow for comparison between the experimental classes and the control classes. Change scores were also utilized for comparison of the girls between experimental classes and the control class. For the analysis of the experimental classes and control class, and the girls in the experimental classes and control class, overall total improvement scores were calculated by measuring the magnitude of change in handwriting performance from the baseline measures to the various test periods.

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The statistical similarities between the boys in the experimental classes and the control classes allow for direct comparison between these groups. As well, change scores have been utilized for comparison of improvements in the boys.

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Table 1

Classes - Baseline Measurement

Comparison of Means and Standard Deviation Between the Experimental Classes and the Control Class at the Baseline (October) Measure

	Mean (M)	Std Dev (SD)	Cases
Total Scores			
Class 1	106.35	23.45	20
Class 2	107.50	25.17	22
Class 3	134.71	24.79	14
Legibility Scores			
Class 1	30.00	3.40	20
Class 2	30.22	4.19	22
Class 3	32.43	2.50	14
Form Scores			
Class 1	22.80	5.54	20
Class 2	23.23	6.18	22
Class 3	26.43	4.77	14
Alignment Scores			
Class 1	15.40	7.94	20
Class 2	17.32	7.89	22
Class 3	24.36	7.82	14
Size Scores			
Class 1	12.89	7.98	20
Class 2	10.36	6.77	22
Class 3	20.09	9.41	14
Spacing Scores			
Class 1	25.90	5.43	20
Class 2	26.36	5.14	22
Class 3	30.57	3.44	14
Speed Scores (Letters Per Minute)			
Class 1	8.50	2.34	20
Class 2	8.89	3.17	22
Class 3	9.55	1.44	8

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Table 2

Girls - Baseline Measurement

Comparison of Means and Standard Deviation Between the Girls in the Experimental Classes and the Girls in the Control Class at the Baseline (October) Measure

	Mean (M)	Std Dev (SD)	Cases
Total Scores			
Class 1	109.33	23.64	15
Class 2	112.60	19.62	10
Class 3	145.09	15.41	11
Legibility Scores			
Class 1	30.47	3.58	15
Class 2	31.30	2.54	10
Class 3	33.36	0.67	11
Form Scores			
Class 1	24.07	5.02	15
Class 2	26.10	4.20	10
Class 3	28.27	3.44	11
Alignment Scores			
Class 1	15.27	8.34	15
Class 2	16.70	7.36	10
Class 3	27.45	5.34	11
Size Scores			
Class 1	13.21	8.11	15
Class 2	10.20	5.98	10
Class 3	24.10	7.96	11
Spacing Scores			
Class 1	27.20	4.96	15
Class 2	28.30	3.62	10
Class 3	27.08	6.46	11
Speed Scores (Letters Per Minute)			
Class 1	8.51	2.65	15
Class 2	9.48	3.33	10
Class 3	9.46	1.45	6

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Table 3

Boys - Baseline Measurement

Comparison of Means and Standard Deviation Between the Boys in the Experimental Classes and the Boys in the Control Class at the Baseline (October) Measure

	Mean (M)	Std Dev (SD)	Cases
Total Scores			
Class 1	97.40	22.83	5
Class 2	103.25	29.18	12
Class 3	96.67	6.51	3
Legibility Scores			
Class 1	28.60	2.61	5
Class 2	29.33	5.12	12
Class 3	29.00	4.00	3
Form Scores			
Class 1	19.00	5.79	5
Class 2	20.83	6.70	12
Class 3	19.67	1.15	3
Alignment Scores			
Class 1	15.80	7.43	5
Class 2	17.83	8.59	12
Class 3	13.00	3.00	3
Size Scores			
Class 1	12.00	8.46	5
Class 2	10.50	7.62	12
Class 3	9.33	1.53	3
Spacing Scores			
Class 1	22.00	5.34	5
Class 2	24.75	5.79	12
Class 3	25.67	2.08	3
Speed Scores (Letters Per Minute)			
Class 1	8.48	1.25	5
Class 2	8.40	3.09	12
Class 3	9.80	1.98	3

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CHAPTER IV

Results

The results of the study are presented in this chapter. At the start of this chapter some of the children's handwriting samples are included. The samples allow the reader to "see" the differences from the baseline measurement in October to the final measurement in June. Samples of one girl in each class and one boy in each class are included for direct observation of change within these groups. Following the samples, the reader will be presented with the statistical comparison of the experimental classes and control classes. The total test scores for each of the classes are presented first followed by the category test scores for the classes. Change within groups is then presented. Following within group comparison, the reader is provided with gender comparisons. Firstly, the statistical analysis of the girls in the experimental classes and the girls in the control class is introduced. Secondly, the statistical analysis of the boys in the experimental classes and the boys in the control class is provided. Tables and Figures follow the presentation of the results for each comparison.

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Handwriting Samples

Figures 1-12 are the pre-test samples (October) and the final test samples (June) of the MHT for students from the experimental classes and the control class. They are presented in the following order:

Figure 1: Girl Class 1: Pre-test (October)

Figure 2: Girl Class 1: Post-test (June)

Figure 3: Boy Class 1: Pre-test (October)

Figure 4: Boy Class 1: Post-test (June)

Figure 5: Girl Class 2: Pre-test (October)

Figure 6: Girl Class 2: Post-test (June)

Figure 7: Boy Class 2: Pre-test (October)

Figure 8: Boy Class 2: Post-test (June)

Figure 9: Girl Class 3: Pre-test (October)

Figure 10: Girl Class 3: Post-test (June)

Figure 11: Boy Class 3: Pre-test (October)

Figure 12: Boy Class 3: Post-test (June)

These samples illustrate the amount of improvement in handwriting skills for the experimental classes and the control class.

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Figure 1

Pre-test Sample: Girl, Class 1

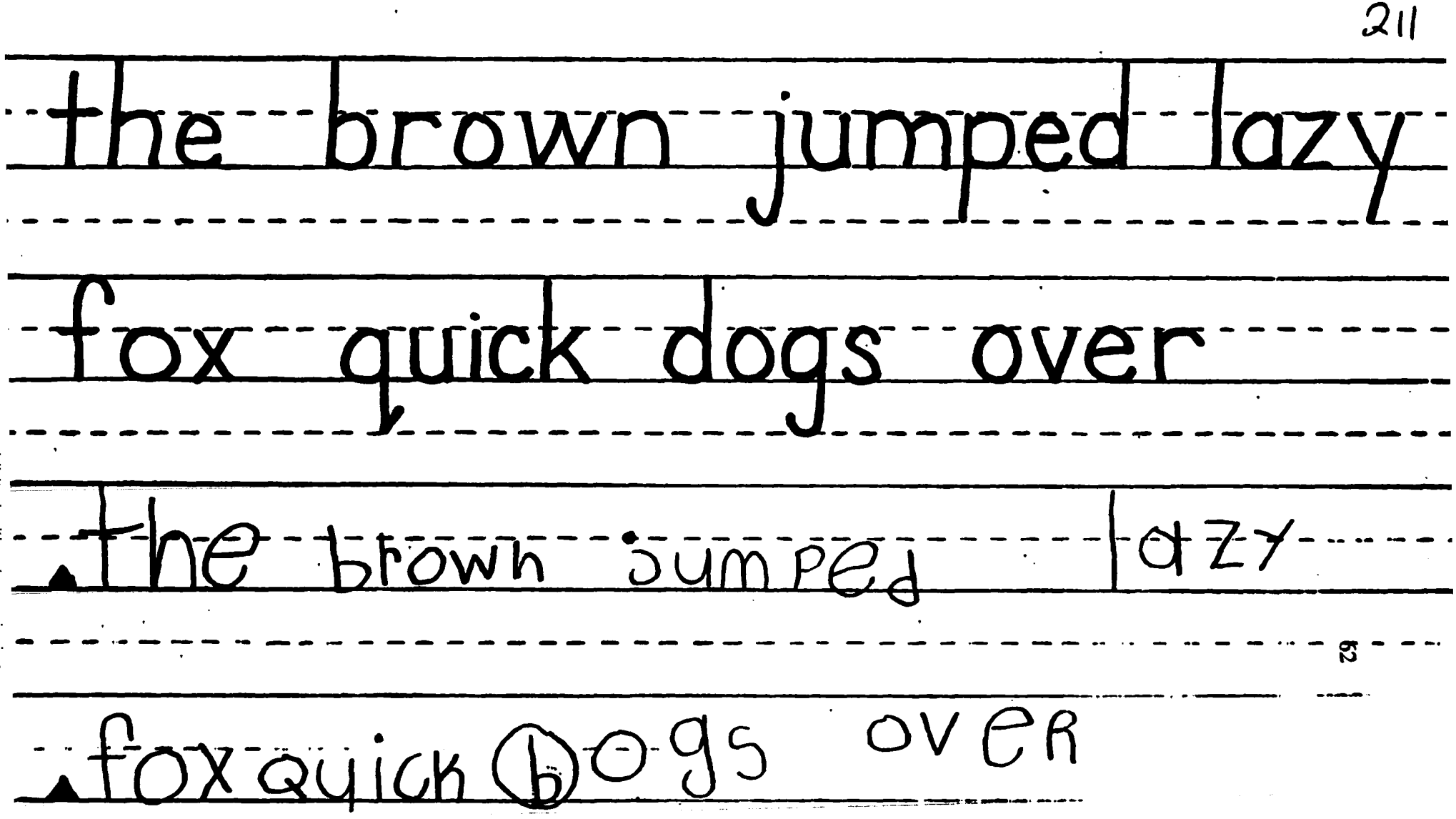

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Figure 2

Post-test Sample: Girl, Class 1

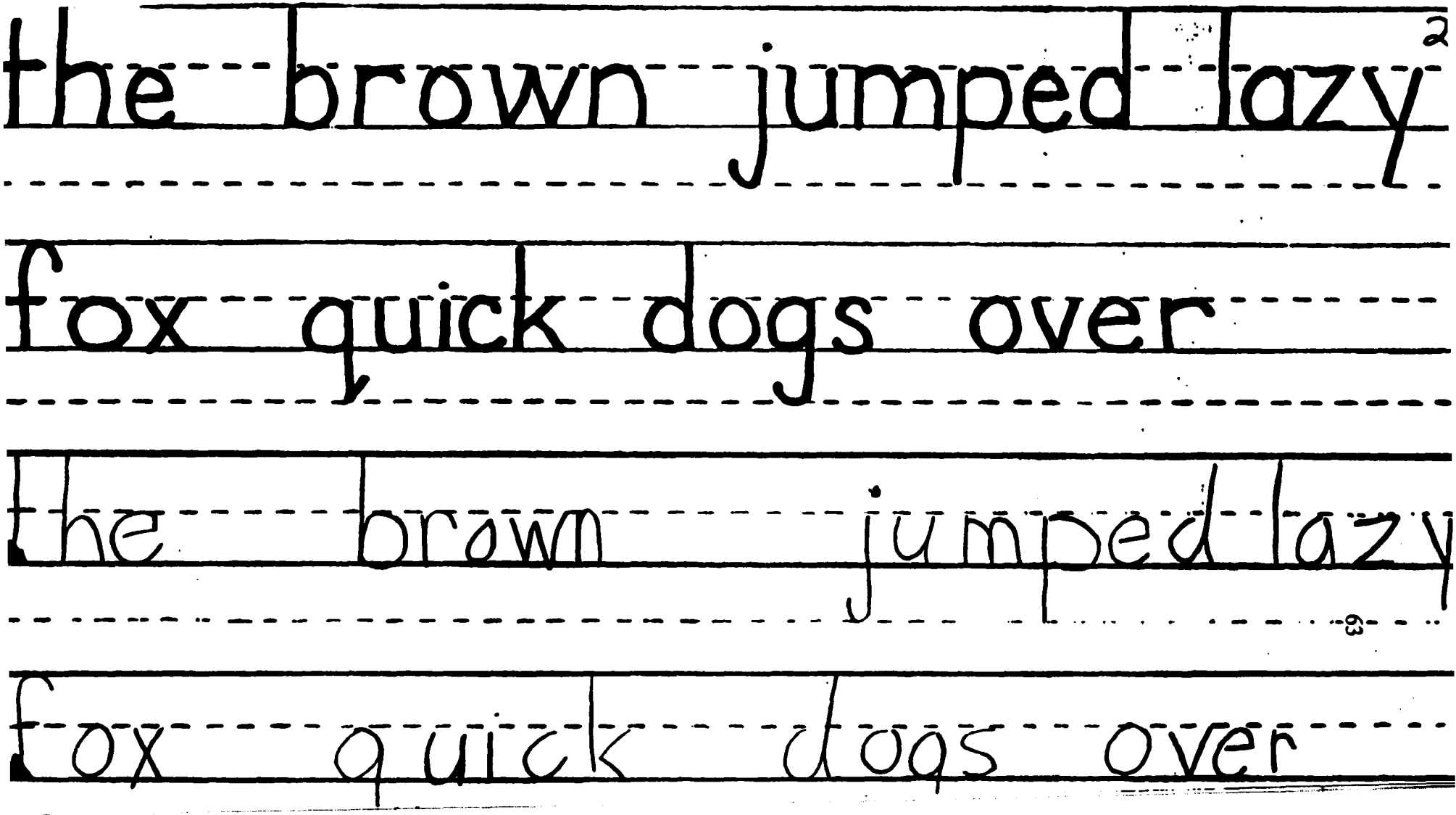

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Figure 3

Pre-test Sample: Boy, Class 1

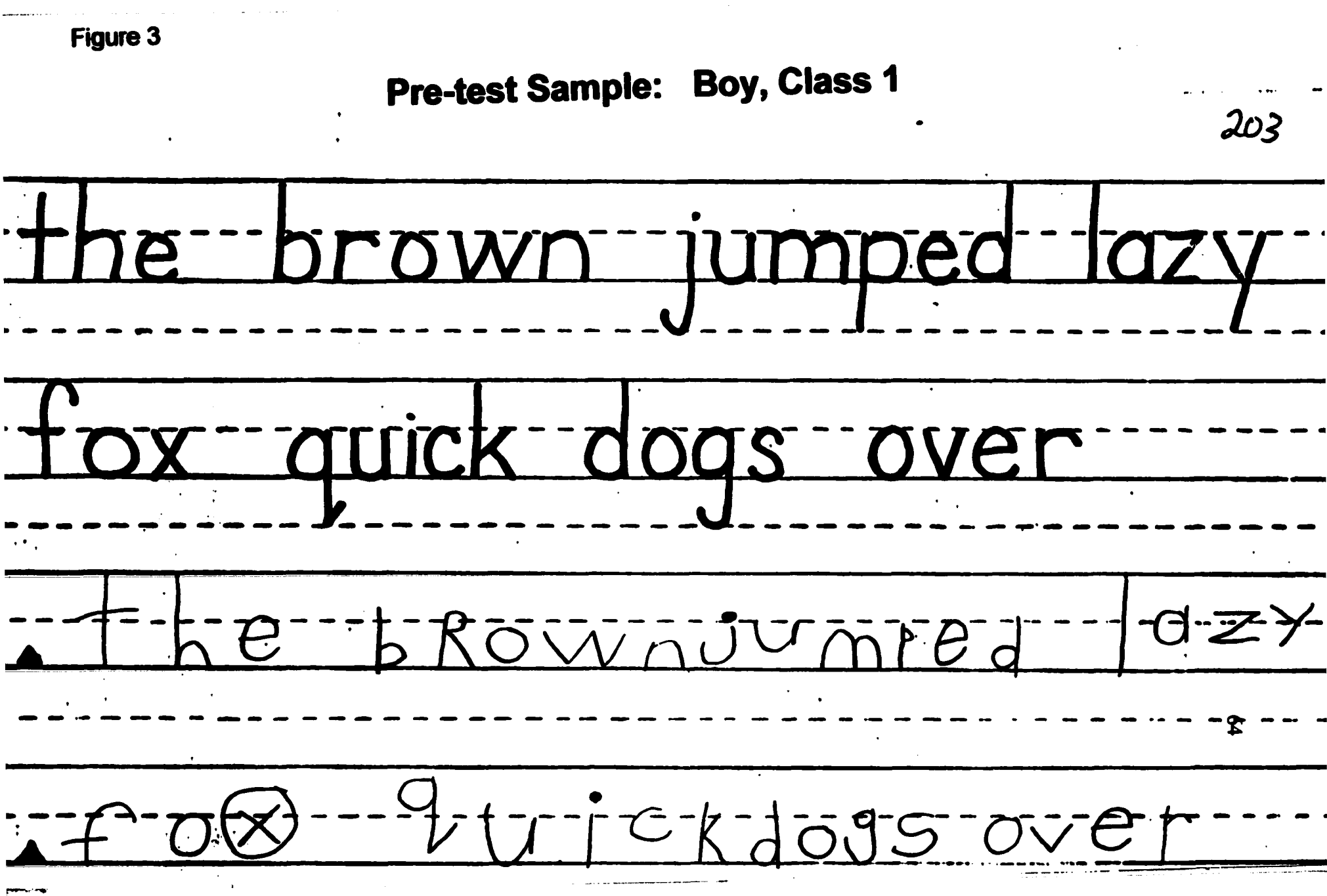

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Figure 4

Post-test Sample: Boy, Class 1

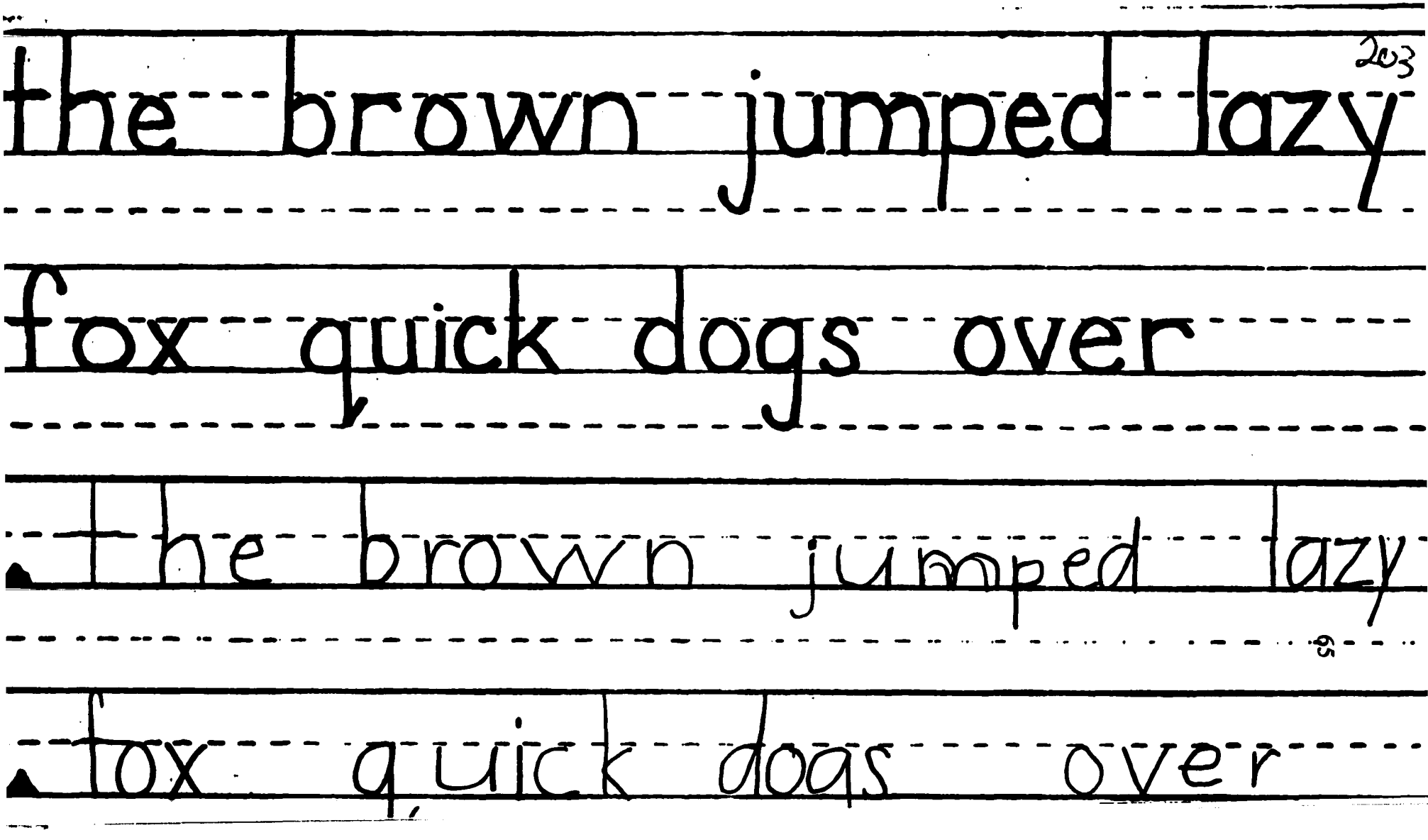

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Figure 5

Pre-test Sample: Girl, Class 2

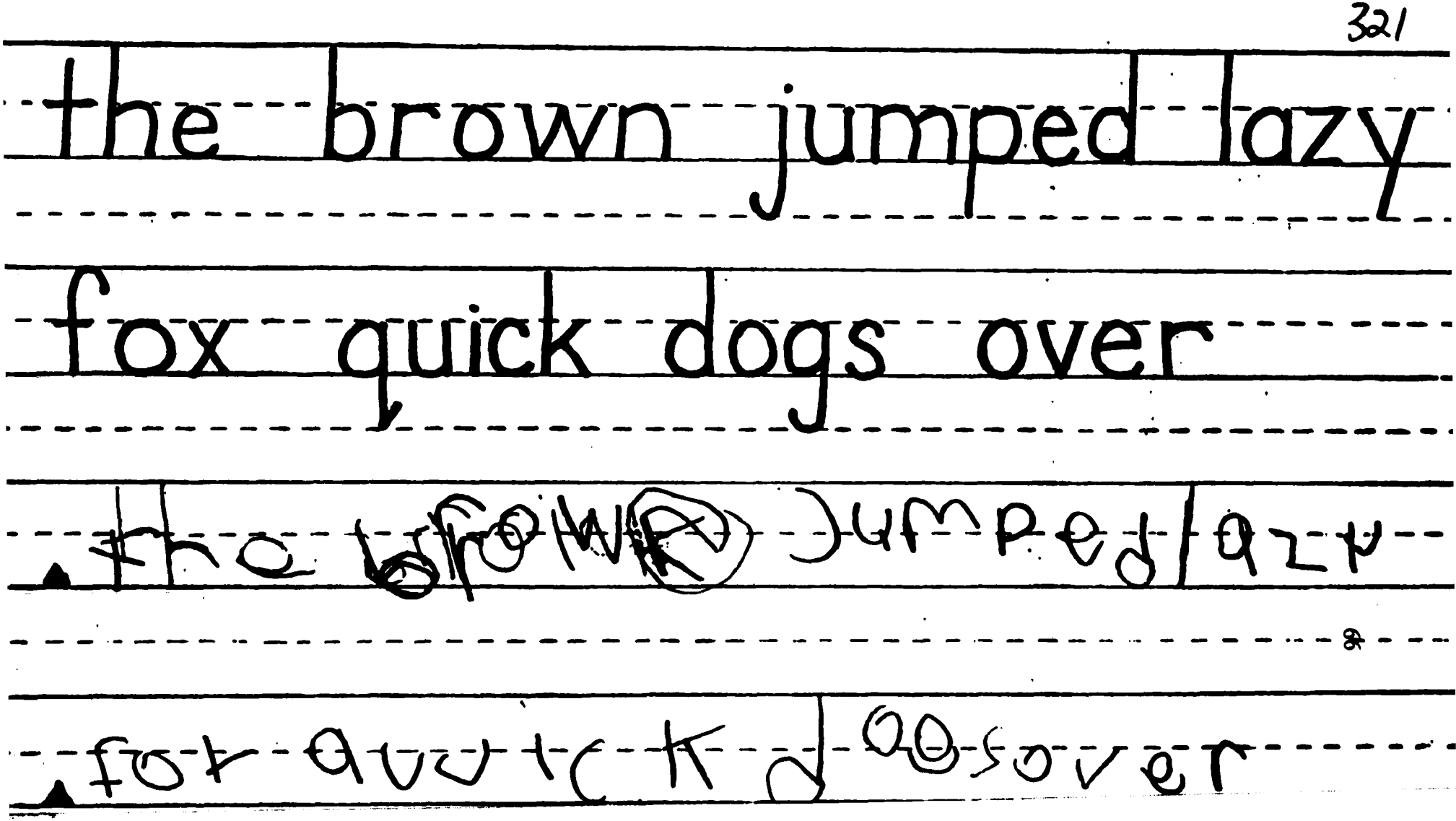

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Figure 6

Post-test Sample: Girl, Class 2

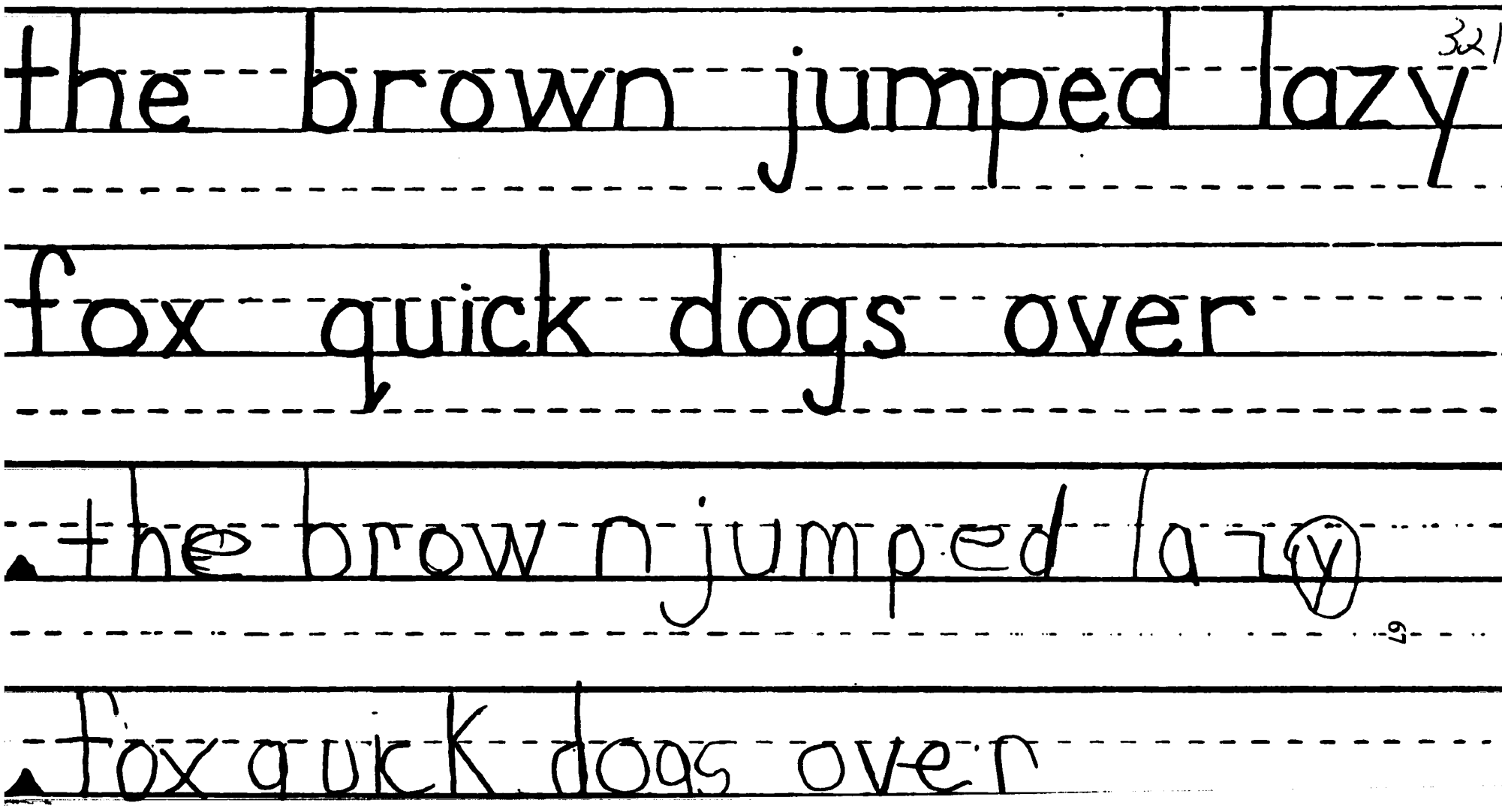

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Figure 7

Pre-test Sample: Boy, Class 2

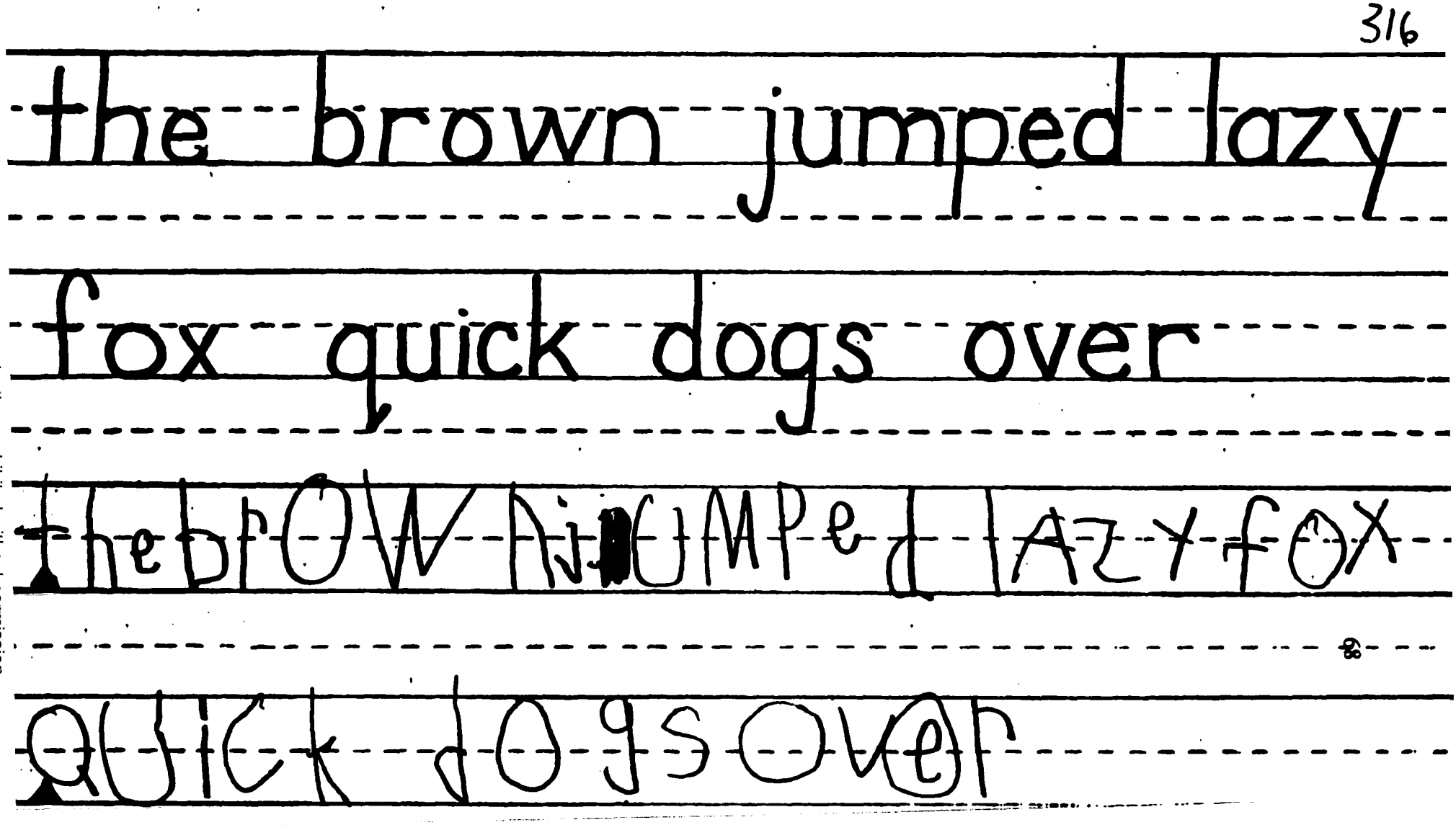

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Figure 8

Post-test Sample: Boy, Class 2

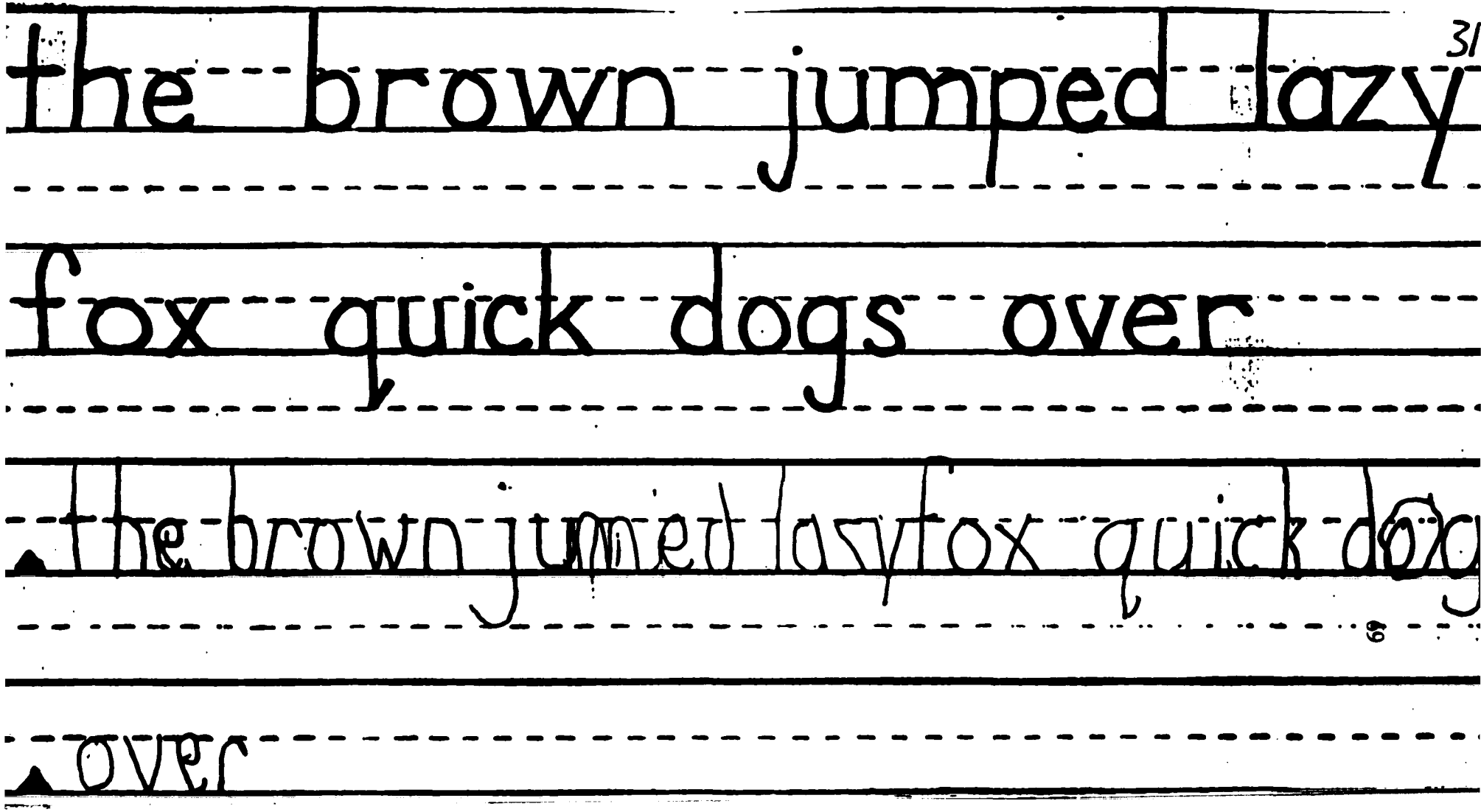

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Figure 9

Pre-test Sample: Girl, Class 3

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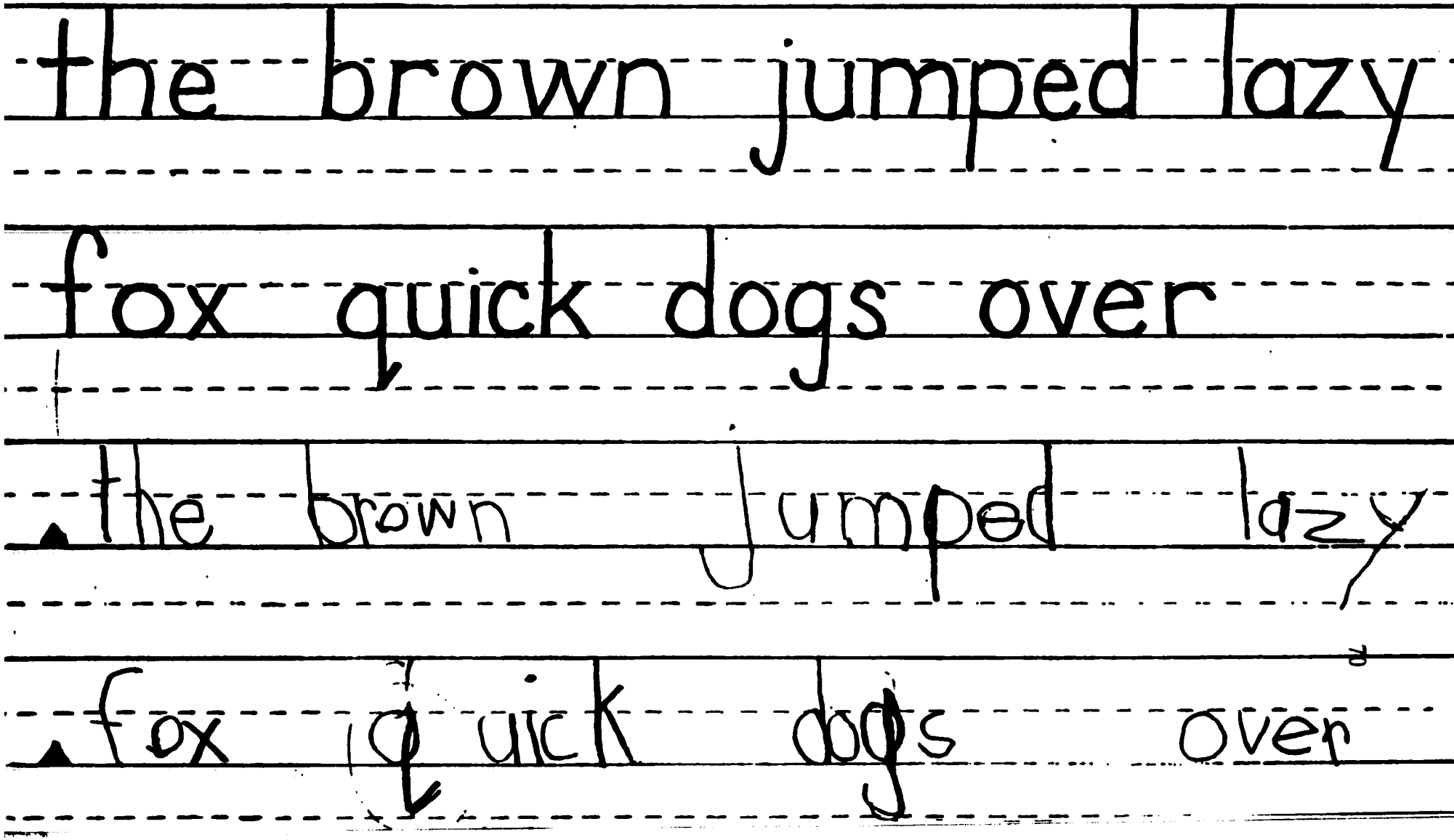

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Figure 10

Post-test Sample: Girl, Class 3

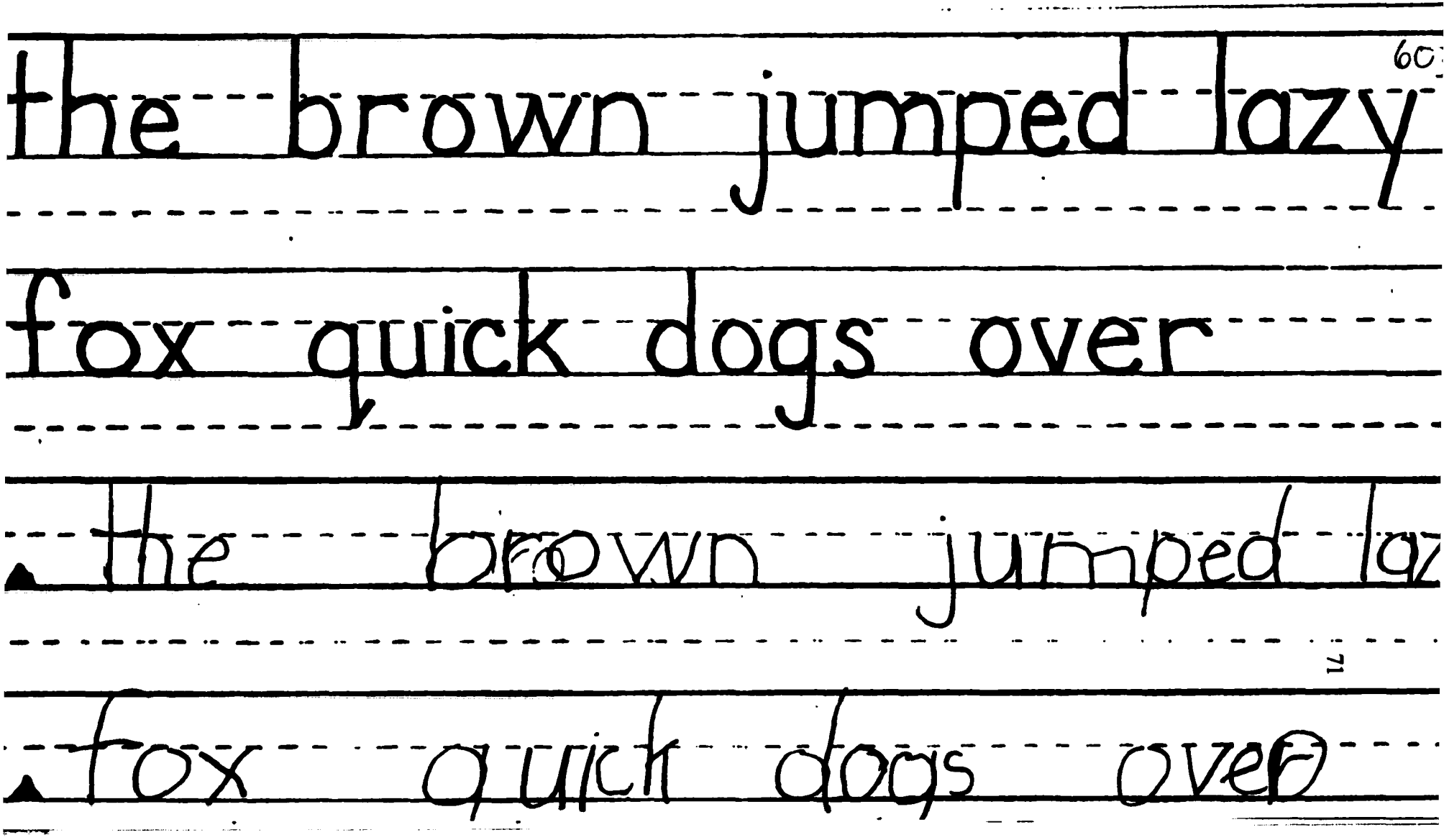

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Figure 11

Pre-test Sample: Boy, Class 3

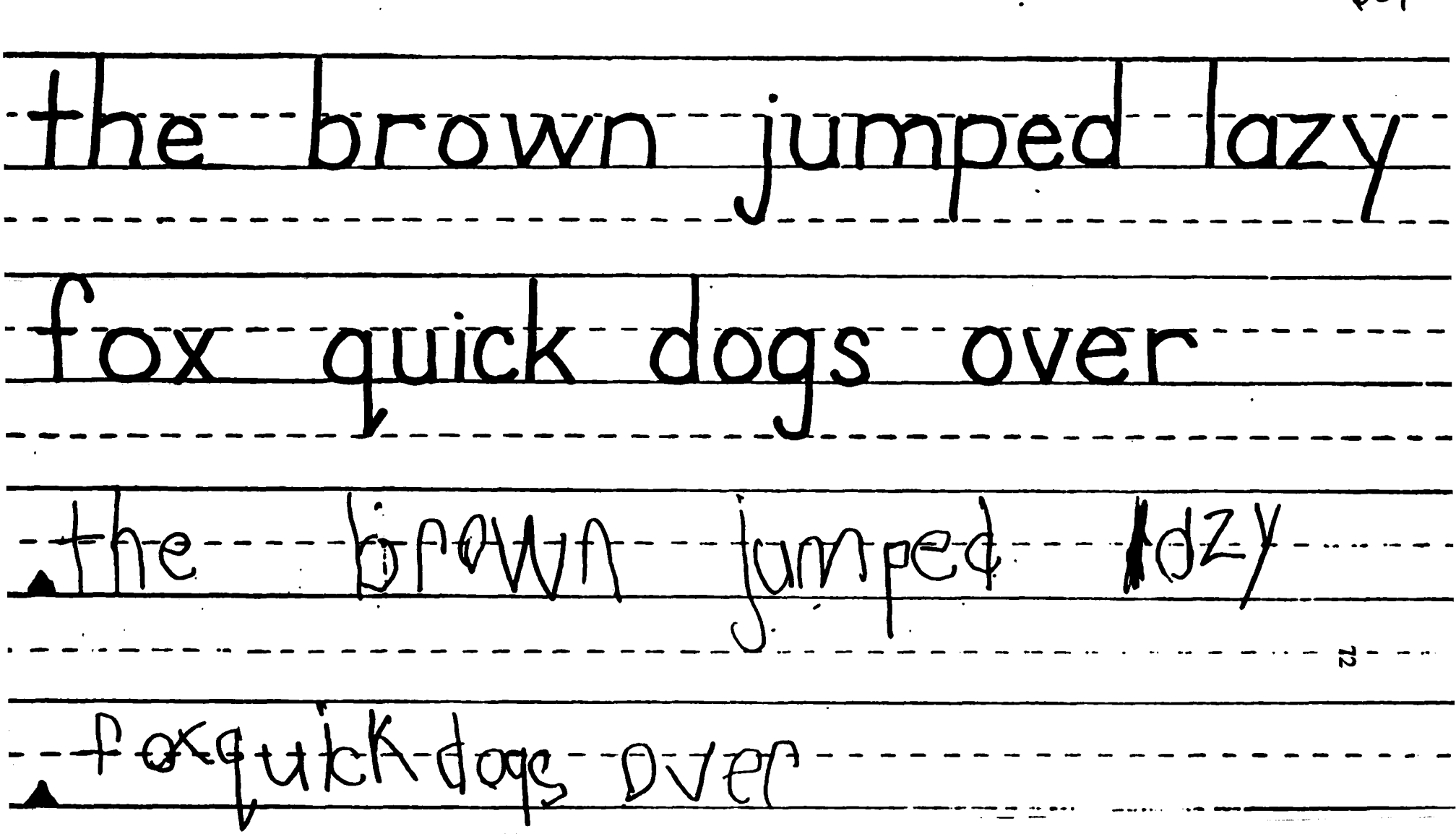

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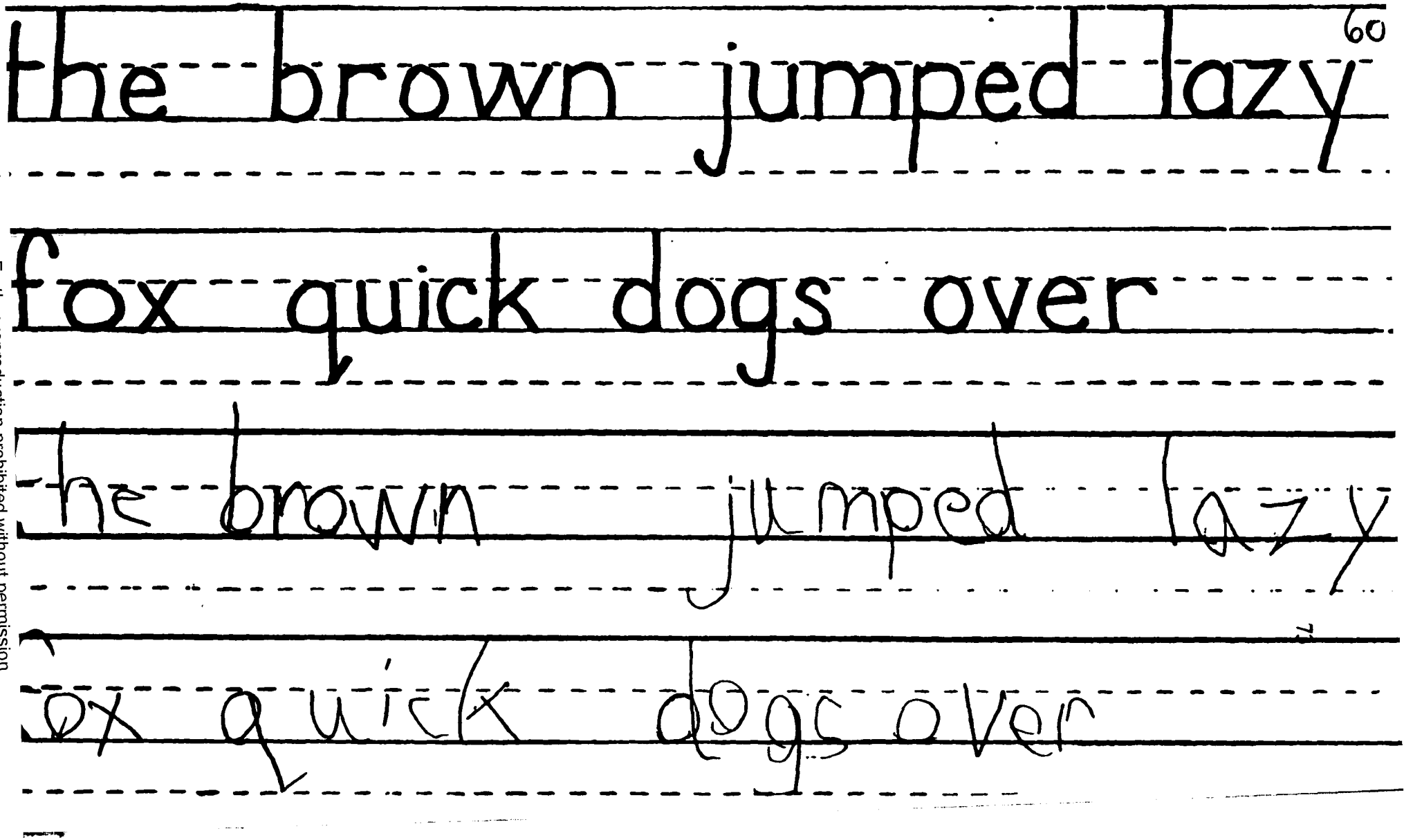
Figure 12

Post-test Sample: Boy, Class 3



Statistical Analysis and the Interpretation of the Results

A statistical analysis was completed on the MHT test scores of the three classes. In order to test for differences between the experimental classes and the control classes on the MHT test scores, a one-way analysis of variance technique (ANOVA) was used. The (ANOVA) is an inferential statistics procedure by which a researcher can test the null hypothesis that two or more population means are equal. If one independent variable is included in the study then the ANOVA is one-way (Wiersma,1991, p. 330). In this study, there is only one independent variable or experimental treatment under study.

When using an ANOVA technique, the total sum of squares (each observation is squared and summed) is partitioned into a number of sum of squares. One sum of squares is based on the mean of all observations; others are sources related to treatment and other reliable variation portions; while other are error sources. Each sum of squares is divided by its df (degrees of freedom) to obtain a mean square. Differences between groups of observations is ascertained by forming a ratio of two mean squares (F ratio) and comparing the resulting value to that obtained from the central F distribution. The central F distribution is the distribution which prevails when the null hypothesis is true (Gaito, 1973).

When analyzing a sample population which received a specific treatment procedure, a population distribution would result if each member of the population obtained a value on a specific dependent variable. In this study, each member of the sample population obtained a total test score on the MHT. If the null hypothesis

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were true (there were no differences between the experimental classes and the control class), the two treatment populations would be the same. Therefore, only one population distribution is involved (central F distribution). On the other hand, if the null hypotheses is not true (there are differences between the experimental classes and the control class), there would be two population distributions present (one central F distribution and a noncentral F distribution). In actual practice, it is unknown whether the null hypothesis is true or not, therefore, samples are drawn, the total sum of squares is partitioned and through appropriated F tests, it is determined if differences exist (Gaito, 1973).

Sources of between group variation, within groups variation and random variation (error variance) are determined. The null hypothesis is tested by forming a ratio of Between Groups mean square (MS) to the Within Groups mean square (MS). If the null hypothesis is true, the F ratio should vary around 1 because both MS will represent estimates of error variation. Therefore the higher the F ratio, the more chances of the null hypothesis being rejected. As a result, differences will exist between the sample populations. The F probability represents the significance or strength of the differences. We will reject the null hypothesis if $p<.05$ (Gaito, 1973).

The one-way ANOVA has a range subcommand of seven different tests that can be used to compare the means of the classes. In this study, the Student-Newman-Keuls (SNK) test was used to compare the means of the three classes to determine which of the classes were different from each other (SPSS, 1988).

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Total Test Scores

Table 4 contains the means and standard deviations of the change scores from the baseline assessment (October) to the subsequent test periods in total test scores on the MHT. An analysis of variance (ANOVA) demonstrated that at the first test period (December), in total test scores, Class 1 exhibited significant improvement relative to Class 3 $F(2,53)=3.18$, $p<.049$. In the second test period (January), both Class 1 and Class 2 demonstrated significantly more improvement than did Class 3 $F(2,55)=14.63$, $p<.000$. Similarly, at the third test period (February, $F(2,47)=11.07$, $p<0.000$); fourth test period (March, $F(2,53)=11.88$, $p<0.000$); fifth test period (April, $F(2,49)=12.41$, $p< 0.000$); sixth test period (May, $F(2,52)=10.34$, $p<0.000$) and the last test period (June $F(2,53)=10.69$, $p<0.000$) both Class 1 and Class 2 demonstrated significantly more improvement on their total writing scores than did Class 3 (see Table 4). Figure 13 displays the total scores by class at the baseline test period (October) and subsequent total scores from the December test period until the June test period.

An ANOVA was performed on the June Total change scores to investigate how class and gender impacted the magnitude of change on the total scores. There was a main effect of class and gender $F(3,50)=6.65$, $p<0.001$. However, only class was significant $F(2,50)=8.64$,$p<0.001$, while gender failed to reach significance $F(1,50)=0.920$,$p<0.34$. The 2-way interaction between class and gender was not significant $F(2,50)=2.65$, $p<0.08$.

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Table 4

Total Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Class on Total Test Scores (MHT)

Time	Experimental Class1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	38.67	32.09	20.43	3.19*	(2,53)	a
SD	19.83	19.61	22.15			
(N)	18	22	14			
Change 2 (Oct.- Jan.)						
M	43.50	41.73	12.14	14.64**	(2,55)	a,b
SD	20.13	19.81	11.53			
(N)	20	22	14			
Change 3 (Oct.-Feb.)						
M	44.12	47.80	14.27	11.07**	(2,47)	a,b
SD	21.41	21.53	12.52			
(N)	17	20	11			
Change 4 (Oct.-Mar.)						
M	42.11	49.14	16.86	11.88**	(2,53)	a,b
SD	19.53	22.07	15.68			
(N)	18	22	14			
Change 5 (Oct.-Apr.)						
M	43.19	52.90	18.85	12.41**	(2,49)	a,b
SD	20.51	21.66	13.43			
(N)	16	21	13			
Change 6 (Oct.-May.)						
M	46.61	52.77	19.15	10.34**	(2,52)	a,b
SD	23.50	21.95	18.18			
(N)	18	22	13			
Change 7 (Oct.-Jun.)						
M	41.75	51.48	18.69	10.69**	(2,53)	a,b
SD	20.54	21.68	16.83			
(N)	20	21	13			

* indicates p<.05
** indicates p<.01

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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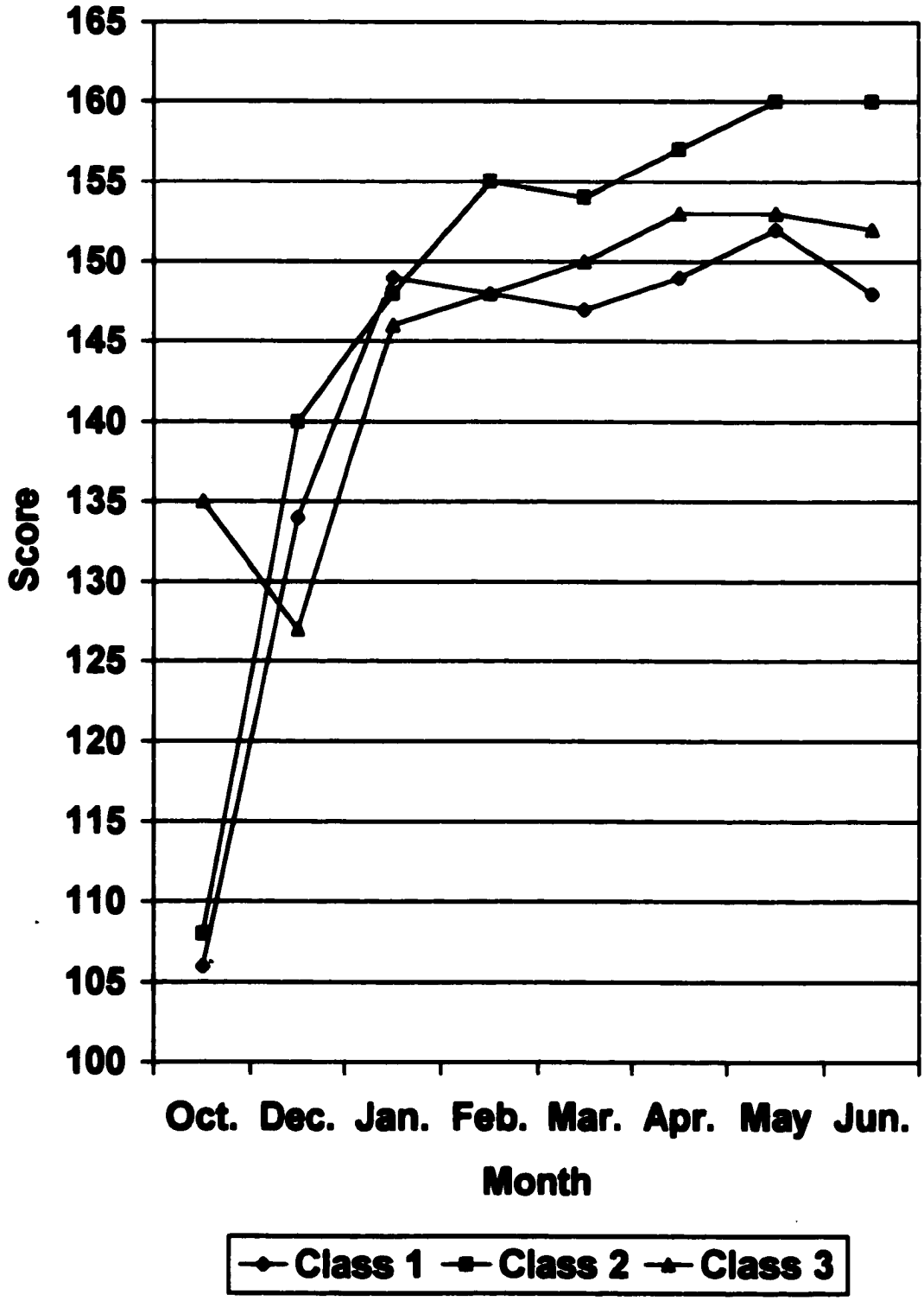
Figure 13: Total Test Scores on the M.H.T. by Class



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Category Test Scores

Five categories of the Minnesota Handwriting Test contributed to the overall total test scores. Each of the five categories were also evaluated using change scores in order to establish relative improvement in each domain. Table 5 through Table 10 located at the end of this section, show the means and standard deviations for each of the category's change scores on the MHT. An ANOVA was performed on the change scores to determine whether the changes were significant. The SNK value on each table will point out which of the classes made a significant change resulting in significant differences. The F ratio is presented on each table. As described earlier, the an F ratio close to 1.00 indicates no differences between the groups. Therefore, the null hypothesis would be accepted. A high F ratio will most probably indicate differences between the groups. Therefore the null hypothesis would be rejected. An F probability (p value) score is provided to identify the chances of type one error. An F probability less than 5% is significant. In this case, $p<.000$ is indicated by two ** and $p<.05$ is indicated by one *. The degrees of freedom (df) indicates the number of ways in which the data are free to vary (n-1) (Wiersma, 1991).

Following each of the tables is a figure (Figures 14 through 19) which illustrates the mean scores on the MHT for each of the three classes for each of the test periods. The figures graph the means for each of the categories. An ANOVA is completed to determine if the changes in the means for each category is significant when comparing classes.

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Legibility

There was no significant difference between the classes at any of the test periods (see Table 5). Figure 14 displays the means of the Legibility category test scores for the experimental and control classes at the baseline period and subsequent test periods. Legibility was not significantly impacted by the handwriting instruction method used.

Form

The Form category change scores are presented in Table 6. Classes 1 and 2 demonstrated significant improvement on form scores when compared to Class 3 ($F(2,53)=3.65$, $p<.03$) at the March test period. At the April test period, only Class 2 demonstrated significant improvement relative to Class 3 ($F(2,49)=3.44$, $p<.04$) in the form category. But in May, both Class 1 and Class 2 showed significant improvement when compared to Class 3 ($F(2,52)=3.79$, $p<.02$). However, these significant improvements were not present at the June test period. Figure 15 displays the means of the Form category test scores on the MHT for each of the classes at the baseline sample period and subsequent test periods.

Alignment

Changes in the Alignment category, which measures the student's ability to position letters on the bottom line are shown on Table 7. Class 1 and Class 2 showed significant improvement relative to Class 3 at all of the test periods, that is:

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December ($F(2, 53)= 6.38$), $p<0.003$), January ($F(2,55)= 9.93$, $p< 0.000$), February ($F(2,47)= 6.41$, $p<0.004$), March ($F(2,53)= 6.67$, $p< 0.003$), April ($F(2,49)=7.92$, $p< 0.001$). May ($F(2,52)= 5.60$, $p<0.005$), and June ($F(2, 53)=7.54$, $p<0.001$) as shown on table 7. There was no significant difference between Class 1 and Class 2. Figure 16 presents the means of the test scores by class for the Alignment category on the MHT from the baseline (October) and subsequent monthly test scores until the final test sample in June.

Size

The Size category change scores are shown in Table 8. Class 1 and Class 2 demonstrated significant improvement relative to Class 3 during the first 3 test periods , December ($F(2, 52)=11.64$, $p<0.000$), January ($F(2,54)=18.34$, $p<0.000$), February ($F(2,46)=16.51$,$p<0.000$). At the March test period, Class 1 and Class 2 also demonstrated significant improvement when compared to Class 3, but Class 2 demonstrated significantly more improvement than Class 1 ($F(2,52)=15.52$, $p<.0000$). At the April ($F(2,49)=18.00$,$p< 0.000$), and May ($F(2,51)=18.89$, $p<0.000$) test periods, Class 1 and Class 2 demonstrated significant improvement in comparison with Class 3 (see Table 8). At the June test period, Class 1 and Class 2 demonstrated significantly more improvement on size scores than did Class 3. Again, in this final test Class 2 demonstrated significantly more improvement than Class 1 ($F(2,52)=13.92$, $p<.0000$). Figure 17 displays the Size category test scores for the classes at the baseline test period and at subsequent test periods until the

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final test sample in June.

Spacing

The spacing category was measured for change in spacing from the baseline measure to the subsequent test periods (see Table 9). No significant differences were identified for the December test, nor for the February, March, April, and May. However, in January, Class 1 demonstrated significant improvement when compared to Class 3 ($F(2, 55)= 4.04$, $p<.023$) and also in June Class 2 demonstrated a significant improvement in test scores when compared with Class 3 ($F(2, 53)=3.32$,$p<.044$). There were no differences noted between Class 1 and Class 2 at any of the test periods (see figure 18).

Speed

At the beginning of the study an ANOVA was completed to determine whether there were differences between the classes in the area of speed. In October, there were no statistical differences in speed for Class 1, Class 2 or Class 3, $F(2,49)= 0.456$, $p<0.64$. At the final test in June, Class 1 and Class 3 were statistically faster in handwriting than Class 2. Class 3 was also statistically faster than Class 1 in June, $F(2,57)=11.33$, $p<0.000$. Speed scores were analyzed for statistical differences in improvement between the classes. No statistical difference in speed was identified in the December and January test periods. At the February test period, Control Class 3 demonstrated significant improvement in speed when

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compared to the Experimental Classes 1 and 2 , $F(2,41)=4.32$, $p<0.02$. In March, April, and May, there were no statistical differences identified between the groups for improvement in speed. At the June test period, Class 1 demonstrated significantly more improvement than Class 2 and Class 3, $F(2,47)=3.21$, $p<0.05$)(see Table 10 and Figure 19).

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Legibility Category Test Scores

Comparisons of Change Scores Between the Experimental Classes and the control Class on Legibility Category Test Scores (MHT)

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	3.72	2.68	4.29	0.57	(2,53)	
SD	3.89	4.02	6.11			
(N)	18	22	14			
Change 2 (Oct.- Jan.)						
M	3.05	2.95	1.46	1.59	(2,55)	
SD	2.98	3.15	2.06			
(N)	20	22	14			
Change 3 (Oct.-Feb.)						
M	2.53	3.45	1.36	1.48	(2,47)	
SD	2.40	4.15	2.34			
(N)	17	20	11			
Change 4 (Oct.-Mar.)						
M	2.78	3.59	1.36	2.30	(2,53)	
SD	2.41	3.87	2.13			
(N)	18	22	14			
Change 5 (Oct.-Apr.)						
M	2.75	3.57	1.31	1.86	(2,49)	
SD	3.24	4.04	1.70			
(N)	16	21	13			
Change 6 (Oct.-May.)						
M	2.61	3.50	1.92	0.92	(2,52)	
SD	3.18	4.00	2.53			
(N)	18	22	13			
Change 7 (Oct.-Jun.)						
M	3.05	3.38	1.46	1.42	(2,53)	
SD	3.12	4.15	1.76			
(N)	20	21	13			

* indicates p<.05
** indicates p<.01

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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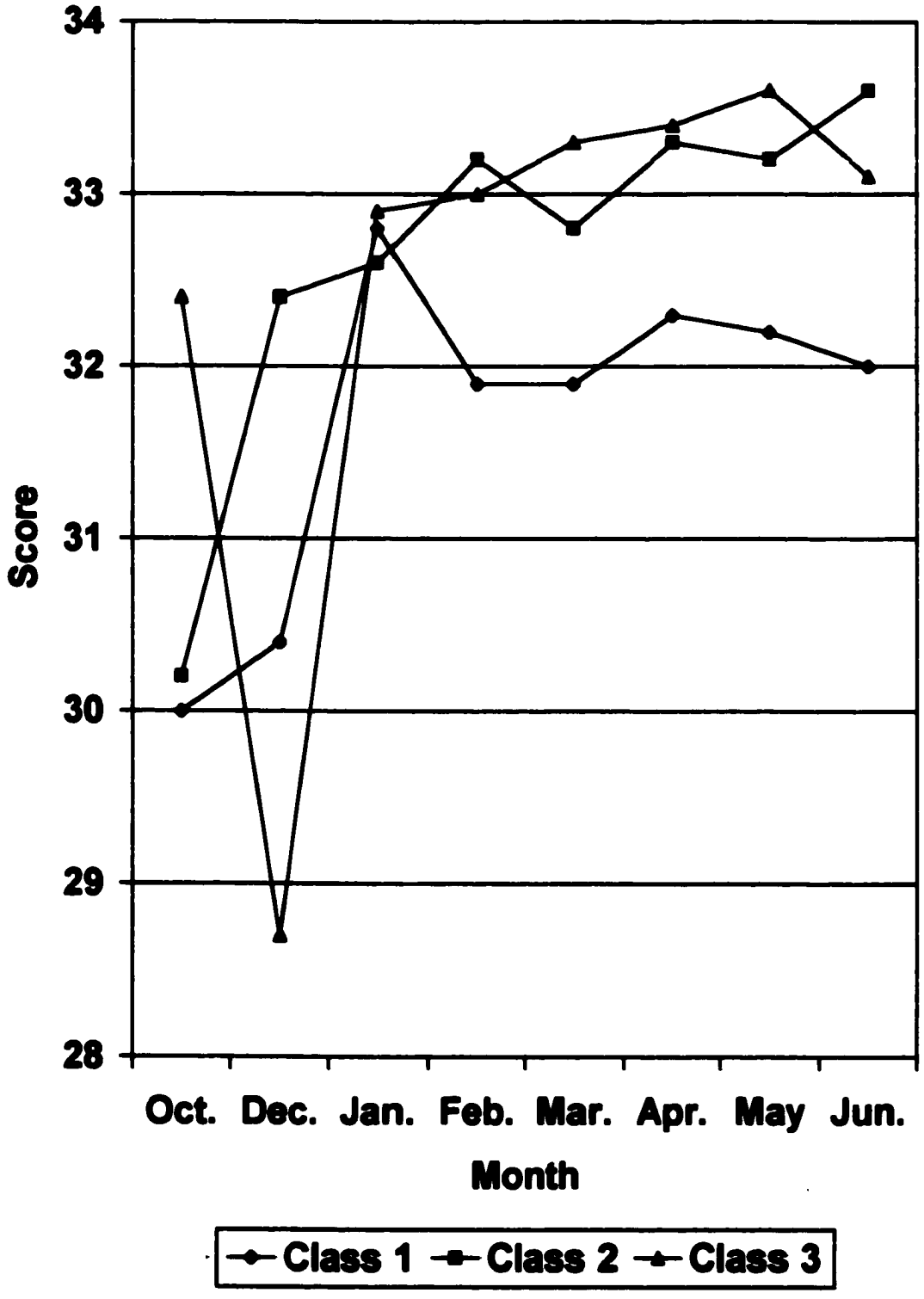
Figure 14: Legibility Category Test Scores on the M.H.T. by Class



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Form Category Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Class on Form Category Test Scores (MHT)

Time	Experimental Class1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	5.22	3.55	5.07	1.08	(2,53)	
SD	4.94	3.08	3.83			
(N)	18	22	14			
Change 2 (Oct.- Jan.)						
M	5.45	5.09	2.50	2.56	(2,55)	
SD	4.57	3.99	2.93			
(N)	20	22	14			
Change 3 (Oct.-Feb.)						
M	6.47	6.10	3.55	2.07	(2,47)	
SD	4.30	4.08	2.91			
(N)	17	20	11			
Change 4 (Oct.-Mar.)						
M	6.72	5.95	2.64	3.66*	(2,53)	a,b
SD	5.03	4.73	2.90			
(N)	18	22	14			
Change 5 (Oct.-Apr.)						
M	6.25	7.33	3.00	3.45*	(2,49)	b
SD	5.48	5.07	2.68			
(N)	16	21	13			
Change 6 (Oct.-May.)						
M	7.61	7.32	3.54	3.80*	(2,52)	a,b
SD	4.86	4.80	2.99			
(N)	18	22	13			
Change 7 (Oct.-Jun.)						
M	6.80	6.14	3.69	2.28	(2,53)	
SD	5.07	4.21	2.14			
(N)	20	21	13			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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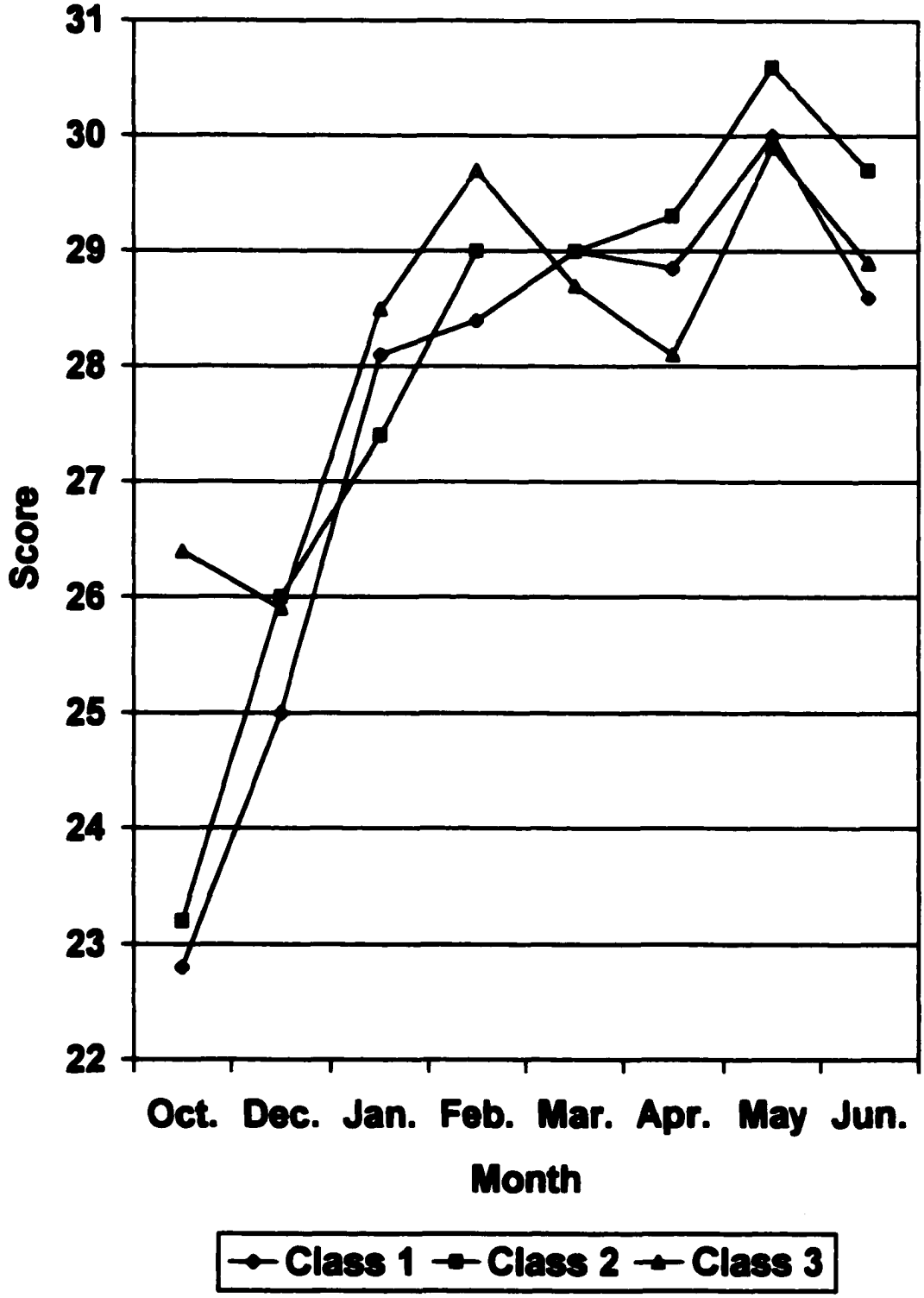
Figure 15: Form Category Test Scores on the M.H.T. by Class



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Alignment Category Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Classes on Alignment Category Test Scores (MHT)

Time	Experimental Class1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	13.11	10.36	4.64	6.38**	(2,53)	a,b
SD	7.70	7.33	3.61			
(N)	18	22	14			
Change 2 (Oct.- Jan.)						
M	15.00	12.64	4.64	9.93**	(2,55)	a,b
SD	7.99	6.88	4.65			
(N)	20	22	14			
Change 3 (Oct.-Feb.)						
M	15.76	14.35	5.73	6.41**	(2,47)	a,b
SD	8.62	7.64	5.69			
(N)	17	20	11			
Change 4 (Oct.-Mar.)						
M	14.83	14.64	6.36	6.67**	(2,53)	a,b
SD	7.62	8.08	5.69			
(N)	18	22	14			
Change 5 (Oct.-Apr.)						
M	15.50	15.90	6.69	7.92**	(2,49)	a,b
SD	7.92	7.06	5.74			
(N)	16	21	13			
Change 6 (Oct.-May.)						
M	15.67	15.59	7.08	6.00**	(2,52)	a,b
SD	8.72	7.59	6.36			
(N)	18	22	13			
Change 7 (Oct.-Jun.)						
M	14.85	15.95	6.46	7.54**	(2,53)	a,b
SD	7.69	7.74	5.74			
(N)	20	21	13			

* indicates p<.05
** indicates p<.01

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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Figure 16: Alignment Category Test Scores on the M.H.T. by Class

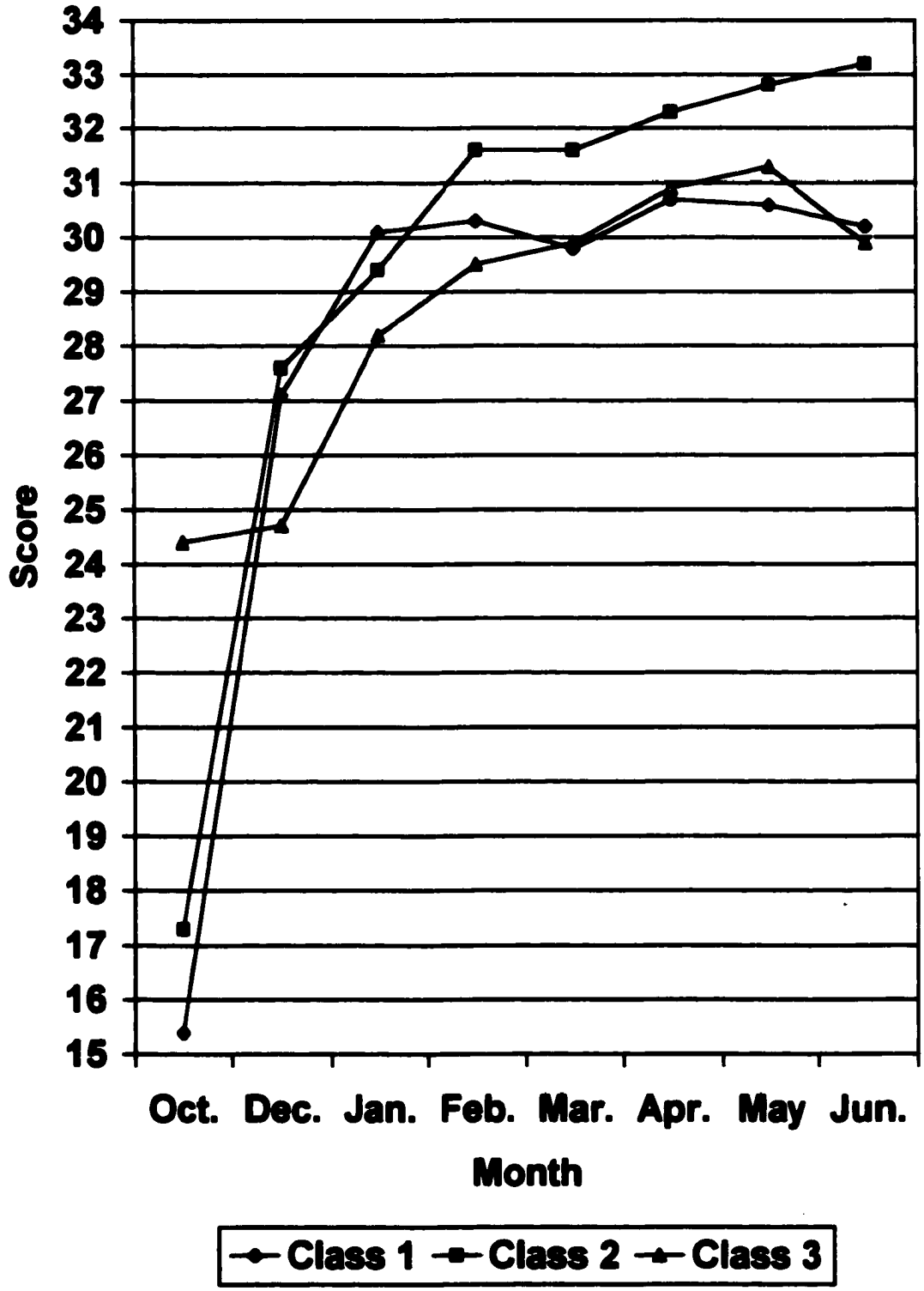

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Table 8

Size Category Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Classes on Size Category Test Scores (MHT)

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	14.18	14.95	5.00	11.64**	(2,52)	a,b
SD	7.80	6.25	4.51			
(N)	17	22	14			
Change 2 (Oct.- Jan.)						
M	17.00	18.68	4.29	18.34**	(2,54)	a,b
SD	8.21	8.22	3.41			
(N)	19	22	14			
Change 3 (Oct.-Feb.)						
M	17.00	19.75	4.55	16.51**	(2,46)	a,b
SD	7.29	7.95	5.35			
(N)	16	20	11			
Change 4 (Oct.-Mar.)						
M	15.35	20.23	7.21	15.52**	(2,52)	a,b,c
SD	6.62	7.57	5.74			
(N)	17	22	14			
Change 5 (Oct.-Apr.)						
M	17.06	21.38	7.62	18.00**	(2,49)	a,b
SD	6.74	6.21	6.75			
(N)	16	21	13			
Change 6 (Oct.-May.)						
M	17.18	21.64	6.54	18.89**	(2,51)	a,b
SD	7.65	6.81	6.62			
(N)	17	22	13			
Change 7 (Oct.-Jun.)						
M	15.89	20.52	7.85	13.92**	(2,52)	a,b,c
SD	7.59	6.53	5.97			
(N)	19	21	13			

* indicates p<.05
** indicates p<.01

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 2 significantly differed from Experimental Class 1

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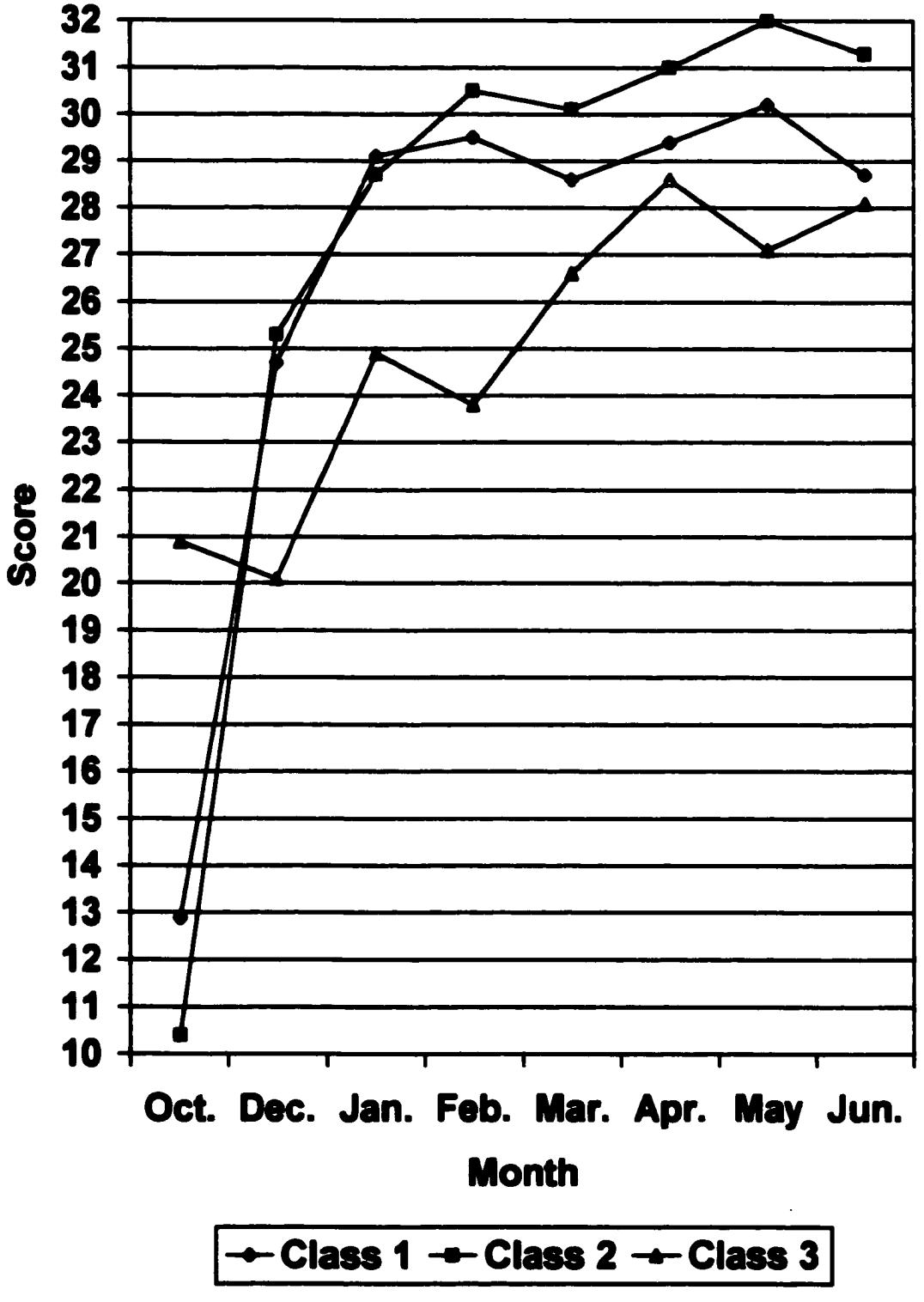
Figure 17: Size Category Test Scores on the M.H.T. by Class



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Spacing Category Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Class on Spacing Category Test Scores (MHT)

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	5.50	3.91	5.43	0.75	(2,53)	
SD	4.26	4.23	5.54			
(N)	18	22	14			
Change 2 (Oct.- Jan.)						
M	5.55	4.00	2.14	4.04*	(2,55)	a
SD	4.26	2.94	2.80			
(N)	20	22	14			
Change 3 (Oct.-Feb.)						
M	5.24	4.85	1.82	2.88	(2,47)	
SD	3.82	4.72	1.94			
(N)	17	20	11			
Change 4 (Oct.-Mar.)						
M	4.02	5.55	2.29	2.99	(2,53)	
SD	3.48	5.01	1.94			
(N)	18	22	14			
Change 5 (Oct.-Apr.)						
M	4.00	5.95	2.54	2.41	(2,49)	
SD	4.49	5.31	2.73			
(N)	16	21	13			
Change 6 (Oct.-May.)						
M	4.50	5.45	2.69	1.83	(2,52)	
S	3.78	4.94	2.87			
(N)	18	22	13			
Change 7 (Oct.-Jun.)						
M	4.35	6.05	2.31	3.32*	(2,53)	b
SD	3.96	5.01	2.39			
(N)	20	21	13			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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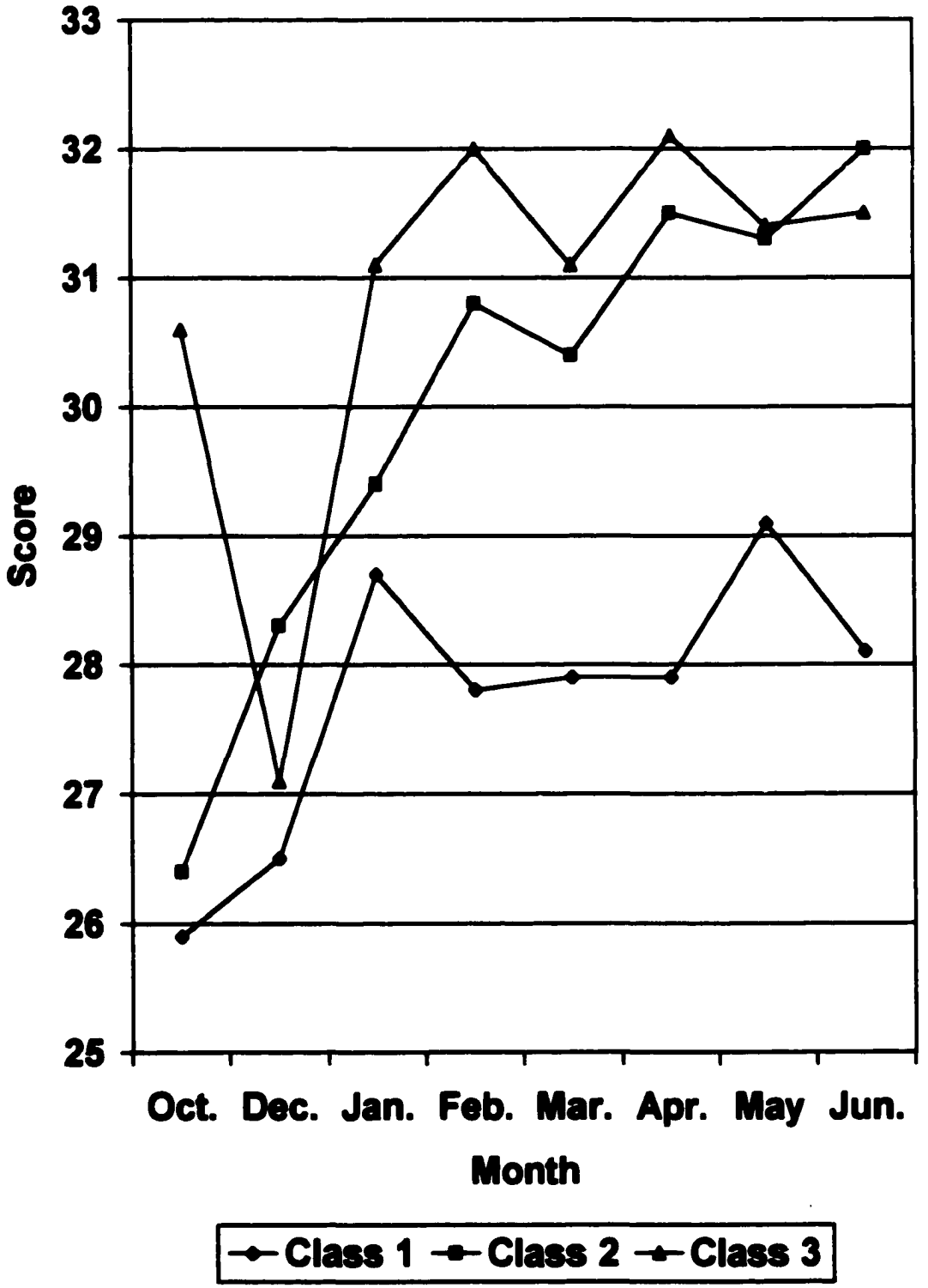
Figure 18: Spacing Category Test Scores on the M.H.T. by Class



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Speed Scores

Comparison of Change Scores Between the Experimental Classes and the Control Class on Speed Scores (MHT)

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct.-Dec.)						
M	3.41	2.87	2.75	0.32	(2,45)	
SD	2.57	2.23	2.36			
(N)	17	21	8			
Change 2 (Oct.-Jan.)						
M	3.08	2.97	3.05	0.02	(2,48)	
SD	2.02	1.84	1.91			
(N)	20	21	8			
Change 3 (Oct.-Feb.)						
M	2.07	2.00	4.40	4.32**	(2,41)	d
SD	1.78	1.70	1.23			
(N)	17	20	5			
Change 4 (Oct.-Mar.)						
M	3.01	2.30	3.73	1.65	(2,41)	
SD	1.98	1.74	1.73			
(N)	15	21	6			
Change 5 (Oct.-Apr.)						
M	3.65	2.38	4.00	2.68	(2,43)	
SD	1.68	2.34	1.42			
(N)	16	21	7			
Change 6 (Oct.-May)						
M	3.33	2.82	3.77	0.70	(2,43)	
SD	2.20	1.83	1.86			
(N)	16	21	7			
Change 7 (Oct.-Jun.)						
M	4.40	2.70	3.71	3.21*	(2,47)	a
SD	2.40	1.99	1.75			
(N)	20	21	7			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2
d= Control Class 3 significantly differed from Experimental Classes 1 and 2

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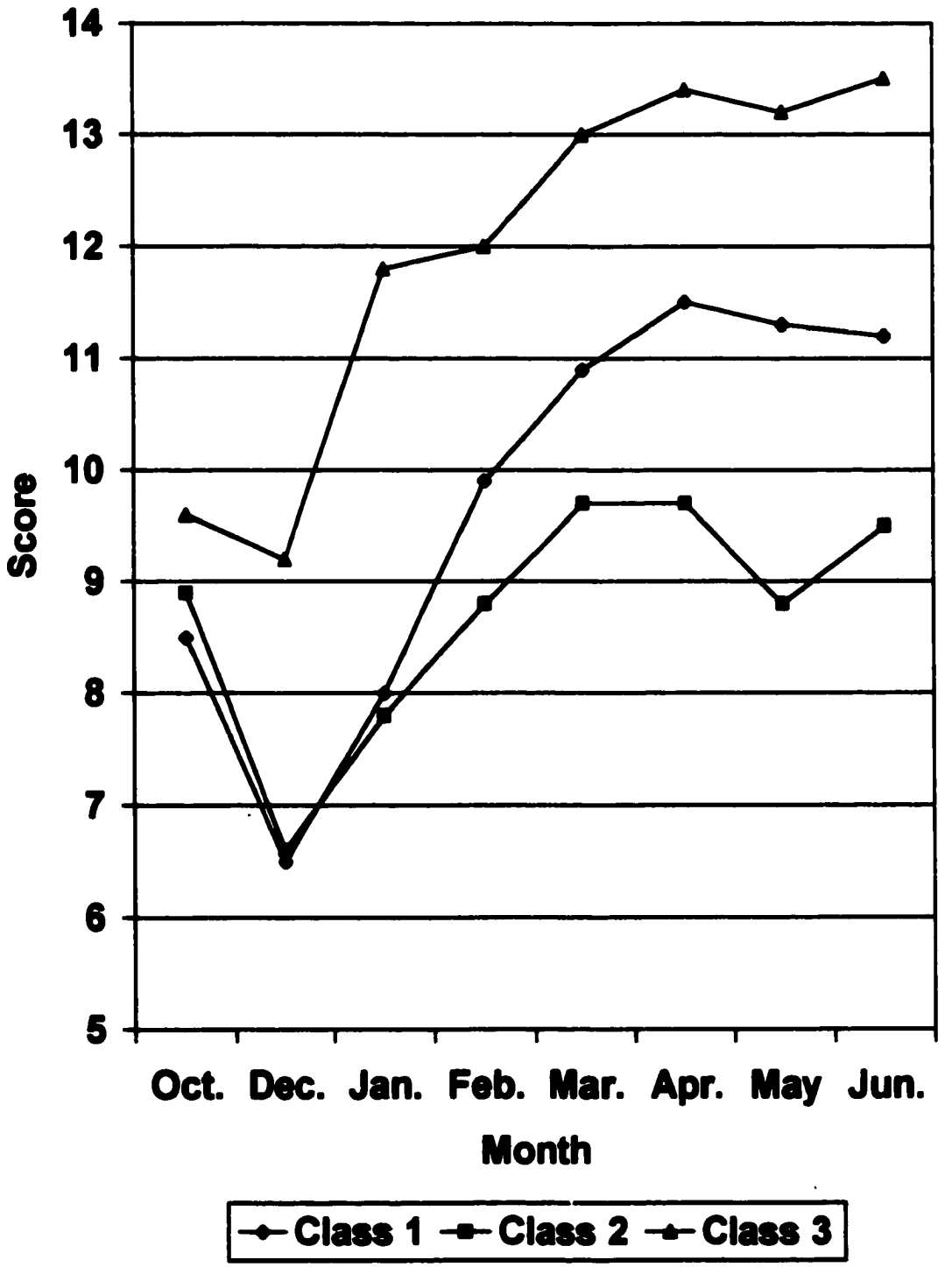
Figure 19: Speed Score on the M.H.T. by Class



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Pre-test and Post-test Scores

Paired samples t-tests were completed to analyse the significance of change and improvement within groups from the baseline measure (October) to the final measure (June) in each of the classes. Similar tests were conducted using the male population and the female population within each classroom. Tables 11 through 16 display the mean, standard deviation, sample size, t-value and the degrees of freedom for each of the classes with combined male and female t-scores, males only and females only. The tables are located at the end of this section.

Total Test Scores

Classes 1, 2, and 3 and both the male and female sub-populations of these classes, demonstrated significant improvements from the pre-test measure (baseline) to the post-test measure on total test scores of the Minnesota Handwriting Test (see Table 11).

Legibility Category Scores

Class 1 demonstrated significant improvement on the pre-test and post-test measures in the Legibility category ($t(19)=-2.36, p<.03$) and Class 2 demonstrated significant improvement ($t(20)=-3.39, p<.003$) from October to June. Class 3 failed to demonstrate significant differences between pre-test and post-test scores ($t(12)=-1.13, p<.281$).

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Male subjects in Class 1 demonstrated significant improvement in scores over time from pre-test to post-test measures ($t(4)=-14.70, p<.000$). This significant improvement was also noted in Class 2 ($t(10)=-2.24, p<.049$). There were no significant differences found within Class 3 males from pre-test to post-test measures (see Table 12).

Female subjects in Class 2 demonstrated significant improvement from pre-test measures to post-test measures in the legibility subcategory ($t(9)=-3.17, p<.011$). No significant changes were noted in the female subjects of Class 1 and Class 3 (see Table 12).

Form Category Scores

Table 13 displays the mean scores, standard deviation and t-test scores for male and female subjects combined and separated. For combined scores in the Form subcategory, significant differences was noted in improvement of the subjects in Class 1 ($t(19)=-4.44, p<.000$), Class 2 ($t(20)=-5.89, p<.000$) and Class 3 ($t(12)=-2.73, p<.0.18$) from the pre-test to post-test measures.

The males in Class 2 demonstrated significant improvement from the pre-test to the post-test ($t(10)=-4.08, p<.002$). No significant improvements were found of the male subjects in Class 1 and Class 3 in the Form subcategory.

The female subjects demonstrated significant improvement from the pre-test scores to the post-test scores in Class 1 ($t(14)=-3.56, p<.003$) and Class 2 ($t(9)=-4.61, p<.001$). Class 3 female subjects failed to demonstrate significant

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improvements in scores from pre-test to post-test (see Table 13).

Alignment Category Scores

All groups demonstrated significant improvement in alignment scores as shown in the probability values which follow (see Table 14). All t-test scores both combined demonstrated significant improvements for Class 1(t(20)=-8.63,p<.000), Class 2 (t(21)=-9.44, p<0.000) and Class 3 (t(13)=-3.84,p<0.002) and for female subjects in Class 1 (t(15)=-7.23, p< 0.000, Class 2 (t(10)= -7.36, p<0.000) and Class 3 (t(10)= -3.35, p< 0.008). The male subjects in Class 1 (t(5)= -4.63, p<0.010, Class 2 (t(11)=-5.95, p<0.000), and Class 3 (t(3)= -4.36, p< 0.050) demonstrated significant improvements from the pre-test measure to the post-test measure.

Size Category Scores

The Size category was analysed for all classes using pre-test and post-test paired t-tests. Class 1 (t(19)=-9.12. P<0.000), Class 2 (t(21)=-14.40, p<0.000), and Class 3 (t(13)= -3.36, p<0.006) demonstrated significant improvement from pre-test to post test measures (see Appendix A9).

All, except females in Class 3 demonstrated significant improvements: male subjects Class 1 (t(5)= -3.08, p<0.04), male subjects Class 2 (t(11)= -9.24, p<0.000, male subjects Class 3 (t(3)=-27.71, p<0.001), female subjects Class 1 (t(18)=-912,p<.000) and female subjects Class 2 (t(20)=-11.02,p<000) (see Table 15).

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Spacing Category Scores

No significant differences were found in Class 1 and Class 3 from the baseline measures in October to the post-test measure in June. Only Class 2 demonstrated significant improvements on pre-test and post-test scores for all subjects on total test scores ($t(20)=-5.12, p<001$). Both male and female subjects in Class 2 demonstrated significant improvement from baseline to post-test ($t(10)=-3.43, p<.035$) and ($t(9)=-4.66, p<.001$). Class 1 male subjects demonstrated a significant improvement from pre-test to post-test scores ($t(4)=-3.15, p<.006$) but the females did not. No other significant differences were found in the Spacing category from pre-test measures to post-test measures. Class 3 failed to reach significant improvements from pre-test to post-test in this domain (see Table 16).

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Table 11

Pre-test / Post-test: Total Test Scores

Comparisons of Pre-test /Post-test t-test Scores Within the Experimental Classes and the Control Class on Total Test Scores

	Experimental Class 1	Experimental Class 2	Control Class 3
MALE/ FEMALE			
October (Pre-test)			
M	106.35	108.43	134.00
SD	23.45	25.40	25.65
June (Post-test)			
M	148.10	159.81	151.31
SD	17.73	6.32	11.69
(N)	20	21	13
t value	-9.09**	-10.74**	-3.30**
D.F.	19	20	12
MALE			
October (Pre-test)			
M	97.40	104.64	96.67
SD	22.83	30.18	6.50
June (Post-test)			
M	141.2	156.82	140.00
SD	26.19	6.66	8.54
(N)	5	11	3
t value	-6.52**	-6.61**	-5.65*
D.F.	14	9	9
FEMALE			
October (Pre-test)			
M	109.33	112.60	145.20
SD	23.66	19.62	16.24
June (Post-test)			
M	150.40	163.10	154.70
SD	14.42	4.07	10.52
(N)	15	10	10
t value	-7.07**	-9.15**	-2.78*
D.F.	14	9	9

*indicates $p<.05$
**indicates $p<.01$

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Table 12

Pre-test / Post-test: Legibility Category Test Scores

Comparisons of Pre-test /Post-test t-test scores within the experimental groups and control group on Legibility Category Test Scores

	Experimental Group 1	Experimental Group 2	Control Group
MALE/FEMALE			
October (Pre-test)			
M	30.00	30.38	32.38
SD	3.40	4.23	2.60
June (Post-test)			
M	32.05	33.57	33.08
SD	2.59	0.81	1.32
(N)	20	21	13
t value	-2.36*	-3.39**	-1.13
D.F.	19	20	12
MALE			
October (Pre-test)			
M	28.60	29.55	29.00
SD	2.61	5.32	4.00
June (Post-test)			
M	32.20	33.27	32.33
SD	2.39	1.01	1.16
(N)	5	11	3
t value	-14.70**	-2.24*	-1.89
D.F.	4	10	2
FEMALE			
October (Pre-test)			
M	30.47	31.30	33.40
SD	3.58	2.54	0.70
June (Post-test)			
M	32.00	33.90	33.30
SD	2.73	0.32	1.34
(N)	15	10	10
t value	-1.35	-3.17**	0.26
D.F.	14	9	9

*indicates p<.05
**indicates p<.01

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Pre-test / Post-test: Form Category Test Scores

Comparisons of Pre-test /Post-test t-test scores within the experimental groups and control group on Form Category Test Scores

	Experimental Group 1	Experimental Group 2	Control Group
MALE / FEMALE			
October (Pre-test)			
M	22.80	23.71	26.00
SD	5.54	5.89	4.67
June (Post-test)			
M	28.80	29.57	28.62
SD	3.49	2.54	3.18
(N)	20	21	13
t value	-4.44**	-5.89**	-2.73*
D.F.	19	20	12
MALE			
October (Pre-test)			
M	19.00	21.55	19.67
SD	5.79	6.53	1.16
June (Post-test)			
M	26.80	28.36	25.00
SD	1.92	1.80	2.00
(N)	5	11	3
t value	-2.54	-4.08**	-3.02
D.F.	4	10	2
FEMALE			
October (Pre-test)			
M	24.07	26.10	27.90
SD	5.02	4.20	3.38
June (Post-test)			
M	29.47	30.90	29.70
SD	3.68	2.64	2.63
(N)	15	10	10
t value	-3.56**	-4.61**	-1.75
D.F.	14	9	9

*indicates p<.05
**indicates p<.01

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Table 14

Pre-test / Post-test : Alignment Category Test Scores

Comparisons of Pre-test /Post-test t-test scores within the experimental groups and control group on Alignment Test Scores

	Experimental Group 1	Experimental Group 2	Control Group
MALE / FEMALE			
October (Pre-test)			
M	15.40	17.29	23.78
SD	7.94	8.08	7.81
June (Post-test)			
M	30.25	33.24	30.08
SD	3.86	1.14	3.38
(N)	20	21	13
t value	-8.63**	-9.44**	-3.84**
D.F.	19	20	12
MALE			
October (Pre-test)			
M	15.80	17.82	13.00
SD	7.43	9.01	3.00
June (Post-test)			
M	29.20	32.82	27.00
SD	6.30	1.40	5.29
(N)	5	11	3
t value	-4.63**	-5.95**	-4.36*
D.F.	4	10	2
FEMALE			
October (Pre-test)			
M	15.27	16.70	27.00
SD	8.35	7.36	5.40
June (Post-test)			
M	30.60	33.70	31.00
SD	2.90	0.48	2.21
(N)	15	10	10
t value	-7.23**	-7.36**	-3.35**
D.F.	14	9	9

*indicates p<.05
**indicates p<.01

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Table 15

Pre-test / Post-test: Size Category Test Scores

Comparisons of Pre-test /Post-test t-test scores within the experimental groups and control group on Size Test Scores

	Experimental Group 1	Experimental Group 2	Control Group
MALE / FEMALE			
October (Pre-test)			
M	12.89	10.57	21.46
SD	7.98	6.86	9.57
June (Post-test)			
M	28.79	31.10	28.23
SD	6.23	3.40	3.88
(N)	19	21	13
t value	-9.12**	-14.40**	-3.36**
D.F.	18	20	12
MALE			
October (Pre-test)			
M	12.00	10.91	9.33
SD	8.46	7.85	1.53
June (Post-test)			
M	25.40	30.73	25.33
SD	10.92	4.22	2.08
(N)	5	11	3
t value	-3.08*	-9.24**	-27.71**
D.F.	4	10	2
FEMALE			
October (Pre-test)			
M	13.21	10.20	25.10
SD	8.11	5.98	7.61
June (Post-test)			
M	30.00	31.50	29.10
SD	3.33	2.37	3.93
(N)	14	10	10
t value	-9.12**	-11.02**	-2.20
D.F.	18	20	12

*indicates $p<.05$
**indicates $p<.01$

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Table 16

Pre-test/ Post-test: Spacing Category Test Score

Comparisons of Pre-test /Post-test t-test scores within the experimental groups and control group on Spacing Category Test Score

	Experimental Group 1	Experimental Group 2	Control Group
MALE / FEMALE			
October (Pre-test)			
M	25.90	26.48	30.38
SD	5.43	5.24	3.50
June (Post-test)			
M	28.25	32.33	31.31
SD	4.88	1.83	2.96
(N)	20	21	13
t value	-1.92	-5.12**	-1.02
D.F.	19	20	12
MALE			
October (Pre-test)			
M	22.00	24.82	25.67
SD	5.34	6.06	2.08
June (Post-test)			
M	27.60	31.64	30.00
SD	7.70	2.16	3.06
(N)	5	11	3
t value	-3.15*	-3.43**	-2.13
D.F.	4	10	2
FEMALE			
October (Pre-test)			
M	27.20	28.30	31.80
SD	4.96	3.62	2.40
June (Post-test)			
M	28.47	33.10	31.60
SD	3.89	0.99	3.03
(N)	15	10	10
t value	-0.88	-4.66**	0.29
D.F.	14	9	9

*indicates p<.05
**indicates p<.01

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Gender Differences

Since handwriting literature suggests that males and females differ in areas of handwriting skill development, the data in this study was further broken down within groups to compare males and females across groups.

Female Subjects

Table 17 through 23 located at the end of this section contain the mean change scores for female subjects on the total test scores and each of the category tests from the baseline assessment (October) to scores in subsequent test periods. As with the whole class tables, these tables include the change scores for female subjects by class, the F ratio, the degrees of freedom and the SNK which identifies which class is different at the test period. Figures 20 to 26 graphs the means for total test scores and category tests at the baseline and each subsequent test period. These figures are located behind each corresponding table for each analysis.

Total Test Scores. Analysis of Variance (ANOVA) demonstrated that at the Second (January) test period, Class 1 and Class 2 female subjects exhibited significant improvement in change scores relative to Class 3, ($F(2,35)=17.23, p<.0000$). Significant differences in improvement noted in Class 1 and Class 2, female subjects, were maintained relative to Class 3 at the third through seventh test periods , February $F((2,29)= 11.70, p< 0.000$, March $F(2,34)= 13.70, p<0.000$, April $F(2,31)=13.09, p<0.000$, May $F(2,33)=15.29, p<0.000$, June

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F(2,34)=13.06, p<0.000 (see Table 17). Figure 20, graphs the means from October to June for the Total Test Scores.

Legibility. The Legibility category change scores for female subjects are presented in Table 18. No significant differences in improvement on change scores were found between females in Classes 1, 2, and 3 at any of the test periods (December through June). Figure 21 graphs the means for the legibility category from October to June.

Form. Table 19 displays the mean change scores, standard deviations and the analysis of variance for the females subjects in the Form category. No significant differences were noted in this subcategory at the December, February, April and June test periods. At the January test, a significant difference was noted in Class1 relative to Class 3 on improvement change scores (F(2,35)=3.51,p<.041). In March and May, significant differences in improvement was noted when females in Class 2 were compared with the females in Class 3. No significant differences were noted between the females in Class 1 and Class 2. Figure 22 graphs the means from the baseline measurement until the final measurement in June.

Alignment. Significant differences in the test scores of the females in Class 1 and Class 2 in comparison to Class 3 was observed for all test periods, (December through June) in the Alignment category (see Table 20). Figure 23

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graphs the means of the baseline measurement and the subsequent measurements.

Size. The Size category change scores were calculated for the females subjects in each group at each of the test periods. Class 1 and Class 2 showed significant improvement comparative to Class 3 at all test periods (see Table 21). There were significant differences in improvement identified between Class 1 and Class 2 at the March test period ($F(2,33)=14.58, p<.0000$), with Class 2 demonstrating more improvement. No other significant differences were noted between Class 1 and Class 2 in the Size category. Figure 24 graphs the means from the October measure to the final measure in June.

Spacing. Table 22 presents the comparison of change scores for the females in Classes 1,2, and 3 for the Spacing category. No significant differences were noted in the change scores for the females at the December, March , April, May and June test periods. Significant differences were observed in Class 1 when in comparison to Class 3 on improvement in the Spacing domain at January testing ($F(2,35)=4.59, p<.017$), and at the February testing ($F(2,29)=4.39, p<.022$). Figure 25 graphs the means of the Spacing Category test score from the baseline measurement to the final measurement.

Speed. A one-way ANOVA was completed with the speed scores at the baseline sample to determine whether there were statistical differences in speed

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between the classes. At the October pre-test period there were no statistical differences in speed for the girls in Class 1, Class 2 or Class 3, $F(2,30)= 0.489$, $p,0.62$. At the June final test period, Class 1 and Class 3 were statistically different in speed than Class 2, $F(2, 35)= 6.94$, $p<0.003$. No significant differences in improvement were found between Class 1, Class 2, and Class 3 for speed at any of the test periods (see Table 23). Figure 26 graphs the means for speed at the October sample and subsequent samples.

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Female Subjects: Total Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Classes on Total Test Scores - Female Subjects

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	33.36	32.10	20.00	1.80	(2,34)	
SD	15.40	16.13	23.90			
(N)	14	10	11			
Change 2 (Oct.- Jan.)						
M	44.27	36.30	7.91	17.23**	(2,35)	a,b
SD	20.74	14.30	7.41			
(N)	15	10	11			
Change 3 (Oct.-Feb.)						
M	44.85	42.11	7.75	11.70**	(2,29)	a,b
SD	23.72	15.40	4.74			
(N)	13	9	9			
Change 4 (Oct.-Mar.)						
M	42.14	45.70	11.36	13.70**	(2,34)	a,b
SD	20.11	17.53	11.08			
(N)	14	10	11			
Change 5 (Oct.-Apr.)						
M	44.25	48.80	14.40	13.09**	(2,31)	a,b
SD	20.36	15.48	11.37			
(N)	12	10	10			
Change 6 (Oct.-May.)						
M	49.07	48.80	12.00	15.29**	(2,33)	a,b
SD	23.43	15.07	8.12			
(N)	14	10	10			
Change 7 (Oct.-Jun.)						
M	41.07	50.50	11.30	13.06**	(2,34)	a,b
SD	22.49	17.44	8.69			
(N)	15	10	10			

* indicates p<.05
** indicates p<.01

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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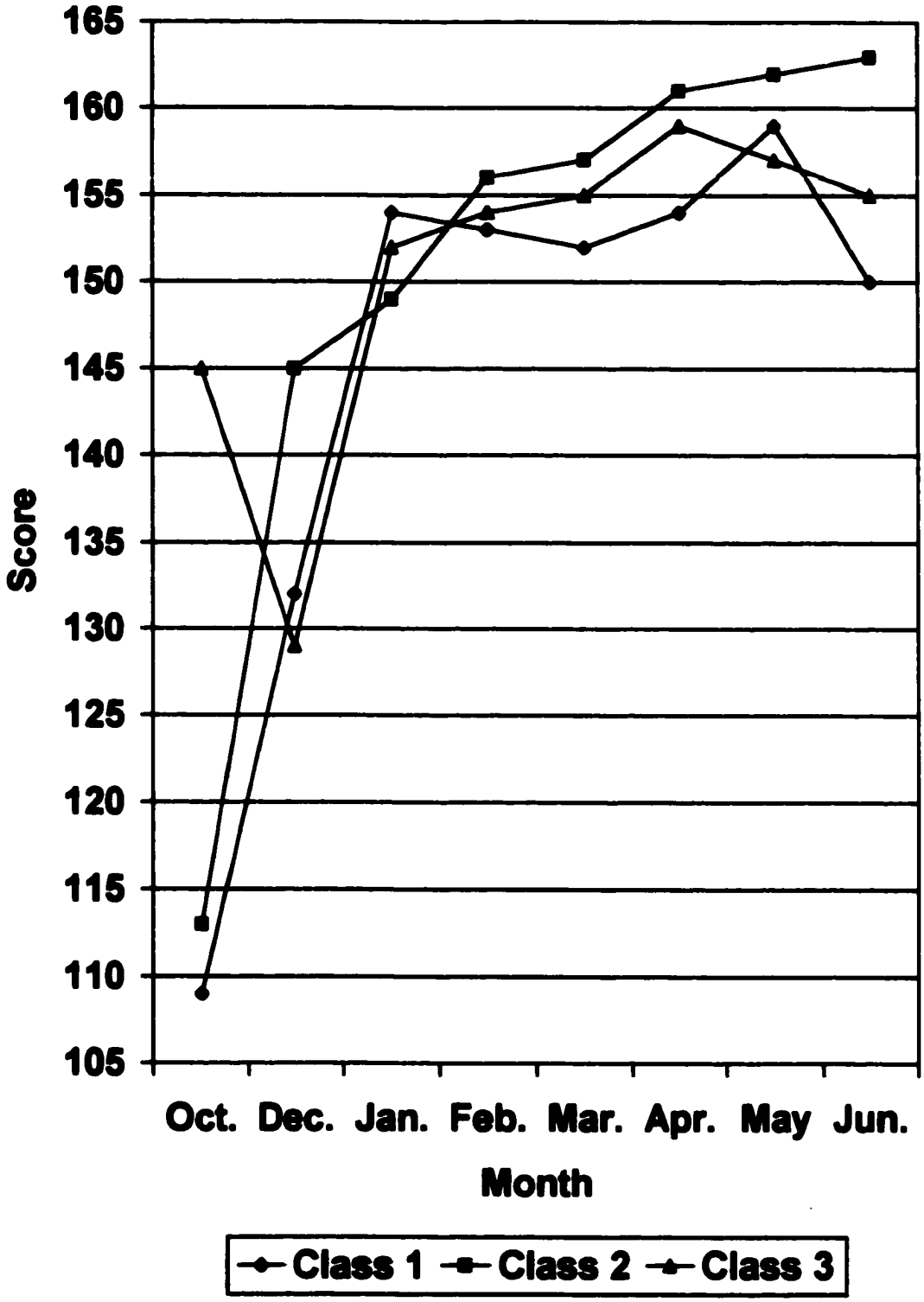
Figure 20: Females - Total Test Scores on the M.H.T. by Class



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Female Subjects: Legibility Category Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Classes on Legibility Test Scores - Female Subjects

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	3.29	2.00	4.82	0.92	(2,34)	
SD	4.16	2.11	6.79			
(N)	14	10	11			
Change 2 (Oct.- Jan.)						
M	3.07	2.00	0.91	2.53	(2,35)	
SD	3.39	1.63	0.94			
(N)	15	10	11			
Change 3 (Oct.-Feb.)						
M	2.31	1.56	0.38	3.17	(2,29)	
SD	2.29	1.33	0.52			
(N)	13	9	8			
Change 4 (Oct.-Mar.)						
M	2.57	2.50	0.73	2.76	(2,34)	
SD	2.59	2.37	0.79			
(N)	14	10	11			
Change 5 (Oct.-Apr.)						
M	2.58	2.20	0.60	2.07	(2,31)	
SD	3.58	1.40	0.70			
(N)	12	10	10			
Change 6 (Oct.-May.)						
M	2.71	1.90	0.80	1.75	(2,33)	
SD	3.58	1.45	0.63			
(N)	14	10	10			
Change 7 (Oct.-Jun.)						
M	2.87	2.60	0.90	1.63	(2,34)	
SD	3.60	2.59	0.74			
(N)	15	10	10			

* indicates p<.05
** indicates p<.01

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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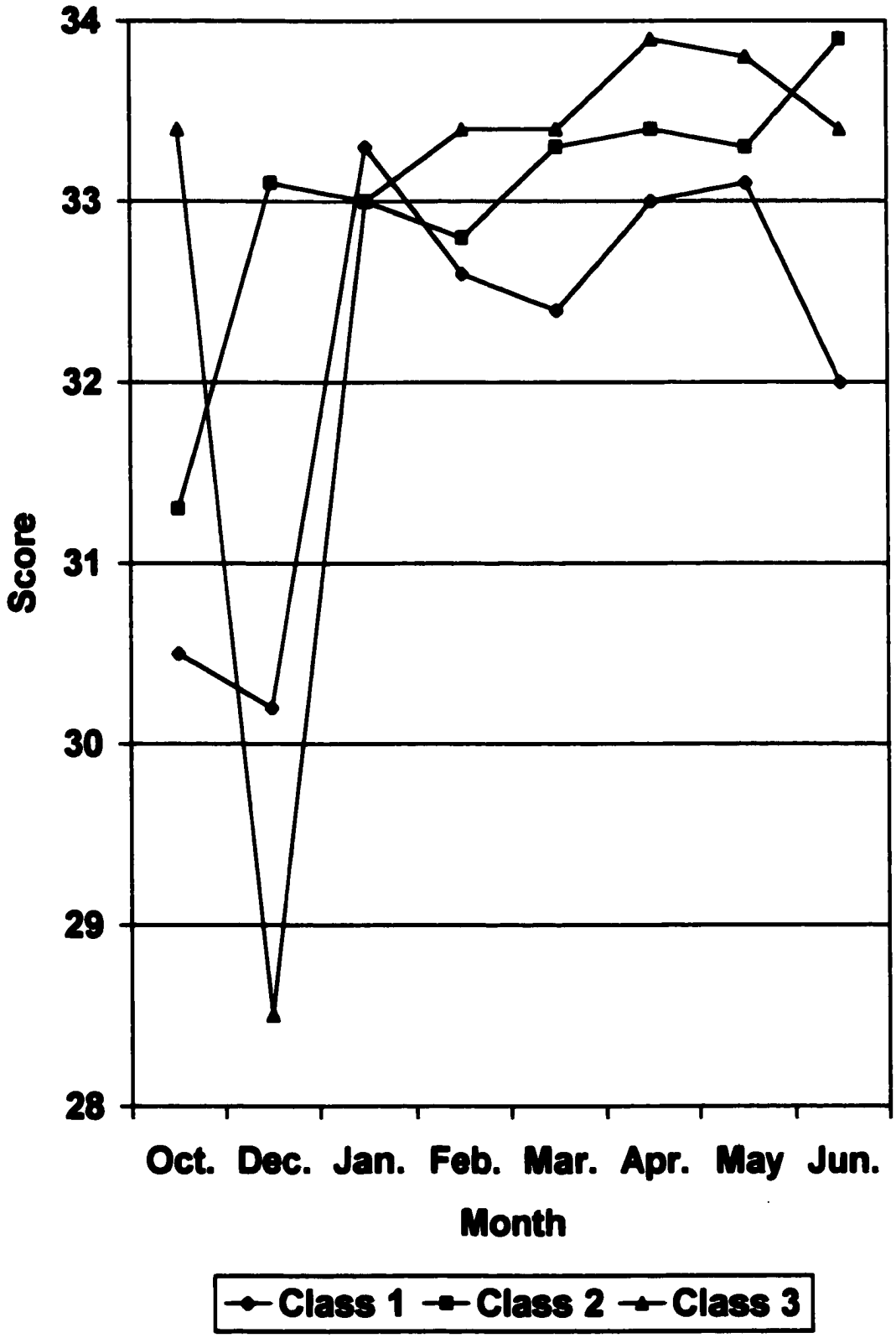
Figure 21: Females - Legibility Category Test Scores on the M.H.T. by Class



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Female Subjects: Form Category Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Classes on Form Test Scores - Female Subjects

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	4.29	3.20	4.91	0.56	(2,34)	
SD	4.20	2.66	3.96			
(N)	14	10	11			
Change 2 (Oct.- Jan.)						
M	5.00	2.80	1.64	3.51*	(2,35)	a
SD	4.61	1.48	2.01			
(N)	15	10	11			
Change 3 (Oct.-Feb.)						
M	6.00	4.33	2.50	3.02	(2,29)	
SD	4.36	2.12	1.20			
(N)	13	9	8			
Change 4 (Oct.-Mar.)						
M	6.21	4.00	1.91	4.95*	(2,34)	a
SD	3.85	3.80	2.21			
(N)	14	10	11			
Change 5 (Oct.-Apr.)						
M	5.58	4.60	2.50	2.19	(2,31)	
SD	4.48	3.13	2.17			
(N)	12	10	10			
Change 6 (Oct.-May.)						
M	7.21	5.20	3.30	3.50*	(2,33)	a
SD	4.46	3.08	2.50			
(N)	14	10	10			
Change 7 (Oct.-Jun.)						
M	6.47	5.00	3.20	2.59	(2,34)	
SD	4.58	2.94	1.69			
(N)	15	10	10			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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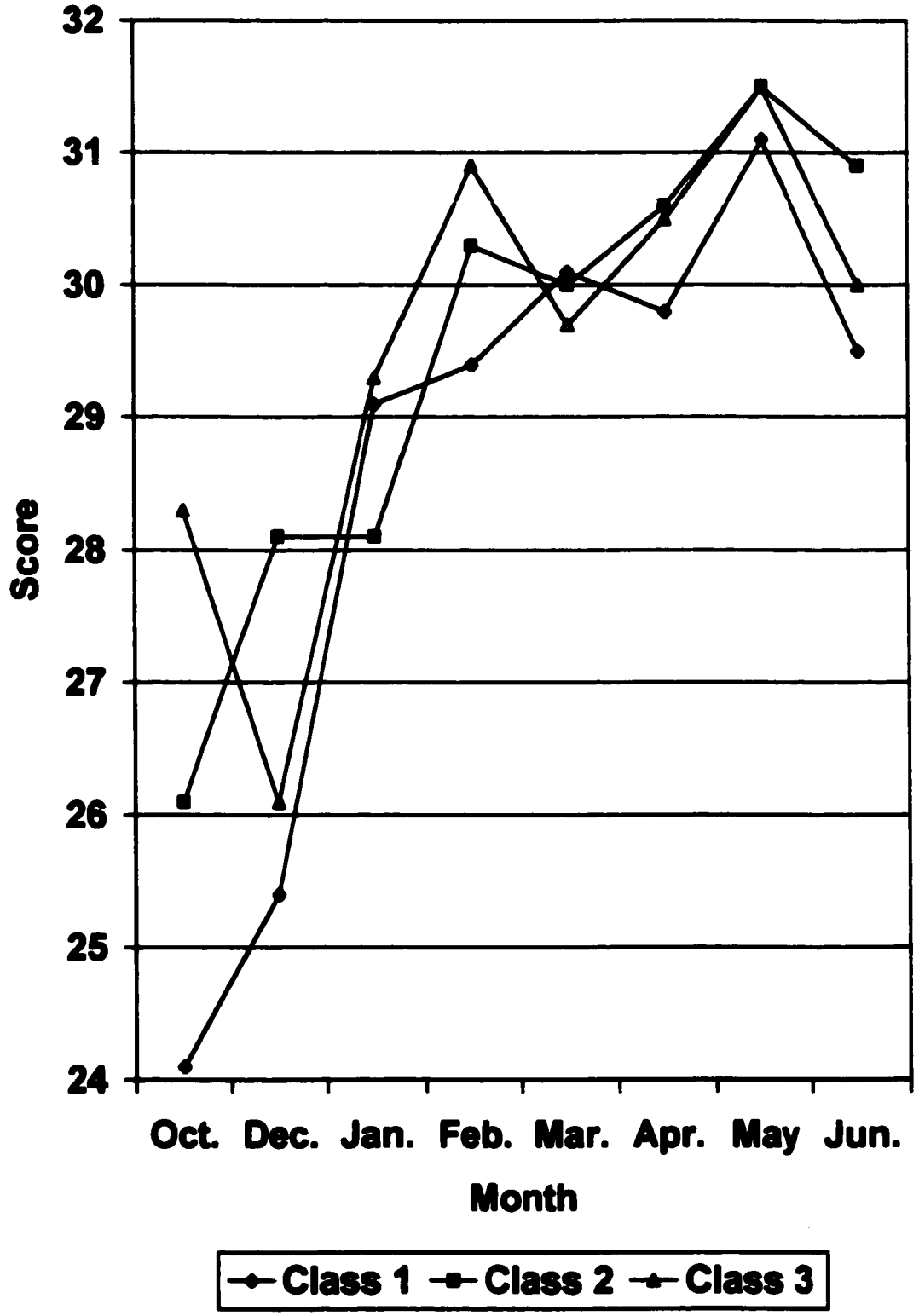
Figure 22: Females - Form Category Test Scores on the M.H.T. by Class



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Female Subjects: Alignment Category Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Classes on Alignment Category Test Scores - Female Subjects

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	12.21	11.10	3.64	5.40**	(2,34)	a,b
SD	7.79	8.10	3.35			
(N)	14	10	11			
Change 2 (Oct.- Jan.)						
M	15.73	11.70	3.27	11.22**	(2,35)	a,b
SD	8.39	6.40	3.35			
(N)	15	10	11			
Change 3 (Oct.-Feb.)						
M	16.85	13.22	2.63	9.69**	(2,29)	a,b
SD	9.29	6.74	1.85			
(N)	13	9	8			
Change 4 (Oct.-Mar.)						
M	15.50	15.90	4.27	10.75**	(2,34)	a,b
SD	8.19	7.05	3.77			
(N)	14	10	11			
Change 5 (Oct.-Apr.)						
M	16.75	16.20	4.70	9.97**	(2,31)	a,b
SD	8.39	6.65	4.97			
(N)	12	10	10			
Change 6 (Oct.-May.)						
M	17.29	16.20	4.20	12.27**	(2,33)	a,b
SD	8.54	6.65	3.08			
(N)	14	10	10			
Change 7 (Oct.-Jun.)						
M	15.33	17.00	4.20	10.54**	(2,34)	a,b
SD	8.21	7.30	3.52			
(N)	15	10	10			

* indicates p<.05
** indicates p<.01

a= Experimental Class 1 significantly differed from Control Class 3
b= Experimental Class 2 significantly differed from Control Class 3
c= Experimental Class 1 significantly differed from Experimental Class 2

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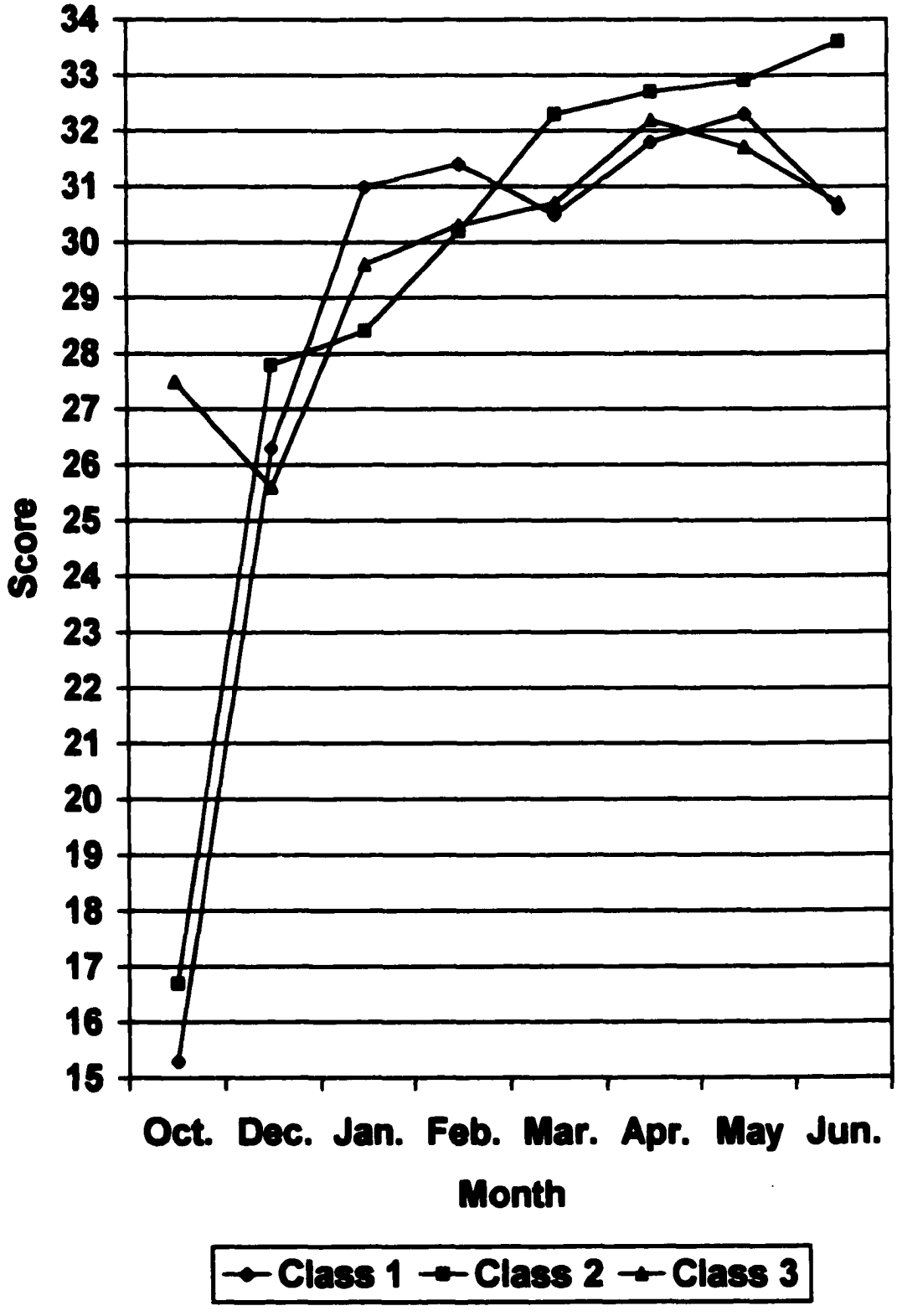
Figure 23: Females - Alignment Category Test Scores on the M.H.T. by Class



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Female Subjects: Size category Test Scores

Comparisons of change scores between the experimental groups and the control group on Size Category Test Scores - Female Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct. -Dec.)						
M	12.69	16.00	4.18	11.18**	(2,33)	a,b
SD	7.24	5.98	3.95			
(N)	13	10	11			
Change 2 (Oct.- Jan.)						
M	17.64	18.70	4.09	14.63**	(2,34)	a,b
SD	7.91	8.58	3.83			
(N)	14	10	11			
Change 3 (Oct.-Feb.)						
M	17.00	21.00	4.50	12.83**	(2,28)	a,b
SD	7.91	6.86	5.42			
(N)	12	9	8			
Change 4 (Oct.-Mar.)						
M	15.46	21.00	6.09	14.58**	(2,33)	a,b,c
SD	6.68	6.78	5.79			
(N)	13	10	11			
Change 5 (Oct.-Apr.)						
M	17.75	21.80	5.50	19.63**	(2,31)	a,b
SD	6.38	6.21	5.56			
(N)	12	10	10			
Change 6 (Oct.-May.)						
M	17.92	22.00	4.40	20.44**	(2,32)	a,b
SD	7.30	6.53	5.19			
(N)	13	10	10			
Change 7 (Oct.-Jun.)						
M	16.79	21.30	5.40	18.86**	(2,33)	a,b
SD	6.89	6.11	4.30			
(N)	14	10	10			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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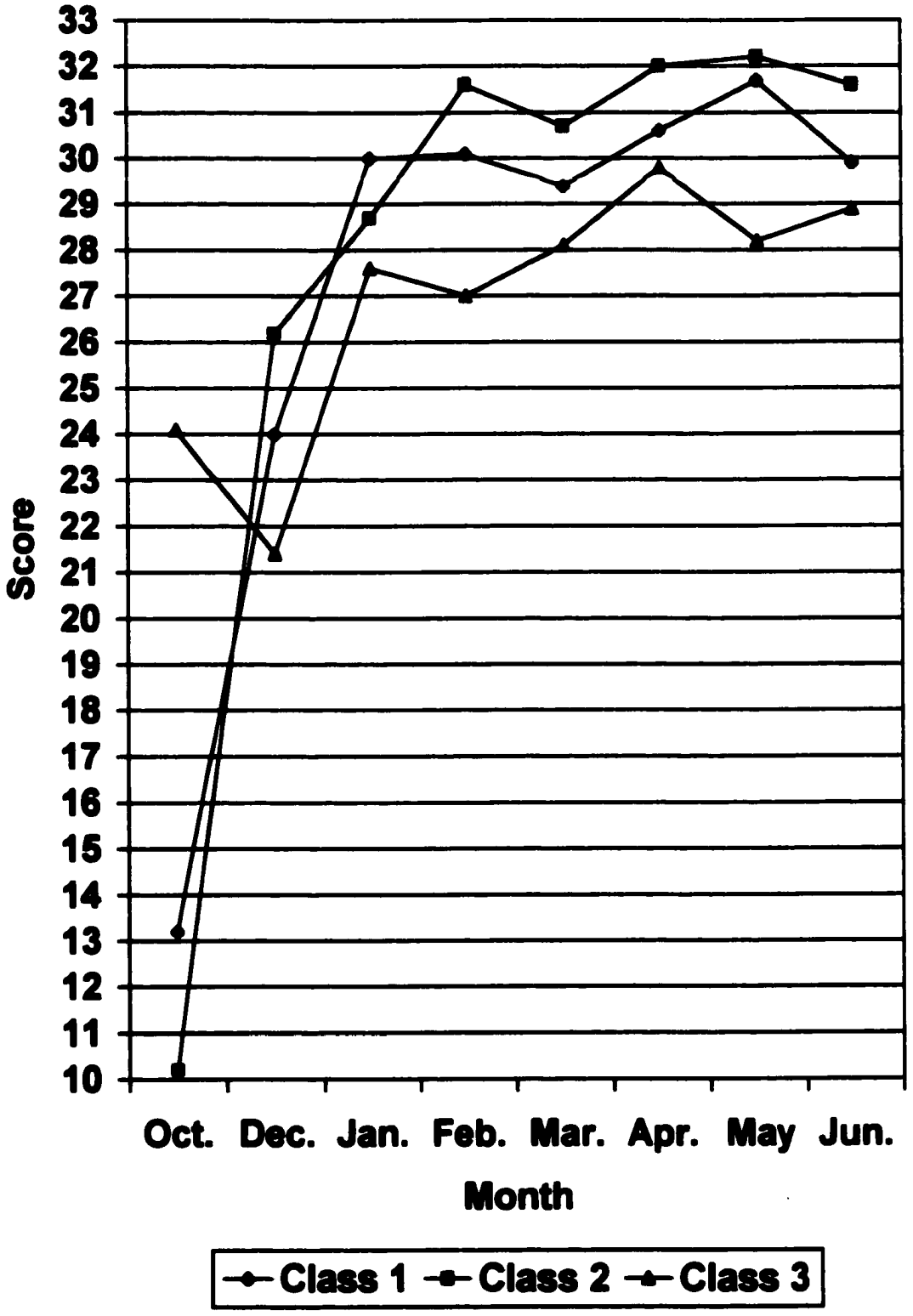
Figure 24: Females - Size Category Test Scores on the M.H.T. by Class



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Female Subjects: Spacing Category Test Scores

Comparisons of change scores between the experimental groups and the control group on Spacing Category test scores - Female Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct. -Dec.)						
M	4.43	3.00	5.73	1.19	(2,34)	
SD	2.71	2.11	6.25			
(N)	14	10	11			
Change 2 (Oct.- Jan.)						
M	5.73	2.90	1.64	4.59*	(2,35)	a
SD	4.61	2.18	2.73			
(N)	15	10	11			
Change 3 (Oct.-Feb.)						
M	4.92	2.44	1.00	4.39*	(2,29)	a
SD	4.15	2.30	0.76			
(N)	13	9	8			
Change 4 (Oct.-Mar.)						
M	4.43	3.10	1.64	3.14	(2,34)	a
SD	3.69	2.23	1.50			
(N)	14	10	11			
Change 5 (Oct.-Apr.)						
M	3.92	4.20	1.50	2.03	(2,31)	
SD	4.40	2.86	1.96			
(N)	12	10	10			
Change 6 (Oct.-May						
M	4.50	3.90	1.70	2.44	(2,33)	
SD	4.16	2.28	1.89			
(N)	14	10	10			
Change 7 (Oct.-Jun.)						
M	3.93	5.00	1.60	3.07	(2,34)	
SD	4.01	2.91	1.43			
(N)	15	10	10			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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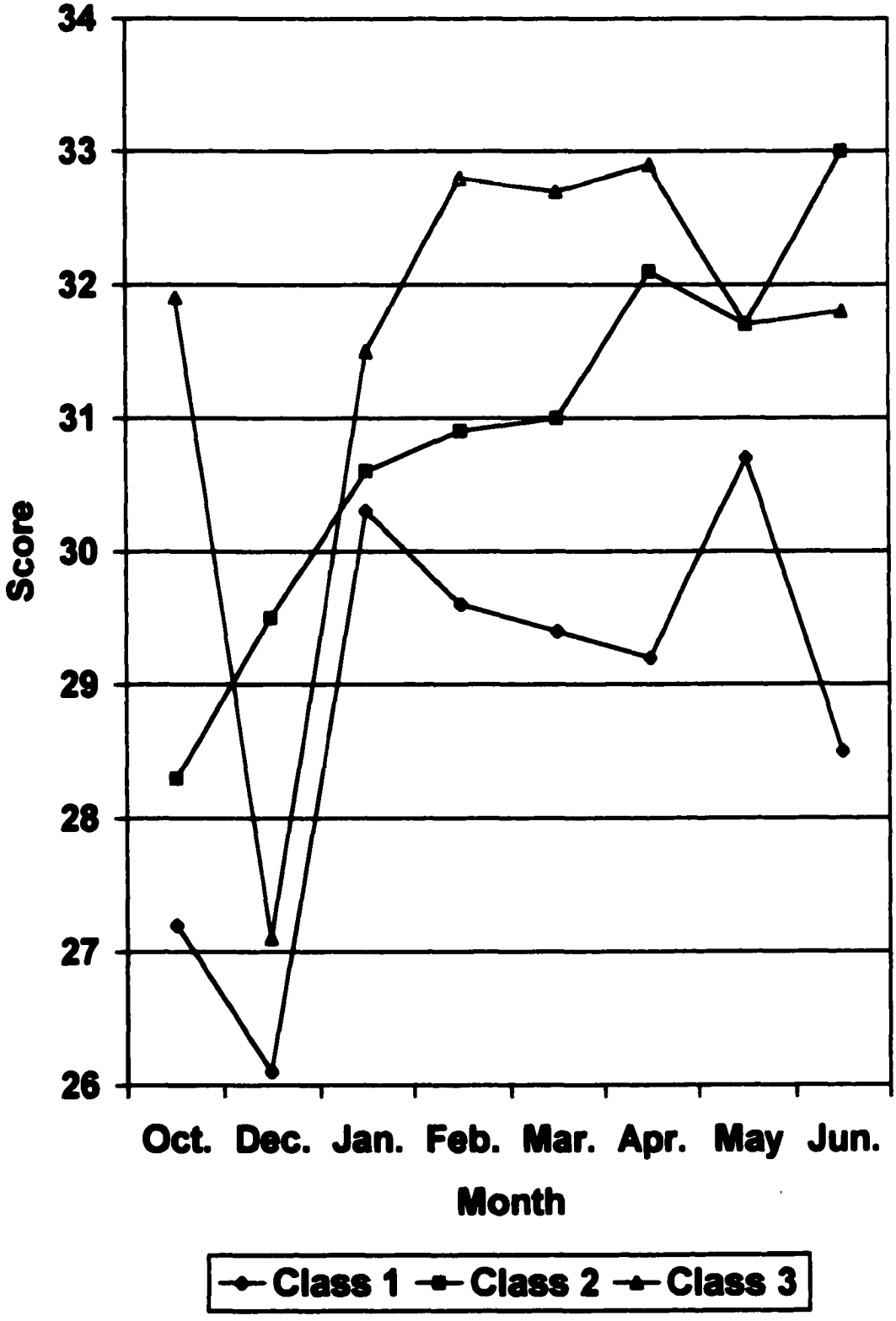
Figure 25: Females - Spacing Category Test Scores on the M.H.T. by Class



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Female Subjects: Speed Scores

Comparisons of change scores between the experimental groups and the control group on Speed Scores - Female Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct. -Dec.)						
M	3.48	3.88	3.00	0.21	(2,28)	
SD	2.72	2.60	2.42			
(N)	13	10	6			
Change 2 (Oct.- Jan.)						
M	3.20	3.28	2.80	0.12	(2,30)	
SD	1.94	2.13	2.01			
(N)	15	10	6			
Change 3 (Oct.-Feb.)						
M	2.18	2.31	4.80	2.96	(2,24)	
SD	1.66	1.96	0.69			
(N)	13	9	3			
Change 4 (Oct.-Mar.)						
M	3.71	2.89	3.70	0.54	(2,23)	
SD	1.86	1.86	1.91			
(N)	11	9	4			
Change 5 (Oct.-Apr.)						
M	3.50	2.84	4.08	0.73	(2,26)	
SD	1.61	2.47	1.42			
(N)	12	10	5			
Change 6 (Oct.-May						
M	3.77	2.67	3.76	0.84	(2,25)	
SD	2.30	1.65	2.05			
(N)	12	9	5			
Change 7 (Oct.-Jun.)						
M	4.51	2.80	3.68	1.53	(2,29)	
SD	2.64	2.18	1.91			
(N)	15	10	5			

* indicates p<.05
** indicates p<.01

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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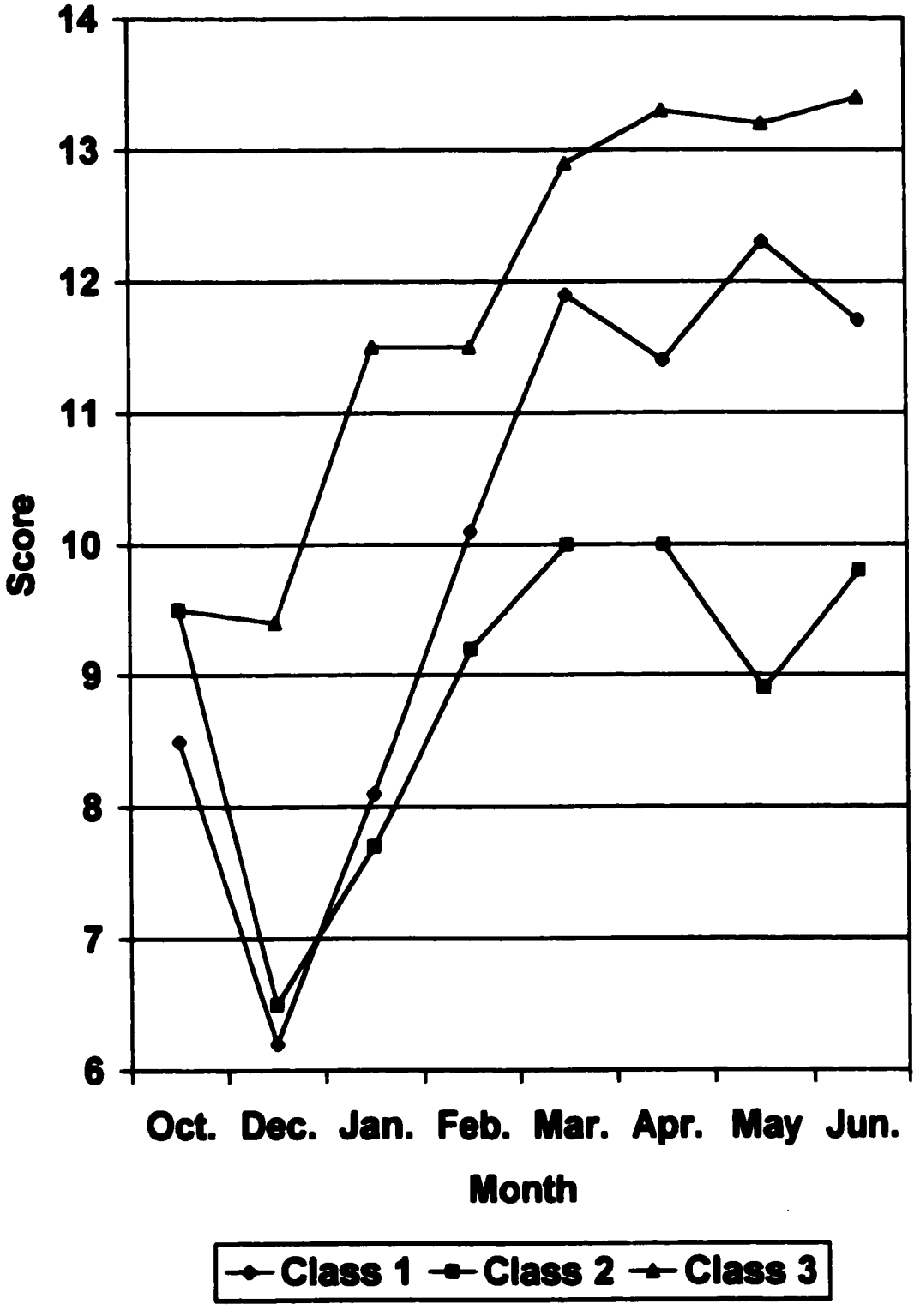
Figure 26: Females - Speed Category Test Scores on the M.H.T. by Class



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Male Subjects

Tables 24 through 30 contain the mean change scores for the male subjects on the total test scores and each of the category test scores from the baseline assessment in October to scores in subsequent test periods. These tables are located at the end of this section along with the corresponding figure. As with the classes and female subjects, these tables display the means for the males in Class 1, Class 2 and Class 3. The F ratio is stated along with the degrees of freedom. The SNK identified which class made significant improvements.

Total Test Scores. An ANOVA was completed for the pretest scores which indicated that the boys in Class 1, Class 2 and Class 3 were the same at the beginning of the study $F(2,19)=0133$, $p<0.88$. Another ANOVA was completed at the end of the study to assess the similarities and differences of this group. It was determined that at the end of the study, Class 2 was significantly different than Class 1 and Class 3 $F(2,21)=4.11, p<0.03$. Comparison of change scores between the experimental groups (Class 1 and 2) and control group (Class 3) on total test scores are displayed on Table 24. No significant differences in change scores were identified between the classes at any of the test periods. Figure 27 graphs the means for the total test scores for the males at the pre-test period in October and subsequent test periods until June.

Legibility. Legibility category scores (see Table 25) failed to demonstrate

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any significant differences between the male subjects in Classes 1, 2, and 3 at any of the test periods between December and June. Figure 28 graphs the means of the legibility category test scores from the baseline sample and subsequent test periods.

Form. Table 26 contains the means and standard deviations of the change scores for the Form category in the male subjects. No significant differences were found in any of the scores at the test periods from December to June. Figure 29 graphs the means for the form category scores during the school year.

Alignment. The Alignment category scores were analyzed for all classes and failed to demonstrate any significant improvements between the classes at any of the test periods (see Table 27). Figure 30 displays the means from the October sample until the June sample.

Size. Comparisons of change scores between Classes 1, 2, and 3 for males, found a significant difference in Class 2 when compared to Class 3 for the February test period ($F(2,17)=3.57, p<.05$) for the Size category. No other significant differences were found between the classes for the Size domain (see Table 28). Figure 31 presents the means on a graph from the October baseline sample until the final sample in June.

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Spacing. Table 29 presents the change scores for the males between the experimental groups and the control group for the Spacing category. No significant differences were found between Classes 1, 2, and 3 in this area. Refer to Figure 32 for the means from the October sample to the June sample.

Speed. An ANOVA was completed to identify any differences in the males between groups for speed at the October pre-test. In October, there was no statistical differences in speed for the males in Class 1, Class 2 and Class 3, $F(2,18)= 0.237$, $p<0.79$. At the final test period in June, the boys demonstrated no statistical differences in speed $F(2,21)=3.024$, $p<0.07$. Change scores for speed were calculated (see Table 30). There were no statistically significant improvements in speed for the male sample. Figure 33 graphs the means for speed in the male subjects.

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Table 24

Male Subjects: Total Test Scores

Comparisons of Change Scores Between the Experimental Classes and the Control Class on Total Test Scores - Male Subjects

Time	Experimental Class 1	Experimental Class 2	Control Class 3	F Ratio	df	SNK
Change 1 (Oct. -Dec.)						
M	57.25	32.08	22.00	2.51	(2,18)	
SD	24.70	22.83	18.19			
(N)	4	12	3			
Change 2 (Oct.- Jan.)						
M	41.20	46.25	27.67	0.92	(2,19)	
SD	20.24	23.08	11.37			
(N)	5	12	3			
Change 3 (Oct.-Feb.)						
M	41.75	52.45	31.67	1.20	(2,17)	
SD	13.60	25.27	9.02			
(N)	4	11	3			
Change 4 (Oct.-Mar.)						
M	42.00	52.00	37.00	0.62	(2,18)	
SD	20.20	25.67	7.41			
(N)	4	12	3			
Change 5 (Oct.-Apr.)						
M	40.00	56.64	33.67	1.43	(2,17)	
SD	23.79	26.27	8.50			
(N)	4	11	3			
Change 6 (Oct.-May						
M	38.00	56.08	43.00	0.86	(2,18)	
SD	24.99	26.60	24.02			
(N)	4	12	3			
Change 7 (Oct.-Jun.)						
M	43.80	52.36	43.33	0.36	(2,18)	
SD	15.02	25.77	13.28			
(N)	5	11	3			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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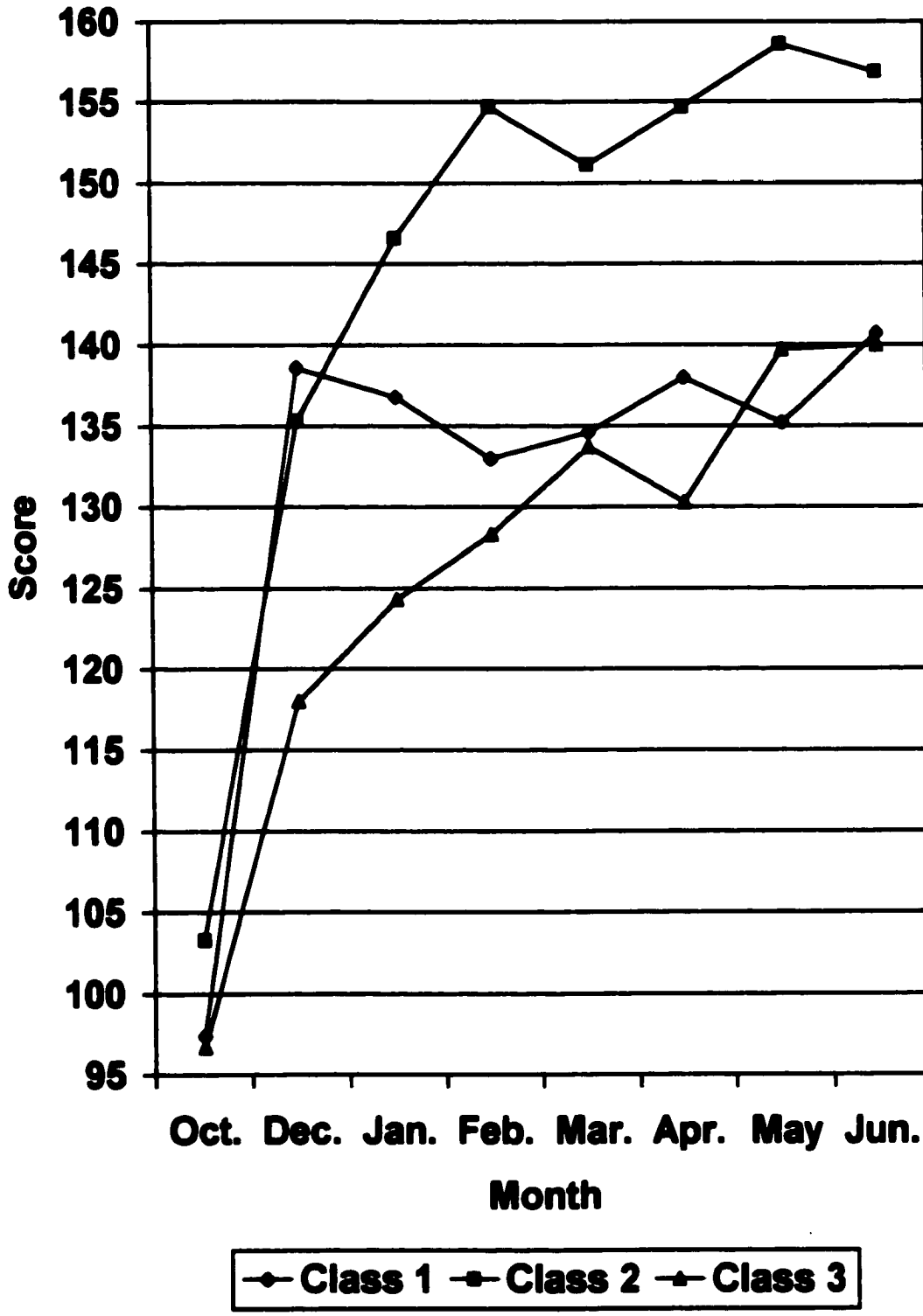
Figure 27: Males - Total Test Scores on the M.H.T. by Class



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Male Subjects: Legibility Category Test Scores

Comparisons of change scores between the experimental groups and the control group on Legibility Category test scores - Male Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct. -Dec.)						
M	5.25	3.25	2.33	0.43	(2,18)	
SD	2.63	5.14	2.08			
(N)	4	12	3			
Change 2 (Oct.-Jan.)						
M	3.00	3.75	3.33	0.08	(2,19)	
SD	1.41	3.91	4.04			
(N)	5	12	3			
Change 3 (Oct.-Feb.)						
M	3.25	5.00	4.00	0.24	(2,17)	
SD	2.99	5.04	3.46			
(N)	4	11	3			
Change 4 (Oct.-Mar.)						
M	3.50	4.50	3.67	0.11	(2,18)	
SD	1.73	4.70	4.04			
(N)	4	12	3			
Change 5 (Oct.-Apr.)						
M	3.25	4.82	3.67	0.22	(2,17)	
SD	2.22	5.23	2.08			
(N)	4	11	3			
Change 6 (Oct.-May						
M	2.25	4.83	5.67	0.70	(2,18)	
SD	1.25	4.95	3.06			
(N)	4	12	3			
Change 7 (Oct.-Jun.)						
M	3.60	4.09	3.33	0.05	(2,18)	
SD	0.55	5.22	3.06			
(N)	5	11	3			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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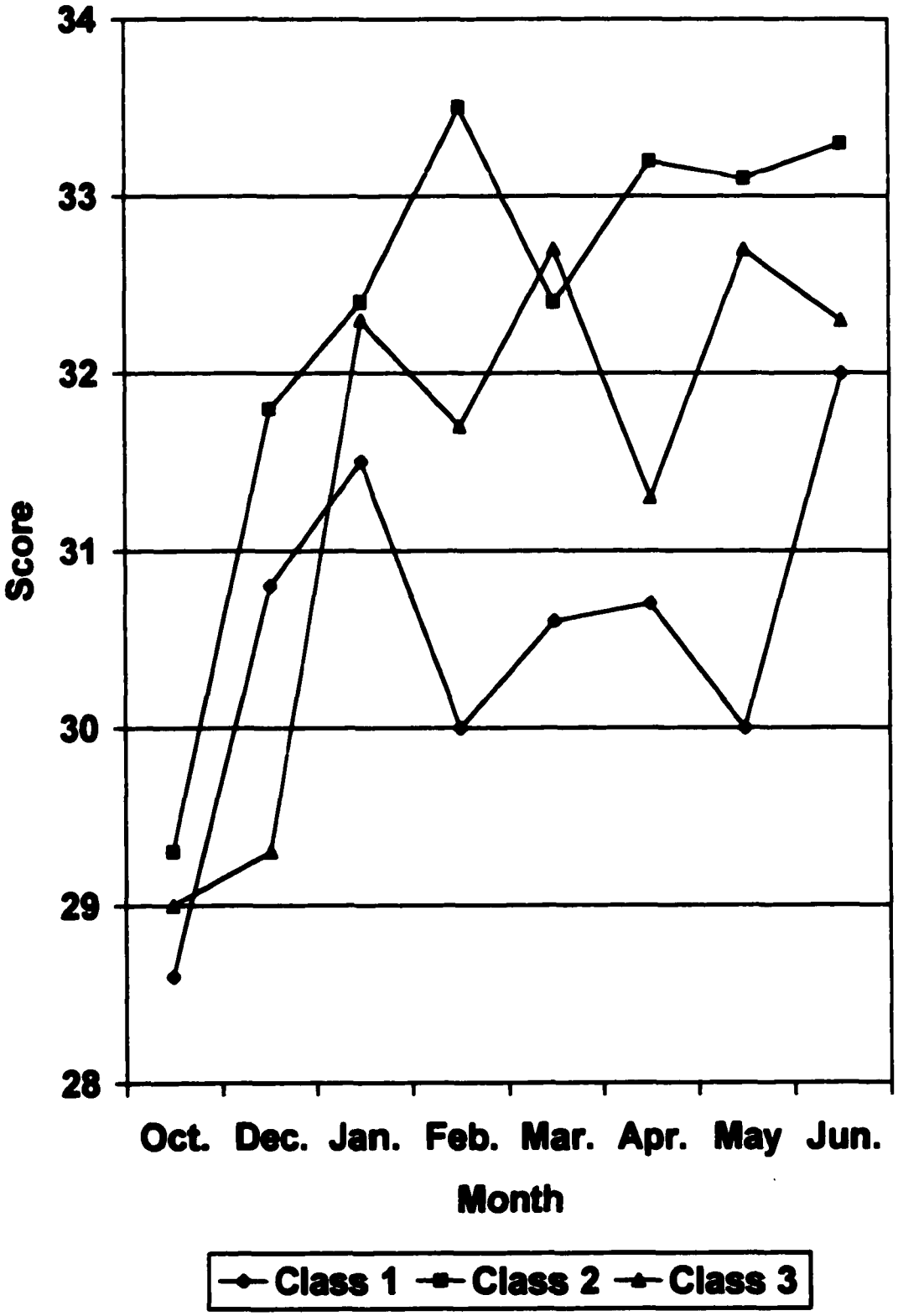
Figure 28: Males - Legibility Category Test Scores on the M.H.T. by Class



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Male Subjects: Form Category Test Scores

Comparisons of change scores between the experimental groups and the control group on Form test scores - Male Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct.-Dec.)						
M	8.50	3.83	5.67	1.79	(2,18)	
SD	6.61	3.49	4.04			
(N)	4	12	3			
Change 2 (Oct.-Jan.)						
M	6.80	7.00	5.67	0.11	(2,19)	
SD	4.66	4.45	4.04			
(N)	5	12	3			
Change 3 (Oct.-Feb.)						
M	8.00	7.55	6.33	0.12	(2,17)	
SD	4.32	4.78	4.62			
(N)	4	11	3			
Change 4 (Oct.-Mar.)						
M	8.50	7.58	5.33	0.28	(2,18)	
SD	8.58	4.94	4.04			
(N)	4	12	3			
Change 5 (Oct.-Apr.)						
M	8.25	9.82	4.67	0.90	(2,17)	
SD	8.34	5.33	4.04			
(N)	4	11	3			
Change 6 (Oct.-May						
M	9.00	9.08	4.33	0.91	(2,18)	
SD	6.68	5.38	4.93			
(N)	4	12	3			
Change 7 (Oct.-Jun.)						
M	7.80	7.18	5.33	0.21	(2,18)	
SD	6.87	5.02	3.06			
(N)	5	11	3			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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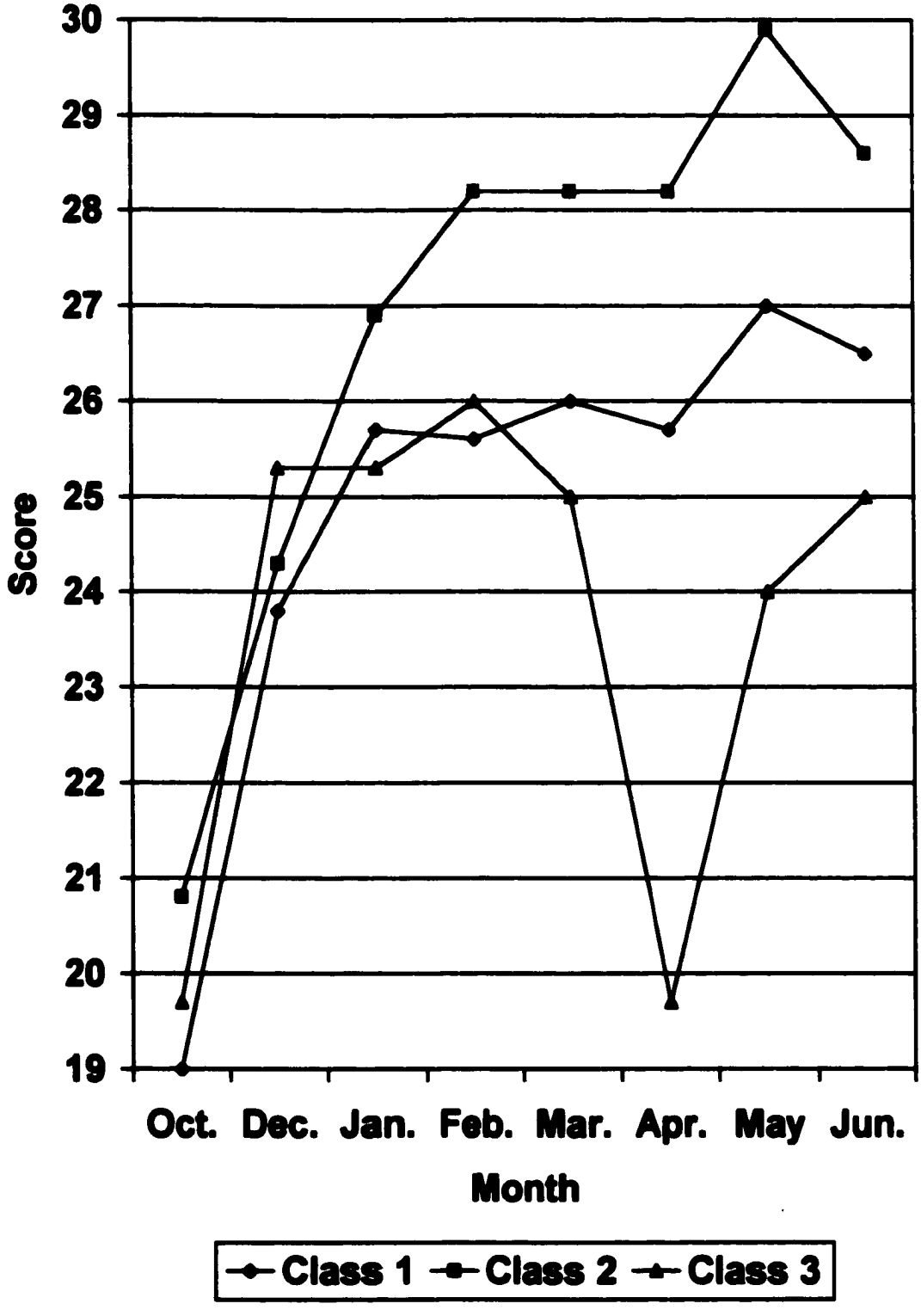
Figure 29: Males - Form Category Test Scores on the M.H.T. by Class



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Male Subjects: Alignment Category Test Scores

Comparisons of change scores between the experimental groups and the control group on Alignment Category test scores - Male Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct. -Dec.)						
M	16.25	9.75	8.33	1.72	(2,18)	
SD	7.50	6.92	1.53			
(N)	4	12	3			
Change 2 (Oct.- Jan.)						
M	12.80	13.42	9.67	0.33	(2,19)	
SD	6.98	7.44	6.03			
(N)	5	12	3			
Change 3 (Oct.-Feb.)						
M	12.25	15.27	14.00	0.25	(2,17)	
SD	5.44	8.51	3.00			
(N)	4	11	3			
Change 4 (Oct.-Mar.)						
M	12.50	13.58	14.00	0.04	(2,18)	
SD	5.45	9.02	5.29			
(N)	4	12	3			
Change 5 (Oct.-Apr.)						
M	11.75	15.64	13.33	0.52	(2,17)	
SD	5.56	7.74	0.58			
(N)	4	11	3			
Change 6 (Oct.-May						
M	10.00	15.08	16.67	0.77	(2,18)	
SD	7.70	8.56	4.51			
(N)	4	12	3			
Change 7 (Oct.-Jun.)						
M	13.40	15.00	14.00	0.08	(2,18)	
SD	6.47	8.35	5.58			
(N)	5	11	3			

* indicates p<.05
** indicates p<.01

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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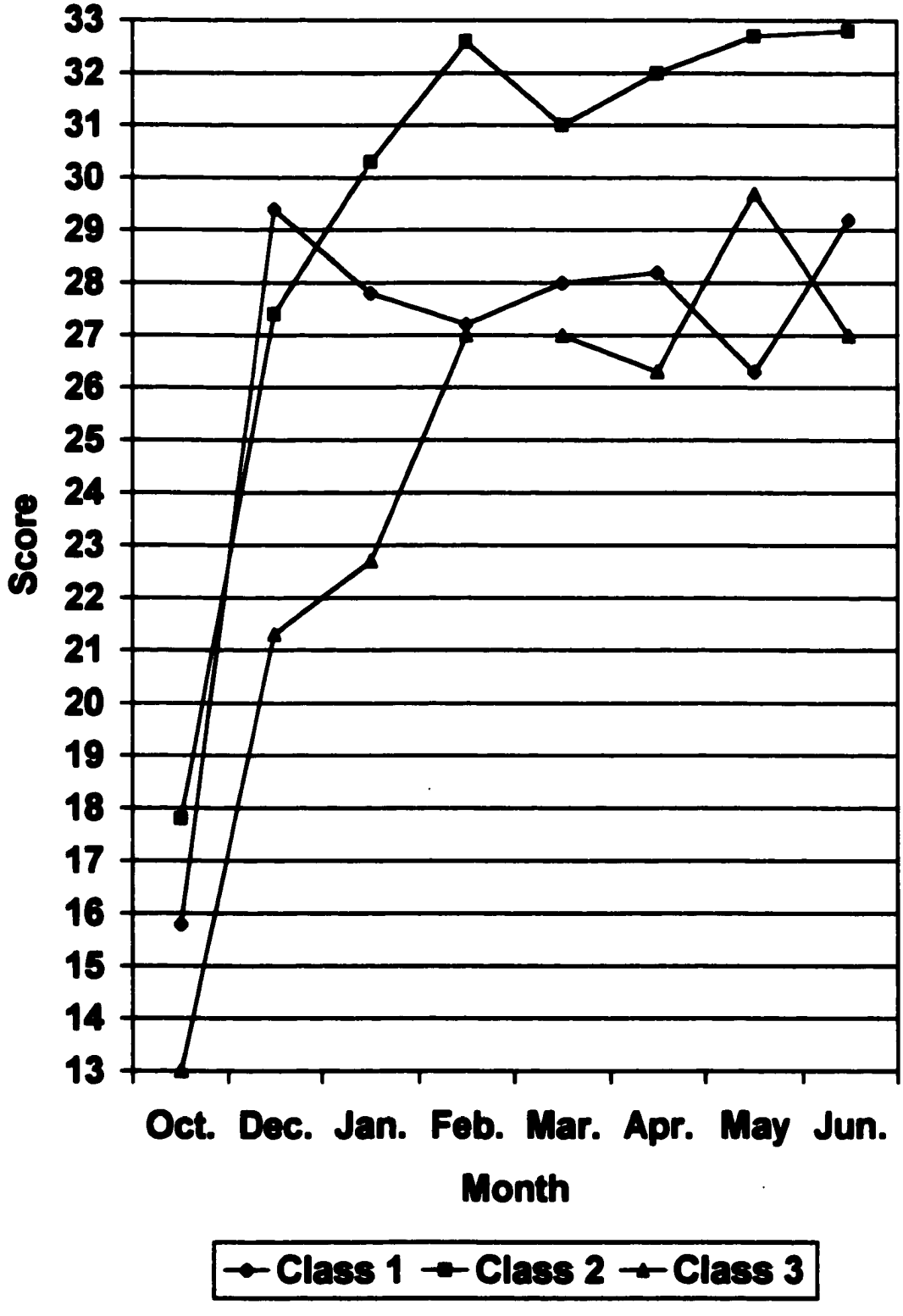
Figure 30: Males - Alignment Category Test Scores on the M.H.T. by Class



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Male Subjects: Size Category Test Scores

Comparisons of change scores between the experimental groups and the control group on Size Category test scores - Male Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct.-Dec.)						
M	19.00	14.08	8.00	2.14	(2,18)	
SD	8.60	6.60	6.08			
(N)	4	12	3			
Change 2 (Oct.- Jan.)						
M	15.20	18.67	5.00	3.36	(2,19)	
SD	9.73	8.29	1.00			
(N)	5	12	3			
Change 3 (Oct.-Feb.)						
M	17.00	18.73	4.67	3.57*	(2,17)	b
SD	6.05	8.93	6.35			
(N)	4	11	3			
Change 4 (Oct.-Mar.)						
M	15.00	19.58	11.33	1.56	(2,18)	
SD	7.44	8.43	3.79			
(N)	4	12	3			
Change 5 (Oct.-Apr.)						
M	15.00	21.00	14.67	1.72	(2,17)	
SD	8.37	6.48	6.11			
(N)	4	11	3			
Change 6 (Oct.-May						
M	14.75	21.33	13.67	1.89	(2,18)	
SD	9.43	7.30	6.51			
(N)	4	12	3			
Change 7 (Oct.-Jun.)						
M	13.40	19.82	16.00	1.35	(2,18)	
SD	9.74	7.11	1.00			
(N)	5	11	3			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Group 1 significantly differed from Control Group
b= Experimental Group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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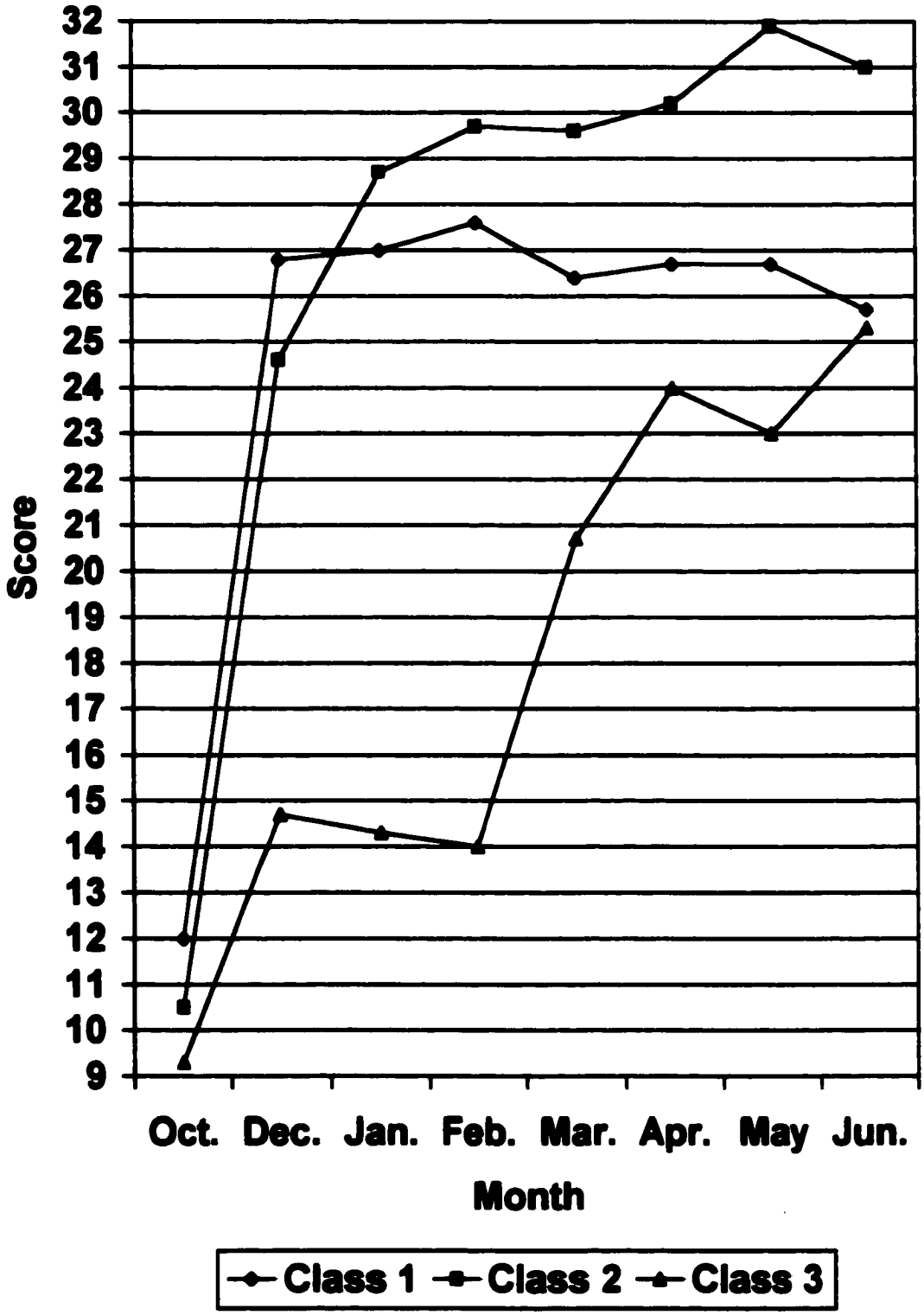
Figure 31: Males - Size Category Test Scores on the M.H.T. by Class



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Male Subjects: Spacing Category Test Scores

Comparisons of change scores between the experimental groups and the control group on Spacing Category test scores - Male Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct. -Dec.)						
M	9.25	4.67	4.33	1.18	(2,18)	
SD	6.85	5.40	1.53			
(N)	4	12	3			
Change 2 (Oct.- Jan.)						
M	5.00	4.92	4.00	0.11	(2,19)	
SD	3.39	3.26	2.65			
(N)	5	12	3			
Change 3 (Oct.-Feb.)						
M	6.25	6.82	4.00	0.44	(2,17)	
SD	2.63	5.34	2.65			
(N)	4	11	3			
Change 4 (Oct.-Mar.)						
M	2.50	7.58	4.67	1.71	(2,18)	
SD	2.38	5.82	1.53			
(N)	4	12	3			
Change 5 (Oct.-Apr.)						
M	4.25	7.55	6.00	0.47	(2,17)	
SD	5.44	6.58	2.00			
(N)	4	11	3			
Change 6 (Oct.-May						
M	4.50	6.75	6.00	0.26	(2,18)	
SD	2.38	6.20	3.46			
(N)	4	12	3			
Change 7 (Oct.-Jun.)						
M	5.60	7.00	4.67	0.25	(2,18)	
SD	3.97	6.37	3.79			
(N)	5	11	3			

* indicates $p<.05$
** indicates $p<.01$

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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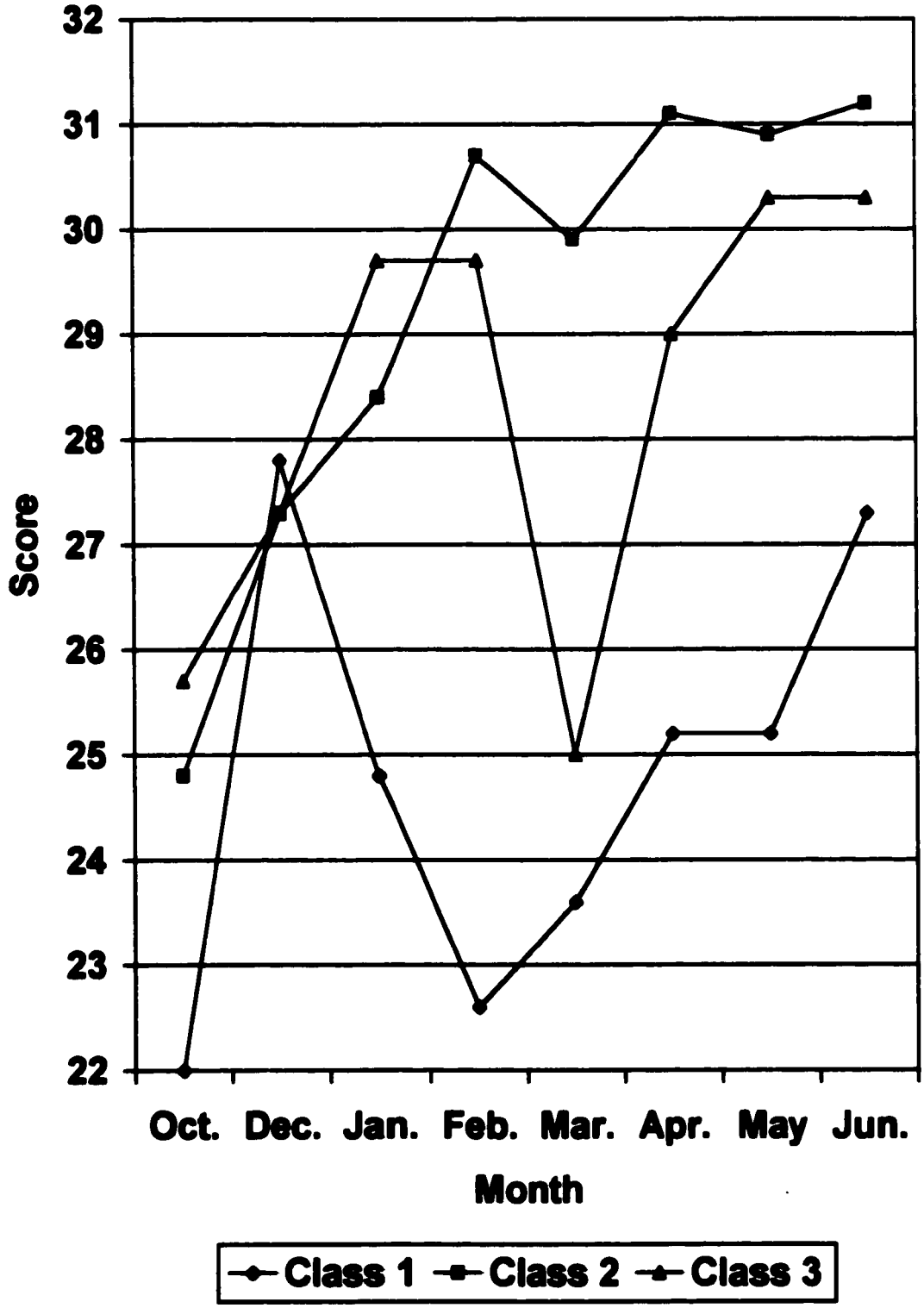
Figure 32: Males - Spacing Category Test Scores on the M.H.T. by Class



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Male Subjects: Speed Scores

Comparisons of change scores between the experimental groups and the control group on Speed Scores - Male Subjects

Time	Experimental Group 1	Experimental Group 2	Control Group	F Ratio	df	SNK
Baseline						
Change 1 (Oct. -Dec.)						
M	3.20	1.96	2.00	0.77	(2,16)	
SD	2.31	1.36	2.83			
(N)	4	11	2			
Change 2 (Oct.- Jan.)						
M	2.72	2.69	3.80	0.31	(2,17)	
SD	2.42	1.58	1.98			
(N)	5	11	2			
Change 3 (Oct.-Feb.)						
M	1.70	1.75	3.80	1.21	(2,17)	
SD	2.39	1.50	1.98			
(N)	4	11	2			
Change 4 (Oct.-Mar.)						
M	1.10	1.87	3.80	2.34	(2,17)	
SD	0.20	1.58	1.98			
(N)	4	12	2			
Change 5 (Oct.-Apr.)						
M	4.10	1.96	3.80	1.70	(2,16)	
SD	2.05	2.24	1.98			
(N)	4	11	2			
Change 6 (Oct.-May						
M	2.00	2.93	3.80	0.67	(2,17)	
SD	1.26	2.02	1.98			
(N)	4	12	2			
Change 7 (Oct.-Jun.)						
M	4.08	2.62	3.80	1.20	(2,17)	
SD	1.73	1.90	1.98			
(N)	5	11	2			

* indicates p<.05
** indicates p<.01

a= Experimental Group 1 significantly differed from Control Group
b= Experimental group 2 significantly differed from Control Group
c= Experimental Group 1 significantly differed from Experimental Group 2

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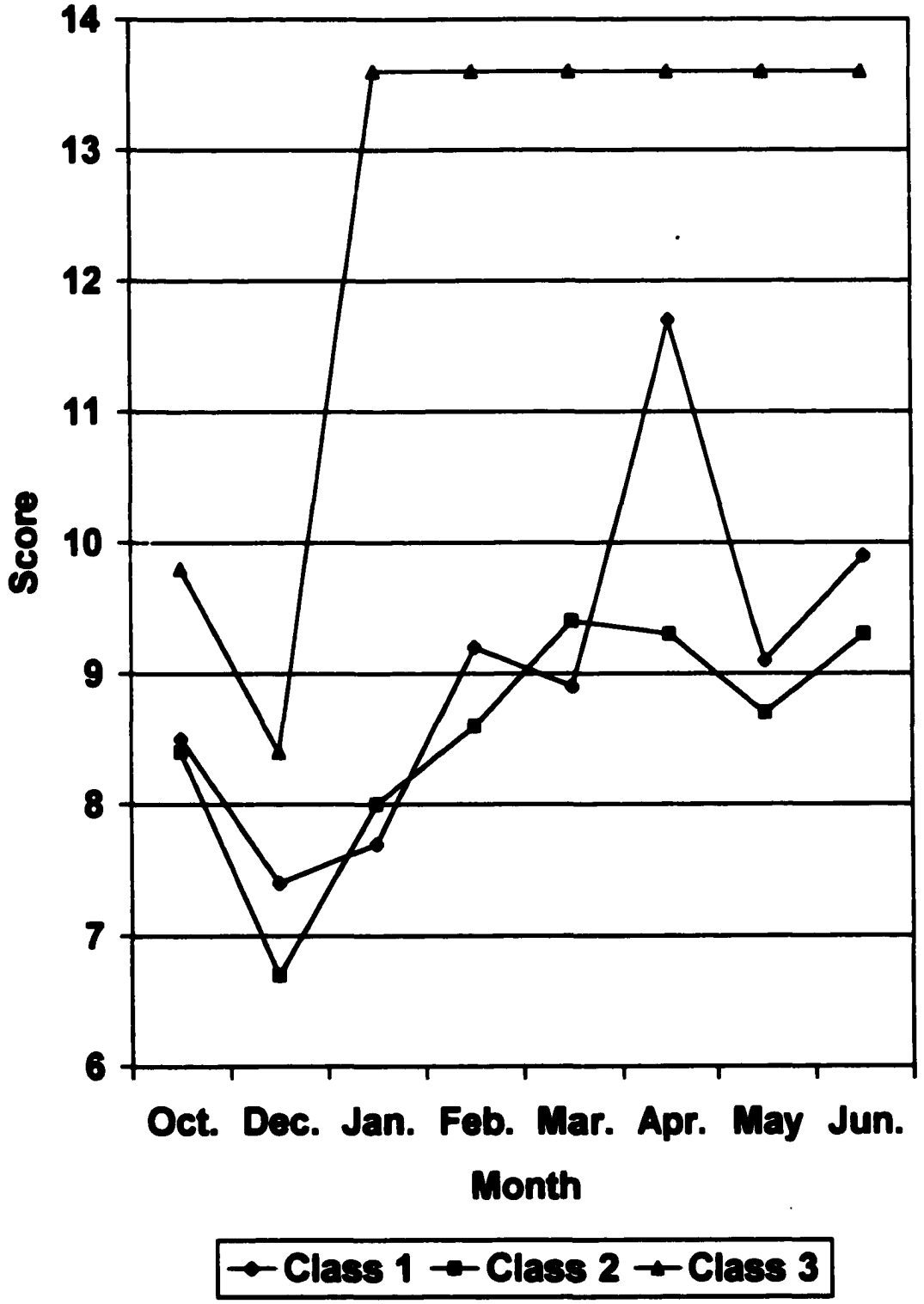
Figure 33: Males - Speed Category Test Scores on the M.H.T. by Class



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CHAPTER V

Discussion

The present study was designed to evaluate the effectiveness of the *Handwriting Without Tears* method of handwriting instruction for improving printing skills in grade one students. At the designated test periods, December to June, the students who received instruction using the *Handwriting Without Tears* method, demonstrated significantly more improvement than the students in the control group using the ball and stick method of instruction.

Hypothesis Testing

Hypothesis One

Hypothesis one was that the subjects would demonstrate an increase in overall scores on the Minnesota Handwriting Test (MHT) compared to the baseline levels. All subjects in both the experimental (Class 1 and Class 2) and the control group (Class 3) demonstrated an increase in total test scores on the Minnesota Handwriting Test from the pre-test (October) to post-test (June). This finding indicates that all the students in the study were printing at a better quality level at

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the end of the school year than in the beginning.

Hypothesis Two

Hypothesis two was that the subjects in the experimental group would demonstrate a greater increase in handwriting test scores than the control group. Because the experimental groups and the control group were not the same at the beginning of the study, the magnitude of change within the groups was used to statistically determine the significance of the change between the groups. In the December sample only Class 2 demonstrated significant differences when compared to Class 3. An Analysis of Variance (ANOVA) of the change scores indicated that the improvement for Class 1 and Class 2 was significantly better than Class 3 for the January to June samples.

Hypothesis Three

Hypothesis three was that the subjects in the experimental Classes 1 and 2 would demonstrate significantly more improvement in the five areas of handwriting skills being evaluated to include: Legibility, Form, Size, Spacing and Alignment. The subjects in the Experimental Classes 1 and 2 demonstrated significantly better improvement in only the Alignment and Size domains. The improvements in these two areas were consistently observed at each of the monthly test periods from December until June. In the other category areas, that is, legibility, form, and spacing, some statistically different improvements were noted at various test

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periods however, the improvements were not maintained monthly on a statistical level. The results of this study support the hypothesis for Alignment and Size categories but not for the other 3 categories.

Hypothesis Four

Hypothesis four was that there would be a difference in the significance of improvement of handwriting skills between the boys and the girls in the Experimental Class 1 and Class 2 and the Control Class 3. In the study, the girls in the Experimental Class 1 and Class 2 demonstrated statistically significant more improvement than the girls in the Control Class 3 on Total Test Scores of the MHT. This improvement was also found to be statistically significant for the Alignment and Size Categories. The boys in the Experimental Class 1 and Class 2 did not yield statistically significant change scores when compared to the Control Class 3 for any of the categories on the MHT. However, it was determined that the boys at the start of the study were the same. As a result, direct comparisons of the data demonstrated that the boys in Class 2 were significantly different than the boys in Class 1 and Class 3 at the end of the study in June. Also, comparisons of the pre-test / post-test t-test scores identify that the boys in all classes made significant gains from the beginning to the end of the study but the boys in Class 1 and Class 2 achieved a higher confidence level $p<0.01$. Class 3 reached $p<0.05$.

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Summary of Findings / Interpretation of Results

At the beginning of the study it was determined that the control Class 3 was different than experimental Class 1 and experimental Class 2. That is, Class 3 demonstrated significantly better skills in handwriting than Class 1 and Class 2 for whole classes. This is also true with the female population (although it was not true for the boys). Because of these differences, gain scores rather than direct comparisons were used to analyse the significance of improvement in each of the classes, both for whole classes and for the girls in all classes.

At the beginning of the study, it was determined that the boys in Class 1, Class 2 and Class 3 were at the same level of ability. That is, the boys in all classes started the study with similar handwriting skills. Because of this, direct comparison of skills at the pre-test and post-test was possible. To add to this information, gains scores were also used to analyse the magnitude of improvement from the baseline measurement to subsequent test periods until June. See Figure 34 for a chart summary of the statistical results.

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FIGURE 34: CHART SUMMARY OF RESULTS

	Total Test Scores			Legibility			Form			Alignment			Size			Spacing			Speed		
	Mixed	Females	Males	Mixed	Females	Males	Mixed	Females	Males	Mixed	Females	Males	Mixed	Females	Males	Mixed	Females	Males	Mixed	Females	Males
Experimental Class1	✔ ●	✔ ●	✖ ●	●	☆	✔ ●	●	●	☆	✔ ●	✔ ●	●	✔ ●	✔ ●	●	☆	☆	✔ ●	✔ ❑	✖ ❑	☆
Experimental Class 2	✔ ●	✔ ●	❑ ●	●	●	✔ ●	●	●	●	✔ ●	✔ ●	●	✔ ●	✔ ●	●	●	●	✔ ●	✖	✖	☆
Control Class 3	✖ ●	✖ ●	✖ ●	☆	☆	☆	●	☆	☆	✖ ●	✖ ●	●	✖ ●	☆	●	☆	☆	☆	✖ ❑	✖ ❑	☆

KEY

✔ Significant improvements; between class comparison

● Significant improvements; within class comparison

❑ Significantly better skills in June; between class comparison

✖ No significant improvements; between class comparison

☆ No significant improvements; between class or within class comparison

Results for Classes

Overall Handwriting Skills. The *Handwriting Without Tears* method was more effective in improving students handwriting when compared to a traditional ball and stick method. Comparisons of change scores for whole classes on total test scores of the MHT identified that at the test periods, January to June, Class 1 and Class 2 demonstrated significantly more improvement than Class 3. At the December test period, Class 1 demonstrated more improvement. This means that the two experimental classes using the *Handwriting Without Tears* method of handwriting instruction demonstrated more improvement in handwriting skills than did Class 3 using the more traditional ball and stick method on a consistent basis throughout the school year. As illustrated in Figure 13, Class 1 demonstrated improvement from October to June with a change in mean from 106.35 to 148.10. Class 2 demonstrated improvement from October to June with a change in mean from 108.43 to 159.81. Class 3 improved from 134.00 to 151.31. Within groups, all changes were significant to the $p<0.01$ confidence level. Within group improvements can be attributed to normal maturation.

Alignment of Letters. The *Handwriting Without Tears* method was found to enhance skills in the alignment of letters more consistently and effectively than a traditional method. From October to June, Class 1 and Class 2 demonstrated significant improvement in the Alignment domain of handwriting in comparison to Class 3. As illustrated on Figure 16, Class 1 demonstrated

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improvement from October to June with a mean change from 15.40 to 30.25. Class 2 demonstrated improvement from 17.29 to 33.24. Class 3 demonstrated improvement from 23.78 to 30.08. Although all classes made significant improvements within class comparison (t-test scores) most likely due to normal maturation of skill, Class 3 did not make significant improvements when compared to Class 1 and Class 2.

Size of Letters. The students using the *Handwriting Without Tears* method demonstrated more skills in producing letters of consistent size than did the students using a traditional ball and stick method. Between class comparison identified that Class 3 did not improve as much as Class 1 and 2 in this area. Class 1 and Class 2 demonstrated more improvement in printing letters the same size than did Class 3. Again, within class improvements for all classes in this domain were significant. This within class improvement is most likely the result of normal development usually seen in grade one students. As illustrated in Figure 17, Class 1 improved from 12.89 to 28.79 from October to June. Class 2 improved from 10.57 to 31.10 and Class 3 improved from 21.46 to 28.23.

Legibility of Printing. The students using the *Handwriting Without Tears* method demonstrated significant improvement in skills from the beginning of the school year to the end of the school year. The students using the traditional method did not improve in legibility from the beginning of the school year to the end

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of the year in June. This improvement and lack of improvement was noted within classes. If the improvement was the result of normal maturation, all students would have made a significant change for each of their handwriting skills from October to June. As noted by the figures, Class 3 started with better skills in this area but no significant differences were found between Class 1, Class 2 and Class 3 on improvements in these domains. However, when comparing scores for within class improvements from the pre-test / post-test t-test, Class 2 significantly improved from October to June at a $p<0.01$ confidence level for legibility (30.00 to 32.05). Class 1 improved significantly at a $p<0.05$ confidence level for this domain (30.38 to 33.57). While Class 3 did not demonstrate significant improvement from October to June (32.38 to 33.08). The within subjects improvement noted in Class 1 and 2 most likely was impacted by the program.

Form. All students in the study improved in this area from the beginning of the school year to the end of the school year. However, the students using the *Handwriting Without Tears* method demonstrated a higher confidence interval than the control class. The strength of the result for Class 1 and Class 2 may have been impacted by the method of handwriting instruction. No significant differences were found between Class 1, Class 2 and Class 3 for improvements in the Form domain. Within class comparison from pre-test (October) to post-test (June), Class 1 and Class 2 improved statistically at a $p<0.01$ level. Class 3 significantly improved at a $p<0.05$ level. Figure 15 illustrates the improvement for Class 1 (22.80 to 28.80),

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Class 2 (23.71 to 29.57) and Class 3 (26.00 to 28.62).

Spacing of Letter and Words. Only the Students in Class 2 using the *Handwriting Without Tears* method demonstrated significant changes in abilities from the beginning of the study in October to the end of the study in June. No significant differences were found for improvements in the spacing domain for any of the classes. For within group improvement as identified by the pre-test / post-test t-test scores, only Class 2 demonstrated significant improvement in skills from the October baseline to the measurement in June. This improvement was demonstrated at a $p<0.01$ confidence interval. Figure 18 illustrates the means of the Spacing scores within the groups for Class 1 (25.90 to 28.25), Class 2 (26.48 to 32.33) and Class 3 (30.38 to 31.31).

Speed. Class 1 and Class 3 were significantly faster than Class 2 at the end of the study. Class 3 was also significantly faster than Class 1 at the end of the study. However, regarding gain scores, Class 1 made significant improvements in speed compared to Class 2 and Class 3 from October to June. These results indicate that Class 3 was maintaining a consistently higher speed than the experimental groups however they did not improve significantly in speed. Class 1 however demonstrated significant increase in speed at the end of the study indicating possible consolidation of skills in handwriting. It appears that Class 2 was spending most time in the process of printing. Class 2 students were still

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developing consolidation of skills in handwriting. It is most likely that an increase of speed would occur in grade 2. A comparison of skills and speed in grade two may be a truer examination of the significance of this relationship.

Results for Females

Overall Handwriting Skills. The *Handwriting Without Tears* method increased handwriting skills in the girls more effectively than the traditional printing method. The girls in Class 1 and Class 2 demonstrated significant improvement in handwriting skills when compared to Class 3 from January to June. All improvement scores achieved a $p<0.01$ confidence interval. When comparing improvement within classes, Class 1 and Class 2 demonstrated significant improvement from October to June with a confidence interval of $p<0.01$. Class 3 demonstrated significant improvement from October to June with a confidence level of $p<0.05$. The differences in the confidence level of the within class findings may be the result of the teaching method. Figure 20 illustrates the means for the total test scores for the girls in Class 1 (109.33 to 150.40), Class 2 (112.60 to 163.10) and Class 3 (145.20 to 154.70).

Alignment of letters. The *Handwriting Without Tears* method impacted on letter alignment in the girls more effectively than the traditional ball and stick method. The girls in Class 1 and Class 2 demonstrated significantly more improvement in alignment than did the girls in Class 3. As demonstrated by the

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pre-test / post-test t-test scores, Class 1, Class 2 and Class 3 improved significantly within classes from the beginning of the school year to the end at a confidence interval of $p<0.01$. This improvement is most likely the result of normal skill development. Figure 23 illustrates the improvements from October to June for Class 1 (15.27 to 30.60), Class 2 (16.70 to 33.70) and Class 3 (27.00 to 31.00).

Size of Letters. The *Handwriting Without Tears* method was more effective in developing print of consistent size in the girls over a traditional ball and stick method. The girls in Class 1 and Class 2 demonstrated statistically greater improvement in printing letters of consistent size than the girls in Class 3. From the pre-test measure to the post-test measure, only Class 1 and Class 2 demonstrated statistically significant improvement for within class comparison. Class 3 did not improve within class comparisons. With normal maturation, it would be expected that all students improve from the baseline measure to final measure. The within group improvements for Class 1 and Class 2 may be partly related to the *Handwriting Without Tears* method. It must be noted however that Class 3 started with better skills in this area. The between group comparison however, made adjustment for this difference. The pre-test / post-test t-tests only look at the subjects within groups and cannot be compared between groups. Figure 24 illustrates the means for size from the baseline sample to the final sample for Class 1 (13.21 to 30.00), Class 2 (10.20 to 31.50) and Class 3 (25.10 to 29.10).

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Legibility of Print. The girls in Class 2 using the *Handwriting Without Tears* method improved in legibility from the beginning of the study to the end of the study. If this within group improvement was the result of normal maturation, all classes would have demonstrated gains in this area. No differences were found between the girls in Class 1, Class 2 or Class 3 for improvements in the legibility of their printing. Figure 21 illustrates the means for legibility from October to June for Class 1 (30.47 to 32.00), Class 2 (31.30 to 33.90) and Class 3 (33.40 to 33.30).

Form. The girls using the *Handwriting Without Tears* method improved from the baseline measurement to the final measurement. The girls using the traditional method did not show improvement in form from the beginning of the study to the end of the study. No consistent statistical differences were found in this domain for the girls in any of the classes. For within class comparisons on the pre-test / post-test t-test, only Class 1 and Class 2 demonstrated significant improvement from October to June. This improvement reached a confidence interval of $p<0.01$. It may be possible that the within class improvement was impacted by the *Handwriting Without Tears* method Figure 22 illustrates the means for the form domain from October to June for Class 1 (24.07 to 29.47), Class 2 (26.10 to 30.90) and Class 3 (27.90 to 29.70).

Spacing of Letter and Words. The girls in Class 2 using the *Handwriting Without Tears* method improved from October to June in the area of spacing. No

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consistent statistical differences were found for the girls in any of the classes with regard to spacing change scores. For within class comparisons, only Class 2 demonstrated significant improvement from the baseline measure to the final measure on the pre-test / post-test t-test with a confidence interval of $p<0.01$. Figure 25 illustrates the means for spacing for the girls from October to June for Class 1 (27.20 to 28.47), Class 2 (28.30 to 33.10) and Class 3 (31.80 to 31.60).

Speed. Class 1 and Class 3 were significantly faster than Class 2 at the end of the study. With regard to gain scores, there were no significant differences in improvement of speed for any of the subsequent test periods. It appears that Class 1 and Class 3 were starting to consolidate their skills in handwriting, while Class 2 was still developing skills therefore handwriting was not yet making a difference in the speed domain. Follow up in grade 2 in the area of speed would help to make further inferences about speed and quality of handwriting.

Results for Males

Overall Handwriting Skills. The boys in Class 2 using the *Handwriting Without Tears* demonstrated the better handwriting skills in June. An ANOVA completed at the end of the study indicated that the boys in Class 2 had better handwriting skills than the boys in Class 1 and Class 3. No statistical differences were found for the boys in any of the classes in gain scores. However, pre-test / post-test t-test identified that the boys in Class 1, Class 2 and Class 3

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demonstrated significant improvements from October to June. This finding suggests that normal skill development was occurring in handwriting skills throughout the school year. Class 1 and Class 2 achieved a higher confidence interval ($p<0.01$). Class 3 achieved a confidence interval of $p<0.05$. Figure 27 illustrates the improvements for Class 1 (97.40 to 141.2), Class 2 (104.64 to 156.82) and Class 3(96.67 to 140.00). This higher significance level may indicate that *Handwriting Without Tears* impacted on overall quality of skills for Class 1 and Class 2.

Legibility of Print. The *Handwriting Without Tears* method was more effective in improving legibility in the boys than the traditional method. Gain scores did not demonstrate any differences between the classes. Pre-test / post-test t-test identified that the boys in Class 1 and Class 2 improved from October to June, whereas, the boys in Class 3 did not improve statistically from the baseline measurement to the final measurement. Figure 28 illustrates the improvement from October to June for Class 1 (28.60 to 32.20), Class 2 (29.55 to 33.27) and Class 3 (29.00 to 32.33). Because the boys started with the same skills in handwriting at the beginning of the study, direct comparisons can be made between groups for any mean scores. Therefore, the improvement noted in the experimental groups from the baseline measurement to June was significant for between group comparisons as well as within group comparisons.

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Form. The boys in Class 2 using the *Handwriting Without Tears* method demonstrated more improvement than the boys in the other two classes. Gain scores did not find any differences in the boys from Class 1, Class 2 or Class 3. Pre-test / post-test t-test identified that only Class 2 made significant improvements from October's baseline measurement to June. Figure 29 illustrates the improvement from October to June for Class 1 (19.00 to 26.80), Class 2 (21.55 to 28.36) and Class 3 (19.67 to 25.00).

Alignment of Letters. The *Handwriting Without Tears* method was similar to the traditional method for improving alignment of letters for the boys. Gain scores did not identify any differences between the boys in this domain. However, the boys in all classes demonstrated improvements from the baseline measurement to June on the pre-test / post-test t-test. Class 1 and Class 2 achieved a confidence interval of $p<0.01$ while Class 3 had a confidence interval of $p<0.05$. Figure 30 illustrates the improvements from October to June for Class 1 (15.80 to 29.20), Class 2 (17.82 to 32,82), and Class 3 (13.00 to 27.00).

Size of Letters. The *Handwriting Without Tears* method was similar to the traditional method for developing consistent size of letters for the boys in the study. No consistent results were found for gain scores in this area. Pre-test / post-test t-test found that the boys improved in this area in all classes. Class 2 and Class 3 improved with a confidence interval of $p<0.01$, while Class 1 had a confidence

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interval of $p<0.05$. Figure 31 illustrates the improvement for size of letters for Class 1 (12.00 to 25.40), Class 2 (10.91 to 30.73) and Class 3 (9.33 to 25.33).

Spacing of Letters and Words. The *Handwriting Without Tears* method was more effective than the traditional method for enhancing letter and word spacing in the boys. No significant differences were found for the boys in this domain for gain scores. For the pre-test / post-test t-test, the boys in Class 1 and Class 2 demonstrated improvement from October to June. The boys in Class 3 did not demonstrate improvement in this area from October to June. Figure 32 illustrates the improvement in spacing from the baseline measurement until the final measurement in June for Class 1 (22.00 to 27.60), Class 2 (24.82 to 31.64) and Class 3 (25.67 to 30.00). Again as indicated earlier, the pre-test and post-test scores can be compared directly between classes for the male sample because of established group similarity at the start of the study. Therefore, the boys in Class1 and Class 2 made significant improvement in this area when compared to Class 3.

Speed. There were no differences in speed for any of the boys in Class 1, Class 2 or Class 3 at the beginning or end of the study. The analysis of gain scores did not identify any differences between the classes in this domain. It is likely that the small sample size for Class 1 and Class 2 for the male sample impacted on the result. Class 1 had a speed of 9.75 letters per minute. Class 2 had a speed of 9.25 words per minute while Class 3 had a speed of 13.5 words per minute. Class 1 had

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a sample of 5 and Class 3 had a sample of 2. Further research is need to identify the changes in speed of handwriting for boys.

Application to Present Literature

Multi-Sensory Approach to Handwriting

The improvement in handwriting skills demonstrated by the students in Class 1 and Class 2 indicate that the use of a multi-sensory structured handwriting program specifically *Handwriting Without Tears* , for improving handwriting skills was more effective than a traditional ball and stick method of instruction. This finding was reached with a very high significance level ($p<0.000$) for whole classes.

The girls using *Handwriting Without Tears* demonstrated significant skill development when compared to the class using traditional methods. This finding achieved a high alpha-level or significance level ($p<0.000$).

Only the boys in Class 2 demonstrated significant improvement at the end of the study when compared to the boys in the other classes. This class had the larger sample size which was favourable. Perhaps, larger sample sizes for the other two classes would have made a difference in the analysis.

These finding supports the work of Furner (1969a, 1969b, 1970) who found that a multi-sensory approach to teaching handwriting improved children's quality of handwriting in grades one, two and three. Multi-sensory methods for teaching handwriting have also been supported by other authors (Alston & Taylor, 1987; Berninger et al., 1997; Graham, 1992, 1997; Lockhart and Law, 1994).

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The *Handwriting Without Tears* method used by the teachers in experimental Class 1 and experimental Class 2 provided the teachers with a comprehensive approach to teaching handwriting. This approach encompassed all areas of handwriting instruction to include: teaching grasp, use of lines, demonstration of letter formation and motor planning, stories to go hand in hand with letter formation, letter formation imitation and letter printing practice. The method provides the teacher with the "how to" related to the many controversies associated with handwriting instruction presented in the literature review.

Alignment and Size

The significant improvement identified in the alignment and size components of printing for Class 1 and Class 2 implies that the *Handwriting Without Tears* method is effective for enhancing skills in these two areas. The results were obtained with a high degree of confidence ($p<0.000$) therefore indicating that the improvement occurred most likely as a result of the handwriting program.

The girls using the *Handwriting Without Tears* method significantly improved in alignment and size domains. The results for the girls likely occurred because of the handwriting method of instruction. A confidence interval of $p<0.000$ was reached for both experimental classes.

The boys in the study did not demonstrate the same results. All the boys in the study improved in alignment and size significantly from the beginning of the study to the end. This improvement may be the result of maturation and instruction

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in handwriting in general, as improvement would be expected. The boys in the experimental classes however, demonstrated significant improvements in the areas of legibility and spacing. Ziviani (1995) identifies that handwriting skills mature with age in legibility areas with letters becoming more accurately formed initially. Once this has developed, consistent spacing occurs and size decreases (most especially in the girls). Horizontal alignment is the last area to develop. If handwriting skill development follow this sequence of events, the boys in the study may be lagging behind the girls in the area of alignment and size. They are however following the natural course for the development of legibility and spacing (the boys in the experimental classes more so than the control class).

One explanation for the improvement in Class1 and Class 2 may be the use of the "double line" in the *Handwriting Without Tears* method (see Appendix A). The double line consists of the bottom line and the top line. Olsen (1997) identifies in her program that "the bottom line keeps the writing straight while the top line controls the size (p.45). According to these findings, the "double lines" used in the *Handwriting Without Tears* method may have contributed to improvement in alignment of letters and size of letters. The students in the experimental classes improved significantly in these domains of all the categories on the MHT. The students in the experimental group used the double lines for printing instruction and during other writing tasks. All letter formation during printing practice was oriented to the double lines on a visual, cognitive and motor basis.

A number of authors, identify that the use of lines increases legibility in

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younger printers and that lines assist students in developing well alignment script of acceptable size.(Burnhill, Hartley, Fraser, Young,1975; Burnhill, Hartley, Davs 1980 ; Jarman ,1979 ; Manning, 1988; Pasternicki, 1987).

The MHT used in this study provided three lined paper for the completion of the handwriting test sample. The children in the experimental classes, who were introduced to the *Handwriting Without Tears'* double line paper demonstrated a transition to using three lined paper at the test periods with good results. Although they were not using three lined paper in the classroom, they continued to demonstrate more significant improvements on test results than the control group. In Addy and Wylie's (1973) survey of 400 teachers in ten states in the United States and one province in Canada, teachers generally preferred three lined paper (top line, middle dotted line, and baseline) when teaching printing. Three lined paper continues to be used in schools at the present time.

In the author's clinical experience, some teachers are concerned about the possible difficulty the children may have changing from double lined paper to three lined paper or to regular lines in exercise books. This study suggests that this type of difficulty would be unlikely. The teachers of the experimental groups assisted the children in this transition by going to the "pink - blue - blue" lined paper in the Hilroy exercise books. They oriented the children to using the blue-blue line as they had used the double lines and indicated that the pink line was the "clouds". The "clouds" orient children visually to print tall letters beyond the top line when using the double lined paper in the *Handwriting Without Tears* program. From the pink-blue-blue

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lines, the children were oriented to the regular blue lines without much difficulty according to the teachers of the *Handwriting Without Tears* classes.

Legibility, Letter Formation , Alignment , Size and Spacing

Ziviani and Elkins (1984) found that as children matured the distance allowed between words (spacing) and the size of letters decreased gradually. Letter formation and horizontal alignment also gradually improved between grades 2-6. In this study, the children using the HWT program in experimental class demonstrated more improvement in alignment and size. The girls also demonstrated significant differences in alignment and size. The boys did not demonstrate significant differences in alignment and size which may be the result of a lag in skill or maturation of skills for the boys in this area. If the study was carried over to grade 2, these domains would most likely change for the boys.

The boys using the *Handwriting Without Tears* method demonstrated significant differences in legibility and spacing from October to June. Class 2 demonstrated significant differences in letter formation or form. The control class did not demonstrate any significant differences in these areas for the girls or the boys. The *Handwriting Without Tears* method most likely impacted on the rate of development in these areas. Further research is needed in this area.

Structured Handwriting Program and Teacher Training in Handwriting

It is difficult to identify the effect, if any, that the structured teaching

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component of the *Handwriting Without Tears* program had on the outcome of the study. The structured teaching component of the *Handwriting Without Tears* is included within the multi-sensory approach. Perhaps the structure of the instruction impacted as much as the multi-sensory component. Further research assessing other structured handwriting programs along with the *Handwriting Without Tears* method may provide information in this area.

It has been noted in the literature, that the lack of teacher training in the area of handwriting may impact on the children's handwriting skill development (Rubin & Henderson, 1982). Peck, Askov, and Fairchild (1980), reported in their review of the literature on handwriting instruction, that the measured effects of teacher's inservice training in handwriting impacted significantly on pupils' performance in manuscript printing. In this case, did the teachers' knowledge of handwriting instruction gained by the *Handwriting Without Tears - Teachers' Printing Guide*, and teacher training in preparation for participation in the study impact on the students' handwriting skills? Further research may be useful to assist in providing more insight and knowledge in this area. Regardless of what parts of the program made the difference, in this case the combination of all three components: the multi-sensory component, the structured component, and the teacher's knowledge gained by training in the *Handwriting Without Tears* method, the students using this method made significant gains in handwriting skills.

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Motor Skill Training and Handwriting Errors

The three most common errors observed in first grade students are incorrect size, incorrect relationship of parts and incorrect placement of the letter relative to the size. These errors are related to lack of motor control (E.R. Lewis and H.P.Lewis,1965). In the present research, the alignment and size categories were the ones with the lowest means of all the five categories on the MHT for all classes. However, during and following the *Handwriting Without Tears* intervention, there was significant improvement in these areas.

Oliver (1990) suggests that "training in one area of the motor skill components tends to enhance overall performance" (p.112). This was true for the children in the experimental classes. The handwriting skills were targeted, intervention or teaching was directed at this particular skill and improvements were noted in overall performance.

Differences Between Boys and Girls

Gender was considered in this analysis as there is evidence in the literature that girls are better handwriters than boys (Graham & Miller, 1980; Tarnopol, Feldman, 1987, Yochman & Parash, 1998) Also, girls develop more quickly in visual motor areas than boys (Judd et al.,1982; Karapetsas & Vlachos,1997) and handwrite faster than boys (Berninger, Vaughan, R.D.Abbott, S.P. Abbott, Woodruff Rogan, Brooks, Reed, 1997; Maeland, 1992; Ziviani, 1984). The girls in the experimental classes who were learning to print using the *Handwriting Without Tears* method,

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demonstrated significantly more improvement in handwriting skills than the girls in the control class. This improvement was noted on a consistent basis from the monthly test periods, January to June. Significant differences in improvement between those in the control and experimental classes were also noted for the girls at all test periods from December until June in alignment and size components on the MHT. The boys failed to show any statistically different improvements in the alignment and size categories however demonstrated improvements in legibility and spacing. Class 2 demonstrated significant improvement in overall handwriting skills and form.

Hamstra-Bletz and Blote (1990) suggest that handwriting skills do improve over time in most students up to grade four when formal handwriting instruction stops. According to their research, the first changes in handwriting skills occurs with maturation of fine motor abilities. With this, the size of handwriting becomes smaller, the word and letter alignment improves and the writing becomes more steady. They note that girls are ahead of boys in this development. This finding has been supported in this research study as the girls demonstrated improvement in these areas were the boys did not make the same gains. All students improved from baseline to post-test within class comparisons in most areas. This improvement is likely due to normal maturation for both the boys and girls. Between the classes, the girls in the Experimental Classes 1 and 2 demonstrated significant improvements when compared to Class 3.

Berninger et al. (1997) concluded that boys are more vulnerable to

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handwriting problems. They reported that boys are more prone than girls to handwriting fluency problems in the elementary grades. Ames, Gillespie, Haines (1979) reported that in many areas of development, girls reach developmental stages about six months sooner than boys. If the study was carried through to grade two, further skill development in the area of overall handwriting, alignment and size for the boys may be identified.

Speed and Accuracy

A study conducted by Judd et al.(1986), reported that boys demonstrated deficiencies in both rate of production of symbols and accuracy of copying symbols. The authors suggested that the difficulties for boys may be related to information processing. The MHT involved a timed test for copying words. If the findings of Judd et al. (1986) are true, the boys in this research may have been slower in processing information for copying words on the MHT.

For whole class comparisons, it was identified that Class 1 and Class 3 were significantly faster than Class 2 and that Class 3 was significantly faster than Class 1. For the girls in the study, Class 1 and Class 3 were significantly faster than Class 2. For the boys, there was no significant differences in speed between the classes however the sample size for Class 1 and Class 3 was small. There were no consistent significant improvements in the classes related to speed over the test periods. However, at the end of the year in June, experimental Class 1 demonstrated significant improvements related to speed in comparison to Class 2

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and Class 3. There is very little research reporting findings of letter and word speed in grade one samples. Ziviani and Watson-Will (1998) noted that in the younger grades, children may not be able to produce fast and legible writing at the same time. Younger children tend to take their time making their work legible before increasing their speed. This finding is supported by the research. The children in both the experimental classes and the control class, did not demonstrate consistent significant improvements in the area of speed. The children were instructed to "write as you usually do when you are trying to use good handwriting" (Reisman, 1991a). It may be hypothesized that the children were focusing on legibility and printing neatly rather than printing fast. All children in the study were given the same instructions therefore it may be assumed that they were trying to use "good handwriting" and the speed for the sample reflected this instruction.

Although speed was scored, the results suggest that the children emphasized neatness over speed. As children become more familiar with the letter formation and develop motor memory for letters, printing becomes more automatic and speed improves. Alston (1991) suggested that when students are writing correctly and confidently, writing at increased speed can be encouraged and monitored. All studies that have analyzed handwriting speeds have started the analysis at the grade two level. Grade one is a year where handwriting skills are developing in the areas of letter formation, alignment, size, and spacing to increase legibility. These components are usually stressed before speed (Ziviani and Watson- Weil, 1998). The emphasis on good handwriting habits is essential to the development of

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efficient handwriting skills.

Another explanation for the differences noted between the experimental classes and the control class in the area of speed, is that the experimental classes were introduced to a new style of manuscript that required them to use a continuous stroke letter formation rather than the ball and stick letter formation. This letter formation was introduced to the children in the experimental classes for the first time during the school year. Prior to the introduction of the continuous stroke letter formation, the children were using a ball and stick letter formation or upper case letters for printing in kindergarten. Possibly the introduction of a new method would have caused the children to be slower than if they were building on a method previously introduced to them. Ziviani and Watson-Will (1997) had similar results with the introduction of modern cursive to a population of children age 7-14. They noted that the children in their study were slower in writing. The authors felt that the slower speed with handwriting may have occurred because of the transition from a traditional handwriting curriculum to the one that was being introduced and used in the system.

Hamstra-Bletz and Blote (1990) argue that the relationship between legibility and speed may not be linear. In their study of grade 2 children, the students with the slowest writing had better letter formation and accuracy than faster writers but the script was more irregular with respect to size and alignment. At grade 3, they noted that fast and slow writers were similar in terms of letter formation and spacing but the script of fast writers was more regular. They identify that variation in the

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proficiency of handwriting skills exists between the grades.

In the present research, the slower writers found in the experimental classes had more consistency in alignment and size of print. They had only one year exposure to the continuous stroke letter formation which may have been a factor in their slower speed on evaluation. These students were using a different style in kindergarten therefore started from "scratch" with the continuous stroke of the *Handwriting Without Tears* method in grade one. The children in the control class were using a traditional method in both kindergarten and grade one. They were introduced to the ball and stick letters in kindergarten prior to starting printing in grade one.

All in all, the relationship between legibility and speed must be looked at from a developmental perspective spanning the primary grades. It appears that the introduction of a different type of letter formation may require the children to slow down to develop a motor memory for printing letters. Once motor memory has developed and has been established, automatic abilities in letter formation will surface leading to proficiency of handwriting. Children must first learn to form the letters correctly and consistently before developing automatic abilities. Once automatic abilities in letter formation surface, handwriting becomes a means to an end by which it becomes the vehicle for writing one's thoughts on paper. It appears that the control class were at a level of more automatic ability than the experimental classes. They also appeared to have more exposure to the traditional method of handwriting whereas the experimental classes only had one year exposure to the

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continuous stroke method of letter formation. Further assessment and evaluation in grade 2 would allow for a more fair comparison of the experimental classes in the area of speed.

Limitations of the Study

The results must be considered within the limitations of this study. The study has a relatively small sample size. Keppel, Saufley, and Tokunga (1992) report that the "F test provides important and necessary information concerning the presence or absence of treatment effects and differences among treatment means in the population" (p.178). They note that the F ratio is directly related to sample size as the size of the F ratio increases as the sample size increases . A larger sample size therefore, may have strengthened the results of the study. Also the small sample of males in Class 1 and Class 3 may not have identified the same results as a larger sample size. In this case, Class 2 with the larger sample size made the greatest improvement. Equal samples would result in increased generalizability for the boys in the study.

Although the study was implemented over the course of the school year which allowed for some information to be gathered about consistent change over time, it may have been useful to extend observations into grade two. Some data suggests that boys develop slower than girls in the area of handwriting, therefore the male sample may have consolidated and improved their skills by grade 2 in the same area that the girls demonstrated improvement in this research.

The MHT was administered in a group situation, therefore, the actual forming

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of the letter was not observed for each student. Letter formation, in its truest sense, was not measured. It would be interesting to evaluate letter formation through individual student observation to see if the children in the experimental class were consistent by using the letter formation rules provided in the *Handwriting Without Tears* program.

Although attempts were made to control variables within the study, more control for teacher variation was placed on the experimental classes because of the structure of the *Handwriting Without Tears* method. However, the fact that two different teachers were providing the experimental treatment provided increased strength to the results, as both experimental classes demonstrated significant differences in total test scores, alignment and size category scores when compared to the control class. Therefore, the effect on handwriting performance as a result of teacher variation was minimized within the experimental classes.

Conclusion

The results of this research indicate that the *Handwriting Without Tears* method of handwriting instruction improved printing skills of grade one students when compared to a more traditional approach. Identified improvements were also noted in the alignment and size of letters. The girls using the *Handwriting Without Tears* method improved significantly in overall handwriting skills and alignment and size. The boys demonstrated improvements in legibility and spacing. Replication of this research using a larger sample size, with equal numbers of girls and boys in the

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experimental group and control group would assist in generalizing results.

Implications for Theory

A multi-sensory approach to teaching printing and cursive handwriting emphasizes the use of sensory motor functions to develop the skill of handwriting to an integrated, automatic level. The results of this study indicate that a multi-sensory approach to teaching handwriting is more effective than a traditional method of instruction for improving handwriting performance of grade one students. It also is more effective than a traditional method in improving alignment of letters on the baseline and consistent letter size. When gender is considered, the *Handwriting Without Tears* method improves girls' overall performance in printing in grade one. As well, it is effective in developing consistent alignment and size of printed words for girls in grade one. For boys, Class 2 demonstrated the most improvement and the boys improved most in legibility and spacing. However, as indicated in the literature, boys' skills in handwriting lag behind girls (Graham & Miller 1980). A larger sample of boys in the control group would have made the sample size between groups more equal possibly increasing the chances of generalizing results for the boys.

The result of this research imply that a structured multi-sensory handwriting program makes a difference in handwriting skills for grade one students. It is uncertain whether the structured approach, teacher training or multi-sensory component impacted individually on the results of the study. Research identifies that a multi-sensory approach impacts on outcome (Furner, 1970). Also research

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identifies that teacher training impacts on manuscript printing outcomes of children (Peck et al., 1980). Whatever the individual impact of these factors, in this study, the three components together made significant differences in handwriting for the students in the experimental classes.

Implications for Research and Practice

There has been increasing interest throughout the United States and Canada in the *Handwriting Without Tears* method of handwriting instruction. Occupational therapists have been using it to treat children with handwriting difficulties as a result of learning disabilities, developmental coordination disorders, attention deficit disorder, autism, Down's Syndrome, cerebral palsy and other related difficulties. Word of mouth about its benefit and success has drawn further attention to this method. There have been no research studies on the benefit of this program in treating children with special needs. Further research is needed in this area.

There continues to be little research on the effectiveness of handwriting instructional methods. With the introduction of the whole language approach to writing, teachers are changing their methods of teaching handwriting in the classroom (Graham, 1996). Whole language approaches rely on indirect rather than direct methods of instruction. It is assumed within this approach, that mechanical skills such as handwriting develop naturally as students are provided with many opportunities to read and write in the classroom (Graham, 1996). Research investigations comparing handwriting instructional approaches between traditional

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methods and whole language process methods is needed.

Replication of this study would increase confidence in generalizing the results to practice. A larger sample population including all girls and boys in each class would make classes more equal in numbers especially for the control group. Also, by using all children in the class, it would be more likely that children of all level of abilities would be accounted for in each class. A larger sample of boys would assist with understanding more generally the impact of handwriting instruction methods for boys.

A longitudinal study over two or three years would allow the researcher to make clearer conclusions about the development of proficient handwriting skills to include the relationship between legibility and speed. As indicated earlier, when automatic ability in handwriting fails to develop or is underdeveloped, the motor aspect of writing impedes content generation. Ziviani and Watson-Will (1997) identify the during the primary years children may not produce fast and legible handwriting simultaneously. Usually, speed is sacrificed for legibility. As with all skill acquisition, attaining quality is a precursor to speed. If quality is not emphasized , practice will ensure permanence not proficiency. The relationship between speed and legibility may need to be examined into higher grades as it is in these grades that handwriting demands increase for students in the classroom.

The *Handwriting Without Tears* method of instruction utilizes a continuous stroke for letter formation of lower case letters. Olsen (1997), identifies that the continuous stroke method is an easier style of handwriting for children to learn for

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the development of efficient handwriting skills. The benefits of the continuous stroke letter formation were not reported for letter formation. In order to analyze the benefits of the continuous stroke, the researcher would have to complete individual samples to observe how children formed their letters. This was beyond the scope of the present study. However, further research about the benefits of the continuous stroke manuscript letters using the HWT would be useful. The benefit of the use of the continuous stroke in manuscript printing in the transition to cursive handwriting, would be interesting to investigate in future research.

In practice, occupational therapists use handwriting programs to remediate skills in certain areas. This research suggests that the HWT method promotes skills in overall handwriting performance and as well, in alignment and letter size. Malloy-Miller, Polatajko and Anstett (1995) identify that specifying remedial methods that are matched to types of handwriting difficulties remains a challenge for clinicians. More research would be beneficial to see if these research findings carry over into populations of children with special needs. Preliminary data suggests that similar benefits may exists. For it is likely, that when intact classrooms are used, as in this case, children who have special needs are included.

For teachers, the outcomes of this study suggest that the *Handwriting Without Tears* method for handwriting instruction for grade one students will improve children's handwriting skills more effectively than a traditional method. The teachers in the experimental classes reported feeling more confident about teaching handwriting using the HWT method. Previously, these teachers used a more

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traditional handwriting instruction method.

In conclusion, the *Handwriting Without Tears* program which includes a structured multi-sensory approach to teaching handwriting, teaching methods and information and handwriting practice using a student's booklet is more effective in improving children's skills in handwriting than a traditional ball and stick method. The development of grasp, use of lines, motor reinforcement for letter formation, stories to enhance memory of letter formation, demonstration techniques, imitation of letter formation and handwriting practice are all integral components of the *Handwriting Without Tears* approach. In grade one, the goal of handwriting instruction is to develop handwriting habits and skills that will lead to proficiency in the motor aspects of writing so that the children can think about what they want to write on paper rather than think about how to make the letters and words. Further research of the *Handwriting Without Tears* method using a larger population with a more even distribution of boys and girls is recommended for generalizing these findings.

The importance of teaching handwriting is reflected in the following quote

> "It is easy and exciting to teach handwriting because with concentration and will, marvelous results are possible. They are visible achievements which are also pleasing to parents. The inevitable sense of success which follows will pay dividends across the rest of the curriculum. For a school to develop a coherent handwriting policy, to train staff and to see the results, the reward both in public relations and in higher standards all round is very worthwhile (Jarman, 1990, p. 153)".

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Appendix A

Components of the *Handwriting Without Tears* Method of Handwriting Instruction

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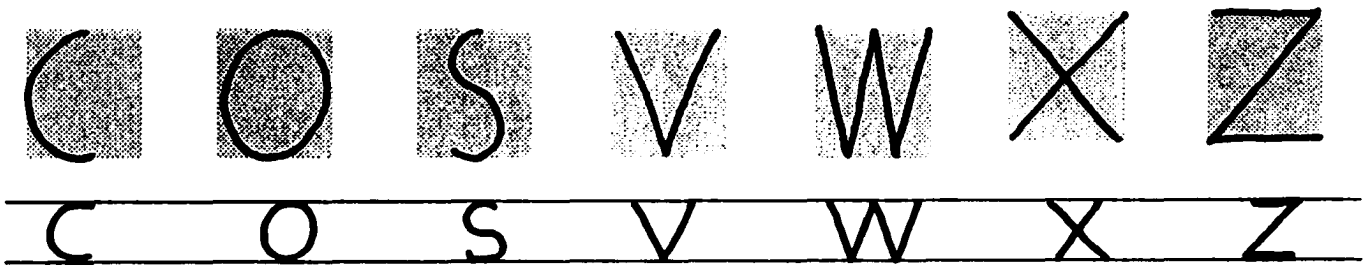
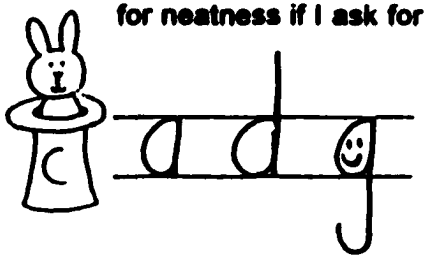
lower case printing

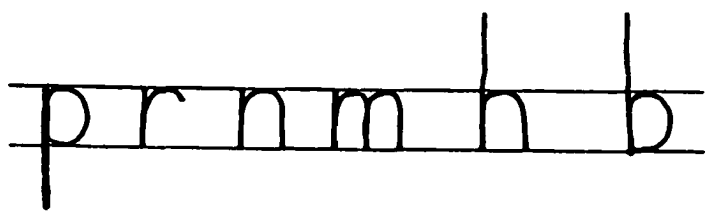
Lower case printing is based on the strong foundation already established in learning to print CAPITAL LETTERS.
The new skills to master are:

1. **Learn to correctly place all letters on the lines.**
2. **Learn correct letter formation habits for all new, or slightly different letters.**
3. **Develop ease and writing fluency.**



Students begin with letters that they already know! These lower case letters are exactly like CAPITALS but are now placed on the lines. The child learns to begin each one of these letters exactly on the top line. As the letter is made it must bump the lines. Children love the "bumper car" image for remembering to place the letters correctly. I have found it unnecessary to ask for neatness if I ask for "bumping the lines." Letters that go above or below the lines are easy because they "stick out. "





For learning correct letter formation habits, there are two very important letter groups. The first group is the Magic C Letter group and consists of letters which begin on the top line with a c stroke. Another important group is the "diver" group. All these letters begin with a down stroke, then come up and over. Thinking of how a diver dives down and then comes up and swims over helps the child learn these letters efficiently and correctly.

To develop ease and writing fluency, the lower case letters are routinely used in words once they have been learned. Word practice maintains skill. Words and sentences are presented with plenty of room for beginners to write correctly.

HANDWRITING WITHOUT TEARS teaches lower case letters with special multi-sensory techniques which children enjoy. As with all instruction, the teacher is there to demonstrate, and watch that letters are imitated correctly prior to practice!

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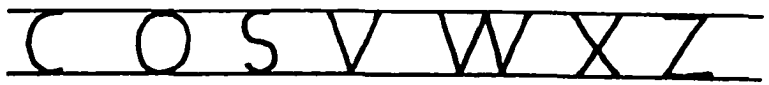
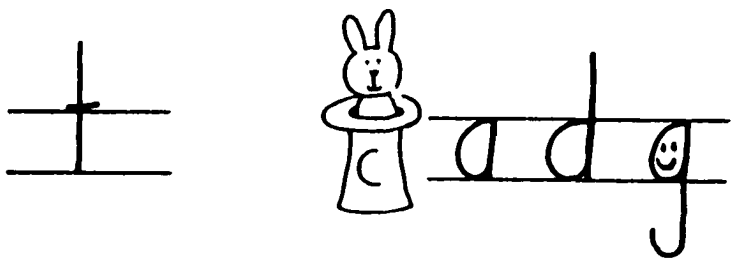
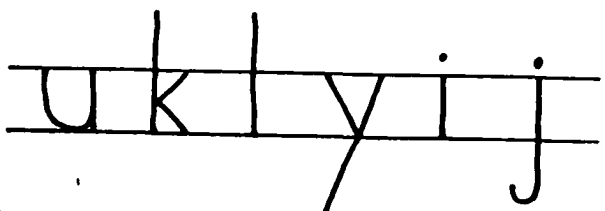
My Printing Book (first grade level) and PRINTING POWER (second grade level) use the same teaching order. It's designed to teach both vertical and rotary placement with the least possible confusion:



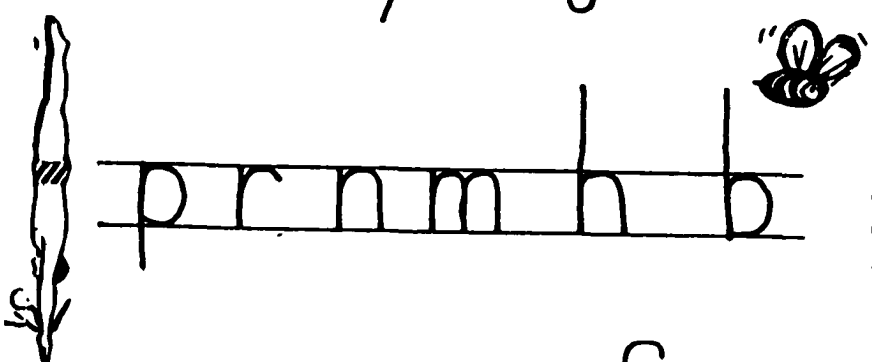
Begin with the letters the child knows correctly from learning capitals first.



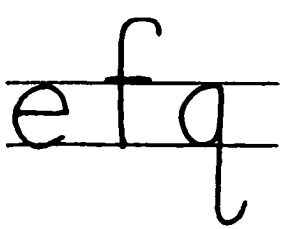
Then teach t and the "Magic c Letters." c a d g
They begin with a c (not a circle).
The c then takes a helicopter ride up and then down.
For the g turn, I say there's an invisible little guy in the g who hopes you'll catch him if he falls.



Add these easy letters.



Finally the "diver group" is presented. They all dive down, come up, and swim over on the same (right) side. For some strange reason, children never seem to reverse h. Think of a honey bee. Start with an h for honey and turn it into a b!



Finish! In words q is followed by u. For the letter q just make a U turn!

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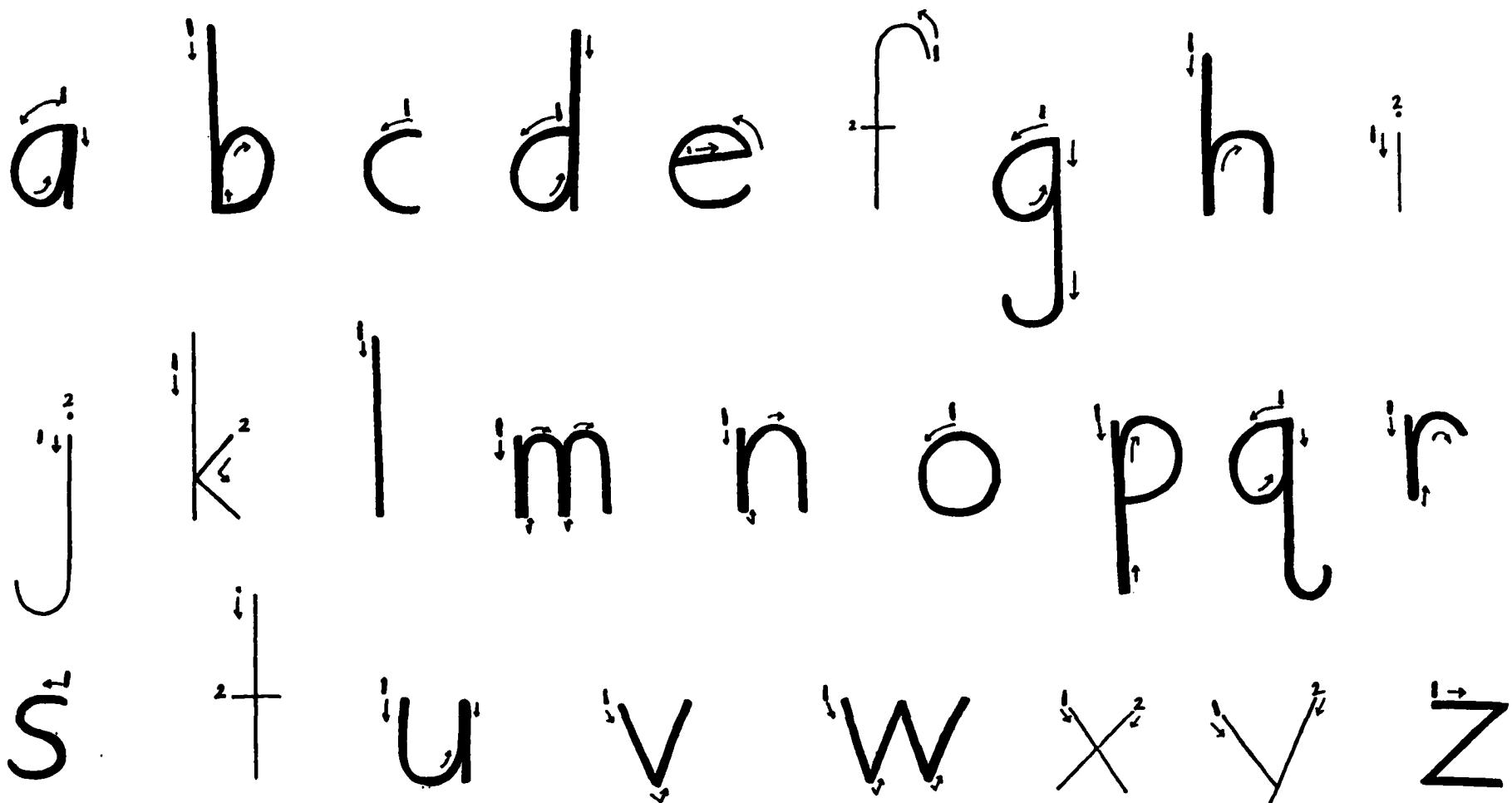
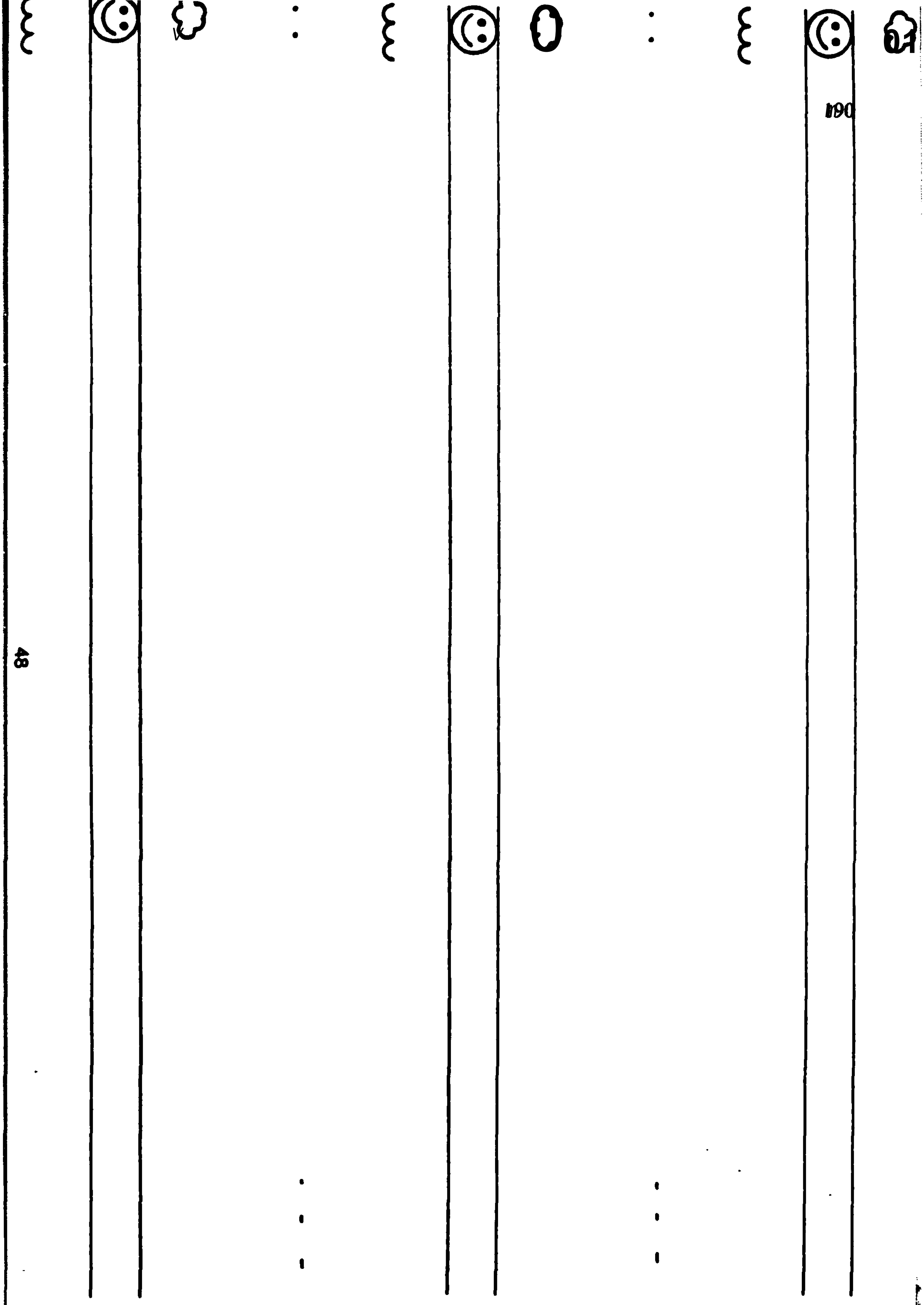
Use one continuous stroke —

Use two strokes ——

lower case letters



Here's an easy way to remember how to make the letters: Think of how you read. You start at the top and then read left to right. The same rule also applies to letters. Start at the top, except for d and e.
Left handed? You may cross f + t from right to left, pulling the pencil into your hand.



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