General Outcome Measures of Beginning Handwriting Development

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Tracy Artemis Bradfield

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Scott McConnell, Ph.D., Advisor

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CHAPTER ONE

Introduction

Learning to write is integrally related to language and literacy development (Ehri, 1987; 1989), and can promote or impede later academic achievement (Diener & Dweck, 1978). Despite this fact, handwriting is virtually ignored as an academic subject. University teacher training programs do not focus on methods to assess and teach handwriting, most elementary schools have no formal handwriting instruction program, and few schools require their teachers to obtain handwriting training (Graham, 1982).

This lack of attention to handwriting instruction and assessment is problematic. By the end of second grade, students are expected to demonstrate a level of proficiency with handwriting that allows them to focus on the cognitive aspects of writing tasks rather than the motoric patterns needed to accurately produce handwritten text. (Cornhill & Case-Smith, 1996; Reisman, 1993). Those who do not learn to use handwriting legibly and functionally at an early age may face a myriad of academic difficulties. For example, difficulty with handwriting can negatively affect both students' ability to express their thoughts in written form (Berninger, 1999) and teachers' perceptions of the adequacy of the finished product (Briggs, 1980; Chase, 1986; Hughes, Keeling & Tuck, 1983).

Handwriting Development and Problems Associated with Handwriting Difficulty

Handwriting is a complex activity that requires the integration of verbal, perceptual and motor skills to produce a specific pattern of movement in order to form letter shapes (Alston & Taylor, 1987). According to Alston and Taylor, movement patterns that have been firmly established through repeated practice are resistant to change. For this reason, they recommend that teachers should monitor students' progress with handwriting development continually, to ensure that students develop fast, fluent, and legible handwriting (Alston & Taylor, 1987). Students who have difficulty developing fast, fluent and legible handwriting experience problems with higher level written expression.

Higher level written expression involves students expressing their knowledge through the production of handwritten text on paper. Teachers use students' written products to assess what they have learned. Students need to have proficient handwriting skills to complete written tasks such as: answering end-of-chapter questions, adding titles and labels to art work, constructing poetry or narrative stories, making journal entries, copying passages from the text, completing spelling tests, completing worksheets, and providing answers to questions posed by the teacher in short answer or paragraph form. Students' ability to demonstrate their knowledge through completion of the aforementioned tasks is strongly affected by level of handwriting proficiency.

Statement of the Problem

Given that writing proficiency is integral to success in school and the affect that poor handwriting has on students' ability to convey knowledge on paper, it is important to monitor students' progress as they begin learning the skill of handwriting. It is important to identify those students who are struggling to achieve basic handwriting proficiency, and monitor the success of interventions targeted to improve their skill. General outcome measures (GOMs) have been used effectively for these purposes in other academic areas such as reading, math, and written expression (Stecker, Fuchs & Fuchs, 2005; Wayman et. al, 2007), but no such measures have been developed for monitoring beginning handwriting skill development.

Purpose of the Study

The purpose of the present study is threefold. First, to address the absence of an appropriate tool for monitoring beginning handwriting development, this study will develop a series of general outcome measures (GOMs) of beginning handwriting. A review of the existing literature on handwriting development and principles of curriculum based measurement will inform this process. Second, the technical adequacy of the newly developed GOMs will be examined to ensure that the proposed measures offer valid and reliable results. Third, the ability of the handwriting GOMs to differentiate skills in ways that are expected based on age and grade level of students will also be examined.

To examine the technical adequacy of the new measures, several forms of reliability will be examined, including inter-rater reliability, alternate forms reliability, and test-retest reliability. In addition, construct validity will be evaluated based on the strength of each new measure's relation to an accepted handwriting measure. It should be noted that finding a "gold-standard" measure of handwriting development will be difficult due to the poor psychometric properties of existing measures (Feldt, 1962; Graham, 1986). Thus, in order to provide additional evidence of construct validity, the strength of the relation between classroom teachers' rating of students' handwriting performance and score on each new measure will also be examined. Finally, significant difference in mean raw score across grades will be examined to determine the measures' ability to detect differences in skill level across grades.

The following research questions will guide examination of the psychometric properties of the measures:

1. What is the inter-rater reliability for each of the general outcome measures of handwriting development?

2. Is there a significant difference in mean score across grades for each of the new general outcome measures?

3. What is the test-retest reliability for each of the general outcome measures?

4. What is the alternate forms reliability for each of the general outcome measures?

5. What is the concurrent criterion validity of the general outcome measures of handwriting development with (a) informal teacher ratings of handwriting performance, and (b) specific subtests of the Test of Handwriting Skills-Revised (THS-R) (Milone, 2007)?

CHAPTER TWO

Review of Literature

In this chapter, I will 1) summarize current knowledge about handwriting development; 2) briefly summarize progress monitoring as a system of assessing skill development; 3) summarize current knowledge about assessment of handwriting development and how traditional methods of assessment have limited utility in a progress monitoring model; 4) summarize current knowledge about general outcome measurement (GOMs); 5) summarize current knowledge about individual growth and development indicators (IGDIs); 6) summarize current knowledge about curriculum based measurement (CBM) of written expression; 7) discuss the initial work of another researcher attempting to develop a GOM of handwriting development; 8) present a rationale for the development of GOMs for beginning handwriting development; and 9) describe the process for development of general outcome measures .

Handwriting

Handwriting is the primary form of written expression for young elementary school students. Up to sixty percent of children's typical school day is allocated to fine motor activities, with writing being the predominant task during these time periods (McHale & Cermak, 1992). These tasks all require the foundational skill of basic handwriting proficiency to allow teachers to accurately assess students' understanding and comprehension of instructional material. If students do not

possess basic handwriting proficiency, it can limit their ability to successfully complete a majority of classroom tasks.

Handwriting difficulties can affect students' ability to complete classroom tasks which require them to express their thoughts in writing. (Graham, 1990; Graham et al., 1997). Results of a cross-sectional study of 300 primary grade, 300 intermediate grade, and 288 junior high students found that transcription (i.e.: handwriting) skills contributed statistically significant variance to written composition ability at all developmental levels (Berninger et al., 1992; Berninger et al., 1994; Berninger et al;., 1996). In addition, another study found that orthographic-motor integration (i.e.: the mechanical skill required to produce writing by hand), accounted for 67% of the variance in performance on written expression tasks (Jones & Christensen, 1999). Due to this large influence handwriting skill has on successful completion of written expression tasks, it follows that students who experience difficulty with handwriting will demonstrate poor performance with tasks requiring them to express their thoughts in writing.

In addition to impact on written expression quality, it has also been suggested that students with handwriting problems need to focus more attention on the physical process of writing, thus limiting use of higher order cognitive skills, planning, and generation of content (Berninger, 1999). Thus, handwriting proficiency is an important foundation upon which success with later writing tasks depends. Due to the number of every day school tasks which involve writing, unsuccessful mastery of handwriting skill can negatively influence later success in school.

Illegible handwriting can also negatively influence a teacher's perception about students' writing skill and students' mastery of the content area. For example, when teachers and other adults were asked to rate two different versions of a paper which only differed in handwriting quality, the neatly written papers were assigned higher scores (Briggs, 1980; Hughes, Keeling & Tuck, 1983). Lower grades resulting from poor handwriting quality, combined with task completion difficulty, can lead students to develop negative feelings about writing and can lead to students' feeling of failure.

One reason for this feeling of failure is that difficulty with the handwriting process can impact a student's ability to keep up with peers and the pace of the class. For example Weintraub and Graham (1998) found that students with poor handwriting needed twice as much time to copy a written passage as those with good handwriting. Furthermore, difficulty with handwriting in young students can lead to a dislike of writing, frustration with writing, and development of a negative mind-set about writing ability, thus limiting their further writing development (Berninger, Mizokawa, & Bragg, 1991). Such a mind-set of frustration and failure can be a powerful barrier to continued academic success (Diener & Dweck, 1978). In order to prevent students from developing a negative attitude about writing, it is important to carefully monitor students' performance as they begin to learn basic handwriting, and provide higher levels of direct support as needed.

Progress Monitoring

Progress monitoring is a well-established system of frequently measuring students' skill in a specific domain to track their progress and to use the data to inform instructional decisions (Fuchs et al. 1998; Stecker, Fuchs & Fuchs, 2005). Such decisions might include adjustments to the pace, amount, or method of instruction. Use of a progress monitoring system has been shown to improve student outcomes in several academic domains (Fuchs & Fuchs, 1986; Fuchs, Fuchs, & Hamlett, 1989) as mediated by increased teacher awareness of the need for instructional adjustments (Fuchs et al., 1991; Coyne & Harn, 2006), and through increased teacher and student awareness of achievement (Fuchs, Deno, & Mirkin, 1984; Spicuzza & Ysseldyke, 1999). Currently, there are no established systems of progress monitoring for beginning handwriting development. Existing handwriting measures are not appropriate for use within a progress monitoring system.

Assessment of Handwriting

Because of the central role writing plays in a child's school day and the negative impacts of handwriting difficulty, it is important to monitor children's progress as they are learning to write, identify children who are struggling, and provide them with intervention as early as possible. The current methods of assessing handwriting development do not fit with this model. Typically, the primary method for assessing handwriting development in classrooms is teacher observation and informal rating (Addy & Wylie, 1973). Informal teacher observation and rating have been shown to be highly unreliable and subjective methods of assessing student

performance (Fuchs & Fuchs, 1984). As such, informal observation and rating are not sufficient as the primary measurement strategies within a progress monitoring system for beginning handwriting.

Standardized Handwriting Assessments

Standardized handwriting assessments are available and offer some helpful improvements over informal observation when considering development of a progress monitoring system, though many are outdated and out of print (Larsen & Hammill, 1989; Phelps & Stempel, 1987; Reisman, 1993; Schneck, 1988). A number of additional issues limit their utility, particularly for use as a progress monitoring tool for students just beginning to learn this skill. First, most of the standardized handwriting assessments available start too late. Children are now beginning to learn handwriting in kindergarten (Snow et al., 1998). However, the majority of available handwriting assessments are only appropriate for students in 3rd to 12th grade (Reisman, 1991). By the time students reach 3rd grade, movement patterns are firmly established, and resistant to change (Alston & Taylor, 1987). In addition, students are expected to use handwriting functionally to complete school tasks by the end of second grade (Cornhill & Case-Smith; Reisman, 1993). Thus, the majority of standardized handwriting assessments miss the critical window of time during which handwriting patterns are being established.

A second limitation of the currently available standardized handwriting assessments is the level of variability in their identification of the important elements of the "handwriting" construct. Handwriting has traditionally been evaluated based

on legibility, a construct that is subjective and hard to define. Attempts at operationalizing legibility have demonstrated that it is a complex interweaving of smaller components such as neatness, uniform arrangement of letters, alignment, proportionality, letter formation, slant, and space between letters and words (Graham, 1986). Legibility is not dependent on any one of these factors but rather the way in which these factors interact within the written product. In addition, there is discernable range in the level of acceptability of all of these factors, such that when these variable factors are compiled, it makes objective quantification of legibility quite difficult.

A third limitation of existing handwriting assessments is that typically they are not designed to be sensitive to improvements in skill level over a short period of time or to individual student growth over time. These limitations become problematic, particularly when teachers wish to evaluate how well each student in the class is learning to write, while the writing instruction is occurring. This type of progress monitoring model is the norm for most other areas of academic instruction (Olinghouse, Lambert & Compton, 2006), but traditional handwriting assessments do not typically fit with such a model.

Generally, there are two different methods of evaluating handwriting performance. These methods will be described below and for each method a specific assessment tool will be reviewed to demonstrate its limited utility for monitoring the progress of students as they begin learning to write.

Typical Methods of Standardized Handwriting Assessment

Global assessment. Global or holistic readability assessment involves the evaluator ranking a student's writing sample in relation to either a sample written by other individuals or pre-given samples (Espin, Weissenburger, Benson, 2004; Rosenblum, Wiess & Parush, 2003). These assessments are referred to as global, because the handwritten product is generally evaluated based on overall or general merit as opposed to specific criteria (Rosenblum, Wiess & Parush, 2003). An example of a global assessment of handwriting is the Test of Legible Handwriting (TOLH), which is appropriate for students from grades 2 - 12 (Larsen & Hammill, 1989). Currently, this assessment is out of publication.

Administration of the TOLH is accomplished by obtaining a sample of a student's handwriting. This is done either by examining an existing piece of student writing, or through use of a picture prompt provided by the test kit (Cizek, 2004). The student's writing sample is then given a raw score, ranging from 1 to 9, which is determined by matching the student's writing sample as closely as possible to one of the provided sample guides. Scorers are instructed to rate the student's writing sample as holistically as possible and to disregard specific deficits such as spacing, letter formation, inconsistent slant, etc. (Cizek, 2004).

The TOLH was originally developed in 1987 and was standardized using a group of 1,723 students, ages 7 to 17, from 19 states, with a nationally representative sample for that time period. This original research on the TOLH demonstrated an average test-retest correlation of .90, and an inter-rater reliability coefficient of .95

(Larsen & Hammill, 1989). Evidence of construct validity for the TOLH is a bit more questionable. Scores on the TOLH have been reported to demonstrate a strong relation with experienced teachers' informal ratings of the handwriting samples, with a correlation of r =.92 being reported (Cizek, 2004). However, this correlation seems obvious because in essence the TOLH is merely a structured rating of a handwriting sample versus an informal, unstructured rating. Comparison of the TOLH with the Test of Written Language-2 (TOWL-2) showed small correlations (r = .25 to r = .33) between the score on the TOLH and specific written language skills measured by the TOWL-2, such as spelling and style (Hammill & Larsen, 1988).

More importantly, in addition to the questionable psychometric properties of the TOLH (being representative of global handwriting assessments), a further limitation of this method of scoring is that it does not provide student specific information. Global methods of assessing handwriting only provide information on how an individual student's performance compares to that of others (norm-referenced), and are not designed to show individual improvement in student performance over time. The TOLH, in particular, does not provide criterion-referenced information, such as the level of handwriting considered to be worst, acceptable, or perfect (Cizek, 2004). In addition, because the TOLH only has nine gross levels for comparison, it would not be sensitive enough to monitor gradual improvement in the skill (Graham, 2004).

Analytic assessments. In contrast to global assessments, analytic evaluations of readability examine specific, objectively defined criteria to assess readability

(Rosenblum, Weiss, & Parush, 2003). These criteria typically include letter form, size, slant, spacing, and line straightness (Bruinsma & Nieuwenhaus, 1991). One commonly used assessment that employs the analytic method of evaluation is the Children's Handwriting Evaluation Scale (CHES-M) (Phelps & Stempel, 1987). The CHES-M requires students to copy two widely-spaced sentences on unlined paper, and scores the students writing based on the following criteria: letter form, spacing, rhythm, and general appearance (Feder & Majnemer, 2003). The first two criteria are further subdivided into four categories with 10 points possible for each category. When all criteria are present, a total score of 100 points is possible.

CHES-M Scoring standards were based on the writing samples of 643 children in grades 1 and 2, which is closer to the target age at which children begin learning handwriting. However, limited current information is available on this assessment's psychometric properties. Only inter-rater reliability was calculated, using the Spearman-Brown formula, and was reported to be .81 and .65, across two different raters. Validity data was not reported.

In addition to concern about questionable psychometric properties and the out-dated norm base of this type of analytic handwriting assessment, the CHES-M is also not sensitive enough to pick up on slight changes in skill due to treatment (Graham & Weintraub, 1996). In addition, due to the complicated nature of the scoring process, this type of handwriting assessment has potential to become overly burdensome to teachers within a progress monitoring framework.

General Outcome Measurement

As can be seen by the criticisms of the most frequently used traditional methods of evaluation of handwriting skill, these methods do not appear adequate to measure small improvements in individual student's skill level over short periods of time. Thus, teachers are not able to continually monitor individual student growth in skill level. To address this gap, it is important to consider the general outcome measurement method and its implications for assessment of handwriting development.

General outcome measurement involves direct and repeated monitoring of a student's performance on a given task, with the task being representative of the desired outcome, and with assessment focused on change in level of performance on that task over time (Deno, S., 1997; Fuchs & Deno, 1991; McConnell, McEvoy, & Priest, 2002). One hallmark characteristic of general outcome measurement is that it provides teachers and professionals with information on rate of change in performance on the desired outcome, which is typically presented graphically, with time on the horizontal axis, and number of correct responses/ performances on the vertical axis. This information is important when evaluating how a specific intervention is working to improve student performance.

General outcome measurement systems are typically of short duration (typically one minute or less), have the capability of being presented in multiple forms, are inexpensive, are easy to administer and score, and are capable of being administered both to individual children and to entire classrooms of children

(VanDerHeyden, Witt, Naquin, & Noelle, 2001). Due to this last positive attribute, general outcome measurement systems can be used to monitor individual student growth over time, and also to compare one student's performance to that of his/ her classmates. By comparing a student's performance to his/ her classmates' performance, a teacher can determine if a student's growth trajectory is discrepant from what would be expected, or off-track for eventual achievement of the long term outcome (Fuchs & Deno, 1997). Moreover, general outcome measurement systems allow professionals to evaluate both the immediate effects of an intervention, as well as how the intervention is working to increase a student's probability of achieving the long term outcome (ECRI Tech Report No.4).

A professional can evaluate how an intervention is working to increase this probability of achieving a long-term goal by examining the difference in slope or trajectory that results from the implementation of an intervention. While higher intensity intervention is being delivered, the professional can continue to monitor student progress through frequent administration of the general outcome measures. An intervention would be deemed effective if it resulted in an increase in slope such that the student's trajectory was more closely aligned with expected rates of growth.

What sets general outcome measurement apart from traditional methods of assessment, is ability to focus on an individual's performance and how performance changes over time. In addition, the utility of a system of general outcome measurement is supported by an abundance of empirical evidence. For example, curriculum-based measurement (CBM) is one form of a general outcome

measurement system that has been developed for use with elementary and secondary students. Many studies have shown that CBM measures satisfy the psychometric properties of reliability and validity (Deno, 1985).

Studies have also linked curriculum-based measurement to increased student academic achievement (Fuchs & Fuchs, 1986; Fuchs, Fuchs, & Hamlett, 1989; Fuchs et al, 1997). Another study has shown that when using a curriculum-based measurement system, teachers increased the number of instructional modifications they made. This increase in modifications based on use of a CBM system has been linked to improved student outcomes (Fuchs, Fuchs, Hamlett, & Stecker, 1991). CBM has also been used to effectively identify primary grade students in need of special services (Van DerHeyden, et al., 2001). Although the majority of work in general outcome measurement has focused on curriculum based measures for students in the primary grades, a unique model of general outcome measurement has been developed for the preschool ages.

Individual Growth and Development Indicators

CBM is a type of general outcome measurement that has been developed and used successfully for elementary and secondary school aged children. For the early childhood education population (birth through age eight), Individual Growth and Development Indicators (IGDIs) have been developed as a set of general outcome measures for young children (McConnell, McEvoy, & Priest, 2002). IGDIs are an extension of the principles of CBM to early childhood populations, and thus they build on the empirical foundation of CBM models.

The IGDIs consist of indicators of child performance in each of the major developmental domain: language, social skills, cognitive skills, motor skills, and adaptive skills (McConnell, Priest, Davis, & McEvoy, 2002). As a type of general outcome measure, IGDIs are designed to monitor developmental growth over time, by providing a visual index of the rate of development. Similar to CBM, IGDIs use slope of progress over time to indicate advancement toward long term outcomes. An increase in slope thus indicates an increase in rate of developmental growth (McConnell, Priest, Davis, & McEvoy, 2002).

However, although IGDIs are similar to CBM measures in a number of ways, they are also unique. In contrast to elementary and secondary students, general outcomes for young children are not as easily identifiable or agreed upon (Scott-Little, Kagan, & Frelow, 2003).

In addition, due to the substantial level of growth in skill development that occurs during the early childhood years, measures which represent the targeted outcome may be too difficult for the youngest children in the designated age range. Thus, measures designed to be representative of the desired outcome often result in a series of zero scores, rather than meaningful data, for these young children. As such, the IGDIs differ from CBM models as measures are often designed to examine growth in the developmental precursors that relate to the expected outcome rather than using repeated measurement of on outcome skill (McConnell, McEvoy, & Priest, 2002). Thus, design of IGDI tasks requires careful consideration to ensure that the tasks are developmentally appropriate, yet still document growth toward a desired outcome.

Although IGDIs are a unique category of general outcome measurement, they still are required to meet the basic characteristics that define general outcome measurement. Two hallmark characteristics of IGDIs are, 1) the use of standardized procedures, and 2) repeated, direct sampling of performance using a consistent measure, over time. Further, demonstration of adequate psychometric properties such as criterion and construct validity, treatment validity, and social validity, as well as inter-rater and alternate forms reliability are necessary (McConnell, et al., 2002).

The reliability and criterion validity of a group of language development Individual Growth and Development Indicators (picture naming, rhyming, and alliteration) has been shown to be moderate to high, including correlation coefficients ranging from .56 to .75 ($p < .001$) for the Peabody Picture Vocabulary Test, 3rd edition (PPVT-III), correlations ranging from .63 to .79 ($p<.001$) for the Preschool Language Scale (PLS), and correlations ranging from .62 to .75 for the Test of Phonological Awareness (McConnell et al., 2002). For these three measures, correlations with age were also moderate to strong, ranging from .41 to .61, and all have demonstrated adequate test-retest reliability (McConnell et al., 2002).

In addition to evidence of the Individual Growth and Development Indicators technical adequacy, IGDIs also demonstrate many other positive attributes, similar to those representing the broad category of general outcome measures. They are constructed to be sensitive to growth over a short period of time (i.e.: several months). They are inexpensive, easy to administer and interpret, can be administered to a group or to an individual student, and allow for evaluation of the effects of an

intervention as well as the effects of a change in intervention (ECRI Tech Report No.4). In addition, IGDIs provide a standardized procedure for monitoring student progress that is comparable across time, assessors, and children (McConnell, et al., 2002). As such, it is apparent that the IGDIs hold true to the basic tenants of general outcome measurement with some adaptation to accommodate for the effects of the developmental process. Given these differences between general outcome measures for the primary/ intermediate grades and preschoolers, it should not be a surprise that measurement of written expression also differs between older and younger students.

CBM of Written Expression

Although much has been done in the area of research on general outcome measures of written expression for older elementary and secondary students (Deno, Marston & Mirkin, 1982; Espin, et al., 2005, Gansle et al., 2004), little attention has been paid to measures of handwriting skill acquisition. Written expression is typically defined as a form of communication that allows students to put their thoughts and ideas on paper, to organize their knowledge and beliefs into convincing arguments, and to convey meaning through well-constructed text (Baker, n.d.). This can be contrasted with handwriting, which is the physical process of producing a specific pattern of movement, using the muscles of the hand and fingers, in order to form letter shapes (Alston & Taylor, 1987). As such, handwriting skill development is a foundation on which later development of written expression skill is based (Berninger et al., 1992; Berninger et al., 1994; Berninger et al;., 1996; Jones & Christensen, 1999).

For older writers, CBM measures of written expression were first developed in the early 1980s. Original CBM writing measures consisted of providing students with a story starter and then asking them to write for up to five minutes. Variables measured included Total Words Written, Words Spelled Correctly, and Letters in Correct Sequence (Deno, Marston & Mirkin, 1982). Initial research on the reliability and validity of these measures demonstrated adequate comparison over time, comparability of forms, internal consistency, and interscorer reliability (Marston & Deno, 1982). A later review of four earlier CBM studies looked at the criterion validity of the measures of total words written, words correct, and correct letter sequences with the Test of Written Language (TOWL) , the Stanford Achievement Test (SAT), Developmental Sentence Scoring, the SAT language subtest, and teachers' holistic rating of writing skill Marston (1989). This review demonstrated fairly high criterion correlations, ranging from .41 - .84 .

Thus, although the reliability and validity of these specific CBM writing measures have long been established (Marston, 1989), there has been some debate as to the practical utility of these measures. Particularly, Gansle et al. (2002) discussed that these measures were not considered meaningful or instructionally useful by some teachers and psychologists. To address this issue, Gansle et al. examined the reliability of several additional measures. These researchers found that, for the third and fourth grade sample they examined, total words written was not the optimal choice for predicting written language skill. Instead, they found favorable results for words in correct sequence, and use of correct punctuation marks. In other research at

the secondary level, number of correct word sequences (CWS) and correct minus incorrect word sequence (CIWS) were found to demonstrate strong correlations with criterion measures (Espin, De La Paz, Scierka, & Roelfs, 2005)..

Therefore, although there has been much work done in the area of CBM measurement of writing proficiency with older elementary and secondary students, little focus has been made on measures to monitor the progress of the physical process of acquiring handwriting skills. One possibility might be to use measures designed for use with older elementary students. However, it has been shown that measures which are used successfully with elementary students, do not demonstrate the same level of reliability and validity with students at the secondary level (Espin & Tindal, 1998). In line with this finding, it would make sense that measures that could be used validly and reliably with older elementary students (third and fourth grade students) who were proficient with handwriting, may not be reliable and valid with younger, beginning writers (kindergarten, 1st, and second grade students).

For example, Total Words Written, Words Spelled Correctly, and Letters in Correct Sequence would not be appropriate measures for students just learning to correctly form letters or learning to produce letters in a fluent manner. These tasks, which are appropriate for older, more experienced writers, would be too difficult for beginning handwriters, and thus would not be sensitive to individual student growth in the physical process of forming letters on paper.

Therefore, although there has been a considerable amount of research demonstrating the valid and reliable use of general outcome measurement (like

CBM) to monitor the progress of written expression in older students, the measures used in this research are not appropriate for beginning handwriters. As such, no current system exists to monitor the progress of beginning handwriting development that allows for frequent measurement of growth in skill over time for individuals. To date, little has been done to address this gap. Only one study has been found which incorporated general outcome measurement of beginning handwriting in kindergarten students (VanDerheyden et al., 2001).

CBM of Handwriting Development

A study by VanDerheyden et al. (2001) was conducted in two suburban public schools in southern Louisiana. The participants utilized for purposes of validity and reliability consisted of a random sample of 40 kindergarten students, of which 31 returned consent forms. Therefore, the sample consisted of children with the following demographics: 65% Caucasian, 32% African American, and 3% Other. There were 18 males and 13 females in the sample. One of the several areas assessed in the study was writing. The task used for this area was a letter copying task, in which the students were presented with a sheet of paper on which the capitol letters A-Z were arranged in either ascending or descending order on the page. Each letter was positioned over an empty box. The probes were scored based on the number of letters made correctly in one minute. Scoring criteria looked at rotation of letters, and extension of lines. Also, lowercase letters were not counted as correct.

The researchers examined several forms of reliability and validity for not only the writing probe, but also several math and reading probes. Results

demonstrated that the writing probe showed alternate forms reliability of .68 and interscorer agreement of 98.75. To examine concurrent validity, several subtests of the Comprehensive Inventory of Basic Skills, Revised (CIBS-R) and the Onset Recognition Fluency probe and Number of Letter Sounds Known probe from the Dynamic Indicators of Basic Early Literacy Skills (DIBELS), were administered. The CBM writing probe developed by VanDerheyden demonstrated moderate concurrent validity with most of the subtests (.21 - .47) with the exception of the "Reads Uppercase Letters" subtest of the CIBS-R, with which the writing CBM probe demonstrated a correlation of .59.

Thus, although VanDerheyden's kindergarten-level CBM writing probe demonstrates solid inter-scorer reliability evidence, questions remain about its alternate form reliability and construct validity. As such, VanDerheyden's work presents a springboard for additional work on the development of general outcome measures of beginning handwriting.

Rationale for Development of Beginning Handwriting GOMs

It is important to start monitoring students' progress with handwriting skill development in kindergarten, as kindergarten is the grade in which formal handwriting instruction typically begins. According to the National Research Council (Snow et al, p.80), by the end of kindergarten standards state that children should be able to independently write many upper and lowercase letters; write (unconventionally) to express own meaning; write their own name (first and last) and the first names of some friends or classmates; and write most letters and some words

when dictated. In addition, by the end of second grade, children are expected to demonstrate a level of proficiency with their handwriting that allows them to complete their school work (Cornhill & Case-Smith, 1996; Reisman, 1993). In other words, in kindergarten students acquire skill in the physical process of making letters and words on paper. By the end of second grade, they need to be proficient enough with this process to use handwriting as a tool to communicate their ideas.

For early interventionists, a first instinct might be to try to determine the fine motor developmental skills that influence handwriting skill acquisition in order to intervene during the preschool years. For example, one might wish to measure student performance on fine motor developmental tasks such as placing pegs in a peg board or stacking blocks at age four, and then analyze how performance of such tasks might predict later handwriting skill in kindergarten. However, despite initial differences in fine motor skill development, it has been shown that handwriting instruction has a huge impact on level of handwriting proficiency (Graham et al., 2000; Berninger et al., 1997).

The relation between handwriting instruction and handwriting proficiency can be seen through the effects of handwriting instruction on students' skill variability. For example, students who were highly variable in skill prior to formal handwriting instruction demonstrated greatly decreased variability after the implementation of formal handwriting instruction (Marr, 2005). This is based on the results of a study which found a correlation of r = .18 between handwriting performance in kindergarten, when handwriting instruction typically begins, and 3rd

grade performance, at which point several years of handwriting instruction have occurred (Marr, 2005). In addition, this same study found that when examining student performance longitudinally, only a small percentage of students who demonstrated low performance in kindergarten continued to demonstrate low performance in 3rd grade (Marr, 2005). This suggests that although differences in fine motor developmental factors may have led to initial variability in handwriting performance, specific handwriting instruction was sufficient to decrease this variability and produce an adequate level of handwriting proficiency.

Process for Development of GOMs of Beginning Handwriting

The process for developing general outcome measures of specific skill development has been articulated by those who have developed such measures in other domains (McConnell, McEvoy & Priest, 2002). The process has five steps, including 1) identifying general outcomes, 2) identifying key elements for each of these outcomes, 3) developing data collection formats for sampling child behavior related to each of these outcomes, 4) developing and pilot-testing scoring procedures to derive psychometrically sound growth and development data from these data collection efforts, and 5) establishing the technical adequacy for these measures (McConnell, McEvoy & Priest, 2002). In congruence with these specified steps, proficient handwriting skill was identified as the general outcome of interest. The researcher then identified tasks that elicited child behaviors associated with this domain, as supported by the literature. The researcher then developed a series of data collections formats, procedures, and scoring criteria which were piloted and then

revised. Final data collection was done for the purpose of examining the technical adequacy of the newly developed measures. These properties include reliability (inter-rater agreement, test-retest reliability, and alternate forms reliability), and validity (concurrent validity with criterion measures). They should also reflect differences in skill level due to age and/or grade.

Summary

Handwriting is a skill that is vitally important to students' academic success. As such, it is important to identify students with handwriting difficulties as early as possible, in order to provide intervention to improve their performance. Standardized assessment tools do exist which evaluate students' handwriting skill, however, they are not viable candidates for progress monitoring as they lack the sensitivity required to focus on an individual's performance and changes in an individual's performance over time due to treatment (Cizek, 1998; Grahan & Weintraub, 1996). Reliable and valid curriculum based measures of written expression have been developed and used with older elementary and junior high school students (Deno, Marston & Mirkin, 1982; Espin, et al., 2005, Gansle, et al., 2004). However, these measures focus on higher level aspects of writing and are not appropriate for monitoring the progress of those just beginning to learn how to write. Progress monitoring tools for beginning writers need to focus on the mechanics of writing. As such, it is important to develop general outcome measures of beginning handwriting development that allow teachers to monitor student progress as they move toward handwriting proficiency.

CHAPTER THREE

Method

The purpose of this study was to develop a series of general outcome measures (GOMs) of beginning handwriting, examine their technical adequacy, and examine their ability to detect a difference in skill level across grades. Guiding research questions included, 1) What is the inter-rater reliability for each of the general outcome measures of handwriting development?, 2) Is there a significant difference in mean score across grades for each of the new general outcome measures?, 3) What is the test-retest reliability for each of the general outcome measures?, 4) What is the alternate forms reliability for each of the general outcome measures?, and 5) What is the concurrent criterion validity of the general outcome measures of handwriting development with (a) informal teacher ratings of handwriting performance, and (b) specific subtests of the Test of Handwriting Skills-Revised?

Settings & Participants

299 students in five kindergarten, five first, and five second grade classrooms in various Iowa elementary schools participated in whole group administration of the GOMs of handwriting development. Classrooms were chosen to proportionally represent the urban, suburban and rural areas of Iowa, with ten of the 15 Iowa Area Education Agencies (AEAs) represented. AEAs are regional service agencies which provide school improvement services for students, families, teachers, administrators

and their communities. Of the ten AEAs represented in this sample, two classrooms were located in the urban Des Moines area and three were located in the suburban area surrounding Des Moines (AEA 11). The remaining ten classrooms were distributed in the following manner: one classroom from the Northwest AEA, two classrooms from AEA 267, one classroom from AEA 1, one classroom from AEA 8, one classroom from AEA 9, two classrooms from AEA 10, one classroom from AEA 13, and one classroom from AEA 14 (see Appendix A for a map of the Iowa AEAs). All students who had been given parental consent, and who were present on the designated days of whole-group administration participated in completing the handwriting GOM forms and the Test of Handwriting Skills.

Measures

GOMs of Handwriting. The general outcome measures of handwriting development forms were developed based on a review of the literature to identify tasks highly correlated with measures of handwriting performance. Identified tasks were letter copying, block letter tracing, dot letter tracing, mazes, and making dots in circles. All tasks included a modeling and sample item component so that the administrator could determine whether students accurately understood how to complete the task before beginning timed administration. Task formats are described in detail below.

Letter copying. The letter copying task was developed based on the assumption that letter legibility makes a significant contribution to the prediction of text legibility (Graham, Weintraub & Berninger, 2001). This task presents students

with two 8 in. x 11 in. sheets of paper, each containing four rows of letters, with rows being made up of four letters. The letters are depicted in the Penmanship Print font, which is a shareware font very similar in appearance to the Zaner-Bloser font typically used in handwriting instruction. Additionally, the font used in constructing these forms shows the letter correctly positioned in relation to the writing lines (solid bottom line, dotted middle divider, solid top line). Immediately beneath each row of given letters is a row which resembles a line of typical, lined handwriting-practice paper (similar to the writing lines described above). Students are asked to look at the provided letters and make the same letter below on the writing line. Letter Copying score is the number of letters correctly copied in one minute, with correctness being evaluated both on letter formation and position of the letter in relation to the writing line. A copy of administration directions, stimulus forms, and the scoring criteria for the letter copying task can be found in Appendix B.

Block letter trace. The second task is a letter tracing task, requiring students to trace outlines of letters, otherwise known as block letter forms. This task presents students with two 8 in. x 11 in. sheets of paper, each containing four rows of block letters, with three letters per row. Students are asked to trace the block letters as quickly and carefully as they can. Block Letter Trace score is the number of letters accurately traced in one minute, with accuracy being defined as ability to keep tracing line within the given stimulus form. A copy of administration directions, stimulus forms, and the scoring criteria for the block letter tracing task can be found in Appendix C.

Dot letter trace. The third task is another letter tracing task, this time requiring students to trace letters made out of dots. This task presents students with two 8 in. x 11 in. sheets of paper, each containing four rows of letters made out of dots, with four letters per row. Students are asked to trace the letters as quickly and carefully as they can, and are given one minute to complete this task. Dot Letter Trace score is the number of letters accurately traced in one minute, with accuracy being defined as ability to maintain the tracing line on the dotted path provided by the given stimulus form. A copy of administration directions, stimulus forms, and the scoring criteria for the dot letter tracing task can be found in Appendix D.

Maze tracing. The fourth task is a maze tracing task, which was developed based on evidence that performance on the Motor Accuracy Test (MAC), which involves tracing a curved black line or maze, is significantly correlated with handwriting in third through fifth grade students (Tseng & Murray, 1994). The maze tracing task is comprised of 12 short mazes of varying complexity which were developed by the researcher. Students are asked to complete the mazes as quickly and carefully as they can, and are given one minute to complete the task. A copy of administration directions, stimulus forms, and the scoring criteria for the mazes task can be found in Appendix E.

Dots-in-circles. The dot- in-circles task was developed based on evidence that shows both precision and speed are needed to achieve functional and legible handwriting (Benbow, 1995). Students were presented with an 8 in. x 11 in. sheet of paper with 15 rows of 11 circles, in bold font, approximately one centimeter in

height. Students are given one minute to make a dot with their pencil in the center of each of the circles. Students are told to try to make as many dots as they can in one minute, by placing one dot in each circle. Each circle successfully completed with a dot in the center is given one point. A copy of administration directions, stimulus forms, and the scoring criteria for the dots-in-circles task can be found in Appendix F.

Criterion measures. Two criterion measures were used to examine the handwriting GOMs criterion and construct validity: an informal teacher rating of each student's handwriting performance and specific sub tests of the Test of Handwriting Skills-Revised (THS-R) (Milone, 2007).

Informal teacher rating. During the data collection period, classroom teachers completed an informal rating of each student's handwriting performance. Teachers were asked to rate each student's general handwriting performance according to the following scale: 4 represents performance in the top 25% of the class, 3 represents performance between the 50^{th} and 75^{th} percentile for the class, 2 represents performance between the 25^{th} and 50^{th} percentile for the class, and 1 represents performance in the bottom 25% of the class. A copy if the informal teacher rating form can be found in Appendix G.

Test of Handwriting Skills-Revised. The Test of Handwriting Skills-Revised (THS-R) is an untimed assessment of handwriting with specific sub tests appropriate for children as young as 6 years 0 months of age, which was why it was chosen as one of the two criterion measures for this study. As was described in the literature

review, none of the other currently available standardized handwriting assessments are appropriate for children of this age and thus could not be used as a criterion. The THS-R was also designed for group administration, which other standardized handwriting assessments that were considered were not. Group administration of the criterion measure was necessary for the data collection design.

Similar to other standardized handwriting assessments, authors of the THS-R report reliability and validity statistics that are discernibly lower than what would be considered acceptable for typical educational assessments. Internal consistency was reported as ranging from .65 to .92. Test-retest reliability for the specific sub tests used ranged from .16 to .83 and inter-rater reliability ranged from .59 to .93. Evidence of validity was poor, with evidence of construct validity being reported as change in student score over time as a representation of expected developmental changes. A factor analysis was also conducted and all sub tests were found to load on one factor. A nationally stratified sample (n = 1,500) was used to establish norms for the THS-R.

Specific sub tests. Four of the ten sub tests of the THS-R were used as criterion measures for this study, and included the Airplane, Bus, Tree and Horse sub tests. Only four of the ten sub tests were selected to reduce burden on classroom teacher and students for total time of administration. In addition, the other 6 sub tests either appeared to repetitively tap the same skill set or appeared to not be useful due to the level of skill required to complete the task (i.e., kindergarteners would all get zero scores).

As such, the Airplane sub test required students to write spontaneously the uppercase letters of the alphabet from memory. The Bus sub test required students to spontaneously write the lowercase letters of the alphabet from memory. The Tree and Horse sub tests required students to copy given uppercase and lowercase letters of the alphabet, respectively.

Data Collection Design

For data collection purposes, the researcher worked in conjunction with 15 occupational therapists (OTs) representing the designated AEA. Due to the structure of Iowa's special education structure, the occupational therapists were able to interact with all classroom students, regardless of special education status. The researcher chose occupational therapists as data collectors because handwriting is an academic subject for which OTs typically provide consultation and intervention.

The researcher initiated and maintained frequent communication with the occupational therapists via email and telephone. The researcher developed a number of forms to guide and direct the data collection process. These included: a checklist which outlined the steps of the data collections procedures, a frequently asked questions (FAQ) document, a contact log, and an administration checklist (samples are included in Appendix H). These were all sent to the occupational therapists electronically prior to training on the GOMs of handwriting and THS administration procedures. Occupational therapists were trained on administration procedures during an Iowa Connections Network (ICN) broadcast from Iowa's State Department of Education building. During this training, the researcher provided an overview of

general outcome measurement and the purpose of the study, in addition to training the occupational therapists on the standardized administration procedures. The researcher left sufficient time to answer all questions posed by the occupational therapists.

During this ICN training, the researcher also reviewed the data collection procedure checklist. The data collection procedure checklist explained the tasks the OTs needed to complete prior to administering the assessment tools. These tasks were as follows: occupational therapists first contacted the school's principal, described the study and obtained their written consent to conduct data collection in the chosen classroom. OTs then contacted the classroom teachers to explain and describe the study and obtain his or her written consent. At this time, the OT would drop off the parent consent forms which were sent home with each child in the classroom. The consent forms were passive such that they only needed to be returned if the parents did not wish to have their child to participate in the study. The parents had one week to return the form. When collecting consents, OTs also obtained and forwarded on to the researcher student lists that contained students' first names, last initial, birth date, and sex. The researcher assigned identification codes to each of the students and utilized these codes for all future documentation purposes.

Once all necessary consents had been obtained, the occupational therapists then worked with the classroom teachers to determine an administration schedule that would be convenient to the classroom teacher. The time line for data collection was structured such that all data was to be collected within a three week period. One

packet of the GOMs of beginning handwriting was administered during the first week of data collection, a second packet was administered during the second week, and specific sub tests of the Test of Handwriting Skills- Revised were administered during the third week. All three assessment periods were conducted as group administration. OTs also distributed the teacher informal rating of handwriting skill form during the first week of assessment, and picked up the completed form during the third week of assessment.

Data Collection Procedures

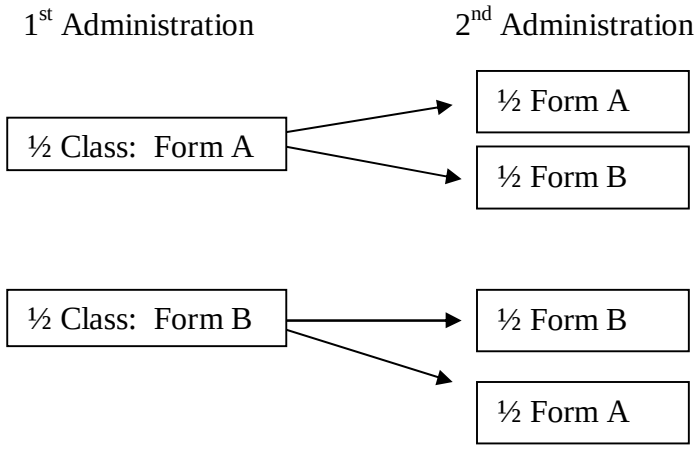
Actual data collection consisted of three components. First, classroom teachers' informal rating of students' handwriting performance was obtained using a format developed by the researcher. Teachers rated each student's general handwriting performance according to the following scale: 4 represents performance in the top 25% of the class, 3 represents performance between the 50^{th} and 75^{th} percentile for the class, 2 represents performance between the 25^{th} and 50^{th} percentile for the class, and 1 represents performance in the bottom 25% of the class. Teachers documented their ratings on the given form during the first week of data collection.

The second component included class-wide administration of the general outcome measures of beginning handwriting forms on two separate occasions. The GOMs of beginning handwriting included the following tasks: letter copying; tracing letters made of dots, tracing block letters, completing short mazes, and making dots in circles. In order to examine alternate form reliability, test packets were constructed so that each student received two alternate versions (Form A and Form

B) of each of the five tasks, with the exception of the dots-in-circles task, for which an alternate form could not be developed.

The alternate forms were presented in a counterbalanced manner, so that half of each class completed Form A during the first administration period, and half completed Form B. For the second administration, which occurred within one week of the first administration, half of the students who received Form A during the first administration received Form A again and half received Form B. For those students who had received Form B first, half received form B again and half received Form A (See Figure 1 below). Each of the tasks were timed for one minute.

Figure 1. Delineation of Administration of Alternate Forms Within Classrooms



These tasks were administered to the whole classroom of students by the occupational therapist in conjunction with the classroom teacher, who assisted with monitoring students to ensure accurate performance of the tasks. Before initiating the group administration, students were given the opportunity to determine whether or not they wished to participate in the activities. Students were given the choice to

complete a different but comparable handwriting development activity if they did not want to participate in the given tasks. All students chose to participate in group administration of the GOMs of beginning handwriting.

The third component involved group administration of specific sub tests of the Test of Handwriting Skills- Revised (THS-R) (Milone, 2007), which were administered one week following administration of the GOMs of handwriting. Again, these specific sub tests included the Airplane, Bus, Tree, and Horse sub tests.

Pilot Study

In order to observe general student response to the tasks, ease of administration, ease of scoring, feasibility of group administration, and feasibility of data collection procedures, the researcher conducted a pilot study in one elementary school in Minneapolis.

During this pilot study, students from two kindergarten, two first, and one second grade classroom participated in group administration of the GOMs of handwriting and specific sub tests of the THS-R. Based on this pilot, the researcher determined that group administration was feasible but that it was beneficial to have the classroom teacher assist in monitoring student performance and provide a visual model of the desired student behavior when needed. In addition, the researcher reformatted the test packets to include trial items so that the administrator could determine student understanding of test directions before starting the actual timed test procedure. The inclusion of the model also allowed for a visual demonstration of the desired task to compliment the verbal directions which further reduced variability

in performance that may be attributed to misunderstanding the task requirements, as might be the case for students with limited English proficiency.

Data Analyses

Mean difference in GOM score across grades. As a method to determine the GOMs' potential for measuring growth over time, five separate one-way analyses of variances (ANOVAs) were calculated, with mean raw score per grade as the target variable. The Bonferoni adjustment was utilized to control for family-wise error rate.

Inter-rater reliability of GOMs. To examine inter-rater reliability of the handwriting general outcome measures, 25% of the collected forms were scored both by two independent scorers who had been trained directly by the researcher. Inter-rater reliability was determined by calculating a Pearson's product-moment correlation coefficient for the following: phase one of administration of Form A of all tasks, phase one of administration of Form B of all tasks, phase two of administration of Form A of all tasks, and phase two of administration of Form B of all tasks.

Test-retest reliability of GOMs. Test-retest reliability was determined through calculation of a Pearson's product-moment correlation coefficient for scores from phase one of administration and phase two of administration for both Form A and Form B for all of the measures.

Alternate form reliability of GOMs. Alternate form reliability was examined through calculation of a Pearson's product-moment correlation coefficient for scores on Form A and Form B of each of the measures. This was done to determine whether

the two forms could be used interchangeably to monitor student progress. During data collection, order of administration was counter-balanced, to control for the effects of order of administration.

Concurrent criterion validity. Concurrent criterion validity was examined by calculating a Pearson's product-moment correlation coefficient for students' scores on each of the handwriting GOMs and specific sub tests of the Test of Handwriting Skills-Revised (THS-R). Additionally, a Spearman's rho coefficient was calculated to examine the strength of relation between score on each of the GOMs and the classroom teacher's informal rating of handwriting skill.

CHAPTER FOUR

Results

In this chapter I present descriptive statistics for students' scores on the five General Outcome Measures. This section also includes an examination of the strength of relation between each of the newly developed measures as a way to determine whether the measures are all tapping the same underlying construct. The descriptive section is followed by the results of the substantive analyses, with detailed results for each of the research questions posed: (a) relation between GOM scores and age; (b) inter-rater reliability; (c) test-retest reliability; (d) alternate forms reliability; and (e) concurrent validity.

Descriptive Statistics

The descriptive statistics listed show the means, standard deviations, and distributions of the newly developed measures (see Table 1). Across measures, variation in mean score appeared to be related to grade. For the most part, it also appeared that the distributions of scores for each of the measures was fairly normal, given Howell's specification that skewness and kurtosis are considered to be within an acceptable range of normality if the statistic falls in the range of negative to twice the standard error (Howell, 1987). The exception to this was average score on Dot Letter Trace for kindergarteners which had a skew of 1.035 and a standard error of .30. This was not a concern as all planned analyses were known to be robust to violations of the assumption of normal distributions

Table 1

Means, Standard Deviations, Skew, and Kurtosis for Measures by Grade

Measure	*n*	*Mean*	*SD*	*Skew*	*Kurtosis*
Letter Copy					
Kindergarten	64	3.77	2.93	.588	-.649
First	87	11.16	5.24	.549	.528
Second	38	11.51	3.87	-.160	-.118
Block Letter Trace					
Kindergarten	64	2.02	1.29	.647	-.045
First	87	3.84	2.29	.506	-.292
Second	38	5.92	2.26	-.188	.237
Dot Letter Trace					
Kindergarten	64	2.43	2.03	1.04	.739
First	87	3.99	2.61	.449	-.235
Second	38	7.39	2.43	.052	.241
Mazes					
Kindergarten	64	2.50	1.57	.990	1.162
First	87	3.16	1.78	.225	-.494
Second	38	5.92	1.67	-.493	.850

Dot-in Circles					
Kindergarten	64	37.91	18.54	-.330	-.658
First	87	42.01	19.81	-.192	-.464
Second	38	58.41	22.54	-.534	-.178

In addition to examining each measure's descriptive statistics, examination of the strength of relation between each of the newly developed measures was conducted as a way to determine whether the measures were all tapping the same underlying construct (see Table 2). The Dots-in-Circles task demonstrated the lowest correlation with the other tasks (r = .250 to .395). The Dot Letter Trace and Block Letter Trace task were most strongly correlated with each other (r = .716). All other tasks showed moderate to approaching strong correlations with each other (Ratner, 2003).

Table 2

Correlation Between Each New Measure

	Letter Copy	*Block Letter Trace*	*Dot Letter Trace*	*Mazes*
Block Letter Trace	.567**	.716**		
Dot Letter Trace	.524**	.635**	.636**	
Mazes	.381**	.288**	.299**	.395**
Dots-in-Circles	.250**			

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

Substantive Analyses

Relation between score on GOM and age. In order to examine the effect of age on the measures, as a way to determine potential for measuring growth over time five separate one-way analyses of variances (ANOVAs) were calculated, utilizing the Bonferoni adjustment to control for family-wise error rate. Dependent variable in each of the ANOVAs was score on the GOM, with grade being the factor of comparison. This analysis was run to examine differences in mean score across groups.

Prior to conducting the ANOVA analyses, each measure was tested for violations of the assumption of homogeneity of variances by calculating a Levene Statistic. The assumption of homogeneity of variances was upheld for the Dot Letter Trace, Mazes, and Dots-in-Circles tasks. Variance for Letter Copying and Block Letter Tracing did vary significantly, and as such, the assumption of homogeneity of variances across groups was violated. However, ANOVA procedure is quite robust to violations of this assumption (Moore, 2004; Howell, 2002) and as such it was determined that proceeding with the ANOVA procedure was acceptable. See Table 3 for results of the analyses.

Table 3

Analysis of Variance of Mean Performance on New Measures Across Grades

			Mean Difference	
Measure	*F*	*Sig.*	*Btw Grades*	*Sig.*

Letter Copy	64.352	.000		
0 to 1			7.353	.000
0 to 2			7.705	.000
1 to 2			.352	1.0
Block Letter Trace	46.902	.000		
0 to 1			1.837	.000
0 to 2			3.913	.000
1 to 2			2.076	.000
Dot Letter Trace	52.446	.000		
0 to 1			1.579	.000
0 to 2			4.979	.000
1 to 2			3.400	.000
Mazes	52.573	.000		
0 to 1			.676	.046
0 to 2			3.436	.000
1 to 2			2.760	.000
Dot-in Circles	13.288	.000		
0 to 1			4.097	.643
0 to 2			20.494	.000
1 to 2			16.396	.000

Note: 0 = kindergarten, 1 = first grade, and 2 = second grade

Examination of the results of the ANOVA analyses showed that for all five newly developed measures, the mean score was significantly different across grades at the $p = .000$ level. After running a post hoc analysis with the Bonferroni adjustment, only two instances were found where the mean difference between groups was not significant at the $p < .05$ level. Mean difference between grade one and two for *Letter Copy* score was .352, $p = 1.0$, and mean difference between kindergarten and first grade for *Dots-in-Circles* was 4.097, $p = .643$. As such, it appears that mean difference between kindergarten and first grade scores on *Letter Copy* accounts for the initial finding of significant differences between groups and that mean difference between first and second grade scores on *Dots-in-Circles* accounts for the initial finding of significant differences between groups. These findings will have implications for the utility of the different measures for progress monitoring the development of beginning handwriting skills across grades.

Inter-rater reliability. In order to examine the extent to which independent scorers obtained similar scores on each measure, a series of Pearson product moment correlations was conducted. Results of these analyses can be found in Table 4. Average inter-rater reliability for each measure across the forms and phases, in order of strength of relation, is as follows: Dots-in Circles, $r = .933$; Letter Copying, $r = .905$; Dot Letter Trace, $r = .804$; Block Letter Trace, $r = .738$; and Mazes, $r = .681$. With the exception of the Mazes task, all measures demonstrated fairly strong inter-rater reliability (Ratner, 2003).

Table 4

Inter-rater Reliability Across Measures, Phases and Forms

Measure	*Phase 1 Form A*	*Phase 1 Form B*	*Phase2 Form A*	*Phase 2 Form B*
Letter Copy	.941**	.827**	.904**	.947**
Block Letter Trace	.798**	.833**	.725**	.595**
Dot Letter Trace	.875**	.707**	.871**	.762**
Mazes	.777**	.604**	.658**	.687**
Dots-in-Circles	.987**	.920**	.940**	.884**

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

Test-retest reliability. In order to examine the correlation between scores at Phase One and Phase Two on all of the measures, Pearson's product moment correlation coefficients were calculated. Table 5 lists the test-retest reliability coefficients for each of new measures. Generally, the correlations were moderate in range, with Letter Copying demonstrating the strongest reliability coefficient, r = .716 (average across Forms A & B). In order of strength of relation, average test-retest reliability across forms for the other measures was as follows: Dots-in-Circles, r = .660; Mazes, r = .612; Dot Letter Trace, r = .584; and Block Letter Trace, r = .530.

Table 5

Test-retest Reliability for Form A and Form B of Each New Measure

Measure	*n*	r =
Letter Copy		
Form A	41	.648*
Form B	60	.784*
Block Letter Trace		
Form A	41	.598*
Form B	60	.462*
Dot Letter Trace		
Form A	41	.541*
Form B	60	.626*
Mazes		
Form A	41	.606*
Form B	60	.618*
Dots-in-Circles		
Form A	41	.753*
Form B	60	.566*

*$p < .05$.

Alternate forms reliability. In order to determine whether each of the new measures' Form A and Form B could be used interchangeably, a series of Pearson's correlation coefficients were again calculated. Note that an alternate form of the

Dots-in-Circles task could not be developed and as such, no statistic is reported. Correlation coefficients of .90 or higher would be considered sufficiently strong such that the forms could be interchangeable (Kline, 1999). As shown in Table 6, none of the new measures met this criterion. The Letter Copy task demonstrated the strongest alternate form reliability, with a correlation of r = .655. In order of strength of relation, alternate forms reliability for the other measures was as follows: Block Letter Trace = .532, Mazes = .525, and Dot Letter Trace = .414.

Table 6

Alternate Forms Reliability of Form A and Form B for all Measures: Aggregation of Phase One and Phase Two

Measure	*n* (A/B pairs)	r =
Letter Copy	113	.655*
Block Letter Trace	113	.532*
Dot Letter Trace	113	.414*
Mazes	113	.525*

*$p < .01$.

Concurrent validity. In order to examine the concurrent validity of each of the new measures, strength of relation to a standardized measure of handwriting development (subtests of the THS-R) and an informal rating of handwriting skill by classroom teacher was examined by calculating a series of Pearson's product-moment correlation coefficients. Table 7 documents the results of these calculations.

According to classification specified by Ratner (2003), all new GOMs showed weak correlation with the classroom teachers' informal rating of handwriting ability (weak = 0 to .3). All correlations between the new measures and the subtests of the Test of Handwriting Skills – Revised (THS-R) were weak to approaching moderate. In order of strength of relation, when averaging across THS-R sub tests, new measure correlation were as follows: Dot Letter Trace, r = .342; Mazes, r = .327; Block Letter Trace, r = .311; Dots-in-Circles, r = .143; and Letter Copying, r = .133.

Table 7

Correlation Between New Measures (Average of Phase One & Two) and Criterion Measures

Measure	*Airplane*	*Bus*	*Tree*	*Horse*	*Informal Rating*
Letter Copy	.170*	.169*	.072	.122	-.021
Block Letter Trace	.304**	.356**	.281**	.304**	-.009
Dot Letter Trace	.291**	.385**	.348**	.343**	.343**
Mazes	.344**	.340**	.308**	.316**	.042
Dots-in-Circles	.177*	.117	.117	.160*	-.033

Note: Airplane, Bus, Tree, and Horse are four specific subtests of the THS-R.

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

CHAPTER 5

Discussion

Proficient handwriting is integral to children's success in school. In order to ensure that students are developing the skills necessary for proficient handwriting, reliable and valid measures are necessary to evaluate student's handwriting ability and monitor their progress over time. Historically, it has been difficult to develop measures of handwriting development that are reliable, valid, and easy to administer and score (Feldt, 1962; Graham, 1986; Feder & Majnemer, 2003). The evaluation of children's handwriting is a challenge, due in part to its inherent subjectivity and the difficulty of identifying essential measurable components of this complex, multi-faceted, developmental skill.

A number of handwriting tests have previously been developed and marketed, but many of these measures are outdated and out of print. For those that continue to be available for use in practical settings, serious concerns exist about their demonstrated psychometric properties (Cizek, 2004; Graham, 1986; Feder & Majnemer, 2003). In addition, for the tools that are available, none target children at the kindergarten level, which is the age at which children are now beginning to learn to write (Snow et al., 1998). Moreover, the complexity of the scoring process for the majority of existing tools limits application of these assessments within actual educational settings (Feder & Majnemer, 2003). As such, existing measures of handwriting do not provide an adequate means of determining competence, individualizing instruction, or monitoring the progress of beginning handwriting development (Graham, 1986).

Given the importance of handwriting for success in school and the lack of acceptable measures to monitor handwriting development, the purpose of this study was to develop a series of general outcome measures (GOMs) of beginning handwriting development and examine their technical adequacy.

In this chapter, I will examine the results for each of the study's research questions and discuss general issues with interpretation of these data. Additionally, I will summarize how this study informs the literature on the feasibility of developing measures of beginning handwriting development appropriate for young children and their utility within a progress monitoring model. Further, I will suggest next steps for further refinement of these measures, including discussion of proposed future research topics.

Correlation Between New Measures

In order to examine whether each of the new measures was tapping the same underlying construct, the strength of relation between measures was examined. The Dots-in-Circles task demonstrated the lowest correlation with the other tasks, suggesting that it may have been tapping a different construct than the other measures. The Dot Letter Trace and Block Letter Trace task were most strongly correlated, which makes sense given that their formats and the child behavior required to complete each task were fairly similar. All other tasks showed moderate to approaching strong correlations with each other, thus providing evidence that the same construct was being tapped by Letter Copying, Block Letter Tracing, Dot Letter Tracing, and Mazes.

Relation of Age to GOM Score

In general, the newly developed measures were all successful in detecting differences in mean performance across grade. Given the assumption that development of handwriting skill varies as a function of age and instruction, the measures' ability to detect difference in mean score across grades provides initial evidence of the developmental and instructional sensitivity of the GOMs. This sensitivity to change in skill level is essential for measures to be used as a progress monitoring tools.

However, Letter Copying did not show a significant difference in mean score from grade one to grade two, thus suggesting a questionable level of sensitivity to instructional and developmental growth after the end of first grade. As such, Letter Copying would be more useful in monitoring progress from the beginning of kindergarten to the end of first grade, once refinements were made to increase its demonstrated reliability and validity.

Inter-rater Reliability

With the exception of the Mazes task (r = .681), all newly developed measures demonstrated fairly strong inter-rater reliability, ranging from .738 to .933. High inter-rater reliability suggests that the scoring formats for each new measure were specific enough to allow for consistency in scoring across observers. This was a promising finding, given that inter-rater reliability coefficients for most of the available standardized handwriting assessments are low to moderate (Feder & Majnemer, 2003). Further, high inter-rater reliability suggests that while there may have been a large degree of variability in the administration of the measures and

resulting student products, the scoring formats were specific enough to reduce variability in scoring of the obtained written products.

Test-retest Reliability

Results of the given analyses demonstrated that test-retest correlation coefficients were moderate in range. Across forms, coefficients ranged from .530 to .716, with Letter Copying demonstrating the strongest test-retest reliability. These test-retest reliability coefficients are not at the level that one would expect for high stakes educational assessment: r= .90 and above (Rudner & Schaffer, 2002). However, reliability coefficients as low as .50 to .60 may be acceptable for a given measure, particularly when test data is combined with other sources of information to make decisions (Rudner & Schaffer, 2002).

It is also interesting to consider the results of the current analyses given the context of the broader field. The most recent review of handwriting measurement tools that could be found listed the following test-retest reliability coefficients: Minnesota Handwriting Test (MHT, Reisman, 1993), r = .58 - .94; Evaluation Tool of Children's Handwriting-Manuscript (ETCH-M, Schneck, 1988), r = .63 - .77; with no test-retest reliability reported for the Children's Handwriting Evaluation Scale-Manuscript (CHES-M , Phelps & Stempel, 1987). The Test of Legible Handwriting (TOLH, Larsen & Hammill, 1989) did report a test-retest reliability coefficient of r = .97. However, in several reviews of this assessment, caution was warned about the true veracity and merit of this reported correlation as it was established by having two members of the PRO-ED research department independently score the same 70 handwriting specimens. Consensus across reviewers found that it is unlikely that

normal users of the scale would obtain such a high level of reliability, (Cizek, 2004; Graham, 1986).

Based upon the statistics reported above, it can be seen that it is difficult to develop measures of handwriting skill that meet typical educational assessment test-retest reliability standards, and as such, it is not surprising that the new measures also demonstrated lower coefficients. In fact, the newly developed measures demonstrate test-retest reliability coefficients that are very much in line with what has typically been demonstrated by more well-established handwriting assessments. This is even more promising given that the scorers in this study were representative of a typical user of the tools, not trained professionals.

Alternate Forms Reliability

None of the new measures demonstrated a level of reliability that would be considered sufficient to allow for the forms to be interchangeable, r = .90 and above (Kline, 1999). Alternate form reliability coefficients ranged from .541 to .648, with the Letter Copy task demonstrating the strongest alternate form reliability. This result suggests that additional refinement would need to be conducted on the tasks to increase their alternate form reliability. One possibility would be to redesign the formats such that they only include uppercase or lowercase letters, as the current formats contain a random sample of both uppercase and lowercase letters. In addition, the fonts used to construct the formats could be revisited. It is possible that other fonts are available that would produce increased consistency in performance across forms.

It is also possible that administration of the measures was not consistent across administrators. Although I trained all administrators extensively and provided them with detailed administration directions and checklists, due to the fact that data was collected in a different state, I was not able to monitor the administrators for fidelity to standardized administration instructions. As such, I can't be certain that the low test-retest and alternate forms reliability are not in part due to variability in administration of the measures.

Concurrent Validity

Based on examination of the analyses conducted, scores on the new measures demonstrated little to weak correlation with the classroom teachers' informal rating of handwriting ability. All correlations between the new measures and the subtests of the Test of Handwriting Skills – Revised (THS-R) were weak to moderate. Of particular interest was that Letter Copying actual demonstrated the weakest relation to the criterion measures (r = .133), despite its strong performance in other analyses conducted for this study. The Dot Letter Trace task demonstrated the strongest relation (r = .342), which is still fairly low.

It is very surprising that the Letter Copying task demonstrated such a weak correlation with the THS-R sub tests, as Letter Copying demonstrates the highest face validity with the developmental skill of handwriting, and was the closest in format to the THS-R sub tests. All four subtest of the THS-R involved the production of letters, similar to the Letter Copying GOM. The Airplane sub test required writing the uppercase letter from memory, the Bus sub test required writing the lowercase letters from memory, the Tree sub test required copying selected uppercase letters,

and the Horse sub test required copying selected lowercase letters. In particular, I had hypothesized that the Letter Copying GOM and the Tree and Horse sub tests would be related because they are, in essence, very similar tasks. One potential explanation for the lack of relation is, again, the fact that the Letter Copying GOM included a random mix of uppercase and lowercase letters, while the THS-R provided separate sub tests for production of uppercase and lowercase letters.

A more plausible explanation is the difference in stimulus formats and scoring procedures between the THS-R and the Letter Copying GOM. For instance, the Letter Copying GOM provided writing lines similar to handwriting paper used by children of this age for handwriting practice. As such, three of the four scoring criteria that needed to be met for a point to be awarded for the Letter Copying GOM focused on letter placement in relation to writing lines (See Appendix I for complete scoring guidelines and an example score sheet). The THS-R did not provide external structure for letter placement on its stimulus forms (letters were made on blank pieces of paper), and as such none of the scoring criteria were related to this aspect of writing legibility. The only criterion that overlapped between the Letter Copying GOM and the THS-R scoring criteria was general ability to recognize the written letter. With this dramatic difference in focus of scoring criteria, it fits that correlations between the Letter Copying GOM and the THS-R sub tests would be somewhat weak. These correlations might increase if the scoring criteria for the newly developed measures were revised to be more in line with those of the THS-R.

Conclusions

Based on the results of the current study, tentative conclusions can be made about the relative merits of each of the newly developed measures and a hierarchy of their potential utility within a progress monitoring system for handwriting development can be proposed.

Overall, I suggest that Letter Copying has the greatest potential as a GOM of beginning handwriting development. Letter Copying demonstrated the strongest reliability coefficients across the measures, in addition to demonstrating a significant difference in mean score from kindergarten to first grade. However, it is a major concern that Letter Copying demonstrated such a weak correlation with the given criterion measures. Due to the strong reliability coefficients and the high face validity associated with the Letter Copying task, it should not be abandoned as a potential GOM; rather, the Letter Copying GOM should be subjected to further evaluation with additional criterion measures, and examined for possible refinements that would increase its correlation with criterion measures.

In future research, I would revisit the scoring criteria I developed, and identify essential components as informed by the literature combined with knowledge gained from practical experience with handwriting instruction. With this revised scoring criteria, I would look for a suitable criterion measure(s). It would be preferable to identify a standardized handwriting assessment for which the construct of handwriting is conceptualized in a manner similar to mine. However, given the literature review that informed this study, serious doubt exists as to whether such a standardized criterion measure could be located. In the absence of such a

standardized measure, another possibility would be to examine correlations between scores on GOMs and ranking by a panel of experts on handwriting performance.

The Mazes GOM ranked second as a potential GOM. The Mazes task demonstrated fairly strong test-retest and alternate forms reliability and correlation with criterion measures. The Mazes task was also demonstrated significant differences in mean performance across grades. Its inter-rater reliability was fairly low, but this could be strengthened by modifying the maze stimulus forms and further refining the scoring criteria. One hesitation in recommending this measure as a GOM of beginning handwriting, is that this task does not have a high level of face validity with the construct of handwriting. As such, one solution would be to pilot the Maze GOM with younger children (4-year-old preschoolers), as a potential pre-writing instruction GOM. It would be more appropriate to use the Mazes task as a GOM of pre-writing skills, because this task is representative of the paper-pencil tasks typically used in preschool settings to help children develop the hand-eye coordination necessary for proficient handwriting.

The Dot Letter Tracing GOM also appears promising as a GOM of beginning handwriting. This task demonstrates a fairly high level of face validity with the construct of handwriting, as it involves the production of letters by the student. In addition, tracing letters made of dots is a very common methodology for teaching letter formation in preschool and kindergarten settings. Moreover, Dot Letter Tracing demonstrated the highest correlation with the criterion measures, moderately strong reliability coefficients, and significant difference in mean score across grades.

On the other hand, even though its format is fairly similar to the Dot Letter Tracing format, Block Letter Tracing was the measure that most consistently demonstrated the weakest performance of all the new measures. Potential explanations could be due both to the stimulus formats and the scoring criteria for the Block Letter Tracing GOM.

The Block Letter Tracing stimulus format was developed using a font that presented letters in outline format. However, the font used may not have been the most conducive to a tracing task, due to the presence of stems and tails on the letters, which may have been confusing to students. In addition, the scoring criteria for this task may not have provided sufficient clarity on what constituted a correct versus incorrect response. However, because it is so similar in format to the Dot Letter Tracing task but demonstrated much weaker reliability and validity, I propose that the Block Letter Tracing task be removed from the list of potential Beginning Handwriting GOMs.

Although the *Dots-in-Circles* task did demonstrate reasonably high reliability coefficients, this measure did not show a difference in mean performance from kindergarten to first grade, a time at which it is most important to monitor handwriting progress. Given this limitation in combination with its extremely low construct validity and weak face validity (i.e.: it does not look like a measure of handwriting skill), I propose that the Dots-in-Circles task be removed from the list of potential beginning handwriting GOMs.

As such, the following measurement hierarchy is suggested: Mazes GOM as a progress monitoring tool to be used in the preschool year prior to kindergarten,

with Letter Copying and Dot Letter Tracing being used as progress monitoring tools from the beginning of kindergarten to the end of first grade. It is unclear whether these tools would continue to be useful for progress monitoring of typically developing children in second grade, as the outcome of interest begins to transition from gaining handwriting proficiency to using handwriting as a tool for written expression.

However, Letter Copying and Dot Letter Tracing could be used as screening tools at the beginning of the second grade year to identify students performing at significantly low levels. The tools could then be used to monitor the progress of and determine intervention effectiveness for students who require intensive levels of individualized handwriting instruction.

Of course, prior to utilization of the Mazes, Letter Copying, and Dot Letter Tracing GOMs within such a measurement architecture, additional research is necessary. This includes, (1) examination of the psychometric properties of the Mazes GOM as a pre-writing fine motor development measure with four-year-old preschoolers, (2) further examination of the construct validity of the Letter Copy GOM given revisions to the scoring criteria and location of additional criterion measures, (3) further examination of the construct validity of the Dot Letter Trace GOM, and (4) establishment of norms or performance benchmarks for the preschool, kindergarten, and first grade years.

Currently, handwriting continues to be a skill that is vitally important to students' success in school. If we expect that students can use handwriting proficiently to express their knowledge, then we need to ensure that reliable and

valid measures exist to allow teachers to monitor student progress as they learn this skill. The current study demonstrates the emerging potential of three new general outcome measures of beginning handwriting development and proposes a measurement architecture utilizing these new measures.

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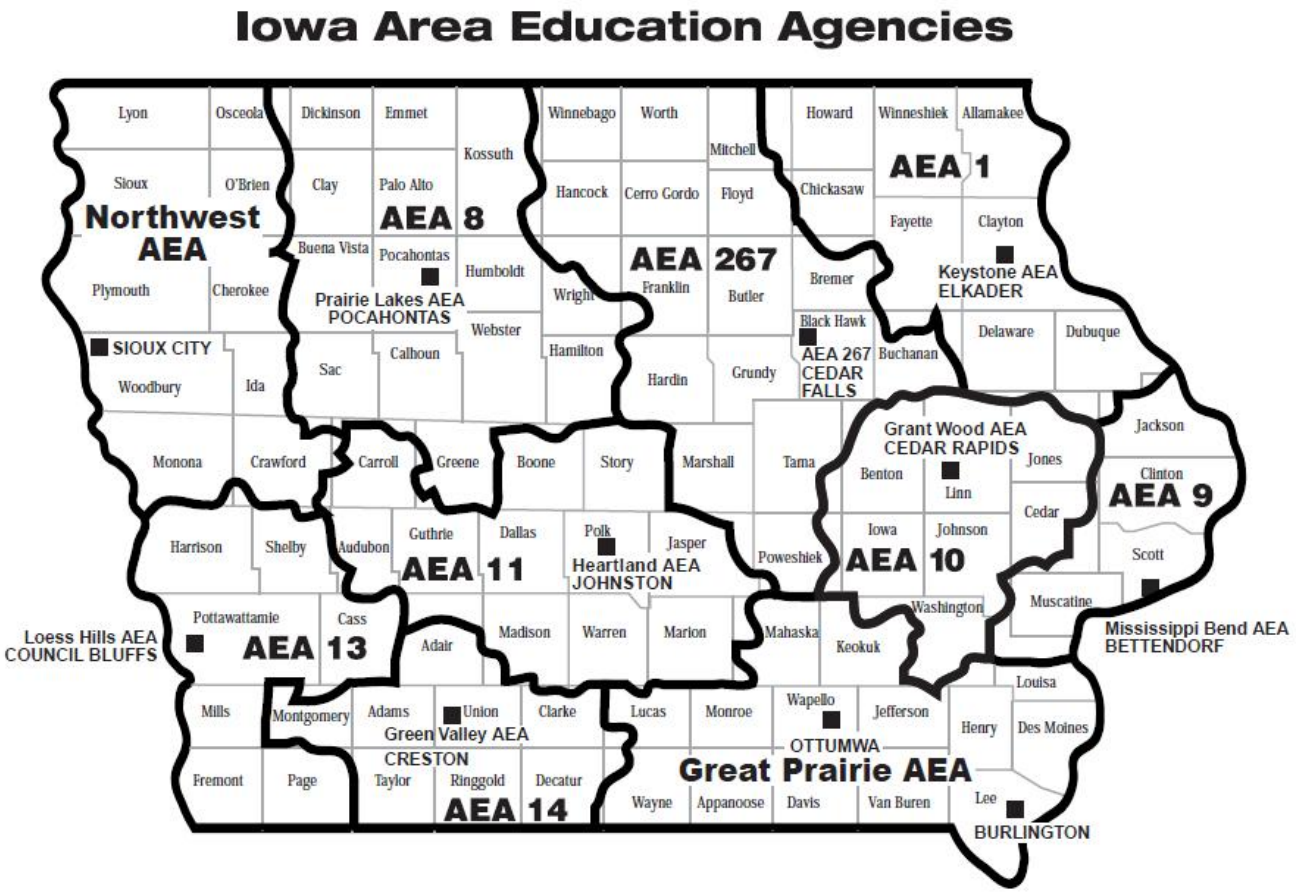
APPENDIX A

Map of Iowa Area Education Agencies (AEAs)



APPENDIX B

Letter Copying

Directions

Stimulus Forms

Handwriting Progress Monitoring: Directions for Administration

Examiner: **"Today you are going to do some activities with a pencil and paper. Some of the activities will involve letters, one will have mazes, and one will have you make dots in some little circles. I am going to time you doing each activity. I need you to listen very carefully to the directions before starting each activity, and be sure to put down your pencil when I say "stop". Also, be sure to do your best work with each activity."**

"**Now, turn to the page that looks like this.** Show the first page of the letter copying probe, which only has the letter "A" on it, with the writing lines below. Quickly check that all students are on the correct page. Once you have determined all students are on the correct page, read the directions for Administration of Letter Copying found below.

Directions for Administration of Letter Copy

Examiner: Say: **"Here is the letter "A"** (point to the letter A)**. Here are some lines to write on** (point to the writing lines)**. I want you to look at the letter and then make that letter down here"** (point to the writing lines)**. "Watch me".**
(Demonstrate making the letter "A" appropriately on the writing lines on the administrator's copy. Hold up the copy and briefly show it to the class.) **"Now you do it."**

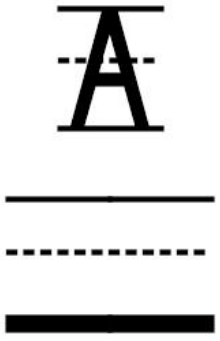
Quickly walk around the classroom to make sure all students appropriately copy the "A" onto the writing lines. Provide praise and correction as needed. Once you have checked to make sure all students have copied the letter correctly, say:

"**Great Job, now turn to the next page; the one with the number 2 at the bottom. Here are some more letters. I want you to look at the letters printed up here** (point to the first letter) **and make that letter down here** (point to the writing lines). **Go across the page** (move your finger across the page to show the direction to go), **and go immediately to the next line when you finish one line. If you finish the last one on the page, go on to the next page** (Demonstrate turning the page with

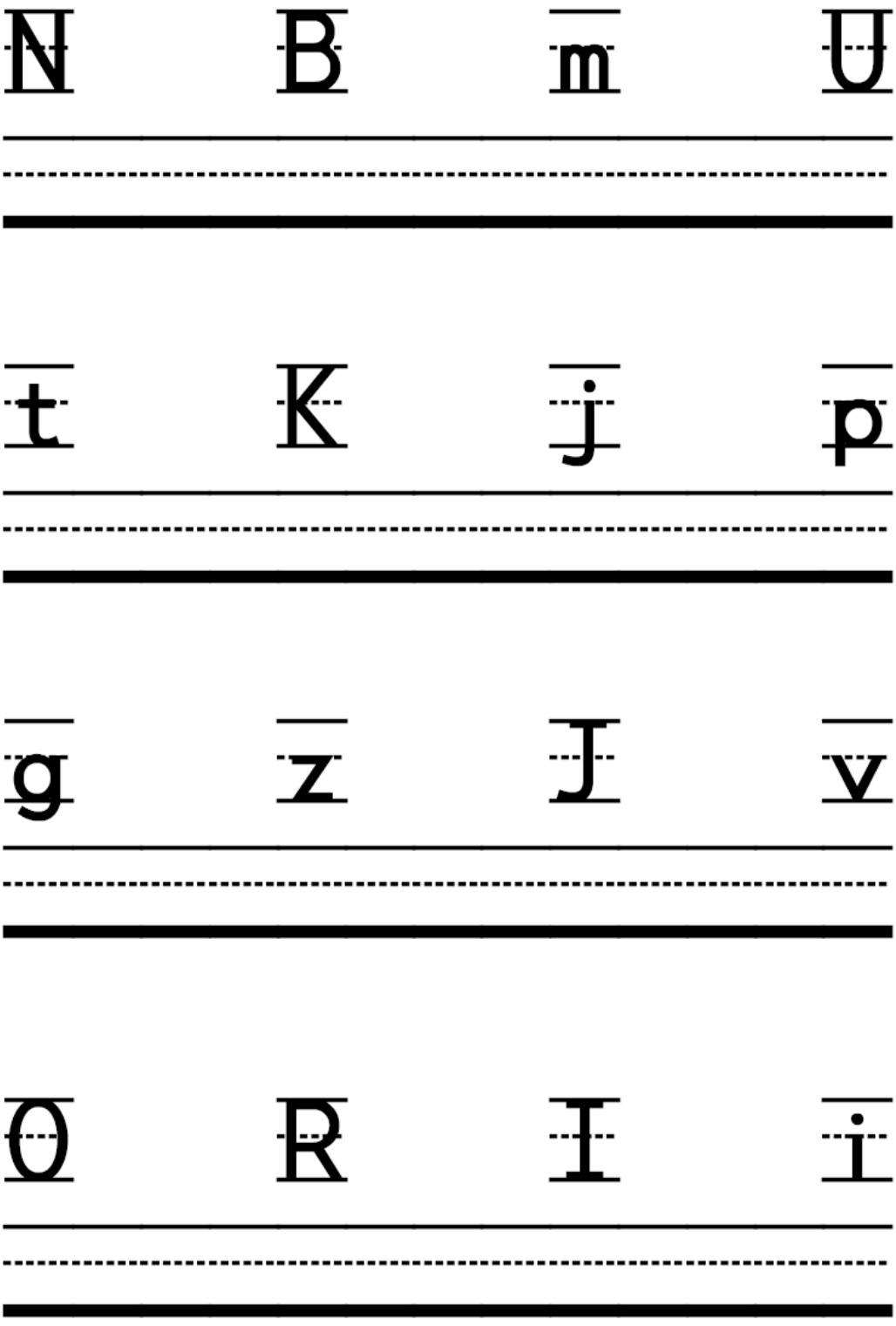
your blank packet)**. <u>If you make a mistake do not erase it</u>. Just go on to the next letter. Do your best work, and make the letters as quickly and carefully as you can. Do you have any questions? Okay, remember when I say stop you need to put your pencils down. Okay? Ready, begin."** Start the timer now for one minute. While the students are working, walk around the classroom to make sure students are correctly completing the task. Provide praise and correction as needed. Provide prompts to students to turn the page as needed. At the end of one minute say, **"Pencils Down".** Praise students for their work.

Then, say "**Now, I need you to turn until you come to the page with the outline of the letter "B" on it, that looks like this."** Show the first page of the block letter tracing probe which says "Block Letter Tracing "at the top and has the letter "B" on it in outline form. Quickly check that all students are on the correct page. Once you have determined all students are on the correct page, read the directions for Administration of Block Letter Tracing found below.

Letter Copying



Form A


N B m U
t K j p
g z J v
Q R I i

APPENDIX C

Block Letter Tracing

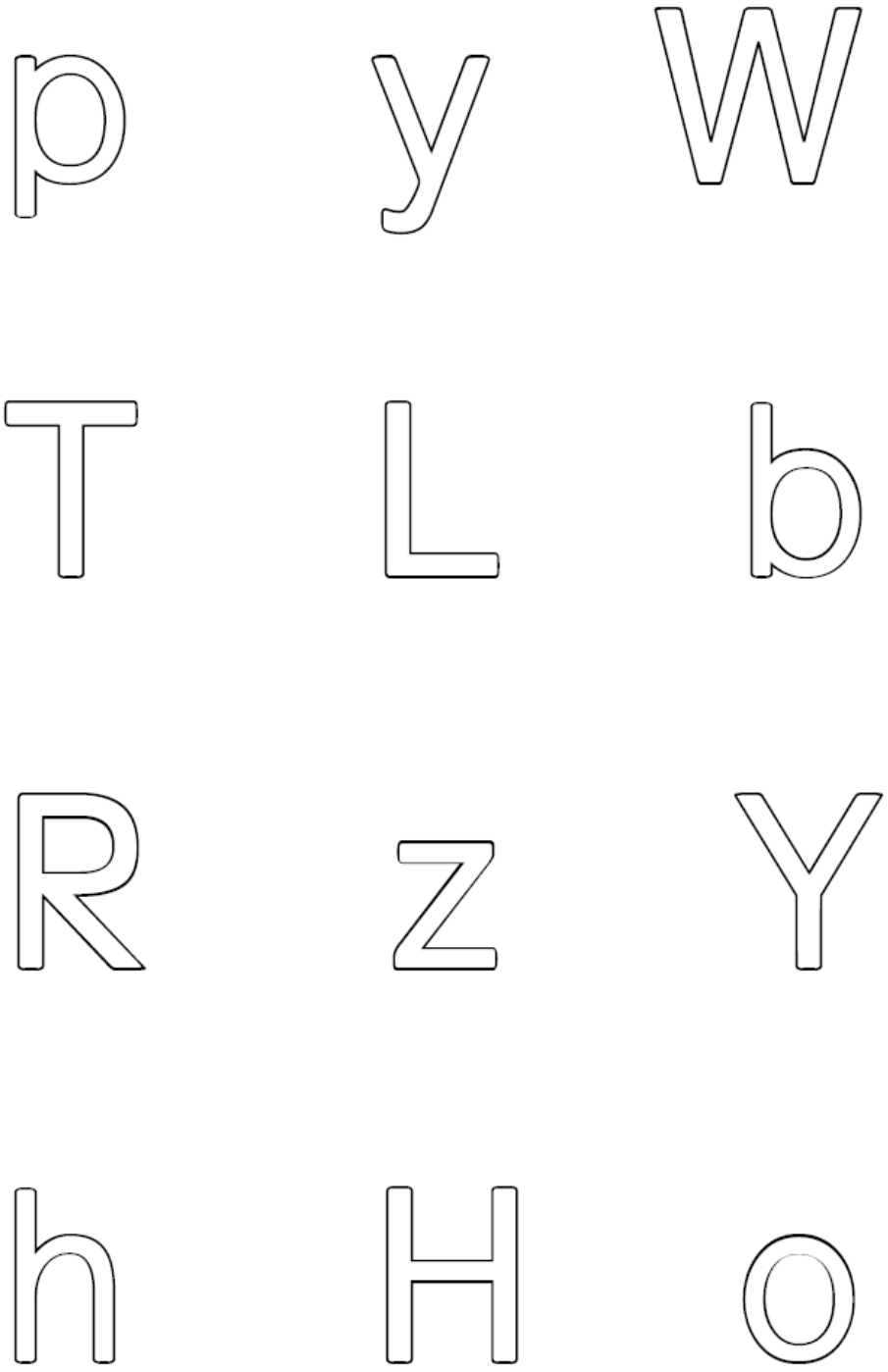
Directions

Stimulus Forms

Directions for Administration of Block Letter Tracing

Examiner: Say: **"Here is the outline of the letter "B"** (point to the outline of the letter "B")**. I want you to trace the letter "B" with your pencil, like this** (on the administrator's copy demonstrate tracing the letter "B" with your pencil. Then hold it up and show to the class)**. Now, it's your turn – trace the letter "B".** Quickly walk around the room to make sure all students correctly trace the letter "B". Provide praise and correction as needed. Once you have determined that all students have correctly traced the letter, then say: **"Turn to the next page; to the one that has the number 5 at the bottom.** (Make sure all students turn the page)**. Here are some more outlines of letters. Going across the page** (move your finger across the page to show the direction to go)**, I want you to trace each letter as quickly and carefully as you can. When you get to the end of one row, go immediately to the next row. If you finish the last one on the page, go on to the next page.** (Demonstrate turning the page). **Remember, if you make a mistake, don't erase it; Just go on to the next letter. When I say stop, put down your pencil. Do your best work, and trace the letters as quickly and carefully as you can. Do you have any questions? Okay, remember to do your best work. Ready, begin"**. Start the timer now for one minute. While the students are working, walk around the classroom to make sure students are correctly completing the task. Provide praise and correction as needed. Provide prompts to students to turn the page as needed. At the end of one minute say, **"Pencils Down".** Praise students for their work.
Then, say "**Now, I need you to turn until you come to the page with a letter "C" on it that is made of dots, like this."** Show the first page of the dot letter tracing probe which is titled, "Dot Letter Tracing", and which only has the letter "C" made of dots on it. Make sure all students have their packet open to that page as well. Once you have determined all students are on the correct page, read the directions for Administration of Dot Letter Tracing found below.

Block Letter Tracing


p y W
T L b
R z Y
h H o


x n b
g P t
j M f
T Z W

APPENDIX D

Dot Letter Tracing

Directions

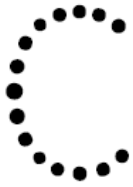
Stimulus Forms

Directions for Administration of Dot Letter Tracing

Examiner: Say: **"Here is the letter "C". It is made of dots. I am going to ask you to trace the letter "C" like this. Watch: you connect the dots.** Demonstrate tracing the letter "C" and then hold it up to show the class**. Now it is your turn** (have the students trace the letter "C" made of dots). Quickly walk around the classroom to make sure all students are completing the task accurately. Provide praise and correction as needed. Once you have determined that all students have correctly traced the letter "C", say: **Now, turn to the next page, to the one with a number 8 at the bottom. Here are some more letters that are made of dots. Going across the page** (move your finger across the page to show the direction to go)**, I want you to trace each letter as quickly and carefully as you can. Connect the dots. When you get to the end of one row, go immediately to the next row. If you finish the last one on the page, go on to the next page.** (Demonstrate turning the page). **If you make a mistake, do not stop to erase it; just go on to the next letter. When you hear me say stop, put your pencil down. Do your best work, and trace the letters as quickly and carefully as you can. Do you have any questions? Okay, remember to do your best work. Ready, begin"**. Start the timer now for one minute. While the students are working, walk around the classroom to make sure students are correctly completing the task. Provide praise and correction as needed. Provide prompts to students to turn the page as needed. At the end of one minute say, **"Pencils Down".** Praise students for their work.

Then, say "**Now, I need you to turn until you come to the page with one small maze on it, like this.** Show the page in your booklet that says "Maze Tracing" at the top, and has the trial maze item on it. Quickly make sure that all students are on the correct page, then read the directions for administration of the maze tracing task below.

Dot Letter Tracing



o R Y c

Q a P H

n e t l

h p m f

APPENDIX E

Mazes

Directions

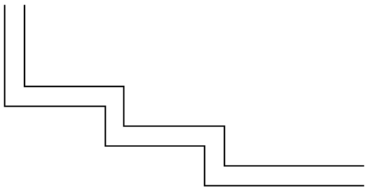
Stimulus Forms

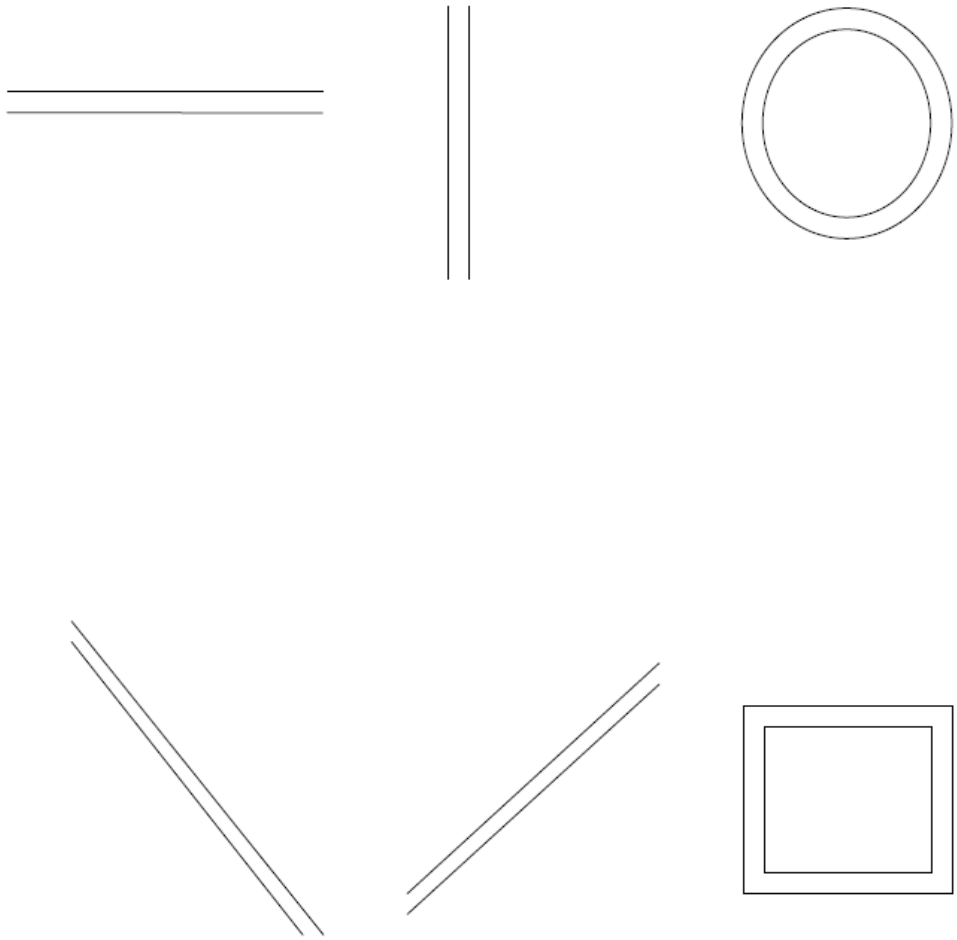
Directions for Administration of Maze Tracing

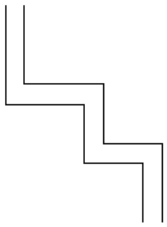
Examiner: Say: **Take your pencil and very carefully follow the maze. It is very important to stay between the dark lines, like this.** (Model tracing the maze and then hold it up to show to the class). **Now it is your turn: carefully trace the maze, staying between the dark lines.** Quickly walk around to make sure all students are completing this trial maze task accurately. Provide praise and correction as needed. Once you have determined that all students have correctly traced the maze say: **Now, turn to the next page; to the one with the number 11 at the bottom. Here are some more small mazes. I want you to start here** (point to first maze in the upper left-hand corner) **and go across the page. When you get to the end of one row, go on to the next. If you finish the last maze on the page, go on to the next page.** (Demonstrate turning the page). **For each maze, use your pencil to go between the dark lines from one end to the other, like following a maze. It is important to work as carefully as you can.** (Really emphasize this point).**Even though I am timing you, you get points for staying between the lines, so remember to do them very carefully. Do you have any questions? Okay, remember to do your best work, and to stay between the dark black lines. If you make a mistake, do not stop to erase it; just go on to the next maze. When I say stop, put your pencil down. Ready, begin".** Start the timer now for one minute. While the students are working, walk around the classroom to make sure students are correctly completing the task. Provide praise and correction as needed. Provide prompts to students to turn the page as needed. At the end of one minute say, **"Pencils Down".** Praise students for their work.

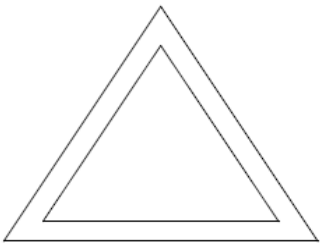
Then, say "**Now, I need you to turn until you come to the page with circles on it, that looks like this.** Show the page that says "Dots-in-Circles" at the top and has the trial item for the dots-in-circles probe. Quickly to check that all students are on the correct page. Once you have determined all students are on the correct page, read the directions for Administration of Dots-in-circles found below.

Maze Tracing









APPENDIX F

Dots-in-Circles

Directions

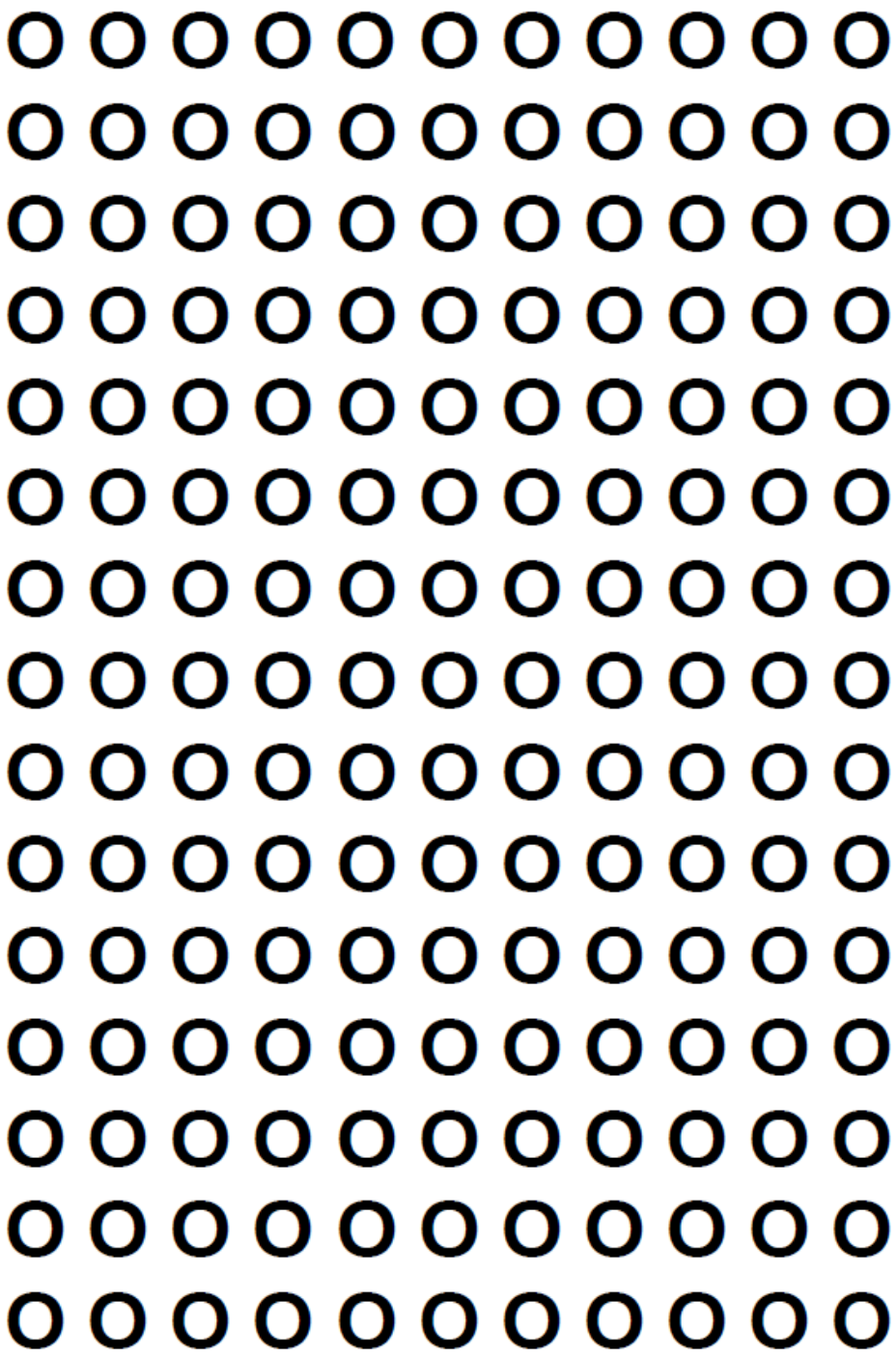
Stimulus Forms

Directions for Administration of Dots-in-Circles

Examiner: Say: **"Here are some circles** (point to the trial row of circles on the page)**. I want you to make a dot in the center of each circle like this, so that the dot does not touch the sides of the dark black circle. Watch me.** (Demonstrate making dots in the middle of each circle on your copy, then hold it up to show the class)**.** Say: **See, I made a dot right in the middle of each circle. It is important to just make dots with the tip of your pencil, not small circles, lines, or slashes. Now it is your turn to make dots in circles. Try it on this row.** Quickly walk around the room to check to see that all students place dots in circles appropriately. Provide praise and correction as needed. Once you have determined that all students know how to make the dots in circles, say:

"Turn to the next page; to the one with the number 14 at the bottom. Here are some more circles. I want you to start here (point to first circle in the upper left-hand corner) **and go across the page. When you get to the end of one row, go on to the next. For each circle, use your pencil to make a dot right in the center of the circle. Also, remember to only make dots, not lines, circles or slashes. Try to work quickly but as carefully as you can. Try to make the dot so that it does not touch the dark black circle. Do you have any questions? Okay, remember to do your best work. Ready, begin".** Start the timer now for one minute. While the students are working, walk around the classroom to make sure students are correctly completing the task. Provide praise and correction as needed. Provide prompts to students to turn the page as needed. At the end of one minute say, **"Pencils Down".** Praise students for their work.

Dots-in-Circles



APPENDIX G

Informal Rating of Handwriting Skill Form

Below you will find a list of the students in your class. On the line following each student's name, write the number which corresponds with your perception of the student's handwriting performance. Please refer to the following scale: **4 represents performance in the top 25% of the class, 3 represents performance between the 50th and 75th percentile for the class, 2 represents performance between the 25th and 50th percentile for the class, and 1 represents performance in the bottom 25% of the class.**

There are no firm rules for how you rate the student's handwriting. You may take into consideration such factors as formation, straightness of lines, size, spacing, etc. I am asking that you make this rating based on overall impression, rather than firm guidelines.

Student Name	Rating
K. G.	
A. L.	
M. C.	
R. G.	
F. D.	
S. M.	
M. M.	
T. B.	

APPENDIX H

Data Collection Forms

Data Collection Procedures Checklist: Getting Ready for the Study

FAQ Document

Contact Log

Administration Checklist

Handwriting Study: Getting Ready For the Study

The following checklist will be helpful when planning participation in this study. The following steps **must** be taken prior to implementation of the study.

____ (1) Review your participation in this project with your supervisor and be sure that he/ she understands the study and its purpose (refer to the enclosed study description).

____ (2) Contact the school's principal. Provide the principal with a copy of the Principal Permission Form, which describes the study. Have him/ her sign the Principal Permission Form documenting that he/ she gives permission for the study to occur in the building he/ she supervises. Once it is signed, please send this form to Tracy Bradfield Morgan at:

Fax #: (612) 625-2093 or
218 Pattee Hall, 150 Pillsbury Drive SE, Minneapolis, MN, 55455

____ (3) Review the study with the classroom teacher(s) that you will be working with. Provide him/ her with a copy of the Teacher Participation Form, which explains the study. Have him/ her sign the form and return it to Tracy Bradfield Morgan at the contact information provided above.

***Please note: It is important to send these forms as soon as you have them signed in order for the study to proceed as planned.**

____ (4) After obtaining the signed Teacher Participation Form, distribute the Parent Consent Forms to the students in the class. Discuss with the classroom teacher the best way to do this. In the past, it has worked best to send them home in the student's backpacks at the end of the day. Please note that these consent forms are in a passive consent format and only need to be returned if the parents do not wish their child to participate in the study. The parents have one week to return the form.

You should collect any signed forms and note those students whose data should not be kept by writing the word “No” next to their code number at the top of the packet. (*Note: If a student’s parent requests that the child should not be included in the study, you will have the child complete the tasks along with his/ her classmates, but the data will not be kept for analysis.)

____ (5) Document all contact with supervisors, administrators and teachers using the provided log form.

____ (6) Set up a data collection schedule with the classroom teacher. You should plan on administering the handwriting progress monitoring probes: one time during the week of February 19-23, 2007, one time during the week of February 26-March 2, 2007. During the week of March 5-9 you will need to administer specific subtests of the Test of Handwriting Skills (THS). You should plan about 15 minutes each week to distribute the packets, have the child complete the work, and then pick up the packets.

____ (7) Obtain a class list that includes each student’s name, gender and birthdate. Send this to Tracy Morgan ASAP so that she can assign students’ code numbers.

GOMs of Handwriting Development

Frequently Asked Questions

(1) Question: Do we need to get active parental permission to complete this study?

Answer: No. This study utilizes a passive consent process, which was approved by the University of Minnesota's Human Subjects Review Board. This process specifies that parents only need to notify you or the researchers when they do NOT wish for their child to participate. Unless the child's parent notifies you, the classroom teacher, or the researcher that they do not wish for their child to participate, then it is assumed that they give their permission.

(2) Question: How do I pass out the packets?

Answer: You will be given a list of names of the students in the classroom you are responsible for. That list will show a code number next to the student's name. You give each student the packet labeled with their code number.

(3) Question: Do all children participate?

Answer: Yes. All children who are present on the day of administration will complete the tasks. If a student's parent requests that the child should not be included in the study, have the child complete the tasks along with his/ her classmates, but do not keep that student's booklet (i.e.: shred this students completed packet).

(4) Question: Should I be concerned if a student is absent?

Answer: No. If a blank packet is returned to the researcher, it will be assumed that the student was absent that day. The researcher will be responsible for sorting this out for data analysis.

(5) Question: Besides administering the progress monitoring packets, is there anything else I need to do?

Answer: Yes. Please also obtain a list of the student's birthdates and genders from the classroom teacher. The teacher should have been made aware that this information would be necessary when he/ she signed the consent form. Also, make sure the teacher has completed the informal rating of student handwriting skill form, which has been sent to you also.

(6) Question: When does my data (i.e.: progress monitoring packets, THS booklets) need to be returned?

Answer: Please have packets returned to Gloria Frolek Clark by March 10th, 2007

(7) Question: Do I need to score the packets before returning them?

Answer: No. Scoring will only be done by those who have received training to ensure reliability. If you are interested in assisting as a trainer, please contact Gloria Frolek Clark at:
(515) 993-4596 (ext 207) or gfrolekclark@aea11.k12.ia.us.

(8) Question: How should I contact if I have questions or problems?

Answer: Tracy Bradfield Morgan (612) 822-5658 or tmorgan@umn.edu or Gloria Frolek Clark (see contact information above).

Study of Handwriting GOMs: Contact Log

Date:	Name:	Describe Contact/ Communication:

Handwriting Study: Administration Checklist

Please follow these steps to ensure that all data is collected appropriately.

Prior to Entering Classroom:

____ (1) Make sure that there is a progress monitoring booklet for each student, and that each booklet is labeled with the student's id code. You should have a class list with the students' names and id codes by which to verify this information.

_____ (2) Make sure you have several blank progress monitoring booklets in case of mistakes.

____ (3) Make sure you have enough sharpened No. 2 pencils for each student in the class. It is best if the erasers are removed from these pencils to prevent students from trying to erase.

____ (4) Make sure that you have reviewed the administration guidelines prior to entering the classroom and that you bring them with you on the day of administration. Also, be sure to have a blank CBM packet with you so that you can provide models for the students when indicated.

____ (5) Make sure you have your bag of themed pencils or stickers to distribute at the end of the session as a thank you for the students.

_____ (6) Remember to pack your timer, as each task is timed for one minute.

_____ (7) Remember to bring the Informal Teacher Rating of Handwriting Skill form with to give to the teacher at your first visit. Plan to pick it back up when you administer the THS subtests.

Once in Classroom:

____ (1) Make sure all students clear their desks and place all extra materials on the floor.

____ (1) Distribute one progress monitoring packet to each student according to the class list. Each packet should be labeled with the student's id code only.

____ (2) Pass out two sharpened No. 2 pencils (with no erasers) to each student in the class.

____ (3) Read the directions, providing models where indicated on a blank CBM packet, and administer the progress monitoring probes. Remember that each probe is timed for one minute

_____ (4) While the students are completing the tasks, walk around to ensure that all students are completing it accurately. Provide correction as needed. For this, it is helpful to have a blank student packet that you can quickly demonstrate the correct way to complete the task if the student is not doing it correctly. If the classroom teacher can assist with this, it would be very helpful.

_____ (5) If you see that a student has started early or not stopped when told, try to document this on his/ her packet. Again, please see if the classroom teacher can assist with monitoring compliance to start and stop times.

_____ (6) Collect all completed packets and pass out thank you items to students.

____ (7) During your final visit, when you are administering the THS subtests, remember to get back the Informal Teacher Rating of Handwriting Skill form from the teacher.

APPENDIX I

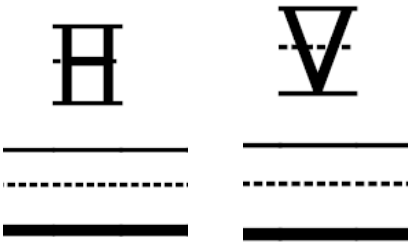
General Outcome Measures
Of
Beginning Handwriting Development:

Scoring Guidelines

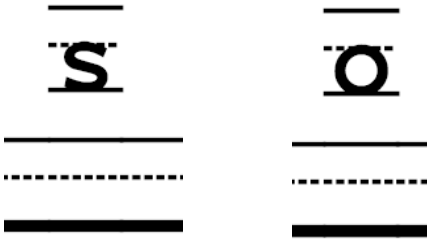
Letter Copying Scoring

Score one point for all letters completed correctly. If you can visibly see the letter, even if it is faint or looks partially erased, score it. Letters are considered to be correctly completed if they meet ALL of the following criteria:

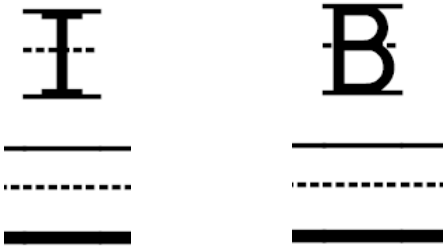
- Student's letter is an exact copy of the stimulus letter.
- Letter is less than 1/16 of an inch above or below the writing lines, except for those letters with tails (g, j, p, q, y).
  Example of letters that do not meet this criteria:



- For lower case letters, letter does not extend /16 of an inch or more above the dashed middle line, except for the letters (b, d, f, h, k, l, t). Also, for dotted letter (i, j) the dot must be visibly distinct from the line forming the letter.
  Example of letters that do not meet this criteria:



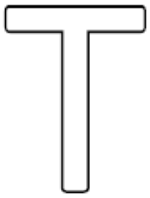
- Letters are not "floating", i.e.: all letters should be less than 1/16 of an inch from the bottom writing line, not float above it.
  Example of letters that do not meet this criteria:



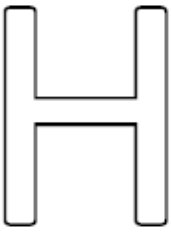
Block Letter Tracing Scoring

Score one point for all letters completed correctly. Letters are considered to be correctly completed if they meet ALL of the following criteria:

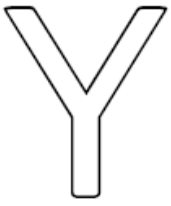
- Student's tracing line does not extend outside of the outline letter stimulus at any point.
- For lower case i and j, the only measure in the main part of the stimulus. You only need to see a pencil mark in the top dot portion of the stimulus.
- Student's line starts and ends within 1/16 of an inch of the given stimulus. Measure from point at which student started his/ her line.
- No stray lines are present.
  Example of stray lines:



- There are no gaps in the student's tracing line greater 1/16 of an inch or greater.
  Example:



- If you can see any pencil on the outside of the stimulus line, do not count as correct.
  Example of pencil on outside of stimulus:



Dot Letter Tracing Scoring

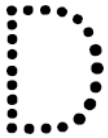
Scoring: Score one point for all letters completed correctly. Letters are considered to be correctly completed if they meet ALL of the following criteria:

- Student's tracing line does not vary from dotted stimulus.
- Student's tracing line does not extend 1/16 of an inch or more past the first or last dot of the stimulus.
- Student's line must go through each dot, i.e.: the student's line should not stop short, start late, or miss dots.

  Example of student lines missing dots:

- Student's line must visibly touch each dot.

  Example of not visibly touching dots:



- No additional lines are present.

  Example of additional lines:

Maze Tracing Scoring

Scoring: Score one point for all mazes completed correctly. Mazes are considered to be correctly completed if they meet ALL of the following criteria:

- Student's line does not go outside of the given stimulus lines. Student's line must stay within the given stimulus.
- Student's line starts and ends within 1/16 of an inch of the given stimulus.
- If you can see any pencil on the outside of the stimulus line, do not count as correct.

Dots-in-Circles Scoring

Scoring: Score one point for each circle completed correctly. For a point to be given, each of the following criteria must be met:

- Dot is in the center of the circle and does not touch any part of the circle.

  Example of touching circle:

- Dots are isolated points, not circles, lines, or slashes.

  Example of circles:

  Example of slashes:

- Observer must be able to see the dot clearly.

Individual Student Score Sheet: Form A

Student ID#: _____ Date of Administration: _____
Phase of Administration: _____

Items	Test Raw Score

Letter Copy

Page 1	Page 2
N B m U	S U s o
t K j p	R J c b
g z J v	Y N C s
O R I I	T E P s

Letter Copy: ____

Block Letter Tracing

Page 1	Page 2
p y W	x n b
T L b	g P t
R z Y	j M f
h H O	T z w

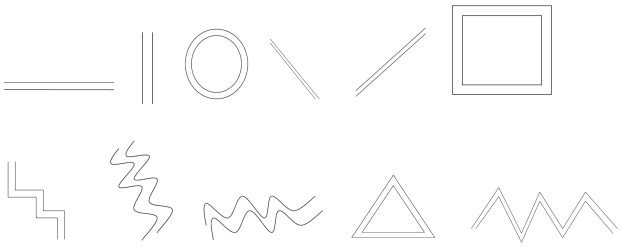
Block Letter Trace: ____

Dot Letter Tracing

Page 1	Page 2
S V l u	o R Y c
c D H G	Q a P H
f e l C	n e t l
m v p W	h p m f

Dot Letter Trace: ____

Maze Tracing



Maze Trace: ____

Dots-in Circles
No record of individual items

Dots-in-Circles: ____