EXPLORING PREDICTORS OF PERFORMANCE ON A CURRICULUM-BASED MEASURE OF WRITTEN EXPRESSION

by

Madison Lee Aitken

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Graduate Department of Human Development and Applied Psychology
Ontario Institute for Studies in Education
University of Toronto

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Madison Lee Aitken
Department of Human Development and Applied Psychology
University of Toronto

Abstract

The role of gender, handwriting automaticity, reading proficiency, and verbal working memory in grade 4 and 5 students’ (N = 42; 23 boys) performance on a curriculum-based measure of narrative writing was examined. Three outcomes were measured: total words written, correct minus incorrect word sequences (accurate production of spelling and grammar in-text), and composition quality. Gender (girls > boys) and handwriting automaticity were significant predictors of total words written, and gender (girls > boys), reading proficiency, and grade (5 > 4) significantly predicted correct minus incorrect word sequences scores. Total words written was the only significant predictor of composition quality. The results suggest that reading proficiency and handwriting automaticity should be assessed alongside written expression in order to identify children at risk for writing difficulties and to inform instructional recommendations for these individuals.
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<tr>
<td>ADHD</td>
<td>Attention Deficit Hyperactivity Disorder</td>
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<tr>
<td>CBM</td>
<td>Curriculum-based measurement</td>
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<tr>
<td>CMIWS</td>
<td>Correct minus incorrect word sequences</td>
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<tr>
<td>EQAO</td>
<td>Education Quality and Accountability Office</td>
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<tr>
<td>TWW</td>
<td>Total words written</td>
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<tr>
<td>TOWL</td>
<td>Test of Written Language</td>
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CHAPTER ONE

Introduction
The Importance of Written Expression

Although research in the area of written expression has lagged behind the study of reading, more attention has been paid to writing in recent years (Hooper, Swartz, Wakely, de Kruif, & Montgomery, 2002). This is a promising trend given the importance of writing to students’ academic achievement. Writing activities are valuable in helping teachers to assess their students’ learning (Britton, Burgess, Martin, McLeod, & Rosen, 1975). As a result, students who struggle with written expression may be less able to demonstrate their knowledge or understanding of a subject than their peers. In addition, written compositions and written responses to reading comprehension questions are often part of large-scale assessments such as the Education Quality and Accountability Office (EQAO, 2009) assessments for grade 3, 6 and 10 students in Ontario, the Foundation Skills Assessment for grade 4 and 7 students in British Columbia (British Columbia Ministry of Education, 2009), and the National Assessment of Educational Progress for grade 8 and 12 students in the United States (Salahu-Din, Persky, & Miller, 2008). Jenkins, Johnson, and Hileman (2004) demonstrated that written expression abilities account for unique increments of variance in performance on constructed response reading comprehension items, even after differences in word reading ability are accounted for. Therefore, students who struggle with written expression may not perform well on the writing portion of these assessments, and may not be able to demonstrate their understanding on the reading comprehension portions. This is particularly concerning given that, in some cases, successful completion of these assessments is required for high school graduation (e.g., EQAO, 2006).

Writing may also be used as a tool to facilitate and enhance students’ learning, helping them to construct and explain their own interpretations of a topic (Britton et al., 1975). For example, eighth grade students who engaged in analytical writing following a peer discussion
demonstrated greater retention of science knowledge than those who engaged in peer discussion alone (Rivard & Straw, 2000). Thus students with weak writing skills may not be able to benefit from writing as a tool to further their learning.

Written expression skills are equally important beyond elementary and high school. In a survey of 120 major American corporations, 86% of human resources directors stated that poorly written application materials would reduce the likelihood of their hiring a candidate. One respondent stated that applicants who submitted poorly written materials “would not be considered for any position” (National Commission on Writing, 2004, p. 10). In addition, more than half of all human resources directors surveyed took salaried employees’ writing skills into account when considering them for promotion (National Commission on Writing). While these findings may not generalize to all employers, they suggest that written expression skills can impact an individual’s success well beyond the elementary and high school years. Based on the potential consequences of poor writing skills in elementary and high school as well as in the workplace, it is important to identify factors associated with writing performance as well as practical assessment tools for the measurement of written expression skills that can inform instructional decisions for students who struggle with writing.

Writing: A Complex Task

Writing is a cognitively demanding task that requires the coordination of multiple sub-skills (McCutchen, 1996). Both adult (Flower & Hayes, 1981) and child (Berninger, Abbott, Whitaker, Sylvester, & Nolen, 1995) theoretical models of writing highlight the multitude of processes involved in written expression. These include lower-order (e.g., handwriting, spelling) and higher-order skills (e.g., planning, organizing), as well as cognitive factors such as memory (Berninger et al.; Flower & Hayes). To be successful, writers must generate ideas, plan (at sentence and text levels), select and spell appropriate words, form individual letters, monitor
their written output, and revise their work. Thus, good writers coordinate both lower- and higher-order writing skills simultaneously and interactively while composing a text (McCutchen, 1988).

Early models of writing such as Hayes and Flower’s (1980) accounted for the complexity of writing, proposing three major processes: (1) planning, which consists of the sub-processes of generating, organizing, and setting goals; (2) translating, which involves transforming material from memory into written sentences; and (3) reviewing, which consists of reading and editing. These processes are best thought of as mental activities that recur throughout the writing process rather than in a linear order (Flower & Hayes, 1981; Olive & Kellogg, 2002). In addition, the writing process occurs within the context of both the task environment and the writer’s long-term memory (Hayes & Flower). It is clear that writing is a complex and dynamic process that demands more than the simple mastery of discrete sub-skills. Indeed, Flower and Hayes describe writing as a process of managing a large number of demands simultaneously, and state that one in the act of writing is “on a full-time cognitive overload” (p.33).

While Hayes and Flower (1980) acknowledged the cognitive demands of writing, they only implied the role of cognitive processes in written expression and did not elaborate on this point. The complexity of written expression has lead to proposed modifications of Hayes and Flower’s model that account more precisely for the cognitive demands of writing (e.g., Berninger et al., 1995; Hayes, 1996; McCutchen, 1988; 1996). One commonly accepted theory posits that the coordination of the sub-skills of writing places a heavy burden on cognitive resources. This capacity theory of writing has been evident in the writing literature even from early research, beginning with Kahneman (1973) whose working theory of writing was of multiple processes competing for limited cognitive resources. The capacity theory of writing also states that automatizing lower-order writing skills, such as handwriting and spelling, to the point where
they no longer require conscious effort frees up cognitive resources for use in the higher-order processes of writing, such as planning and generating content (MacArthur & Graham, 1987). This automatization in turn facilitates the writing process and improves written output through the efficient allocation of cognitive resources.

The number of sub-skills and processes involved in written expression makes the assessment of this important academic skill complex. Moreover, students may struggle with many aspects of written expression. Therefore, teachers and other professionals working in the education system require tools that will provide them with useful information about children’s areas of strength and need in writing.

**Curriculum-Based Measurement**

Several standardized measures of spontaneous written expression exist for use with elementary school children, including the Test of Written Language – 4th Edition Contextual Conventions and Story Composition subtests (Hammill & Larsen, 2009), the Writing Samples subtest of the Woodcock Johnson Tests of Achievement – 3rd Edition (Woodcock, McGrew, & Mather, 2001), the Essay Composition subtest of the Wechsler Individual Achievement Test – 3rd Edition (Wechsler, 2009), and the Written Expression subtest of the Kaufman Test of Educational Achievement – 2nd Edition (Kaufman & Kaufman, 2005). While these measures allow the comparison of a student’s performance with a normative sample, some authors have suggested that curriculum-based measurement (CBM) may provide more useful information about students’ academic skills (Deno, 1985; Gansle, Noell, Van Der Heyden, Naquin, & Slider, 2002; Marston, 1989).

CBM consists of “a set of standard simple, short-duration fluency measures of reading, spelling, written expression, and mathematics computation” (Shinn & Bamonto, 1988, p. 1). Each individual measure is called a probe. The goal of CBM is to provide teachers in both
general and special education classrooms with information about student performance on which they can base instructional decisions (Deno, 1985). CBM can be used to monitor students’ progress through frequent administration of different probes at the same level of difficulty. In this way, students’ growth can be tracked by establishing a baseline and graphing subsequent results. This information can be particularly useful for determining whether or not an intervention or instructional strategy has been effective (Deno). Individual CBM probes can also be used to obtain a snapshot of students’ performance at a given point in time (Deno).

CBM provides teachers and others working in the education system with an objective measure of a student’s performance in a given area. First, teachers create or select CBM probes for use with their students based on the curriculum used in their class. They then administer this measure to the entire class and calculate the class mean for the scores generated. This allows the teacher to compare individual students to the class mean to gain a sense of whether they are performing above average, below average, or on par with their classmates (Deno, 1985). While this process is not standardized as are norm-referenced measures, it is a significant improvement on informal observation, which is the most common assessment method used by special education teachers to determine whether or not students are meeting instructional goals and grasping material taught in daily lessons (Fuchs, Fuchs, & Warren, 1982). Fuchs and colleagues’ study revealed some of the limitations of informal observation, including discrepancies between teachers’ judgments and students’ actual attainment of learning objectives, as measured by an independent observation of the student. Teachers were accurate in determining when students met objectives, but not when they failed to meet objectives. That is, teachers frequently stated that students had met objectives when they had not. This is particularly troubling as struggling students may not receive the support they need if teachers incorrectly believe they are meeting learning objectives. Thus the information provided by CBM represents an important objective
supplement to observation that can help teachers to identify students at risk for academic
difficulties and monitor students’ progress in critical academic skills.

Several characteristics of CBM make it particularly useful for implementation in the
classroom compared to standardized measures of academic skills. First, CBM is linked directly
to the curriculum in which students are being instructed as teachers can develop or select their
own measures (Deno, 1985; Jenkins, Deno, & Mirkin, 1979). In addition, administering these
measures to an entire class or an entire grade within a school provides useful information on how
individual students are progressing in the curriculum of interest relative to their classmates
(Deno). Thus the information CBM provides about a student’s performance or progress is both
practical and easily interpreted by parents and teachers (Deno).

In addition to its direct ties to the curriculum, CBM is more sensitive to small
improvements in student performance than are standardized measures (Jenkins et al., 1979).
Because the average scores on standardized assessments increase with successive months or
years, students cannot increase their scores unless they increase their performance relative to the
normative sample. Therefore, these measures are not likely to reveal growth in individual
students’ academic skills (Deno, 1985). This insensitivity to student progress can lead educators
to abandon an intervention that may be effective, or to continue an intervention that is not
working in the hopes of eventually seeing improvement (Deno). Curriculum-based measures can
also be administered more frequently than standardized measures (daily, weekly, monthly, or
annually) because of their short duration and the ability to create multiple equivalent forms,
which reduces the likelihood of practice effects (Jenkins et al.). Thus, CBM represents an
alternative to standardized assessments that is sensitive to short-term growth and that can inform
teachers’ instructional planning on a weekly or even daily basis (Deno).
Cost-effectiveness is also an important consideration in the public education system. Compared to standardized assessments, CBM is much more cost-effective in terms of both time and money. Curriculum-based measures take only a few minutes (1 to 5) to administer in comparison to standardized measures, which often take approximately one hour (Deno, 1985). In addition, CBM does not require the purchase of testing materials as teachers can develop or select their own curriculum-based measures (Deno). The cost-effectiveness of CBM makes it more accessible than standardized assessments as a means of assessing student performance and progress in the school system.

While CBM has many strengths, it also has some limitations. In particular, normative information is not available for most domains (although see Hasbrouck & Tindal, 2006 for oral reading fluency norms). Similarly, limited information is available regarding growth in children’s performance on these measures over time, particularly in written expression (e.g., McMaster & Campbell, 2008). Despite these limitations, CBM remains a useful assessment tool that provides objective information about children’s performance and allows for repeated measurement over time.

**CBM of written expression.** CBM of written expression generally involves the presentation of a writing probe (a picture, story prompt or a topic sentence) followed by a 1 minute period during which the student can plan his or her narrative, and 3 to 5 minutes of writing (McMaster & Espin, 2007). As noted above, the brevity of these writing samples facilitates their administration in the school system (Deno, 1985). Moreover, there is evidence that 3 and 5 minute samples demonstrate similar reliability and validity, suggesting that even very brief writing tasks provide useful information about students’ performance (Espin et al., 2000).
Curriculum-based measures of writing lend themselves to a variety of scoring methods, including production-dependent (scores that depend on how much the student writes), production-independent (scores that are independent of how much the student writes, such as percentages), and accurate-production indices (scores that assess fluency and accuracy simultaneously; Jewell & Malecki, 2005). The range of scores that can be generated from curriculum-based measures of writing makes them easily adaptable for use with students of different ages or for monitoring students’ progress in particular aspects of written expression (e.g., composition length or spelling accuracy).

Total words written is among the most widely used CBM scores. It is a production-dependent measure of compositional fluency determined by counting the number of words in the child’s composition regardless of spelling (Jewell & Malecki, 2005). While total words written is commonly used and easy to score, it measures fluency only, limiting its utility for the detection of difficulties in other aspects of written expression. Correct minus incorrect word sequences has been proposed as an additional score that provides rich information about children’s writing skills, particularly in the junior grades and beyond (Espin et al., 2000; Malecki & Jewell, 2003). Junior grade children’s correct minus incorrect word sequences scores correlate more strongly with performance on criterion measures of writing than do their total words written scores, although this difference is not significant in younger children (e.g., Jewell & Malecki). Therefore correct minus incorrect word sequences may be a more valid indicator of writing performance than total words written for older elementary school students. Correct minus incorrect word sequences is an accurate-production index of spelling and grammar that takes both accuracy and fluency into account and assesses basic mechanics of writing (Espin et al.). It is calculated by subtracting the number of incorrect word sequences from the number of correct word sequences. A correct word sequence is defined as “two adjacent writing units (i.e., word-
word or word-punctuation) that are acceptable within the context of what is written” (Jewell & Malecki, p. 32). For example, subject-verb agreement, capitalization, final punctuation, and spelling are taken into account when determining whether word sequences are correct (see Appendix A for detailed scoring criteria used in the present study). A correct minus incorrect word sequences score of 0 corresponds to 50% of the word sequences being written correctly, whereas a negative score indicates that more than half of the word sequences were written incorrectly. In contrast, high positive scores indicate the student performed well in terms of both writing productivity and spelling and grammatical accuracy. Therefore correct minus incorrect word sequences scores can be easily interpreted by both teachers and parents. Scoring CBM writing samples for both total words written and correct minus incorrect word sequences may provide richer information about children’s areas of strength and need in writing and help to identify more children at risk for writing difficulties than using either index alone.

The reliability of CBM of written expression has been established in terms of inter-scorer agreement, test-retest reliability, split-half reliability and alternate-form reliability. In general, inter-scorer agreement for CBM of writing is high ($r > .90$; see McMaster & Espin, 2007 for a review), and test-retest reliability correlations are modest to high with the highest correlations being reported for same day testing (McMaster & Espin). Split-half reliability coefficients within a single writing sample are also high ($rs = .96$ to $.99$; Marston & Deno, 1981), indicating that students’ performance does not differ across the duration of a single writing sample. Finally, alternate-form reliability coefficients have been reported as modest to high (McMaster & Espin). These findings indicate that the reliability of CBM of written expression is acceptable and provide further support for its utility as a measure of writing performance.

The validity of CBM as a measure of written expression has been established through multiple studies correlating CBM writing scores with criterion measures of writing. In general,
CBM scores are moderately to strongly correlated ($r$ = .67 to .88) with scores on the Test of Written Language (Hammill & Larsen, 1978; see McMaster & Espin, 2007 for a review) and with holistic ratings of composition quality made on a four-point scale ($r$ = .69 to .85; Espin et al., 2000; Espin et al., 2005). These correlations do not differ across CBM writing probe types (story prompt vs. topic sentence vs. picture stimulus), grade levels (third through sixth grade), or time to write (3 minutes vs. 5 minutes; see McMaster & Espin for a review). Fewster and MacMillan (2002) also examined whether students’ CBM scores in grades 6 and 7 predicted their grade 8, 9, and 10 grades in English and Social Studies, two of the most reading- and writing-intensive courses (Fewster & MacMillan). Using multiple linear regression, they determined that CBM of written expression scores reliably predicted students’ English and Social Studies grades (medium effect size) as well as their membership in special education or remedial support classes versus general education or honours classes. Thus CBM represents a valid and promising method of assessing written expression in elementary and middle school children that is sufficiently sensitive to identify students who may be at risk for later academic difficulties.

In summary, CBM is a useful assessment tool that can provide information about students’ strengths and weaknesses and growth in written expression, which can be used to inform instructional planning for individual students. The reliability and validity of CBM as a means of assessing written expression in elementary and middle school children has been established. However, two areas of research that remain to be explored further are the usual trajectories of growth in written expression over time (weekly, monthly, annually), and the factors that predict performance on these brief tasks. The present study focuses on the latter question in order to inform assessment using CBM of written expression as well as instructional planning based on CBM data.
Potential Predictors of Performance on CBM of Written Expression

Given the multiple sub-skills and processes involved in written expression, it is not surprising that many factors contribute to the prediction of writing performance (Abbott & Berninger, 1993; Abbott, Berninger, & Fayol, 2010; Olinghouse, 2008). It is important to consider the role of both cognitive and academic skills, as well as variables such as grade and gender in explaining writing performance. In addition, it is important to consider multiple predictors simultaneously due to the complexity of written expression (Olinghouse).

Grade and gender. The only studies to date examining predictors of performance on CBM of written expression have examined age and gender differences (Jewell & Malecki, 2005; Malecki & Jewell, 2003). Developmental differences in written expression have been reported consistently across studies of elementary school children. On average, older students write longer (Berninger & Fuller, 1992; Jewell & Malecki; Malecki & Jewell; Swanson & Berninger, 1996) and higher quality compositions, based on content and organization (Swanson & Berninger), than students one or two grades younger. These differences are significant within primary (grades 1 to 3; Berninger & Fuller) and junior divisions (grades 4 to 6; Swanson & Berninger). Older students also earn higher correct minus incorrect word sequences scores than younger students (Jewell & Malecki; Malecki & Jewell). Therefore, grade level is an important consideration in the assessment of writing abilities, with as little as one grade level difference between students being associated with differences in performance across both mechanical and higher order aspects of written expression (e.g., Berninger & Fuller).

Gender differences in writing performance have also been reported across studies of elementary school students, including studies using CBM tasks (Jewell & Malecki, 2005; Malecki & Jewell, 2003). Girls generally write longer compositions than boys (Berninger, Whitaker, Feng, Swanson, & Abbott, 1996; Jewell & Malecki; Malecki & Jewell; Olinghouse,
and their compositions are rated higher in overall quality (Ma & Klinger, 2000; Olinghouse; Swanson & Berninger; although see Berninger et al., for an exception). However, available evidence is mixed regarding gender differences in correct minus incorrect word sequences scores (Jewell & Malecki; Malecki & Jewell). One study using a large sample of children reported that girls earn higher correct minus incorrect word sequences scores than boys, and that these differences are more apparent in junior and senior grade students than in primary grade students (Malecki & Jewell). Thus there is evidence that girls outperform boys in some aspects of written expression. However, it is not clear whether these gender differences are consistent across metrics of writing proficiency (i.e., compositional fluency, spelling and grammatical accurate production, composition quality).

**Transcription skills.** Transcription skills, sometimes referred to as “mechanics of writing” (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997) are an important component of written expression (Berninger, 2000a). Handwriting is one aspect of transcription that is particularly important to writing proficiency, especially in terms of productivity-based outcomes (Graham & Harris, 2000). In both primary and junior grades, students’ ability to write quickly and accurately, as measured by alphabet writing and/or paragraph copying tasks, is a significant predictor of their compositional fluency, and overall composition quality relative to their grade level (Berninger, Cartwright, Yates, Swanson, & Abbott, 1994; Graham et al.). This is in line with the capacity theory of writing in that children whose handwriting is automatic (i.e., requiring little conscious effort) may be able to write longer and higher quality compositions than children for whom handwriting is more demanding. However, Olinghouse (2008) suggested that the association between handwriting fluency and composition quality may be indirect through their shared relationship with compositional fluency. In Olinghouse’s study, children were given 5 minutes to plan their compositions and 15 minutes to write a narrative
based on a picture prompt. Composition quality was rated holistically on a seven-point scale, while compositional fluency was defined as the total number of words written in 15 minutes regardless of spelling. Children also completed a copying task which was used as a measure of handwriting fluency. Although handwriting fluency and compositional fluency were both significant predictors of composition quality when examined separately, when both were examined simultaneously (along with other variables), only compositional fluency predicted composition quality. Therefore, further research is necessary in order to draw conclusions about the association between handwriting and composition quality. I did not locate any studies that examined handwriting as a predictor of correct minus incorrect word sequences or other measures of in-text spelling and grammatical accuracy, but the covariance between handwriting fluency and spelling ability is significant in junior grade students (Graham et al.). However, handwriting and spelling are individual skills that can develop independently (Berninger). Thus, handwriting may be predictive of children’s correct minus incorrect word sequences scores, which measure in-text spelling and grammatical accuracy.

Overall, existing research underscores the importance of assessing children’s handwriting fluency alongside outcome variables such as compositional fluency and quality in order to draw accurate conclusions about children’s written expression skills.

**Reading proficiency.** Although reading and writing are distinct skills (Berninger, Abbott, Abbott, Graham, & Richards, 2002), their close association has been well-established (e.g., Abbott & Berninger, 1993; Abbott et al., 2010; Woodfin, 1968). While I did not locate any studies that examined the relationship between reading proficiency and performance on CBM of written expression, research using other measures of writing suggests that reading proficiency is likely to play a role in performance on these tasks. For example, Woodfin found that, along with language scores, reading ability was the best consistent predictor of writing skill in third grade
children. Studies of clinical populations also support the link between reading ability and writing proficiency. When children with expressive language delays were followed longitudinally, their composite reading scores (word reading and reading comprehension) at age 8 significantly predicted their composite writing scores at age 13 (Rescorla, 2005). Therefore there is evidence of shared processes in reading and writing (see Fitzgerald & Shanahan, 2000 for a review) in both clinical and non-clinical populations.

Reading proficiency has been examined as a potential predictor of performance across levels of written expression abilities, and findings differ depending on the writing outcome measured. For example, although reading proficiency is related to children’s compositional fluency (i.e., total words written), this relationship appears to be indirect in junior grade students (Abbott & Berninger, 1993). Using structural equation modeling, Abbott and Berninger found that the path between a general reading ability factor (reading comprehension and word and pseudoword reading accuracy) and compositional fluency was significant in primary grade students, but not in junior grade students. However, Berninger and colleagues (2002) found that reading proficiency was a significant predictor of handwriting skills in both primary and junior grade students. Therefore, the contribution of reading proficiency to total words written scores may be indirect through its relationship to handwriting fluency.

Evidence from studies using other measures of in-text spelling and/or grammatical accuracy suggests that reading proficiency is likely to be predictive of children’s correct minus incorrect word sequences scores (Berninger et al., 2002; Mäki, Voeten, Vauras, & Poskiparta, 2001; Wakely, Hooper, de Kruif & Swartz, 2006). In a large sample of unreferred primary and junior grade children, scores on a cloze task measuring reading comprehension exerted a direct, significant influence on in-text spelling accuracy, regardless of grade level (Berninger et al.). Along these lines, Wakely and colleagues found that and grade 4 and 5 students who made the
highest percentage of spelling errors in their narrative compositions were also those with the weakest reading comprehension scores. Finally, in a sample of Finnish-speaking children, second grade students’ ability to decide quickly whether a word was a real word or a pseudoword predicted their in-text spelling, capitalization, and punctuation scores in the third grade (Mäki et al.). While this latter finding must be interpreted with caution because Finnish is a more orthographically regular language than English, the overall evidence suggests that reading proficiency supports children’s compositional spelling and grammatical accuracy, and therefore is also likely to be associated with their correct minus incorrect word sequences scores.

Reading proficiency is also an important predictor of junior grade children’s composition quality (Abbott & Berninger, 1993). Berninger and colleagues (2002) found that children’s scores on a cloze task measuring reading comprehension exerted a direct influence on their overall composition quality scores. Moreover, children classified as poor readers in the first grade are more likely than their peers to become poor writers by the fourth grade (scoring 3 or less on a 9-point holistic quality rating scale; Juel, 1988). Specifically, 68% of children classified as poor readers were also poor writers by the time they reached fourth grade, whereas only about 14% of children classified as good readers were classified as poor writers in the fourth grade (Juel). Overall, existing studies provide evidence of a robust relationship between reading proficiency and the quality of students’ written compositions.

Reading proficiency is an important predictor of children’s performance on writing tasks that has yet to be examined in relation to CBM of written expression. It is important to determine whether reading proficiency is associated with performance on CBM of written expression as children who perform poorly on measures of reading ability may also struggle with aspects of written expression.
Working memory. Working memory is a central construct of cognitive psychology (Shah & Miyake, 1999). While multiple conceptions exist (Shah & Miyake), it is generally agreed that working memory designates “the monitoring, processing, and maintenance of information” during on-line cognition (Baddeley & Logie, 1999, p. 28).

Working memory is an important component of cognitive models of writing (Berninger et al., 1995; Hayes, 1996) that is necessary for the coordination of the many sub-skills involved in written expression. Writers must simultaneously generate ideas, plan (at sentence and text levels), select and spell appropriate words, form individual letters, monitor their written output, and revise their work. Therefore, written expression taxes working memory resources through its need for the simultaneous processing and storage of information during the coordination of these sub-processes (McCutchen, 1996; Swanson & Berninger, 1996).

While relationships between both verbal and nonverbal working memory and written expression have been investigated, stronger associations have been found between verbal working memory and writing than between nonverbal working memory and writing (e.g., Berninger et al., 1994). Berninger and colleagues examined the written expression skills of grade 4, 5, and 6 children using one narrative and one expository writing sample, each completed in 5 minutes. Composition quality was measured on a five-point scale (1 = considerably below grade level; 5 = considerably above grade level). They found that verbal working memory contributed significant and unique variance to compositional fluency (i.e., total words written) and quality. Similarly, in a sample of primary-grade children, verbal working memory was a significant predictor of composition coherence, an aspect of composition quality (Bourke & Adams, 2003). Verbal working memory also predicts narrative composition fluency and quality (measured on the same 5-point scale used by Berninger and colleagues) above and beyond the variance accounted for by reading in grade 4, 5 and 6 students (Swanson & Berninger, 1996).
This indicates that working memory is a unique predictor of writing performance rather than it contributing indirectly to writing through its association with reading proficiency. Although no studies were located that examined the relationship between working memory and in-text spelling and grammatical accuracy, verbal working memory predicts children’s single-word spelling accuracy (Jongejan, Verhoeven, & Siegel, 2007), and evidence from experimental studies with adults supports the role of verbal working memory in grammatical accuracy (Fayol, Largy & Lemaire, 1994). Therefore working memory appears to play a role in both the mechanical and higher order aspects of the writing process.

**Summary and Research Question**

There is substantial evidence that curriculum-based measures are reliable and valid indicators of written expression in elementary school children. In particular, correct minus incorrect word sequences, an accurate-production indicator of writing proficiency, may be more valid than total words written for the assessment of junior grade students’ written expression (e.g., Jewell & Malecki, 2005). However, little is known about the factors that predict performance on the scores that can be derived from these brief tasks. Existing research suggests that grade, gender, handwriting, reading proficiency, and verbal working memory are associated with written expression abilities. The present study explores which variables among grade, gender, reading proficiency, handwriting automaticity, and verbal working memory, are unique predictors of children’s total words written and correct minus incorrect word sequences scores. In order to provide a basis for comparison, I also examined the same variables (with the exception of grade) as potential predictors of holistic composition quality, a widely used indicator of written expression abilities.
Organization of Thesis

Chapter 2 contains a manuscript written and submitted for publication that includes the methods and results sections of my Master’s thesis. It also includes a brief introduction that summarizes the key background information from Chapter 1, as well as a brief discussion of the results and their implications. Chapter 3 presents an extended version of this discussion that is broader and more in-depth than the discussion included in Chapter 2.
Abstract

This study examined the role of gender, handwriting automaticity, reading proficiency, and verbal working memory in grade 4 and 5 students’ ($N = 42$; 23 boys) performance on a curriculum-based measure of narrative writing. Three outcomes were measured: total words written, correct minus incorrect word sequences (accurate-production of spelling and grammar in-text), and composition quality. Scores on the objective curriculum-based measurement indices were moderately correlated with the holistic quality score. Gender (girls > boys) and handwriting automaticity were significant predictors of total words written. Gender (girls > boys), reading proficiency, and grade (5 > 4) significantly predicted correct minus incorrect word sequences scores. The only significant predictor of composition quality was total words written. These findings suggest that it is important to consider handwriting automaticity in the assessment of children’s writing abilities and in planning instruction for children with writing difficulties.
Exploring Predictors of Performance on a Curriculum-Based Measure of Written Expression

Writing is a multifaceted task that requires the coordination of several sub-skills and processes (Graham & Harris, 2000). Developmental models of writing highlight the contributions of lower-order (e.g., handwriting, spelling) and higher-order skills (e.g., planning, organizing), as well as cognitive factors such as memory (Berninger, Abbott, Whitaker, Sylvester, & Nolen, 1995; Flower & Hayes, 1981). The complexity of written expression means that it is possible for students to struggle with the task due to difficulties with one or several of the sub-skills and processes implicated. This is particularly concerning as writing skills are important to individuals’ success in school, in the workplace, and in their daily lives (see Graham & Perin, 2007 for a review). At school, in-class and large-scale assessments often require children to communicate their ideas in writing (e.g., British Columbia Ministry of Education, 2009; Britton, Burgess, Martin, McLeod, & Rosen, 1975; Education Quality and Accountability Office, 2009; Jenkins, Johnson, & Hileman, 2004). Children who struggle with writing may not be able to convey their knowledge and ideas adequately in written form and thus perform poorly on these assessments, resulting in low grades (Graham, 2006). Writing is also often used to facilitate students’ learning (e.g., Britton et al.; Rivard & Straw, 2000). Students with weak writing skills may not derive the same benefits from learning activities that require writing (e.g., journals) as their peers (Graham & Perin). Written expression skills are equally important in the workplace, and can impact an individual’s ability to secure a job and earn promotions (National Commission on Writing, 2004). Writing difficulties may even impact individuals’ social participation in daily life as writing is increasingly required for communication through text messaging and email (Graham & Harris, 2011). Given the importance of written expression skills, reliable, valid, and easy to administer assessment tools
are essential in order to identify students at risk for writing difficulties (McMaster & Espin, 2007).

**Curriculum-Based Measurement of Written Expression**

Although standardized measures provide norm-referenced information about achievement, curriculum-based measurement (CBM) may provide more useful information about the development of skills such as writing because it is directly tied to the curriculum in which students are instructed, and is more sensitive to small improvements in performance (Deno, 1985; Gansle, Noell, Van Der Heyden, Naquin, & Slider, 2002; Marston, 1989). CBM consists of “a set of standard simple, short-duration fluency measures of reading, spelling, written expression, and mathematics computation” (Shinn & Bamonto, 1988, p. 1). It can be used to monitor students’ progress through frequent administration of different probes at the same level of difficulty or as a screening tool to identify children at risk for learning difficulties (Deno; McMaster & Espin, 2007).

CBM of written expression involves the presentation of a picture, story prompt or topic sentence followed by 1 minute to plan and 3 to 5 minutes to write (McMaster & Espin, 2007). The brevity of these measures facilitates their administration in the school system, particularly when repeated measurement is to be used (Deno, 1985). Students’ compositions can be scored for multiple indices to assess various aspects of writing performance. *Total words written* (TWW) is among the most widely used CBM scores (Gansle et al., 2002). It is a measure of compositional fluency determined by counting the number of words in the child’s composition regardless of spelling (Jewell & Malecki, 2005). While TWW is commonly used and easy to score, it measures fluency only, limiting its sensitivity to difficulties in other aspects of writing. *Correct minus incorrect word sequences* (CMIWS) is an additional CBM index that provides richer information about children’s writing skills than TWW, particularly in the junior grades.
and beyond (Espin et al., 2000; Malecki & Jewell, 2003). There is also evidence that CMIWS scores are a more valid indicator of writing proficiency than TWW in the junior grades (Jewell & Malecki). CMIWS is an “accurate-production” (Jewell & Malecki, p. 27) index of spelling and grammar that takes fluency into account as well as accuracy of basic mechanics of writing (e.g., spelling, capitalization, punctuation; Espin et al.). It is calculated by subtracting the number of incorrect word sequences from the number of correct word sequences. A correct word sequence is defined as “two adjacent writing units (i.e., word-word or word-punctuation) that are acceptable within the context of what is written” (Jewell & Malecki, p. 32; see Powell-Smith & Shinn, 2004 for training materials for CBM scoring). Scoring CBM writing samples for TWW and CMIWS may provide more complete information about children’s areas of strength and need in written expression than using either index alone.

The reliability and validity of various CBM indices of written expression have been established across multiple studies (see McMaster & Espin, 2007 for a review). These studies have found high inter-scorer agreement and split-half reliability coefficients, and modest to high test-retest correlations and alternate-form reliability (Marston & Deno, 1981; McMaster & Espin). In addition, CBM scores are moderately to strongly correlated ($r_s = .67$ to $0.88$) with scores on the Test of Written Language (Hammill & Larsen, 1978; see McMaster & Espin for a review) and with holistic ratings of composition quality made on a four-point scale ($r_s = .69$ to $0.85$; Espin et al., 2000; Espin, De La Paz, Scierka, & Roelofs, 2005). CBM scores also predict academic achievement in high school English and Social Studies, two of the most reading- and writing-intensive courses (Fewster & MacMillan, 2002). However, little research has examined the relationship between children’s performance on CBM scoring indices and student characteristics known to be associated with writing performance. The majority of existing studies have explored gender and age differences (Jewell & Malecki, 2005; Malecki & Jewell,
On average, older students earn higher TWW and CMIWS scores than younger students (Jewell & Malecki; Malecki & Jewell). Gender differences in CBM writing performance have also been reported in elementary school students. Girls generally score higher than boys on TWW and other measures of compositional fluency (e.g., Jewell & Malecki; Malecki & Jewell). Available evidence is mixed regarding whether or not boys and girls differ on CMIWS scores (Jewell & Malecki; Malecki & Jewell). Malecki and Jewell reported that boys performed more poorly than girls on CMIWS and these differences were more apparent in junior and senior grade students than in primary students. In a subsequent study by Jewell and Malecki, however, gender differences were limited to those CBM indices that assessed fluency (e.g., TWW).

In the present study we explored whether handwriting automaticity, word-level reading skills, and working memory were associated with grade 4 and 5 children’s scores on two CBM indices: TWW and CMIWS. We also examined whether these same variables were predictive of composition quality, a commonly used measure of writing proficiency (e.g., Juel, 1988; Ma & Klinger, 2000; Olinghouse & Graham, 2009). Whereas TWW and CMIWS primarily measure the mechanics of writing, the quality scores capture higher order aspects of narrative writing, including organization, story development, word choice, and coherence. Both TWW and CMIWS scores are correlated with composition quality (e.g., Jewell & Malecki, 2005), and several existing studies have examined predictors of composition quality (e.g., Olinghouse, 2008; Swanson & Berninger, 1996). However, we did not locate any studies that concurrently examined the factors (aside from age and gender) associated with performance on CBM indices and a holistic measure of composition quality. Our goal was to acquire a better understanding of those factors that are associated with children’s scores on these three measures of written expression. This paper responds to the North American context in which there is an emphasis on progress monitoring (the use of performance data gathered through repeated measurement over
time to inform instructional decisions; Safer & Fleischman, 2005) using CBM. However, the findings may also be of interest to international audiences as indices similar to those associated with CBM are often used as indicators of writing ability (e.g., Berninger, Cartwright, Yates, Swanson, & Abbott, 1994; Mäki, Voeten, Vauras, & Poskiparta, 2001). Moreover, the results will be useful for those who wish to begin using CBM in research or practice. Below we briefly review the research examining the contribution of handwriting fluency, working memory, and reading ability to objective and holistic measures of written expression.

Transcription skills are an important component of written expression (Berninger, 2000a), and handwriting fluency is particularly important in terms of productivity-based outcomes (Graham & Harris, 2000). Students’ ability to write quickly and accurately is associated with their compositional fluency and quality (Berninger et al., 1994; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). However, the association between handwriting fluency and composition quality may be indirect through their shared relationship with compositional fluency (Olinghouse, 2008). In Olinghouse’s study of grade 3 children, compositional fluency (i.e., TWW) and handwriting fluency were significant predictors of holistic composition quality (rated on a seven-point scale) when examined separately. However, when both were examined simultaneously, only compositional fluency predicted composition quality. Although we did not locate any studies of handwriting fluency as a predictor of CMIWS, handwriting fluency is associated with spelling ability in junior grade students (Graham et al.). Thus, handwriting automaticity may predict children’s CMIWS scores, which measure in-text spelling and grammatical accuracy.

Working memory has been identified as an important component of cognitive models of writing (Berninger et al., 1995; Hayes, 1996). Children’s working memory capacity is often examined with tasks that require the concurrent maintenance and processing of information
Working memory is important to written expression because writers must simultaneously generate ideas, plan, select and spell appropriate words, form individual letters, monitor their written output, and revise their work as necessary (McCutchen, 1996; Swanson & Berninger, 1996). Indeed, verbal working memory predicts compositional fluency and quality even after differences in reading ability have been accounted for (Berninger et al., 1994; Bourke & Adams, 2003; Swanson & Berninger). Although we did not find any studies that examined the relationship between working memory and CMIWS, prior research has documented an association between verbal working memory and children’s single-word spelling (Jongejan, Verhoeven, & Siegel, 2007). In addition, children with poor working memory exhibit weaknesses in monitoring their work for errors (Gathercole et al., 2008). Hence, children with poor working memory may perform more poorly than their peers on the CMIWS index because it also assesses their accuracy with writing conventions (e.g., punctuation, capitalization).

Although reading and writing are discrete skills (Berninger, Abbott, Abbott, Graham, & Richards, 2002), their close association is well-established (e.g., Abbott & Berninger, 1993; Abbott, Berninger, & Fayol, 2010). We did not locate any studies that examined the role of reading ability in children’s performance on CBM of written expression, but evidence from studies using other writing measures indicates that reading skills (e.g., word reading, passage comprehension) predict the quality of children’s narrative compositions (e.g., Berninger et al.; Olinghouse, 2008). In addition, word reading and reading comprehension scores are associated with in-text spelling and grammatical accuracy (Berninger et al.; Mäki et al., 2001; Wakely, Hooper, de Kruif & Swartz, 2006). Word and text-level reading proficiency do not exert a direct relationship on older elementary students’ compositional fluency (Abbott & Berninger; Berninger et al.; Olinghouse). However, word reading proficiency is related to children’s
handwriting fluency (Berninger et al.; Olinghouse) and working memory (e.g., Jongejan et al., 2007; Gottardo, Stanovich, & Siegel, 1996), which may in turn constrain their performance on productivity-based measures such as TWW. Therefore, children who are poor readers are likely to score lower than their peers on measures of composition quality and CMIWS, but the contribution of reading proficiency to TWW scores may not be independent of the contribution of handwriting fluency or working memory.

**Summary and Research Question**

The main objective of the study was to assess the joint contribution of several student-level predictors to children’s scores on the CBM writing indices and the measure of composition quality. Given the complexity of written expression, it is important to examine multiple predictors as potentially contributing to performance on writing tasks (Olinghouse, 2008). Therefore, in this exploratory study, we addressed the following research question: Which variables, among grade, gender, handwriting automaticity, verbal working memory, and reading proficiency, are the best predictors of children’s scores on a holistic measure of composition quality and two CBM indices: TWW and CMIWS?

**Method**

**Participants**

Data were collected from two cohorts (N = 45) of grade 4 and 5 students as part of a battery of reading, writing, and cognitive measures. Participants were recruited from two schools through a letter sent home with each student in the participating classrooms. Written consent was obtained from parents or guardians, and participants provided informed assent. Students with a parent-reported diagnosis of a learning disability or attention-deficit hyperactivity disorder (ADHD) were not excluded, and stimulant medication was not discontinued for students with ADHD. Data collection was completed in December and January.
by trained graduate students in an urban private school (cohort 1; \( n = 23 \)) and a suburban public school (cohort 2; \( n = 22 \)). Cohort 1 was completed one year before cohort 2.

**Measures**

**Handwriting automaticity.** Participants completed the Alphabet Writing task from the Process Assessment of the Learner Test Battery for Reading and Writing (Berninger, 2000b). They were asked to print the lowercase letters of the alphabet in order as quickly and neatly as possible. In preliminary analyses, total time to write the alphabet was more closely associated with the writing outcomes than the number of letters written correctly in 15 seconds (the original scores generated for the Alphabet Writing task, based on criteria outlined in the test manual; Berninger). For this reason, and because handwriting fluency is more closely related to writing proficiency than is handwriting quality (Graham et al., 1997), we used the total time scores as an independent variable (multiplied by -1 to facilitate interpretation).

**Reading proficiency.** The Sight Word Efficiency and Phonetic Decoding Efficiency subtests of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999) were administered. Participants read a list of words and a list of pseudowords of increasing difficulty as quickly as possible. The raw score for each subtest is the number of words read correctly in 45 seconds. The test-retest reliability of the TOWRE ranges from .82 to .97 and its validity has been established through correlation with criterion measures (Torgesen et al.). Scores on the TOWRE also correlate highly with performance on reading comprehension tasks (Torgesen et al.), and it has been used as an indicator of reading proficiency in previous studies of writing in elementary students (e.g., Olinghouse & Graham, 2009). Because scores on the Sight Word Efficiency and Phonetic Decoding Efficiency subtests were highly correlated in our sample \( (r = .84) \), we converted participants’ raw scores on these subtests to \( z \) scores and averaged them to create a reading proficiency score.
**Working memory.** A computerized, object version of the Self-Ordered Pointing Task (Petrides & Milner, 1982) was used to measure verbal working memory. The task is a revised version of that used by Cragg and Nation (2007) to measure working memory in 5 to 11 year old children. The Self-Ordered Pointing Task measures verbal working memory using common, nameable objects (Joseph, Steele, Meyer, & Tager-Flusberg, 2005) and requires participants to update verbal information and inhibit previous responses (Petrides & Milner). Prior research suggests that vocabulary does not play a role in performance on this task (Cragg & Nation); therefore, scores do not appear to be confounded with language ability (Cragg & Nation).

Participants were seated approximately 40 centimetres from the screen of a laptop computer and completed a practice trial to ensure they understood the task. For each level, an array of pictures was presented on the screen. They completed four levels of 4, 6, 8, and 10 picture stimuli in cohort 1, and four levels of 6, 8, 10, and 12 picture stimuli in cohort 2. Participants completed two trials at each level, beginning with the 4-stimuli level in cohort 1 and with the 6-stimuli level in cohort 2. They were instructed to click on a different picture on each presentation using the computer mouse, and not to click on the same picture twice. The placement of the pictures changed with each presentation, and the number of presentations per level corresponds to the number of pictures. The pictures were not aligned to a grid to eliminate the possibility of receiving a high score by continuously clicking on the same location (Cragg & Nation, 2007). Scores were the total number of errors across all trials at the 6-, 8- and 10-stimuli levels as the total error score has demonstrated high test-retest reliability (Ross, Hanouskova, Giarla, Calhoun & Tucker, 2007), and data for both cohorts were available at these levels. We multiplied these scores by -1 to facilitate interpretation. Accuracy on the practice trial was high, with 76% of children making no errors. Therefore, participants did not appear to have difficulty understanding the task or using the computer mouse. There was no significant difference
between cohort 1 ($M = 5.33$, $SD = 3.51$) and cohort 2 ($M = 5.95$, $SD = 3.20$) on the total error score, $t(40) = -.60$, $p > .05$.

**CBM of written expression.** A curriculum-based measure of narrative writing was administered to small groups of students. Participants wrote a composition in response to the writing probe, “I was so surprised when I woke up this morning and looked out my window. I saw...” They were each given a blank sheet of paper and a pencil with an eraser and were told they were going to write a story. The tester read the writing probe to the participants, who were given 2 minutes to think about the writing probe and make notes on a blank paper. Two minutes of planning time were allowed rather than the usual one minute in order to examine differences in planning abilities and how these may predict writing performance. However, planning scores were not correlated with any writing outcomes in preliminary analyses (all $ps > .10$). Therefore it is unlikely that the additional time impacted children’s performance on the writing task.

Following the planning time, participants were asked to begin writing their stories on a lined paper with the writing probe typed at the top. They were told to do their best work and to guess if they were not sure how to spell a word. Participants were allowed 5 minutes to write. This time limit was chosen as we believed it would be more appropriate than 3 minutes given the age of the students. However, we also wanted to maintain the brevity of the CBM task. Evidence from previous studies suggests that 3 and 5 minute writing samples demonstrate similar reliability and validity (Espin et al., 2000).

The first author scored the narratives for TWW and CMIWS. Forty percent of the narratives were randomly selected and independently scored by a trained graduate student to obtain inter-rater agreement, which was acceptably high for both indices (intraclass correlation coefficients of .99 for both TWW and correct word sequences, which was used to calculate CMIWS scores). Composition quality was scored on a 7-point scale ($1 = $considerably below
grade expectations; 7 = considerably above grade expectations). Before scoring, each narrative was typed and corrected for spelling and grammatical errors (following Graham et al., 1997; Olinghouse, 2008), as handwriting, and spelling and grammatical errors can impact quality ratings (Marshall & Powers, 1969). A graduate student in a pre-service teacher education program with experience in junior grade classrooms completed the quality scoring. The rater selected anchor papers representative of the values of 1 and 7 on the rating scale for each grade, and then scored the remaining writing samples. The first author then independently scored the narratives using the same anchors, and final quality scores were determined by averaging the scores given by the two raters (following Graham et al.; Swanson & Berninger, 1996). Inter-rater agreement (.73, $r = .53$) was comparable to that reported in similar studies (e.g., Berninger et al., 1994; Swanson & Berninger).

**Data Analysis**

Before analysing data, we examined histograms and skewness and kurtosis statistics. The skewness statistic for handwriting automaticity was elevated ($z = 3.42$). However, we used the raw scores because predictor variables do not need to be normally distributed (Field, 2009). Alpha was set to .05 for all analyses.

To account for potential differences between cohorts, univariate analyses of variance were carried out comparing the two groups on TWW, CMIWS, and composition quality. Because no significant differences were found (all $p$s > .05), we combined the data from the two cohorts for the remaining analyses.

Data were then analysed in two stages. We first conducted a series of preliminary partial correlation analyses to determine the predictor variables most strongly associated with TWW, CMIWS, and composition quality. The correlation of each dependent variable with each predictor of interest was examined, covarying the remaining predictors of interest. In order to
maximize power given the relatively small sample size, we then used the three variables most strongly correlated with the given dependent variable in the partial correlations as predictors in the regression analysis to determine which predictors accounted for significant amounts of unique variance in each writing outcome.

**Results**

**Sample Characteristics**

We restricted the analyses to participants for whom data for all measures were available. One participant was unable to complete the measures, and data for the handwriting task were missing for two participants, resulting in a final sample of 42 (n = 21 for each cohort and each grade; cohort 1 = 12 boys; cohort 2 = 11 boys; mean age = 10.05 years). Ninety percent of the participants spoke English at home. Eight participants had one or more parent-reported diagnoses: 6 were diagnosed with ADHD, 6 with a learning disability, and 2 with an emotional behavioural disorder. Descriptive statistics and correlations are reported in Table 1.

**Preliminary Analysis**

The results of the partial correlations appear in Table 2. Handwriting automaticity, gender, and grade were most strongly correlated with TWW. Gender, reading proficiency, and grade were most strongly correlated with CMIWS scores (although handwriting automaticity was also significantly correlated with CMIWS). TWW, reading proficiency, and working memory correlated most strongly with composition quality. These variables were selected as the independent variables for the multiple regression analyses predicting each writing outcome.

**Multiple Regression Analyses**

The results of the multiple regression analyses are presented in Table 3. In the regression analysis for TWW, one influential case was identified (standardized residual > 2.5) which was an outlier in the partial plot for reading proficiency. We excluded the case from this analysis and
reran the partial correlations excluding this participant (the coefficients from this analysis are reported in Table 2). The final regression model accounted for 37% of the variance in TWW. Handwriting automaticity was a significant, unique predictor of TWW, and girls wrote longer compositions than boys. In the second regression analysis the model accounted for 50% of the variance in CMIWS. Grade 5 students scored higher than grade 4 students, and girls scored higher than boys. Reading proficiency was also a significant, unique predictor of CMIWS. Finally, TWW, reading proficiency, and working memory together accounted for 38% of the variance in composition quality. However, the only significant predictor of composition quality was TWW.

**Discussion**

Our results provide preliminary information about the contribution of grade, gender, handwriting automaticity, verbal working memory, and reading proficiency to upper elementary school children’s performance on objective and holistic measures of written expression. TWW, a measure of compositional fluency, was predicted by gender (girls > boys) and handwriting automaticity. CMIWS scores, which measure spelling and grammatical accurate-production, were predicted by grade (5 > 4), gender (girls > boys), and reading proficiency. Finally, holistic composition quality was predicted by TWW only, a measure of compositional fluency. Below we discuss the predictors of each writing outcome, limitations of the current study, and implications for practice.

**TWW.** In previous studies, handwriting fluency (speed and accuracy of handwriting) has explained significant increments of variance in compositional fluency (i.e., TWW; Berninger et al., 1994; Graham et al., 1997). Our results suggest that handwriting automaticity, independent of accuracy, is associated with the length of grade 4 and 5 students’ compositions as measured by TWW. Prior research has also reported gender differences favouring girls on the TWW index
Our findings show that these gender differences in writing productivity are not explained by differences in handwriting automaticity. Further research is necessary to understand what individual difference variables account for gender differences in TWW scores.

In the present study, TWW scores were not sensitive to grade level differences. It is possible that this lack of grade level differences reflects the lower validity of TWW as an indicator of writing proficiency in junior grade students relative to other measures such as CMIWS (Jewell & Malecki, 2005). Based on the preliminary partial correlation analyses we can hypothesize that reading proficiency and verbal working memory would not have predicted TWW scores in the regression analyses because they were not significantly correlated with TWW in the partial correlation analyses. This is in line with previous research which has found that reading proficiency is not a direct predictor of compositional fluency for junior grade students (Abbott & Berninger, 1993). However, previous studies support the role of verbal working memory in compositional fluency (e.g., Berninger et al., 1994; Swanson & Berninger, 1996), a finding that was not replicated in the present study. These discrepant findings may be due to differences in the demands of the verbal working memory tasks. Our measure of verbal working memory, the Self-Ordered Pointing Task, requires individuals to update verbal information in memory frequently (Petrides & Milner, 1982), whereas the tasks used in other studies required individuals to maintain and process verbal information concurrently (Berninger et al.; Swanson & Berninger). Future studies using both processing and updating verbal working memory tasks as well as experimental manipulations of verbal working memory load during writing (see McCutchen, 2000 for a review) are necessary in order to understand the association between children’s verbal working memory and writing proficiency.

CMIWS. Consistent with prior research with elementary school children (Malecki &
Jewell, 2003), girls scored higher than boys on CMIWS, the CBM index that assesses in-text spelling and grammatical accurate production, independent of reading proficiency. Similar gender differences have been reported for measures of single-word spelling from dictation, proofreading, and in-text spelling and grammar (Allred, 1990; Mäki et al., 2001; Swanson & Berninger, 1996). CMIWS scores were sensitive to grade level differences of only one year, providing further evidence of their validity as an indicator of writing proficiency for older elementary and middle school students (e.g., Espin et al., 2000; Malecki & Jewell). Reading proficiency also accounted for significant increments of variance in the final model for CMIWS a finding that parallels the results of previous studies in which reading proficiency has been associated with single-word spelling abilities and in-text spelling and grammatical accuracy (Abbott et al., 2010; Berninger et al., 2002; Mäki et al., 2001). Our results provide preliminary evidence that the ability to read words quickly and accurately is related to children’s accurate production of spelling and grammar while writing. This is in line with Conrad’s (2008) experimental research showing that reading practice leads to transfer to spelling ability, possibly by increasing orthographic knowledge.

Although handwriting automaticity correlated significantly with CMIWS scores in the preliminary partial correlations, the sample size did not allow us to include it as a fourth predictor in the regression analysis. The results of the preliminary analysis support the examination of handwriting automaticity in future studies as a factor in explaining children’s CMIWS scores.

Verbal working memory was not significantly correlated with CMIWS scores in the zero order or partial correlations. However, previous studies support the role of verbal working memory in spelling and grammatical accuracy (e.g., Fayol et al., 1994; Jongejan et al., 2007). Therefore, as was the case with TWW, the lack of association between verbal working memory...
and CMIWS in the present study may be due to the nature of the working memory task used. Further research is necessary in order to draw conclusions about the role of verbal working memory in children’s CMIWS scores.

**Composition quality.** Previous studies have reported that girls score higher than boys on measures of composition quality (e.g., Olinghouse, 2008; Swanson & Berninger, 1996), and that reading proficiency is associated with composition quality (e.g., Abbott & Berninger, 1993; Berninger et al., 2002; Juel, 1988; Olinghouse). However, neither of these findings was replicated in the present study. This may be because the compositions were typed and corrected for spelling and grammar before quality scoring was completed. In our sample, stronger reading abilities and female gender were associated with higher in-text spelling and grammatical accurate production (CMIWS) scores. Given that spelling and grammar influence overall quality ratings of students’ compositions (Marshall & Powers, 1969), correcting spelling and grammar before quality scoring may have minimized differences due to gender or reading ability. It should be noted that Olinghouse used typed and corrected passages for quality ratings and found gender differences and an association between reading ability and composition quality. However, in Olinghouse’s study participants were allowed 15 minutes to write their compositions. Therefore, an alternative explanation for these discrepant findings is that differences in composition quality associated with gender or reading ability may not emerge unless students write longer narratives, allowing for greater story development.

Our results suggest that the association between handwriting automaticity and composition quality is indirect through their shared relationship with compositional fluency, in line with Olinghouse’s (2008) findings. In our sample handwriting automaticity was correlated with composition quality. However, when other predictors (including TWW) were accounted for, handwriting automaticity was no longer significantly correlated with composition quality.
Therefore, students with dysfluent handwriting may earn lower ratings of composition quality than their peers because they tend to write shorter compositions. This may be particularly true for writing measures with time limits such as CBM tasks, the Test of Written Language – 4th Edition (Hammill & Larsen, 2009) Contextual Conventions and Story Composition subtests, and the Wechsler Individual Achievement Test – 3rd Edition (Wechsler, 2009) Essay Composition subtest. It is possible that the correlation between TWW and composition quality may have been somewhat inflated in the present study due to the brief period of time participants were allowed to write. However, previous research using longer writing samples has also found a correlation between compositional fluency and quality (e.g., Olinghouse), providing support for an association between these two metrics beyond the brief writing task used in the present study.

Although previous studies suggest that verbal working memory plays a role in students’ composition quality (e.g., Berninger et al., 1994; Swanson & Berninger, 1996), it was not a significant predictor of composition quality in the present study. Again, this may be due to the nature of the working memory task used. Further research is needed in order to clarify the role of working memory in the quality of children’s brief writing samples.

**Limitations**

The findings of the present study must be interpreted in light of some limitations. First, the small sample size may have resulted in reduced power to detect small effects in the regression analyses. Further research using a larger sample of students is needed to confirm and expand upon our results. In addition, participants with diagnoses of ADHD, learning disabilities, or emotional behavioural disorders, or for whom English was a second language were included in the analyses. However, none of the participants had a level of English language proficiency that interfered with their ability to complete the tasks, and diagnostic statistics were examined for all regression analyses and influential cases excluded where appropriate. We also examined the
relationship between diagnosis and writing scores in the partial correlations and found that it was not sufficiently strong to be considered as a predictor in the regression analyses. Participants were allowed 2 minutes to plan their narratives rather than the 1 minute usually allotted in CBM of written expression. However, the quality of participants’ plans was not correlated with any of the writing indices. It is possible that allowing more time for planning would make the quality of participants’ plans a more useful variable. TWW, CMIWS and quality scores were also drawn from the same writing sample, which may have raised the level of correlation among these variables. In addition, the language of assessment was English, and therefore the results may not generalize to other languages. Finally, the present study also assessed writing proficiency using a narrative task, and a different pattern of results may have emerged if an expository task were used. However, previous studies have found similar patterns of relationships between predictor variables and performance on narrative and expository tasks (Berninger et al., 1994; Swanson & Berninger, 1996).

Implications

CBM writing assessments are tools that teachers and school psychologists can use to gain insight into a student’s writing proficiency. Our findings provide evidence of the sensitivity of these measures to individual differences, making them useful as a tool for both cross-sectional and longitudinal research. In our sample, TWW and CMIWS were correlated, but not strongly enough to suggest that they are simply measuring the same skill. Thus scoring the writing samples for both indices, as well as overall quality, provides a more complete picture of a student’s writing performance than examining either index alone. The information gained from these indices can in turn inform goal setting and instructional decisions for individual students.

Our results begin to shed light on the factors that contribute to performance on CBM writing tasks. In particular, the CMIWS index, an “accurate-production” (Jewell & Malecki,
2005, p. 27) indicator of writing proficiency, was sensitive to individual differences in reading proficiency even in a relatively strong sample of readers such as the one in the present study (only one participant had a standard score below 85 and the mean standard score was 108 on the Total Word Reading Efficiency index of the TOWRE). Therefore, teachers and school psychologists may also need to assess the reading skills of children who perform poorly on this measure (i.e., have negative scores or scores close to zero) or who show little growth in CMIWS scores over time.

Handwriting automaticity was the only significant predictor of TWW, which in turn uniquely predicted the quality of children’s compositions. This suggests that handwriting automaticity plays a role in children’s written expression even in the later elementary grades (see also Graham et al., 1997; Wagner et al., 2011). Collectively, these findings indicate that handwriting automaticity should be assessed as a potential factor in performance on both informal and standardized measures of written expression. This may be particularly important when TWW is used as an indicator of growth in written expression. Students with slow or inefficient handwriting may need additional, explicit instruction in handwriting to increase their automaticity in text production. Students may also benefit from using a word processor (Graham & Perin, 2007); however, typing does not always provide an advantage over handwriting in terms of composition length or quality because keyboarding skills are often less fluent than handwriting (Berninger, Abbott, Augsburger, & Garcia, 2009; Connelly, Gee, & Walsh, 2007).

The presence of gender differences in TWW and CMIWS scores builds on existing research (Jewell & Malecki, 2005; Malecki & Jewell, 2003), and suggests that it is important for teachers and school psychologists to recognize that boys may struggle more with writing than girls, particularly on indices that measure productivity and lower-level writing skills such as spelling and grammar (Mäki et al., 2001; Swanson & Berninger, 1996). The gender differences
in spelling and grammatical accurate production (CMIWS) suggest that teachers need to use a range of instructional approaches to promote engagement and interest in writing, and to build students’ basic spelling and grammar skills. It is equally important to use assessment tools such as CBM to monitor students’ growth in written expression and to adapt instruction when little or no progress is noted. Doing so will help all children to develop appropriate spelling and grammar skills.

**Conclusion**

Our results demonstrate that handwriting automaticity is a unique predictor of children’s TWW scores, whereas word-level reading proficiency added unique variance to the prediction of CMIWS scores. In turn, compositional quality was uniquely predicted by children’s writing fluency, as assessed with their TWW scores. These results provide further evidence of the importance of handwriting automaticity to children’s writing proficiency and the relationship between word-level reading skills and children’s performance on writing indices that take spelling and grammar into account (e.g., Berninger et al., 1994; Graham et al., 1997; Mäki et al., 2001). Our results extend current research by demonstrating that gender differences in writing productivity are independent of individual differences in handwriting automaticity. Overall, these findings suggest a need for writing evaluations that assess multiple aspects of writing including writing productivity, conventions, and quality and that take transcription skills and reading proficiency into account. CBM may provide school professionals with additional insight into children’s progress in writing – a useful supplement to school-based assessment of writing. Researchers, educators, and school psychologists may find CBM a useful means of capturing children’s performance on lower-order aspects of written expression.
Table 1

*Descriptive Statistics and Zero-Order Correlations among Predictors of Written Expression and Writing Indices*

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Grade</td>
<td>–</td>
<td>–</td>
<td>.08</td>
<td>.04</td>
<td>-.07</td>
<td>.29</td>
<td>.33*</td>
<td>-.18</td>
</tr>
<tr>
<td>2. Gender</td>
<td>–</td>
<td>–</td>
<td>.07</td>
<td>.05</td>
<td>.06</td>
<td>.31*</td>
<td>.44*</td>
<td>.25</td>
</tr>
<tr>
<td>3. Handwriting automaticity a</td>
<td>48.60</td>
<td>16.82</td>
<td>–</td>
<td>.23</td>
<td>.04</td>
<td>.38*</td>
<td>.37*</td>
<td>.33*</td>
</tr>
<tr>
<td>4. Reading proficiency</td>
<td>0.00</td>
<td>0.96</td>
<td>–</td>
<td>.26</td>
<td>.35*</td>
<td>.51*</td>
<td>.38*</td>
<td></td>
</tr>
<tr>
<td>5. Working memory b</td>
<td>5.64</td>
<td>3.33</td>
<td>–</td>
<td>.22</td>
<td>.25</td>
<td>.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. TWW</td>
<td>68.14</td>
<td>20.67</td>
<td>–</td>
<td>.73**</td>
<td>.58***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. CMIWS</td>
<td>47.57</td>
<td>24.82</td>
<td>–</td>
<td>.36*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Composition quality</td>
<td>3.76</td>
<td>1.44</td>
<td>–</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. CMIWS = correct minus incorrect word sequences; TWW = total words written.*

*a* Descriptive statistics for handwriting automaticity are based on the total time to write the alphabet. However for all analyses the inverse of this value was used to facilitate interpretation;  
*b* Descriptive statistics for working memory are based on the total number of errors. However, for all analyses the inverse of this value was used to facilitate interpretation.

*p < .05. **p < .01. ***p < .001
Table 2

Partial Correlation Coefficients for Predictors of Interest with Outcome Measures

| Predictor                        | TWW  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Child has diagnosis</td>
<td>-.07</td>
</tr>
<tr>
<td>Grade</td>
<td>.25</td>
</tr>
<tr>
<td>Gender</td>
<td>.31</td>
</tr>
<tr>
<td>Handwriting automaticity</td>
<td>.38*</td>
</tr>
<tr>
<td>Reading proficiency</td>
<td>.14</td>
</tr>
<tr>
<td>Working memory</td>
<td>.09</td>
</tr>
<tr>
<td>TWW</td>
<td>–</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CMIWS</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>-.27</td>
<td>.00</td>
<td></td>
</tr>
<tr>
<td>.45**</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>.44**</td>
<td>.08</td>
<td></td>
</tr>
<tr>
<td>.35*</td>
<td>.15</td>
<td></td>
</tr>
<tr>
<td>.46**</td>
<td>.21</td>
<td></td>
</tr>
<tr>
<td>.16</td>
<td>.16</td>
<td></td>
</tr>
<tr>
<td>.34*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Coefficients represent partial correlations controlling for the remaining variables in the column. CMIWS = correct minus incorrect word sequences; TWW = total words written.

* n = 41;  

Parent-reported diagnosis of Attention-Deficit/Hyperactivity Disorder, Learning Disability, and/or Emotional-Behavioural Disorder.

*p < .05. **p < .01.
Table 3

Results of Linear Regression Analyses Predicting Performance on the
Curriculum-Based Measure of Written Expression

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TWW</strong>&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>6.63</td>
<td>5.12</td>
<td>.17</td>
</tr>
<tr>
<td>Gender</td>
<td>13.32</td>
<td>5.10</td>
<td>.34*</td>
</tr>
<tr>
<td>Handwriting automaticity</td>
<td>.49</td>
<td>0.15</td>
<td>.42**</td>
</tr>
<tr>
<td><strong>CMIWS</strong>&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>13.80</td>
<td>5.64</td>
<td>.28*</td>
</tr>
<tr>
<td>Gender</td>
<td>18.99</td>
<td>5.67</td>
<td>.39**</td>
</tr>
<tr>
<td>Reading proficiency</td>
<td>12.37</td>
<td>2.97</td>
<td>.48**</td>
</tr>
<tr>
<td><strong>Composition Quality</strong>&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading proficiency</td>
<td>0.26</td>
<td>0.21</td>
<td>.17</td>
</tr>
<tr>
<td>Working memory</td>
<td>0.05</td>
<td>0.06</td>
<td>.11</td>
</tr>
<tr>
<td>TWW</td>
<td>0.04</td>
<td>0.01</td>
<td>.50**</td>
</tr>
</tbody>
</table>

Note. CMIWS = correct minus incorrect word sequences; TWW = total words written.

<sup>a</sup> n = 41; <sup>b</sup> $R^2 = .37$ ($p < .01$); <sup>c</sup> $R^2 = .50$, ($p < .01$); <sup>d</sup> $R^2 = .38$ ($p < .01$).

*p < .05. **p < .01.
CHAPTER THREE

Discussion
Discussion

The results of the present study provide preliminary information about the factors that predict children’s performance on curriculum-based measures of written expression. Total words written, a measure of compositional fluency, was predicted by gender (girls > boys) and handwriting automaticity. Correct minus incorrect word sequences scores, which measure spelling and grammatical accurate-production, were predicted by grade (5 > 4), gender (girls > boys), and reading proficiency. Finally, holistic composition quality was predicted by total words written only. Although total words written and correct minus incorrect word sequences scores were highly correlated, the magnitude of the correlation coefficients suggests that these writing outcomes are not simply measuring the same skill. Thus scoring the writing samples for both indices, as well as overall quality, provides a more complete picture of a student’s writing performance than examining either index alone. Below I discuss the predictors of each writing outcome, implications for research and practice, limitations of the current study, and directions for future research.

Predictors of Performance on the Three Writing Measures

Total words written. Consistent with prior research, girls scored higher than boys on total words written (Jewell & Malecki, 2005; Malecki & Jewell, 2003), and these gender differences were not better explained by differences in handwriting automaticity. While there is substantial evidence that older children write longer compositions than younger children (Berninger & Fuller, 1992; Jewell & Malecki; Malecki & Jewell; Swanson & Berninger, 1996), this finding was not replicated in the present study. Grade was not a significant predictor of total words written in the regression analysis and was not significantly correlated with total words written in the initial zero order correlations. Previous studies that have found significant grade-level differences have used much larger sample sizes, ranging from 200 to over 900 participants.
It is possible that differences associated with one grade level were too small to be detected in the present study due to the relatively small sample size. However, the lack of grade level differences may also be due to the lower validity of the total words written index, relative to other measures such as correct minus incorrect word sequences, for the assessment of junior grade students’ writing performance (Jewell & Malecki).

Evidence from previous studies indicates that handwriting is an important factor in children’s writing performance (Berninger et al., 1994; Graham et al., 1997), and the relationship between handwriting automaticity and total words written in the present study supports and extends these results. Two studies (Berninger et al.; Graham et al.) have found that handwriting fluency (speed and accuracy) contributes significant increments of variance to compositional fluency (i.e., total words written). The present study suggests that handwriting automaticity, independent of accuracy, is associated with the length of junior grade students’ compositions even after gender differences and grade level are accounted for.

Although reading proficiency was significantly correlated with total words written, when grade, gender, handwriting automaticity and working memory were covaried, this relationship was no longer significant. This parallels the findings of previous studies which have found only an indirect relationship between reading ability and compositional fluency (i.e., total words written) in junior grade children (Abbott & Berninger, 1993; Berninger et al., 2002). Therefore, while stronger readers may write longer compositions than weaker readers, this relationship is not due to reading ability exerting a direct influence on compositional fluency.

Finally, previous studies support the role of verbal working memory in compositional fluency (e.g., Berninger et al., 1994; Swanson & Berninger, 1996), a finding that was not replicated in the present study. These discrepant findings may be due to differences in the
demands of the verbal working memory tasks. The measure of verbal working memory used in the present study, the Self-Ordered Pointing Task, requires individuals to update verbal information frequently in memory and to inhibit previous responses (Petrides & Milner, 1982). In contrast, tasks used in other studies that have found a link between verbal working memory and writing have required individuals to maintain and process verbal information concurrently (e.g., Berninger et al.; Swanson & Berninger). Therefore it is possible that the maintenance and processing of verbal information is implicated in written expression more so than updating and inhibiting. This fits with the capacity theory of writing (McCutchen, 1996; Swanson & Berninger), which conceptualizes written expression as taxing working memory due to the need for simultaneous processing and storage of information during the coordination of the many sub-skills involved in writing. Future studies using both processing and updating types of verbal working memory tasks, as well as experimental manipulations of verbal working memory load during writing (see McCutchen, 2000 for a review) are necessary in order to better understand the association between children’s verbal working memory and writing proficiency.

Correct minus incorrect word sequences. The present study adds to existing research in the area of developmental differences by grade on CBM of written expression scores. Consistent with prior research (Jewell & Malecki, 2005; Malecki & Jewell, 2003), fifth grade students scored higher than fourth grade students on the correct minus incorrect word sequences index. These results extend previous findings by demonstrating that grade level differences are independent of reading proficiency. Therefore, students do appear to increase their spelling and grammatical accurate production in the junior grades regardless of their reading ability, and these differences are apparent between students as little as one grade apart.

Previous research findings were inconsistent (Jewell & Malecki 2005; Malecki & Jewell, 2003) in terms of gender differences in the correct minus incorrect word sequences scores. The
results of the present study parallel Malecki and Jewell’s findings that girls score higher than boys on this measure, and provide further evidence that girls produce more grammatically correct and correctly spelled text than boys during brief, timed writing tasks. These gender differences were not due to differences in reading proficiency.

Reading proficiency did, however, predict children’s correct minus incorrect word sequences scores, a finding that is in line with the results of previous studies in which reading proficiency was associated with in-text spelling and grammatical accuracy (Berninger et al., 2002; Mäki et al., 2001). Similarly, other studies have reported an association between single-word spelling from dictation and word reading abilities (Abbott et al., 2010; Berninger et al.). While the association between children’s writing ability and their reading comprehension and word reading accuracy has been examined (Abbott and Berninger, 1993; Berninger et al.; Olinghouse, 2008), I did not locate any studies that examined reading fluency as a predictor of writing proficiency in English speaking children. Therefore, the present study provides preliminary evidence that children’s ability to read familiar words and decode novel words quickly and accurately is predictive of their in-text spelling and grammatical accurate-production. Moreover, the present study used a relatively strong sample of readers (only one participant had a standard score below 80 and the mean standard score was 108). Therefore, this suggests that even small differences in word reading fluency are associated with advantages, or disadvantages, in spelling and grammatical accuracy. In an intervention study Conrad (2008) demonstrated that a reading practice program involving training in reading 40 words lead to transfer to spelling of both trained and novel words. Conrad theorized that this was because the reading program increased children’s overall orthographic knowledge. However, correct minus incorrect word sequences measures both spelling and grammatical accurate-production, and
therefore it is not clear whether reading proficiency also supports children’s grammatical accuracy.

Limited information was available regarding the role of handwriting automaticity in children’s spelling and grammatical accurate production. Graham and colleagues (1997) found that handwriting fluency and spelling ability covaried significantly in junior grade students, a finding that was replicated in the present study, with significant zero-order and partial correlations found between handwriting automaticity and correct minus incorrect word sequences scores. However, Berninger (2000a) states that handwriting and spelling are distinct skills that can develop independently. The sample size in the present study was not sufficient to allow for the examination of handwriting automaticity as a predictor of children’s correct minus incorrect word sequences scores. The results of the preliminary partial correlation analysis suggest that handwriting automaticity should be considered as a factor that may account for correct minus incorrect word sequences scores in future studies. Further research is necessary in order to clarify the role of handwriting automaticity in spelling and grammatical accurate-production.

Verbal working memory was not significantly correlated with correct minus incorrect word sequences scores in the zero order or partial correlations. However, previous studies suggest that verbal working memory is associated with spelling and grammatical accuracy (e.g., Fayol et al., 1994; Jongejan et al., 2007). Therefore, as was the case with total words written, the lack of association between verbal working memory and correct minus incorrect word sequences in the present study may be due to the nature of the verbal working memory task. Further research is necessary in order to draw conclusions about the role of verbal working memory in children’s correct minus incorrect word sequences scores.

**Composition quality.** The measurement of composition quality based on
appropriateness for grade level did not allow for the examination of grade level differences. However, gender differences in composition quality were examined and were non-significant. Although previous studies have reported that girls score higher than boys on measures of composition quality (Ma & Klinger, 2000; Olinghouse, 2008; Swanson & Berninger, 1996), gender was not correlated with composition quality either in the zero order correlations, or when other variables of interest were controlled for (handwriting automaticity, reading proficiency, working memory, and total words written). This may be because handwriting, spelling, and grammar influence overall quality ratings of students’ compositions (Marshall & Powers, 1969), and girls scored higher than boys in the present sample on correct minus incorrect word sequences, the measure of spelling and grammatical accurate production. Moreover, girls’ handwriting is rated higher in legibility than boys’ across elementary and middle school grades (Graham, Berninger, Weintraub, & Schafer, 1998). Therefore, removing spelling, grammar, and handwriting from the assessment of composition quality may have minimized gender differences in the present sample. It should be noted that one study did use typed and corrected versions of participants’ compositions in quality scoring (Olinghouse) and found gender differences in composition quality. Therefore, an alternative explanation is that gender differences in composition quality may not emerge unless students write longer narratives, allowing for greater story development.

Olinghouse (2008) stated that the association between handwriting fluency and overall composition quality is indirect through its relationship to compositional fluency, a suggestion that is supported by the results of the present study. Handwriting automaticity was correlated with ratings of overall composition quality but when other predictors, including total words written, were controlled for, the relationship between handwriting automaticity and composition quality was no longer significant. Therefore, students with dysfluent handwriting are likely to
earn lower ratings of overall composition quality than their peers because they tend to write
shorter compositions, and this may be particularly true for writing tasks with time limits such as
the CBM task used in the present study. However, many of the most commonly used
standardized measures of spontaneous written expression also have a time limit, including the
Conventions and Story Composition subtests. Moreover, many of the factors that go into
evaluating children’s writing on the TOWL-4 depend on the quantity of text produced. On the
Contextual Conventions subtest of the TOWL-4, children’s stories are not scored if they contain
fewer than 40 words. In addition, several of the scoring criteria are fluency-dependent. For
example, children earn points based on the number of paragraphs, compound sentences, and
introductory phrases and clauses in their compositions (Hammill & Larsen). Therefore,
children’s handwriting automaticity may also constrain their performance on standardized
measures of written expression.

Contrary to previous research (Abbott & Berninger, 1993; Berninger et al., 2002; Juel,
1988; Mäki et al., 2001; Olinghouse, 2008; Woodfin, 1968), reading proficiency was not a
significant predictor of composition quality in the present sample. As was the case with gender,
it is possible that typing the compositions and correcting them for spelling and grammatical
errors may have minimized differences associated with reading ability. There is evidence that
reading ability predicts children’s spelling and grammatical accuracy when composing text
(Berninger et al.; Mäki et al.; Wakely et al., 2006), and these mechanical aspects of writing may
have influenced quality ratings of children’s compositions in previous studies, resulting in
differences in quality being magnified. However, Olinghouse found that composition quality
was associated with reading ability despite having typed and corrected the compositions before
quality scoring. Therefore, differences in composition quality associated with reading ability may only emerge when children write longer narratives than those written in the present study. Further research is needed in order to draw conclusions regarding the relationship between the quality of children’s compositions and their reading ability, independent of spelling and grammatical accuracy.

Finally, verbal working memory was not a significant predictor of composition quality in the regression analysis. This is in contrast to prior research which has found that verbal working memory is associated with performance across multiple aspects of writing performance, including composition quality (Berninger et al., 1994; Bourke & Adams, 2003; Swanson & Berninger, 1996). Again, as noted earlier, these discrepant findings may be due to differences in the demands of the verbal working memory tasks.

The language demands of the verbal working memory task may also explain the lack of association between verbal working memory and the writing indices in the present study. The verbal working memory tasks on which performance was associated with writing outcomes in previous studies are more demanding of children’s oral and written language skills than the measure used in the present study. For example, the listening generation span task (e.g., Berninger et al., 1994; Swanson & Berninger, 1996) involves listening to a series of semantically unrelated sentences, answering a question about the sentences, and then writing one grammatically acceptable sentence for the last word of each sentence presented. In contrast, the oral language demands of the measure used in the present study are minimal, requiring only the naming of common objects, and there are no demands on written language. Therefore, it is possible that the relationship between verbal working memory and writing proficiency in previous studies may be partially explained by general language abilities, given the importance of oral language to writing acquisition (Abbott & Berninger, 1993). Further research controlling
for expressive and receptive language abilities and including other predictors of writing ability such as gender, handwriting fluency, verbal working memory and reading ability is necessary to test this hypothesis.

**Implications for Practice**

**Assessment.** Administering curriculum-based measures is often compared to taking a student’s temperature (e.g., Deno, 1985). That is, performance on these measures is indicative of overall ‘health,’ but may not provide specific information about what explains any weaknesses that may be present. The findings of the present study begin to shed light on the factors that underlie performance on these measures. Although total words written and correct minus incorrect word sequences scores were highly correlated, the magnitude of the correlation coefficient suggests that these writing outcomes are not simply measuring the same skill. Thus scoring the writing samples for both indices would provide a more complete picture of a student’s writing performance than examining either index alone. Doing so may help teachers and school psychologists to identify those students at risk for writing difficulties due to weaknesses in reading proficiency and/or lack of handwriting automaticity. This information can in turn inform interventions, goal setting and instructional decisions for individual students.

The results of the present study provide further evidence of the sensitivity of correct minus incorrect word sequences, an “accurate-production” (Jewell & Malecki, 2005, p. 27) indicator of writing proficiency, for junior grade students (Malecki & Jewell, 2003). Correct minus incorrect word sequences scores differentiated between students only one grade apart. They were also sensitive to individual differences in reading proficiency even in the relatively strong sample of readers in the present study. Therefore, teachers and school psychologists may also need to assess the reading skills of children who perform poorly on this measure (i.e., have negative scores or scores close to zero) or who show little growth in correct minus incorrect
word sequences over time.

Similarly, handwriting automaticity was a significant predictor of total words written scores, suggesting that children who struggle with handwriting are likely to earn low scores on this measure. Teachers and school psychologists should be aware of this as children who earn very low total words written scores relative to their classmates, or who show little growth in total words written over time, may have slow or inefficient handwriting. These students may require explicit instruction in handwriting to increase their automaticity in text production. Students may also benefit from using a word processor (Graham & Perin, 2007); however, typing does not always provide an advantage over handwriting in terms of composition length or quality because keyboarding skills are often less fluent than handwriting (e.g., Berninger, Abbott, Augsburger, & Garcia, 2009; Connelly, Gee, & Walsh, 2007).

The presence of gender differences in total words written and correct minus incorrect word sequences scores builds on existing research (Jewell & Malecki, 2005; Malecki & Jewell, 2003), and provides further evidence of the sensitivity of these indices to individual differences compared to the measure of composition quality also examined in this study. These findings suggest that it is important for teachers and school psychologists to recognize that boys may struggle more with writing than girls, particularly on indices that measure productivity and lower-level writing skills such as spelling and grammar.

**Instruction.** The results of this study provide information that may serve to guide writing instruction. In particular, the gender differences in spelling and grammatical accurate production suggest that teachers need to use a range of instructional approaches to promote engagement and interest in writing, and to build students’ basic spelling and grammar skills as well as their ability to generate well-organized and clear narrative and expository text. It is equally important to use assessment tools such as CBM to monitor students’ growth in written
expression and to adapt instruction when little or no progress is noted. Doing so will help all children to develop appropriate spelling and grammar skills.

Handwriting automaticity was the only significant predictor of total words written in the present study, which in turn uniquely predicted the overall quality of children’s compositions. Similarly, in a recent study using structural equation modeling Wagner and colleagues (2011) found strong associations between handwriting fluency and grade 4 students’ compositional fluency and macro-organization (an aspect of writing quality). Therefore, it appears that handwriting automaticity plays an important role in children’s writing performance, even in the later elementary grades. However, a scan of the curricula of all Canadian provinces and territories revealed that expectations for handwriting speed or fluency are absent in many cases (British Columbia Ministry of Education, 2010; Ministère de l’Éducation, 2001; Ontario Ministry of Education, 2006), or do not extend into the junior grades (Atlantic Provinces Education Foundation, 1996). Moreover, no Canadian provinces or territories have curricula that consistently include expectations for handwriting speed or fluency at all elementary grade levels (Alberta Learning, 2000; Manitoba Education and Training, n.d.; Saskatchewan Ministry of Education, 2010; Northwest Territories Education, Culture, & Employment, 2006). It seems that the importance of handwriting automaticity has been largely overlooked in the Canadian education system. The results of the present study suggest that teachers should aim to develop children’s handwriting automaticity throughout elementary school, which may facilitate their compositional fluency and in turn lead to higher quality writing. Although there is evidence that building primary grade children’s handwriting fluency leads to their writing longer compositions (Berninger et al., 1997), further research is needed to confirm this in a sample of junior grade students. The results of the present study also suggest that school psychologists should assess handwriting automaticity as a potential factor accounting for writing performance on both
informal and standardized measures of written expression.

**Limitations**

The findings of the present study must be interpreted in light of some limitations. First, the small sample size may have resulted in reduced power to detect small effects in the regression analyses. The sample size also limited the number of predictors that could be entered in the regression analyses. As a result, further research using a larger sample of students is needed to confirm and expand upon these results. In addition, participants with diagnoses of ADHD, learning disabilities, or emotional-behavioural disorders, or for whom English was a second language were included in the sample. However, none of the participants had a level of English language proficiency that interfered with their ability to complete the tasks, and diagnostic statistics were examined for all regression analyses and influential cases excluded where appropriate. I also examined the relationship between diagnosis and writing scores using partial correlations and found that it was not sufficiently strong to be considered as a predictor in the regression analyses. Moreover, the diverse sample of students used in the present study represents the population of students teachers and school psychologists are likely to encounter, and therefore may contribute to the ecological validity of the results.

Participants were allowed 2 minutes to plan their narratives rather than the 1 minute usually allotted in CBM of written expression. However, the quality of participants’ plans was not correlated with any of the writing indices. It is possible that allowing more time for planning may have made the quality of participants’ plans a more useful variable. Total words written, correct minus incorrect word sequences, and quality scores were also drawn from the same writing sample, which may have raised the level of correlation among these variables. In addition, the correlation between TWW and composition quality may have been somewhat inflated in the present study due to the brief period of time participants were allowed to write.
However, previous research using longer writing samples has also found a correlation between compositional fluency and quality (e.g., Olinghouse, 2008), providing support for an association between these two metrics beyond the brief writing task used in the present study. Finally, the present study assessed writing proficiency using a narrative task, and a different pattern of results may have emerged if an expository writing task were used. However, previous studies have found similar patterns of relationships between predictor variables and performance on narrative and expository tasks (Berninger et al., 1994; Swanson & Berninger, 1996).

**Directions for Future Research**

The present study provides preliminary information about the factors that may impact children’s performance on curriculum-based measures of written expression. However, further research is necessary in order to expand upon these results and confirm the new hypotheses suggested. First, the present study used a sample of junior grade children, and it may be useful to expand the sample to include primary grade children in order to determine whether the predictors associated with performance on the CBM indices vary across grade divisions. Second, as discussed earlier, further research using measures tapping a range of working memory functions, including updating and inhibiting, and storage and manipulation, would provide useful information about the nature of the relationship between working memory and written expression. Experimental manipulations of working memory load during writing would be particularly useful in suggesting causal relationships between working memory and various aspects of writing performance. Third, further research on the role of handwriting automaticity in children’s writing proficiency would provide additional support for the conclusions drawn in the present study regarding its importance. Studies examining the effects of training programs to increase handwriting automaticity at various ages may inform curriculum development and intervention planning for students who struggle with written expression. It would also be
informative to examine the relationship between keyboarding skills and performance on curriculum-based measures completed using word processing programs. Finally, studies examining predictors of performance on curriculum-based measures over time would provide evidence of causal relationships between predictors such as working memory, handwriting automaticity, and reading proficiency, and performance on the CBM indices.

**Conclusion**

The results of the present study demonstrate that handwriting automaticity is a unique predictor of children’s total words written scores, whereas word-level reading proficiency added unique variance to the prediction of correct minus incorrect word sequences scores. In turn, compositional quality was uniquely predicted by children’s compositional fluency, as measured by their total words written scores. These results provide further evidence of the importance of children’s handwriting automaticity to their writing proficiency and the relationship between word-level reading abilities and children’s performance on writing indices that take spelling and grammar skills into account (e.g., Berninger et al., 1994; Graham et al., 1997; Mäki et al., 2001). The results extend current research by demonstrating that gender differences in writing productivity are independent of individual differences in handwriting automaticity. Overall, these findings suggest a need for writing assessments that assess multiple aspects of writing including writing productivity, conventions, and quality and that take transcription skills and reading proficiency into account. CBM of written expression may provide school professionals with additional insight into children’s progress in writing – a useful supplement to school-based assessment.
References


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Appendix:

Scoring Criteria for Curriculum-Based Measures of Written Expression

Children’s writing samples will be scored for four curriculum based measurement (CBM) indices. The following guide outlines the scores to be generated and provides scoring guidelines for each.

General Scoring Instructions

Begin by scoring the sample for Total Words Written (TWW), then Words Spelled Correctly (WSC). Next, score the sample for Correct Word Sequences (CWS) and Total Possible Correct Word Sequences (TPCWS). It is helpful to score in pencil.

1) Total Words Written (TWW)

Total Words Written is simply the number of words the child wrote, regardless of spelling.

Scoring Guidelines
- Underline each word
- Count all words written, regardless of spelling
  E.g., I saw a rabbit and a cat (TWW = 7)
- Do not count numerals (numbers not spelled out) as words
  E.g., There were 1000 aliens outside (TWW = 4)
  E.g., The clock said 6:00 PM (TWW = 4)
  EXCEPTION: 2nd Street
- Count abbreviations as words
- When students write long strings of letters or push words close together, try to pull apart words with recognizable invented or correct spelling and count each as its own word
  E.g., We walked to the park (TWW = 5)
  E.g., It was a butiful day (TWW = 5)
- If it is not possible to pull the string of letters apart into words, count the string as one word, or count each line as one word for longer strings
- If the student writes all or part of the story starter, count those words
- Count contractions (wouldn’t, couldn’t) as one word
- When compound words are written as two distinct words, count each as a word
  E.g., eye brow (TWW = 2)

2) Words Spelled Correctly (WSC)

Words Spelled Correctly is the number of English words spelled correctly, regardless of the context. Before scoring a word as being spelled incorrectly, make sure to consider the word out of context of the sentence. It is often difficult to inhibit the reaction to score a word as incorrect when it may actually be a correctly spelled English word.

Scoring Guidelines
- Draw a box around incorrectly spelled words
E.g., The kat and the dawg were outside. (WSC = 5)

- Consider words in isolation. They do not have to be spelled correctly for the context, be grammatically correct, or make sense in the context of the sentence.
  E.g., I [grabed] my bothers toy [truk]. (WSC = 4)
  E.g., I ran to my window than I ran downstairs. (WSC = 9)

- If the word is a contraction, it is only correct if it is punctuated correctly
  E.g., She ran until she couldn't run anymore (WSC = 6)

- Ignore unnecessary capitals
  E.g., The Sun wAs shining (WSC = 4)

- Proper nouns and the pronoun I must be capitalized to be counted as correct
  E.g., Vicki and I are going outside. (WSC = 5)
  E.g., Vicki and I were in France. (WSC = 4)

NOTE: In some cases you may not be able to tell if the letter is capital or lower case. In these cases, give the benefit of the doubt and score as correct

- If letters are reversed, score as incorrect if they make a new word. Otherwise score as correct (e.g., reversed “s” or “c” would be scored as correct because it does not make a new letter).
  E.g., I saw a bolphin. (WSC = 3)

- If compound words are written as two separate words, consider each separately for spelling. The compound word is not considered incorrectly spelled.
  E.g., I ran down stairs. (WSC = 4)
  E.g., I ran down staires. (WSC = 3)

3) Correct Word Sequences (CWS) and Total Possible Correct Word Sequences (TPCWS)
Correct Word Sequences are adjacent words that are spelled correctly and are grammatically correct given the context of the sentence.

Total Possible Correct Word Sequence (TPCWS) is the number of correct plus the number of missed or incorrect word sequences.

Scoring Guidelines
- Mark a correct word sequence with a ^ between the two words or between the word and the punctuation mark.

- Mark incorrect, or missed correct word sequences with a º between the two words or between the word and where the punctuation mark should be.

- A correct word sequence is noted between two words that are spelled correctly and grammatically correct given the context of the sentence. When a word is spelled incorrectly and/or grammatically incorrect in the sentence context, mark an incorrect word sequence on either side of that word.
- As long as the first word of the story is spelled correctly, also note a correct word sequence before it as well. This word does not need to be capitalized for the CBM stories because they use a “story starter” sentence.

- Words can also make sequences with essential punctuation marks (periods, question marks, exclamation marks) at the end of a sentence.
  
  E.g.,  I put on my shoes than I put on my jacket. (CWS = 10, TPCWS = 12)

  E.g.,  I went to the straw with my sister. (CWS = 7, TPCWS = 9)

- At the end of a sentence, the final punctuation mark (period, exclamation mark or question mark) makes a sequence with the last word of the sentence, and another sequence with the first word of the next sentence.

  E.g.,  The squirrel ran up the tree. The cat ran after it. (CWS = 13, TPCWS = 13)

- Commas and quotation marks are not considered essential marks of punctuation (so no extra carets are gained for adding them, and none are lost for not adding them).

  E.g.,  I bought bananas apples and oranges at the store. (CWS = 10, TPCWS = 10)

  E.g.,  My Mom said come downstairs for dinner. (CWS = 8, TPCWS = 8)

- The first letter of a sentence must be capitalized. When the first letter of a sentence is not capitalized, that word cannot make a correct sequence with the following word, so note an incorrect word sequence there as well.

  E.g.,  The squirrel ran up the tree. the cat ran after it. (CWS = 11, TPCWS = 13)

- When a student writes a run-on sentence, attempt to find the point at which a new sentence is necessary in order for the story to make sense. Less than perfect style is acceptable (e.g., several phrases joined by “and” or “but”), but run-on sentences in which there is clearly more than one subject are not.

  E.g.,  I was going to run outside but then I saw my mom and then my dad came inside and said “look out!” (CWS = 22, TPCWS = 22)

  E.g.,  I was a princess and I had a white horse my maid said I had to go on an adventure. (CWS = 19, TPCWS = 22)

  *Note that the ∞ indicates the point at which there should have been a period. Two correct sequences are missed: One for not putting a period, and one for not capitalizing the following word. For this reason, a correct word sequence is also missed following the first word of the “sentence.”

Because of the way the story prompts are constructed, children often begin phrases with “I.” When the “I” happens to be capitalized at the point where a new sentence should begin, the student only loses one CWS (for not having the period there).

E.g.,  I looked and looked for the shiny object but it wasn’t there ∞ I ran outside to look for it. (CWS = 20, TPCWS = 21)