# EXPLORING HANDWRITING USE, HANDWRITING INSTRUCTION, AND HANDWRITING QUALITY OF FIRST-YEAR UNIVERSITY STUDENTS

by

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ABSTRACT

Handwriting is perceived by some individuals to be a “dying art” (Sharp & Titus, 2016), despite its cognitive and academic benefits over typing (e.g., Mueller & Openheimer, 2014). Twenty-nine students completed paper and pencil tasks where they were asked to form upper- and lower-case print and cursive letters, copy sentences using their typical handwriting, only print, and only cursive, and questionnaires about their handwriting and typing use and their handwriting instruction. Results indicated that students used handwriting more frequently than typing for academic tasks overall and for most categories of specific academic tasks, and they reported using handwriting or a variety of tasks at work and at home. As well, results indicated that students are less legible when forming cursive letters compared to print letters, and less fluent with cursive handwriting compared to print and a mix of the two styles. Finally, students reported receiving a high number of components of evidence-based handwriting instruction but reported a perception that their handwriting was inadequate. These findings, along with possibilities for future research, and practical implications for teachers, educational policy makers, teacher education programs, and school psychologists are discussed.

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*"Piglet noticed that even though he had a very small heart, it could hold a rather large amount of gratitude."* — A.A. Milne, Winnie-the-Pooh

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# CHAPTER 1: LITERATURE REVIEW

Written expression is a general term used to refer to the production of written language to convey thoughts and ideas (Dockrell, 2014). Written expression plays a significant role in our society. In university, students need to take notes and to display their comprehension by composing written text (Graham & Perin, 2007). The National Commission on Writing for America's Families, Schools, & Colleges (NCWAFSC; 2003; 2004) noted that outside of school, many high-paying jobs require sound written expression skills (e.g., for reports, communication with colleagues). Further, some trends suggest that demands for on-the-job written expression proficiency will only increase in the future (Bazerman, 2006; Smart, 2008). Research also suggests that written expression can be therapeutic for physical and psychological distress (Baikie & Wilhelm, 2005). Certainly, written expression is important in educational settings and in everyday life. However, written expression is a broad term that is comprised of several different, closely connected skills.

## Terminology

**Handwriting**. One basic, but frequently overlooked part of written expression is handwriting. Handwriting is a specific component of written expression and is an umbrella term for the generation of written symbols onto paper by hand (Feder & Majnemer, 2007). These written symbols, also known as graphemes, are the physical representation of the sounds and meaning of language (Kandel & Spinelli, 2010). Graphemes vary between languages, but languages such as English and French use the letters of the Latin alphabet (e.g., a, b, c). In languages that use the Latin alphabet (e.g., English, French), there are two primary styles of handwriting. The first, referred to as print, can be described as writing letters as individual symbols, without physically joining them when writing a word (Feder & Majnemer, 2007). The

second style, known as cursive, is described as when letters are joined together to make a word (Feder & Majnemer, 2007). Some letters differ in form between the two styles (see Appendix D to compare print and cursive letter forms) and many individuals tend to use a mix of these two styles in their everyday handwriting (Graham, 2018).

**Handwriting legibility and fluency**. There are two important components of handwriting. The first component, handwriting legibility, is defined as generating letters in a way that is standard for the language and clearly recognizable to the reader (Bayat & Küçükayar, 2016). Having legible handwriting (i.e., using easily recognizable letter forms) means that it takes less effort for a reader to interpret what has been written. However, legibility is also important for other reasons. For example, the legibility of handwriting can affect the readers' perceptions of the quality of ideas expressed in written text; Graham, Harris, and Hebert (2011) found that essays written by school-aged children with less legible handwriting received lower grades from teachers than more legible versions of the same paper.

The second important component of handwriting is fluency, which is often defined as the amount of correct text an individual can produce within a specified time limit (usually per minute; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). Handwriting fluency has been found to be an important factor in the amount of content produced and the quality of students' grammar in written expression, accounting for up to 42% of the variance in the quality of writing samples from students in elementary school through to at least grade 9 (Graham et al., 1997; Graham, Berninger, Weintraub, & Schafer, 1998).

Handwriting legibility and handwriting fluency have a strong reciprocal relationship (Graham, 2018; Weintraub & Graham, 1998). Fluency is reduced when individuals attempt to handwrite with a high degree of legibility, and when speed (an integral part of fluency) of

handwriting is increased to put more ideas on paper, handwriting tends to become less legible. For students, this reciprocal relationship is problematic as they are often forced to write under timed conditions (Graham, 2018). Students can choose to handwrite quickly to get as much information down during an exam or when taking notes, but they run the risk of producing text that they or their instructor will have difficulty reading. On the other hand, they can handwrite legibly, but this can result in a text with less, and sometimes insufficient, information. As a result, students' handwriting needs a balance of legibility and fluency.

**Post-Secondary Education**

Post-secondary education has become increasingly important in recent years. More jobs require some form of university or college training, and the possession of a university degree or a college diploma is an important predictor of later economic, social, and psychological success (Chesters & Watson, 2016; Connolly, Flynn, Jemmott, & Oestreicher, 2017). Perhaps as a direct result, more young adults are continuing their education past the high school level. According to the Association of Universities and Colleges of Canada (AUCC; 2011), enrollment at universities and colleges across Canada has more than doubled since the early 1980s. Most of these students are under the age of 22 and are enrolled in programs on a full-time basis (four or more courses per semester; AUCC, 2011).

The first year of post-secondary education is especially important. The first year (especially the first few months) brings new social, psychological, and academic challenges for many students (Connolly et al., 2017). First year grade-point average (GPA) is a significant predictor of drop-out risk (Araque, Roldan, & Salguero, 2009), graduating on time (Bail, Zhang, & Tachiyama, 2008), and employability following graduation (Pinto & Ramalheira, 2017). However, the first year is difficult for many students. First-year students face considerable

increases in independence and academic demands (Connolly et al., 2017); Students are expected to read, study, and write a considerable amount more than they had in high school. Unsurprisingly, some students have difficulty coping with this increase, and a large portion of students who drop-out do so following first year (Chesters & Watson, 2016). To help support first-year students in their academic endeavours, we must understand the factors that contribute to the difficulties experienced by these students.

**The Importance of Handwriting**

In recent years, many have argued that handwriting is a skill that is losing its importance and that the use of typing can remediate the limitations of poor handwriting (e.g., Freedman, Hull, Higgs, & Booten, 2016; Manzi, Martinez, & Durmysheva, 2017). Certainly, there has been an increase in the amount of written expression that is being completed using technology (Freedman et al., 2016). However, as Graham (2018) noted, handwriting continues to be a necessary skill.

Research has demonstrated that children who practice spelling using handwriting acquire spelling skills more quickly than those who practice spelling using typing (Cunningham & Stanovich, 1990). Additionally, handwriting skills are important predictors of the higher-order aspects of written expression (e.g., sentence structure, logical and understandable sentences paragraph structure, and audience awareness) and the relationship between handwriting and these skills is observed even when compositions are generated using technology such as laptops (Alkhamra, Al Natour, Abu Dahab, & Al Abdallat, 2012; Bayat & Küçükayar, 2016; Berninger, Nagy, Tanimoto, Thompson, & Abbott, 2015; Jones & Christensen, 1999; Medwell & Wray, 2014; Wicki Hurschler Lichtsteiner, Saxer Geiger, & Müller, 2014). As such, handwriting has

benefits over typing when it comes to the development of other, more complex aspects of written expression.

Handwriting has also been linked to children's development of reading and reading-related skills. Handwriting has frequently been found to be related to school-aged children's word reading (Beers, Mickail, Abbott, & Berninger, 2017; Berninger et al., 2006; Julius, Meir, Sheter-Nissim, & Adi-Japha, 2016). The relationship between children's word reading and handwriting may be due to their shared relationship with orthographic awareness, which is defined by Conrad, Harris, and Williams (2013) as the processing of the visual form of letters, letter clusters, and words. Orthographic awareness has been found to be closely and directly related to children's reading (Chung, Chen, & Deacon, 2018; Conrad et al., 2013; Conrad & Deacon, 2016; Mimeau, Ricketts, & Deacon, in press), and numerous studies have found relationships between children's handwriting skills and their orthographic awareness (e.g., Berninger, Cartwright, Yates, Swanson, & Abbott, 1994; Berninger & Hart, 1993). Longcamp, Zerbato-Poudou, and Velay (2005) studied the development of word reading, orthographic awareness, and phonological awareness (i.e., the understanding and manipulation of the sound structure of language) of children learning to spell using handwriting and children learning to spell using typing. The children who were learning to spell using handwriting had higher scores on measures of orthographic awareness, phonological awareness, and word reading than those who were learning to spell using typing. The authors suggested that students learning to spell using handwriting were involved in a more active learning process where they spent more time attending to each letter of the words they were spelling, due to each letter's unique formation, as compared to the rote, identical movements used when typing. The authors further explained that actively attending to the letters may also help with the development of reading-related skills and

word reading itself as it allows for children to be more aware of the forms of letters and, consequently, words.

Handwriting skills are also a predictor of math skills in children. Research has demonstrated that students with poor handwriting skills tend to make more errors in calculating math questions as compared to their peers with good handwriting skills (e.g., Maeland & Svik, 1993; Stievano, Cammisuli, Michetti, Ceccolin, & Anobile, 2018). To complete math problems, students must use their working memory, a cognitive system used to temporarily store and manipulate information (Fuchs, Compton, Fuchs, Paulsen, Bryant, & Hamlett, 2005; Geary, 2004). Just and Carpenter (1992) explained that working memory has only a certain amount of space for an individual to manipulate information. As such, when more information is added to an individuals' working memory, it can become overloaded, resulting in mistakes in the output of information. This perspective of working memory may explain why students with poor handwriting skills tend to make more mathematics errors (Stievano et al., 2018). A child who needs to spend more of the resources in their working memory on thinking about how to make their work more legible for their teacher would have fewer resources in their working memory to devote to their calculations. As well, a child who has poor handwriting skills may make errors with lining up numbers when completing math questions, resulting in the child calculating the wrong numbers together.

Handwriting has also been shown to benefit learning more generally. Mueller and Oppenheimer (2014) had university students watch one of five Ted Talks. The students were randomly assigned to groups that were provided with either a laptop or a notepad and pen, and they were told to take notes on the video as if they were taking notes in a lecture. The students who took notes using a laptop were more likely to transcribe the lecture verbatim, while the

students who took handwritten notes were more likely to summarize the material in their own words. After a delay, the participants were asked factual and conceptual questions about the material. Although no significant differences were observed on the factual questions, the students who took notes by hand scored significantly better on conceptually-based questions. The authors suggested that handwritten notes lead to more active learning of material which can help support students' academic success. Graham (2018) has also suggested that handwriting encourages a deeper, more active learning process as compared to typing. As Graham (2018) and Longcamp et al. (2005) both argue, handwriting letters and words better promotes attending to what is being written, which allows individuals to think about, and better understand, the material.

**Written Expression Difficulties and Learning Disabilities**

Individuals can struggle with written expression skills for several reasons (Dockrell, 2014). For example, some students struggle with understanding and using the rules of grammar (Wheeler, Nickerson, Webb, & Silver, 2013) while other students struggle with spelling (Charitaki, Soulis, Tzivinikou, & Peklari, 2018). For some individuals, difficulties in written expression are the result of, or are exacerbated by, poor handwriting skills (Graham, Harris, & Fink, 2000). Handwriting difficulties are common in those diagnosed with a number of conditions and disabilities, such as Attention Deficit-Hyperactivity Disorder (e.g., Brossard-Racine, Majenmer, Shevell, & Snider, 2008), Autism Spectrum Disorder (e.g., Godde, Tsao, Gepner, & Tardif, 2018), Intellectual Disability (e.g., Grindle, Cianfaglione, Corbel, Wormald, Brown, Hastings, & Hughes, 2017), and Developmental Coordination Disorder (e.g., Rosenblum, Aassy Margieh, & Engel-Yegar, 2013).

Handwriting difficulties are especially prevalent among students with Learning Disabilities, which are neurodevelopmental disorders that affect the way an individual processes

information and/or language resulting in an impairment in their ability to acquire academic skills (e.g., reading, written expression, math; Silver et al., 2008). Learning disabilities are relatively common, with lifetime prevalence rates estimated to be between 5 and 10% (Calder Stegemann, 2016; Learning Disabilities Association of Canada 2007; Moll, Kunze, Neuhoff, Bruder, & Schulte-Körne, 2014; Statistics Canada, 2015). Approximately 7 to 30% of individuals with learning disabilities have difficulty with written expression (Dockrell, 2014; Hamstra-Bletz & Blote, 1993; Katusic, Colligan, Weaver, & Barbaresi, 2009). In a meta-analysis of 53 studies, Graham, Collins, and Rigby-Wills (2017) demonstrated that students with learning disabilities scored lower than their typically-achieving peers in most areas of written expression (e.g., written expression quality [*ES* = -1.06]; organization [*ES* = -1.04]; vocabulary [*ES* = -0.89]; sentence fluency [*ES* = -0.81]; genre elements [*ES* = - 0.82]; output [*ES* = -0.87]; and writing motivation [*ES* = -0.42]). However, the most dramatic difference was in scores on measures of transcription (i.e., spelling, grammar, and handwriting; *ES* = -1.14). Graham and colleagues' (2017) results suggested that students with learning disabilities have significant difficulty with many areas of written expression, but their difficulties with the act of transcription (including handwriting) are most profound. Handwriting difficulties do not appear to be exclusive to children with specific impairments in written expression. Sumner, Connelly, and Barnett (2014) found that children with dyslexia (a learning disability in reading) have less legible and slower handwriting as compared to their peers with average to above-average reading skills.

Individuals with handwriting difficulties (with and without diagnoses) often form graphemes incorrectly and/or have larger handwriting than is developmentally typical (Graham, Struck, Santoro & Berninger, 2006). They have also difficulties with leaving consistent spaces between letters that make up words (i.e., letters are either far apart or clumped together) and/or

between words (e.g., writing *thecat* instead of *the cat*), all of which can make it difficult for others to read what has been written (Graham et al., 2006; Volman, van Schendel, & Jongmans, 2006). Engel-Yeger, Nagauker-Yanuv, and Rosenblum (2009) found that students diagnosed with dysgraphia (a learning disability in written expression) take additional time to complete assignments, even when their handwriting is relatively legible, leading the authors to conclude that handwriting is effortful for these students.

**Written Expression Difficulties of High School and University Students**

Written expression is integral to communicating knowledge and engaging in activities at work and in school (Graham, Struck, Santoro, & Berninger, 2006; McHale & Cermak, 1992). However, many individuals struggle to acquire good written expression skills. In the most recent Nova Scotia provincial language arts examination, approximately 40% of high school students did not meet basic expectations for written expression (Nova Scotia Department of Education and Early Childhood Development, 2016). The fact that high school students struggle to acquire basic written expression skills is troubling on its own, but it is also concerning considering the fact that enrollment rates at universities and colleges in Canada have doubled over the last 30 years, and are expected to continue to increase (AUCC, 2011). This means that many of these students in Nova Scotia will likely be entering post-secondary education of some kind, where the writing demands are more intense than those in high school (Fallahi, Wood, Austad, & Fallahi, 2006). If these students' written expression difficulties at the high school level are any indication, they will likely struggle even more with the written expression demands of the post-secondary education environment. Indeed, university instructors commonly report that a substantial portion of first-year university students arrive without the basic written expression skills needed to succeed in a post-secondary setting (Fallahi et al., 2006; Holtzman, Elliot, Biber,

& Sanders, 2005; Rawson, Quinlan, Cooper, Fewtrell, & Matlow, 2005; Whitehead, 2002). Further, post-secondary students themselves report difficulty with written expression more often than they report difficulties with math and reading (Rachal, Daigle, & Rachal, 2007). Outside of post-secondary education, 81% of surveyed employers report that high school graduates are ill-equipped when it comes to forms of written expression for the workplace, such as memos, notes, and reports to coworkers (Casner-Lotto & Barrington, 2006). Overall, it is clear that many students who are graduating from high schools have not acquired the written expression skills needed for post-secondary settings and or to prepare them for occupational environments.

Research suggests that some university students may have difficulty with written expression due to difficulties with handwriting. Connelly, Dockrell, and Barnett (2005) studied the relationship between university students' handwriting fluency and the quality of their essay responses on a mock exam. The students in this sample wrote a mean of 76.5 letters per minute (*SD* = 10.7). This rate is akin to previously published data for children in grade 5 (*M* = 72.75, *SD* = 15.21; Graham et al., 1998a). Connelly et al.'s (2005) results suggest that some students who had average handwriting skills when they were children may not show improvements in handwriting fluency between elementary school and post-secondary education. This may be problematic for these students. If these individuals are writing at the same pace and with the same skills as they did when they were younger, then they may not be able to meet the increased written expression demands of university. Indeed, the students in Connelly's study struggled not only with fluent handwriting, but they also demonstrated difficulty with expressing their comprehension of the material. Additionally, the scores on handwriting fluency accounted for 41% of the variance in the quality of the students' essays, and the students who had the least fluent handwriting tended to also have the lower quality essays. The authors suggest the findings

of their study support the assertion that handwriting can constrain overall quality of written expression, and they also suggest that university students may struggle with written expression skills in part due to their difficulties with handwriting fluency.

**The Effect of Handwriting Style on Handwriting Skills**

An additional factor that may affect handwriting skills is the style (i.e., cursive or print) of handwriting used. There has been debate regarding the effect of handwriting style on students' handwriting speed, handwriting legibility, and other written expression skills (Ediger, 2002). There is little agreement within the fields of education, policy, and research whether one style (print or cursive) has specific benefit over the other (Ediger, 2002). Ediger (2002) pointed out that there is a case to be made for both styles. He noted that cursive can be preferred because there are no gaps between letters and it is therefore the quicker style of handwriting to use. On the other hand, because print is like the text used in most reading material (e.g., books, signs), some argue that it is easier to learn to print first and that the skills developed when learning to print can support the later development of cursive handwriting (Ediger, 2002). Indeed, in Canada, most students begin their school career by learning print in grade 1, with cursive being introduced around grade 3 (Morin, Lavoie, & Montesinos, 2012).

However, research findings are mixed. In studies of elementary school-aged children, students who use cursive handwriting are indeed sometimes shown to be more fluent handwriters than those who use print handwriting (Ediger, 2002; Morin et al., 2012). However, both Meulenbroek and Van Galen (1990) and Bara and Morin (2013) found that elementary school-aged children who used print handwriting copied text more fluently than those who used cursive handwriting. In terms of legibility, Bo and colleagues (2014a) found that school-aged children produced more legible and accurate letters in print as compared to cursive letters Some

researchers have suggested that students who use a mix of print and cursive are more fluent handwriters than students who use just one or the other. In a study of 600 students in grades 4 to 6, Graham, Weintraub and Berninger (1998b) found that there was no difference in handwriting fluency between students who used only print or only cursive. Instead, Graham et al. (1998) found that students who used a mix of the two styles were faster than those who used only one style. Additionally, in a study of grade 2 students in Quebec, Morin et al. (2012) found that, at both the beginning and the end of the school year, students who only used cursive and students who only used print were both slower than their peers who used a mix of print and cursive. These studies seem to suggest that using only one style may not necessarily be advantageous when it comes to fluency, but instead support students using a mix of the two styles.

It is important to consider that our ability to come to definite conclusions is greatly limited by the fact that almost all studies on handwriting have focused solely on elementary school-aged children who are just learning to handwrite (Graham, 2018). Potentially, the effect of handwriting style on handwriting fluency and legibility observed in the current literature may be the result of the developmental process of learning to handwrite. Children begin their handwriting development after the first year of life by scribbling lines (Dockrell, 2014). By age three, most children can draw simple straight lines and circles, shapes that are used more frequently in print than cursive (Bo et al., 2014a). Bo and colleagues argued that because of this early exposure, children are more adept at producing straight lines and circles (i.e., at printing) than at producing the slanted or curved lines used in cursive. Further, Graham (1992) noted that children need to move their hands and wrists more when forming cursive letters than when they form print letters. Because younger children's motor control is limited, they have trouble with

these actions, making their production of cursive letters to be less legible and less fluent. To determine the role of development, more longitudinal research would be necessary.

## Evidence-based Handwriting Instruction

Unlike speech, but similar to reading, handwriting is not a naturally acquired skill. Instead, it is a skill that must be taught. As such, evidence-based handwriting instruction is one crucial step to addressing handwriting difficulties (Graham, 2018). It should be noted that, at present, there is no gold standard for handwriting instruction. However, research has identified five key components of evidence-based handwriting instruction. A summary of these components follows.

**Explicit instruction.** A general recommendation from the literature is to provide explicit instruction. Explicit instruction is defined as systematic and specific instruction in a specific area (Berninger et al., 1997; Graham, 2010). For handwriting, there are two components of explicit instruction: explicit instruction about pencil grip and explicit instruction about letter formation (Graham, 2010, 2018). Explicit instruction is especially imperative for helping children to develop efficient handwriting (Graham, 2010).

***Explicit instruction in pencil grip.*** To handwrite, legibly and fluently, we need to hold our pens and pencils in a way that allows the muscles in our wrists and fingers to allow us full control over these utensils to legibly form letters (Graham, 2010). Although there are multiple ways to grip a pen or pencil, some ways allow easier use of these muscles than others. For instance, a tripod grip (where the pen or pencil is rested on the pads of the thumb and index finger, while being supported by the middle finger) allows a better range of motion with which to handwrite without moving the elbow compared to other grips, such as a fisted grip (where the pen or pencil firmly grasped by all five fingers). A larger range of motion allows for a steadier

and less effortful handwriting production. As such, Graham (2010) has suggested that teachers need to specifically demonstrate an effective grip, such as a tripod grip, to their students to help ease the potential fatigue and discomfort that can occur when learning to handwrite. It is important that as children practice handwriting, their teachers explicitly encourage the use of an efficient grip (Graham, 2010). Teachers must correct their students who use inefficient grips (such as a fisted grip) and help them practice and become comfortable with a grip that will help them gain better control over their writing utensil (Graham, 2010). Because English writers write from left to right, left-handed individuals should also hold their pen or pencil slightly further back from the tip to avoid smearing text that they have already written (Edwards, 2003). Similarly, left-handed students should be taught to place their paper tilted slightly to the right to reduce the possibility of smearing already written text (Graham, 2010). The explicit instruction in the use of these writing tools is important so that children can write comfortably, minimizing the effort needed for the mechanics of handwriting (Troia and Graham, 2003).

***Explicit instruction in letter formation.*** Explicit instruction is not just needed for using writing tools; children also need to be explicitly taught the symbols of their language. To write English, knowledge of how to form the letters of the alphabet is required. It is recommended that teachers explicitly and systematically teach their students the names of the letters while also coordinating instruction in forming letters (Troia & Graham, 2003). Troia and Graham (2003) also suggested that each letter should be specifically taught and differences between upper- and lower-case letters, and letters that are like each other (e.g., b and d) should be explained. Troia and Graham (2003) suggested that teaching similar letters at times close to each other may be confusing for children who end up struggling to remember the differences between the letters. Jongbloed-Pereboom, Peeters, Overvelde, Nijhuis-van der Sanden, and Steenbergen (2015)

found that explicit, verbal instruction about legibility helped increase handwriting fluency for both children with Intellectual Disabilities and their typically-developing peers. In summary, explicit instruction in handwriting is beneficial for improving legibility and fluency.

**Visual cues.** Another beneficial component of handwriting instruction is for the teacher to guide students through the formation of letters with visual cues, such as arrows (Edwards, 2003; Graham et al., 2008). Berninger et al. (1997) studied 144 Grade 1 students who were identified as being at-risk of developing handwriting difficulties. These students were assigned to one of five experimental intervention groups (motor imitation; visual cue; memory retrieval; visual cue + memory retrieval; or copy) or into the phonological awareness (control) group. Each group met twice a week for twelve weeks. The visual cue, memory retrieval and the visual cue + memory retrieval groups had the largest improvement in handwriting legibility and copying fluency under timed conditions. More specifically, the visual cue and memory retrieval group had the largest improvement of the three. The results of Berninger and colleagues (1997) suggest that visual cues are helpful for developing handwriting skills. Troia and Graham (2003) further suggest that teachers should use a scaffolding strategy; teachers should begin by encouraging students to trace letters using visual cues, before moving on to copying letters using visual cues, and eventually moving up to writing the letters by memory (Troia & Graham, 2003).

**Teacher feedback.** The feedback that teachers provide their students has also been found to be crucial for handwriting. Asher (2006) found that when teachers help students identify incorrect or poorly formed letters and encourage them to rewrite poorly formed letters, students are more likely to correct these letters. It is also recommended that teachers also praise and encourage correctly formed letters (Cutler & Graham, 2008).

As well, although teachers should provide feedback on students' handwriting, some scaffolding should occur. For example, teachers could move from providing feedback on letters to having their students identify which of their own letters they have formed correctly and what letters need improvement (Graham et al., 2008; Troia & Graham, 2003).

**Daily, independent practice**. Handwriting instruction should be a frequent, ideally daily, part of the classroom environment in elementary school (Edwards, 2003). Graham et al. (2012) found that 15 minutes of handwriting time per day improved students' handwriting fluency and legibility. It is important to note that only 5-10 minutes per day should be devoted explicitly to instruction, and the rest of handwriting time should be devoted to guided practice (Beringer & Richards, 2002). Generally, research supports, short but frequent amounts of handwriting instruction and practice time in the classroom (Beringer et al., 1997; Graham et al., 2008). As well, students' independent practice has been shown to be crucial for handwriting development. Graham et al. (2008) recommended that teachers present their students with opportunities to write on their own (e.g., by encouraging students to complete assignments by hand, not just on a computer). Further, students should be encouraged to create their own goals when it comes to learning to write (Troia & Graham, 2003).

Although no absolute gold-standard exists for handwriting instruction, the literature has identified the previously described components (explicit instruction in pencil grip, explicit instruction in letter formation, visual cues, teacher feedback, and daily, independent practice) as being vital for the development of functional handwriting ability. A meta-analysis by Santangelo and Graham (2016) found that evidence-based handwriting instruction improves legibility and fluency. Further, the authors noted that use of these components of evidence-based handwriting instruction also had positive effects on students' higher order written expression processes (e.g.,

length, quality). Santangelo and Graham also noted that these benefits were demonstrated in children from grades primary to nine, in students with handwriting difficulties, with and without specific diagnoses, and in those who had average handwriting skills. In summary, to be effective and evidence-based, handwriting instruction must include these components.

**Handwriting Instruction in Schools**

Although these components of handwriting instruction seem to be effective in helping students develop handwriting skills, not all educational jurisdictions have policies that require instruction using these components. Graham and colleagues (2008) reported that 79% of school districts in the United States included handwriting in their curriculum, and over 90% of surveyed kindergarten to grade 3 teachers included handwriting instruction in their classroom. These teachers also reported that they taught handwriting for approximately 70 minutes per week, well within the suggested amount. However, the teachers expressed concern about whether their instruction was effective. The authors also noted that, although handwriting was included within the curriculums, not all curricula seemed to adhere to evidence-based instruction.

Several studies have highlighted a disconnect between what the research literature suggests is evidence-based handwriting instruction and the handwriting instruction that is employed in schools. Vander Hart and colleagues (2010) examined the handwriting curriculums used by four kindergarten teachers and compared them to the components of evidence-based handwriting instruction supported by the literature. The authors noted that the four teachers were using some components of evidence-based handwriting instruction (e.g., use of visual cues). However, they noted that the teachers did not consistently implement most components of evidence-based handwriting instruction, such as explicit instruction in pencil grip or letter formation, scaffolding in their feedback, or daily, independent practice. Although their sample

size was quite small, their results do indicate that some teachers may not be using effective strategies to teach handwriting. Graham and colleagues (2008) also noted that one in ten teachers taught handwriting only once per week or less, far less than what is recommended by the literature. Asher and Estes (2016) surveyed elementary school teachers across the midwestern United States on their handwriting instructional practices. Many of the teachers reported using some form of evidence-based handwriting instruction; however, approximately a quarter of the respondents reported using practice outside of those supported by the research.

One reason why teachers do not engage in these effective practices could be the lack of focus on handwriting in jurisdictional curriculums. Nye and Sood (2018) interviewed nine kindergarten teachers on their perceptions of handwriting instruction in schools. The teachers identified the lack of a handwriting curriculum as a primary barrier to providing handwriting instruction. These teachers felt a lack of guidance on how best to teach handwriting, especially to children who are experiencing difficulty with learning to handwrite. Minimal focus on handwriting in the curriculum is also an area of concern in Nova Scotia. Alexander (2015) compared evidence-based handwriting instructional practices and two Nova Scotia curriculum documents, the Nova Scotia Language Arts curriculum (Nova Scotia Department of Education and Early Childhood Development, 2015) and the Teaching in Action, Grades Primary-3 document (Nova Scotia Department of Education, 2006). Alexander (2015) found that neither document explicitly mentioned handwriting skills as a specific outcome; instead the two focused on the compositional aspects of writing. At the moment in Nova Scotia, teachers are not required or encouraged to teach handwriting skills to students.

If teachers do opt to spend time teaching handwriting, they will, in many cases, be without specific guidance on the best practices to teach this skill. This is troublesome, as only

12% of teachers reported that their education has made them feel adequately prepared to teach handwriting (Graham et al., 2008). This lack of confidence among teachers is not surprising, as only 34% of teachers reported taking at least one course in handwriting instruction during their training (Donica, Larson, & Zinn, 2012). Additionally, less than one-third of teachers reported participation in professional development related to handwriting instruction (Donica et al., 2012). As a result, it is clear that many teachers are underequipped to teach handwriting, and this could lead to a great deal of variability in the handwriting instruction students receive. This is problematic, because, as Asher (2006) noted, varying quality in handwriting instruction is detrimental to the development of students' handwriting.

# CHAPTER TWO: EXPLORING HANDWRITING USE, HANDWRITING INSTRUCTION, AND HANDWRITING QUALITY OF FIRST-YEAR UNIVERSITY STUDENTS

Written expression plays a significant role in our society. In university, students need to take notes and to display their comprehension by composing written text (Graham & Perin, 2007). The National Commission on Writing for America's Families, Schools, & Colleges (NCWAFSC; 2003; 2004) noted that outside of school, many high-paying jobs require sound written expression skills (e.g., for reports, communication with colleagues). Further, some trends suggest that demands for on-the-job written expression proficiency will only increase in the future (Bazerman, 2006; Smart, 2008). Research also suggests that written expression can be therapeutic for physical and psychological distress (Baikie & Wilhelm, 2005). Certainly, being able to write is important not just in educational settings, but also in everyday life. However, written expression is a broad term that is comprised of several different, closely connected skills, and one of these important, but often overlooked, skills is handwriting

## Importance of Handwriting

Broadly, handwriting is an important skill for all people, as we handwrite in many different circumstances, such as when filling out application forms, signing our name on a bank cheque, or during written portions of job interviews. For students, strong handwriting skills are especially essential. Students are often required to write responses on tests and examinations (e.g., essay questions) to display their understanding of course material (Graham & Perin, 2007). If these tests and exams are handwritten, students' handwriting must be legible enough so that the marker can read the students' responses. Students must also be able to handwrite fluently so that they can produce enough text and information to demonstrate their understanding within a limited amount of time. Additionally, students must also make notes during lectures (Graham & Perin, 2007). As with essay questions, handwriting fluency and legibility are important for good

note-taking; students must keep up with the speech of the lecturer, while also producing text that is easy to read when the student is studying or organizing their notes. Indeed, handwriting fluency has frequently been found to account for a significant portion of the variance in quality of undergraduate students' note-taking (Manzi, Martinez, & Durmysheva, 2017; Peverly et al., 2007; Peverly & Sumowski, 2011; Peverly et al., 2013).

Handwritten work has also been shown to be beneficial in terms of academic performance. Mueller and Oppenheimer (2014) asked students to record notes during a lecture. Half of the participants were instructed to handwrite these notes, while the other half was told to type their notes. The students who had handwritten their notes scored higher on tests of the lecture material that had been administered immediately following the class and following a delay than those who had been asked to type. Additionally, some researchers have noted that handwriting supports the development of higher-order written expression skills, such as sentence production, grammar, and audience awareness, and that these skills may later be transferred to typed text (e.g., Alkhamra et al., 2016; Berninger et al., 2015; Jones & Christensen, 1999; Medwell & Wray, 2014; Wicki et al., 2014). In a study of students in years 5 and 6 (the British equivalent to grades 4 and 5)**,** Connelly, Gee, and Walsh (2007) found that handwritten text was written more fluently, had higher word counts, contained fewer grammatical mistakes, and was more logical than texts that were typed. Finally, Anthony, Yang, and Koedinger (2007) found that students reported handwriting to be more flexible than typing when it comes to math and other academic areas where spatial arrangement is important. Even with the technology that is available in the 21st century, the importance of handwriting to learning cannot be overlooked

## Handwriting Use

One common argument against the continuation of handwriting instruction is that students no longer need to use handwriting in the classroom as recent technology has made it possible to accomplish these tasks using a laptop or other technology (e.g., Sharp & Titus, 2016). Sharp and Titus (2016) explored the perspective of handwriting instruction among 39 literacy teachers. Many of the teachers in this study perceived handwriting instruction as "antiqued" or "a waste of time." Several teachers indicated that their only perceived use of teaching handwriting was to help students to read historical documents that may be written in cursive and/or to be able to sign their names on forms. Many of the teachers felt that, otherwise, time was better spent teaching keyboarding or typing skills, as these were skills the teachers perceived students used more frequently. Indeed, several studies by Mogey and colleagues have suggested that university students are more likely to choose typing over handwriting for long answer questions on examinations in the classroom (Mogey & Fluck, 2015; Mogey & Hartley, 2013; Mogey, Patterson, Burk, & Purcell, 2010).

Although the above studies seem to suggest support for handwriting and handwriting instruction is becoming less common in schools (e.g., Sharp & Titus, 2016), it is important to consider the limitations of these studies. First, Sharp and Titus (2016) studied teachers' perceptions of the value of handwriting, rather than looking at the percentage of time handwriting was actually used by students. It is possible that students are using handwriting more than these teachers perceived. Second, the studies looking at students' choice between handwriting and typing for examinations are limited in several ways. The samples for each of those studies were all obtained from the same singular campus in the United Kingdom. As well, in those studies, students were allowed to choose which modality to use; consequently, these

studies may not be naturalistic as some universities have policies about using technology unless required as part of an academic accommodation for a disability (Graham & Perin, 2007). Further, they only explore students' use of handwriting for written examinations, and do not explore use of handwriting for other academic tasks, such as note-taking.

**Written Expression and Handwriting Difficulties**

Despite the fact that written expression is necessary to appropriately communicate understanding and to fully participate in activities at work and in school (Graham, Struck, Santoro, & Berninger, 2006; McHale & Cermak, 1992), many individuals struggle to acquire good written expression skills. In the most recent Nova Scotia provincial language arts examination, approximately 40% of high school students did not meet basic expectations for written expression (Nova Scotia Department of Education and Early Childhood Development, 2016). Over the last 30 years, enrollment rates at universities and colleges in Canada have doubled (AUCC, 2011), meaning that many of these Nova Scotia students are likely going to enter post-secondary education of some kind, where the writing demands are more intense than those in high school (Fallahi, Wood, Austad, & Fallahi, 2006). If their written expression difficulties at the high school level are any indication, these students will likely struggle with the written expression demands of the post-secondary education environment. Indeed, university instructors commonly report that a substantial portion of first-year university students arrive without the basic written expression skills needed to succeed in a post-secondary setting (Fallahi et al., 2006; Holtzman, Elliot, Biber, & Sanders, 2005; Rawson, Quinlan, Cooper, Fewtrell, & Matlow, 2005; Whitehead, 2002). Further, students themselves report difficulty with written expression more often than they report difficulties with math and reading (Rachal, Daigle, & Rachal, 2007). Even high school graduates who do not intend to attend post-secondary education

are likely not acquiring the skills needed to function in the workplace, as evidenced by the fact that 81% of surveyed employers report that high-school graduates are ill-equipped when it comes to using written expression for workplace tasks such as writing memos, notes, and reports for their coworkers (Casner-Lotto & Barrington, 2006). Overall, it is clear that students who are graduating from high schools have not acquired the written expression skills needed for post-secondary or occupational environments.

Individuals can struggle with written expression skills for several reasons (Dockrell, 2014). Some students struggle with understanding and using the rules of grammar (Wheeler, Nickerson, Webb, & Silver, 2013) while other students struggle with spelling (Charitaki, Soulis, Tzivinikou, & Peklari, 2018). For some individuals, difficulties in written expression are the result of, or are exacerbated by, poor handwriting skills (Graham, Harris, & Fink, 2000).

Research suggests that some university students have difficulty with handwriting and that this is associated with difficulty with written expression. Connelly et al. (2005) studied the relationship between university students' handwriting fluency and the quality of their essay responses on a mock exam. The students in this sample wrote a mean of 76.5 letters per minute (*SD* = 10.7). This rate is akin to previously published data for children in grade 5 (*M* = 72.75, *SD* = 15.21; Graham et al., 1998a). Connelly et al.'s (2005) results suggest that some students who had average handwriting skills when they were children may not show improvements in handwriting fluency between elementary school and post-secondary education. This may be problematic for these students, because if individuals are writing at the same pace and with the same skills as they did when they were younger, they may not be able to meet the increased written expression demands of university.

**The Effect of Handwriting Style on Handwriting Skills**

An additional factor that may affect handwriting skills is the style (i.e., cursive or print) of handwriting used. There has been debate regarding the effect of handwriting style on students' handwriting speed, handwriting legibility, and other written expression skills (Ediger, 2002). There is little agreement within the fields of education, policy, and research whether one style (print or cursive) has specific benefit over the other (Ediger, 2002). Ediger (2002) pointed out that there is a case to be made for both styles. He noted that cursive can be preferred because there are no gaps between letters and it is therefore the quicker style of handwriting to use. On the other hand, because print is like the text used in most reading material (e.g., books, signs), some argue that it is easier to learn to print first and that the skills developed when learning to print can support the later development of cursive handwriting (Ediger, 2002). In Canada, most students begin their school career by learning print in grade 1, with cursive being introduced around grade 3 (Morin, Lavoie, & Montesinos, 2012).

Research findings about the benefits of print and cursive handwriting are mixed. In studies of elementary school-aged children, students who use cursive handwriting are indeed sometimes shown to be more fluent handwriters than those who use print handwriting (Ediger, 2002; Morin et al., 2012). However, both Meulenbroek and Van Galen (1990) and Bara and Morin (2013) found that elementary school-aged children who used print handwriting copied text more fluently than those who used cursive handwriting. In terms of legibility, Bo and colleagues (2014a) found that school-aged children produced more legible and accurate letters in print as compared to cursive letters Some researchers have suggested that students who use a mix of print and cursive are more fluent handwriters than students who use just one or the other. In a study of 600 students in grades 4 to 6, Graham, Weintraub and Berninger (1998b) found that there was no

difference in handwriting fluency between students who used only print or only cursive. Instead, Graham et al. (1998b) found that students who used a mix of the two styles were faster than those who used only one style. Additionally, in a study of grade 2 students in Quebec, Morin et al. (2012) found that, at both the beginning and the end of the school year, students who only used cursive and students who only used print were both slower than their peers who used a mix of print and cursive. These studies seem to suggest that using only one style may not necessarily be advantageous when it comes to fluency, but instead support students using a mix of the two styles.

It is important to consider that our ability to come to definite conclusions is greatly limited by the fact that almost all studies on handwriting have focused solely on elementary school-aged children who are just learning to handwrite (Graham, 2018). Potentially, the effect of handwriting style on handwriting fluency and legibility observed in the current literature may be the result of the developmental process of learning to handwrite. Children begin their handwriting development after the first year of life by scribbling lines (Dockrell, 2014). By age three, most children can draw simple straight lines and circles, shapes that are used more frequently in print than cursive (Bo et al., 2014a). Bo and colleagues argued that because of this early exposure, children are more adept at producing straight lines and circles (i.e., at printing) than at producing the slanted or curved lines used in cursive. Further, Graham (1992) noted that children need to move their hands and wrists more when forming cursive letters than when they form print letters. Because younger children's motor control is limited, they have trouble with these actions, making their production of cursive letters to be less legible and less fluent. To determine the role of development, more longitudinal research would be necessary.

## Evidence-based Handwriting Instruction

Unlike speech, but similar to reading, handwriting is not a naturally acquired skill. Instead, it is a skill that must be taught. As such, quality handwriting instruction is one crucial step to addressing handwriting difficulties (Graham and Harris, 2002). It should be noted that, at present, there is no gold standard for handwriting instruction. However, the literature has identified five key components of instruction that are particularly effective for teaching handwriting.

**Explicit instruction.** A general recommendation from the literature is to provide explicit instruction. Explicit instruction is defined as systematic and specific instruction in a specific area (Berninger et al., 1997; Graham, 2010). For handwriting, there are two components of explicit instruction: explicit instruction about pencil grip and explicit instruction about letter formation (Graham, 2010, 2018). Explicit instruction is especially imperative for helping children to develop efficient handwriting (Graham, 2010).

***Explicit instruction in pencil grip.*** To handwrite, legibly and fluently, we need to hold our pens and pencils in a way that allows the muscles in our wrists and fingers to allow us full control over these utensils to legibly form letters (Graham, 2010). Although there are multiple ways to grip a pen or pencil, some ways allow easier use of these muscles than others. For instance, a tripod grip (where the pen or pencil is rested on the pads of the thumb and index finger, while being supported by the middle finger) allows a better range of motion with which to handwrite without moving the elbow compared to other grips, such as a fisted grip (where the pen or pencil firmly grasped by all five fingers). A larger range of motion allows for a steadier and less effortful handwriting production. As such, Graham (2010) has suggested that teachers need to specifically demonstrate an effective grip, such as a tripod grip, to their students to help

ease the potential fatigue and discomfort that can occur when learning to handwrite. It is important that as children practice handwriting, their teachers explicitly encourage the use of an efficient grip (Graham, 2010). Teachers must correct their students who use inefficient grips (such as a fisted grip) and help them practice and become comfortable with a grip that will help them gain better control over their writing utensil (Graham, 2010). Because English writers write from left to right, left-handed individuals should also hold their pen or pencil slightly further back from the tip to avoid smearing text that they have already written (Edwards, 2003). Similarly, left-handed students should be taught to place their paper tilted slightly to the right to reduce the possibility of smearing already written text (Graham, 2010). The explicit instruction in the use of these writing tools is important so that children can write comfortably, minimizing the effort needed for the mechanics of handwriting (Troia and Graham, 2003).

***Explicit instruction in letter formation.*** Explicit instruction is not just needed for using writing tools; children also need to be explicitly taught the symbols of their language. To write English, knowledge of how to form the letters of the alphabet is required. It is recommended that teachers explicitly and systematically teach their students the names of the letters while also coordinating instruction in forming letters (Troia & Graham, 2003). Troia and Graham (2003) also suggested that each letter should be specifically taught and differences between upper- and lower-case letters, and letters that are like each other (e.g., b and d) should be explained. Troia and Graham (2003) suggested that teaching similar letters at times close to each other may be confusing for children who end up struggling to remember the differences between the letters. Jongbloed-Pereboom, Peeters, Overvelde, Nijhuis-van der Sanden, and Steenbergen (2015) found that explicit, verbal instruction about legibility helped increase handwriting fluency for

both children with Intellectual Disabilities and their typically-developing peers. In summary, explicit instruction in handwriting is beneficial for improving legibility and fluency.

**Visual cues.** Another beneficial component of handwriting instruction is for the teacher to guide students through the formation of letters with visual cues, such as arrows (Edwards, 2003; Graham et al., 2008). Berninger et al. (1997) studied 144 Grade 1 students who were identified as being at-risk of developing handwriting difficulties. These students were assigned to one of five experimental intervention groups (motor imitation; visual cue; memory retrieval; visual cue + memory retrieval; or copy) or into the phonological awareness (control) group. Each group met twice a week for twelve weeks. The visual cue, memory retrieval and the visual cue + memory retrieval groups had the largest improvement in handwriting legibility and copying fluency under timed conditions. More specifically, the visual cue and memory retrieval group had the largest improvement of the three. The results of Berninger and colleagues (1997) suggest that visual cues are helpful for developing handwriting skills.

**Teacher feedback.** The feedback that teachers provide their students has also been found to be crucial for handwriting. Asher (2006) found that when teachers help students identify incorrect or poorly formed letters and encourage them to rewrite poorly formed letters, students are more likely to correct these letters. It is also recommended that teachers also praise and encourage correctly formed letters (Cutler & Graham, 2008). As well, although teachers should provide feedback on students' handwriting, some scaffolding should occur; teachers should move from providing feedback on letters to having their students identify which of their own letters they have formed correctly and what letters need improvement (Graham et al., 2008; Troia & Graham, 2003).

**Daily, independent practice.** Students' independent practice has been shown to be crucial for handwriting development. Graham et al. (2008) recommended that teachers present their students with opportunities to write on their own (e.g., by encouraging students to complete assignments by hand, not just on a computer). Graham et al. (2012) found that spending even 15 minutes on independent practice per day improved students' handwriting fluency and legibility. It is important to note that only 5-10 minutes per day should be devoted to explicit instruction, and the rest of handwriting time should be devoted to independent practice (Beringer & Richards, 2002). Further, students should be encouraged to create their own goals when it comes to learning to handwrite (Troia & Graham, 2003). Generally, research supports, short but frequent amounts of handwriting instruction and practice time in the classroom (Beringer et al., 1997; Graham et al., 2008).

Although no absolute gold-standard exists for handwriting instruction, the literature has identified the previously described components (explicit instruction in pencil grip, explicit instruction in letter formation, visual cues, teacher feedback, and daily, independent practice) as being vital for the development of functional handwriting ability. A meta-analysis by Santangelo and Graham (2016) found that evidence-based handwriting instruction improves legibility and fluency. Further, the authors noted that use of these components of evidence-based handwriting instruction also had positive effects on students' higher order written expression processes (e.g., length, quality). Santangelo and Graham also noted that these benefits were demonstrated in children from grades primary to nine, in students with handwriting difficulties, with and without specific diagnoses, and in those who had average handwriting skills. In summary, to be effective and evidence-based, handwriting instruction must include these components.

## Handwriting Instruction in Schools

Although these components of handwriting instruction seem to be effective in helping students develop handwriting skills, not all educational jurisdictions adhere to these guidelines. Graham and colleagues (2008) reported that 79% of school districts in the United States included handwriting in their curriculum, and over 90% of surveyed kindergarten to grade 3 teachers included handwriting instruction in their classroom. These teachers also reported that they taught handwriting for approximately 70 minutes per week, well within the suggested amount. However, the teachers expressed concern about whether their instruction was effective. The authors also noted that, although handwriting was included within the curriculums, not all curricula seemed to adhere to evidence-based instruction.

Several studies have highlighted a disconnect between what the research literature suggests is evidence-based handwriting instruction and the handwriting instruction that is employed in schools. Vander Hart and colleagues (2010) examined the handwriting curriculums used by four kindergarten teachers and compared them to the components of evidence-based handwriting instruction supported by the literature. The authors noted that the four teachers were using some components of evidence-based handwriting instruction (e.g., use of visual cues). However, they noted that the teachers did not consistently implement most components of evidence-based handwriting instruction, such as explicit instruction in pencil grip or letter formation, scaffolding in their feedback, or daily, independent practice. Although their sample size was quite small, their results do indicate that some teachers may not be using effective strategies to teach handwriting. Graham and colleagues (2008) also noted that one in ten teachers taught handwriting only once per week or less, far less than what is recommended by the literature. Asher and Estes (2016) surveyed elementary school teachers across the midwestern

United States on their handwriting instructional practices. Many of the teachers reported using some form of evidence-based handwriting instruction; however, approximately a quarter of the respondents reported using practice outside of those supported by the research.

One reason why teachers do not engage in these effective practices is the lack of focus on handwriting in jurisdictional curriculums. Nye and Sood (2018) interviewed nine kindergarten teachers on their perceptions of handwriting instruction in schools. The teachers identified the lack of a handwriting curriculum as a primary barrier to providing handwriting instruction. These teachers felt a lack of guidance on how best to teach handwriting, especially to children who are experiencing difficulty with learning to handwrite. Minimal focus on handwriting in the curriculum is also an area of concern in Nova Scotia. Alexander (2015) compared evidence-based handwriting instructional practices and two Nova Scotia curriculum documents, the Nova Scotia Language Arts curriculum (Nova Scotia Department of Education and Early Childhood Development, 2015) and the Teaching in Action, Grades Primary-3 document (Nova Scotia Department of Education, 2006). Alexander (2015) found that neither document explicitly mentioned handwriting skills as a specific outcome; instead the two focused on the compositional aspects of writing. As such, teachers in Nova Scotia are not required to teach handwriting skills to students.

If teachers do opt to spend time teaching handwriting, they will, in many cases, be without specific guidance on the best practices to teach this skill. This is troublesome, as only 12% of teachers report that their education has made them feel adequately prepared to teach handwriting (Graham et al., 2008). A lack of confidence among teachers is not surprising, as only 34% of teachers report taking at least one course in handwriting instruction during their training (Donica, Larson, & Zinn, 2012). Additionally, less than a third of teachers report

participation in professional development related to handwriting instruction (Donica et al., 2012). As a result, it is clear that many teachers are underequipped to teach handwriting, which could lead to a great deal of variability in the handwriting instruction students receive. This is problematic, because, as Asher (2006) noted, varying quality in handwriting instruction is detrimental to the development of students' handwriting.

It is important to consider some of the limitations of the current research on handwriting instruction. First, the lack of inclusion of the components of evidence-based handwriting instruction have focused greatly on curriculums and classrooms in the United States, leaving the inclusion of the components of evidence-based handwriting instruction in other countries, such as Canada, largely unexplored. As well, these studies have examined what teachers report doing in their classrooms, and do not explore what students recall or notice about their handwriting instruction. Most research on handwriting has largely focused on elementary school-aged children (Graham, 2018), although some research does suggest that many university students are not able to handwrite fluently and legibly and that this contributes to their difficulty with written expression. Although we know that there are cognitive and academic benefits to using handwriting, some (e.g., Sharp & Titus, 2016) assert that handwriting is a "dying" form of communication, but there is a lack of research that looks at whether and for what tasks university students are continuing to use handwriting. The current study aims to address these gaps in the literature by answering the following questions.

## Research Questions and Hypotheses

**Research area one.** We know that there are cognitive benefits of handwriting, especially for students' memory for course material (Mueller & Oppenheimer, 2014) and higher order written expression processes (Connelly et al., 2005). We also know that using handwriting

supports the development of students' handwriting fluency and legibility (Toria & Graham, 2003). However, the lack of handwriting instruction in schools coupled with the easy availability of technology (e.g., laptops, phones) for electronic communication could mean that students do not actually use handwriting very often. Therefore, the first research question is: What proportion of the time do first-year university students report using handwriting and typing for academic tasks when they were in high school and in university? Based on Sharp and Titus (2016) and Mogey and colleagues' previous research, it is possible that students may report using handwriting less than typing. The second research question in this area is: Is there a change in the amount of reported handwriting use between high school and university? Laptop and computer use may be encouraged or even required in many university courses. Therefore, it is anticipated that there would be a decrease in reported handwriting use between high school and university. Finally, the third research question in this area is: What do first-year university students report about non-academic use of handwriting? Based on data from the NCWAFSC (2003; 2004) and anecdotes, handwriting is used in occupational settings for tasks such as making notes for colleagues and reporting information and at home for communicating with family members. As such, it is anticipated that students would report using handwriting for similar tasks at work and at home.

**Research area two**. Connelly et al. (2005) found that many university students in their study had slow handwriting fluency. To build on this research, the second research area is the quality (legibility and fluency) of first-year students' handwriting. More specifically, three questions will be answered. First, how many upper- and lower- case, print and cursive letters are students able to form legibly? Previous research has indicated that handwriting is often not included in curriculums (e.g., Alexander, 2015), many teachers report not knowing about the

components of evidence-based handwriting instruction (Nye & Sood, 2018), and anecdotal evidence suggests that the little handwriting instruction that students receive is on print handwriting compared to cursive handwriting. Consequently, it is hypothesized that students will be able to correctly form more print letters than cursive letters. As well, because the rules of grammar and capitalization lead to upper-case letters being used in text less often than lower-case, it is anticipated that students will be able to correctly form fewer upper-case than lower-case letters. It is particularly anticipated that students will be able to correctly form fewer upper-case cursive letters than any other type of letter, as upper-case cursive letters are the letters that the students would use the least frequently.

The second research question in this area is: What types of handwriting legibility errors do students make? Based on previous research that suggests many students have received little explicit instruction in letter formation (e.g., Vander Hart et al., 2010), it is anticipated that most errors would result from omissions of letters, using incorrect style, or be globally incorrect due to a lack of knowledge of correct letter formation.

The third research question in this area is: does handwriting fluency differ depending of the style (only print, only cursive, or typical) of handwriting used? Previous research has indicated that children's handwriting fluency is highest when they use a mix of print and cursive followed by when they use only print, and their handwriting fluency scores are lowest when they use only cursive (Graham et al., 1998b; Morin et al., 2012). As such, it is anticipated that the university students in the current study would follow a similar pattern: their handwriting fluency scores would be highest when using their typical handwriting (anticipated to be a mix of cursive and print), somewhat slower when they are using only print, and slowest when using only cursive.

**Research area three.** Previous research has identified five key components of evidence-based handwriting instruction (explicit instruction in pencil grip, explicit instruction in letter formation, visual cues, teacher feedback, and daily, independent practice). However, these components are not always part of the approach to instruction in the classroom (Vander Hart et al., 2010). As such, the third research area for this study is focused on the handwriting instruction received by students when they were children. The first question for this area is: How many and which components of evidence-based handwriting instruction do first-year university students report having received when they were younger? It is hypothesized that most students will recall receiving few of the five components of evidence-based handwriting instruction. This is anticipated for several reasons. First, there is a lack of handwriting mentioned in many jurisdictional curriculums (Alexander, 2015; Asher & Estes, 2016; Nye & Sood, 2018). Additionally, the literature suggests that many teachers have received little training in handwriting (Donica et al., 2012; Graham et al., 2008). As such, it is likely that many of these student's teachers may not have had knowledge of evidence-based handwriting instruction. An additional aspect of this research question is: Do first-year university students recall receiving components of handwriting instruction that cannot be clearly categorized as one of the components of evidence-based instruction? Again, based on the fact that teachers generally report having little training in handwriting instruction, and Vander Hart et al.'s (2010) finding that elementary school teachers use numerous components of handwriting instruction not supported by the literature, it is anticipated that the students would report receiving various components of non-evidence-based handwriting instruction.

## Method

### Participants

Participants were 29 university students (27 female) who were enrolled in their first year of post-secondary study and who had graduated from high school in the previous two years. Inclusion criteria also included having a language that uses the Roman alphabet (e.g., English or French) as the primary language of instruction in the early years of schooling, and not having a medical condition that would affect motor control in their hands and/or arms, such as carpal tunnel syndrome or arthritis (see Appendix A for questions asked to determine eligibility).

Participants ranged in age from 18 years to 20 years ($M$ = 18.38, $SD$ = 0.56). Twenty-seven students reported that they primarily write using their right hand, and two participants reported using their left hand. Students reported being registered in a variety of programs (Bachelor of Science, $n$ = 14; Bachelor of Arts, $n$ = 8; Bachelor of Arts [Child and Youth Study], $n$ = 4; and major in psychology without specification of degree program, $n$ = 3). Twenty-seven students graduated from high school in a Canadian province (Nova Scotia, $n$ = 23; Ontario, $n$ = 2; New Brunswick, $n$ = 1; Newfoundland, $n$ = 1), one student reported graduating high school in the United States of America, and one student did not respond to the question. Most participants (58.6%) reported their high school average to be in the 90-100% range with the remaining participants reporting their average as being in the 80-89% range (37.9% of participants) or in the 70-79% range (3.4% of participants). There was more variability in participants' average grades in university, as 27.6% of participants reported their average to be in the 90-100% range, 44.8% reported their average to be in the 80-89% range, 20.7% reported their average to be in the 70-79% range, and 6.9% reported their average to be in below the 60% range. Twenty-seven

students reported that their first language was English, and two reported that their first language was Filipino.

## Materials

**Demographics.** Participants completed a demographics questionnaire. Participants were asked about their gender, age, program of study in university, handedness, first language, average grades in high school and in university, and the province from which they graduated high school (see Appendix B).

### Handwriting quality tasks.

***Handwriting fluency***. Participants' handwriting fluency was measured using a sentence copying task. For this task, the participants were shown two pangrams (sentences that contain every letter of the alphabet) on the top of a sheet. These two pangrams were "The job requires extra pluck and zeal from every young wage earner" and "While making deep excavations, we found some quaint bronze jewelry." Participants were asked to copy the sentences as many times as possible for two minutes. This type of task has been used in previous studies that use handwriting fluency (e.g., Barnett et al., 2011; Bo et al., 2014b). These studies have used "the quick brown fox jumps over the lazy dog." However, the current study used two different sentences. This decision was made for several reasons. First, using more than one sentence may reduce the possibility that participants' fluency would increase over the time spent on the task because of increased familiarity with the sentence. Second, because "the quick brown fox jumps over the lazy dog" is a common pangram, it is possible that some students will already be familiar with the sentence, meaning they will be able to reproduce the sentence more quickly.

All the words used in the two sentences can be found in the Corpus of Contemporary American English and are moderate- to high-frequency words (Davies, n.d.). Using moderate- to

high-frequency words reduces the possibility that participants will have difficulty with the task because of unfamiliarity with the stimuli.

Participants completed the fluency task under three conditions. For the first condition, the participants were instructed to copy the sentences as they would if they were copying notes in class to evaluate the fluency of the handwriting they would typically use (typical fluency). At this point, participants were not explicitly informed of the two styles of handwriting to reduce the possibility that they would attempt to produce text in a style they perceived to have been desirable. After completing the task using the handwriting that they would use to copy notes in class, they were provided with an explanation of the two styles of handwriting (print and cursive). After this explanation, participants were asked to copy the two sentences again by using print (print fluency). After they copied the sentences using print, they were asked to copy the sentences using cursive (cursive fluency).

Participants copies were later scored by counting the number of correctly formed letters produced. Letters were considered as correct if they were clearly identifiable, in the correct position, and, in the case of the print and cursive conditions of the task, the correct style. Letters that were either capitalized when they should not have been (e.g., *Q*uaint, wor*K*ers), or not capitalized when they should have been (e.g., *w*hile) were considered correct, as long as they meet the above criteria. Similar criteria have been used in previous studies (e.g., Barnett et al., 2011; Bo et al., 2014b). Participants' scores on each condition (typical fluency, print fluency, and cursive fluency) were the average number of letters produced per minute (the total number of letters copied divided by 2), with higher scores indicating more fluent handwriting.

***Handwriting legibility*.** Handwriting legibility was measured using an alphabet writing task. Participants were asked to write all 26 letters of the alphabet in boxes on a sheet of paper.

The participants were asked to complete this task four times: 1) lower-case and in print; 2) upper-case and in print; 3) lower-case and in cursive; and 4) upper-case and in cursive. Participants were asked to attempt each letter, but they could leave the corresponding block blank if they were unsure of how to form a specific letter.

The produced letters were scored based on whether they were recognizable out of context, had all parts of the letter, and were the correct case and style. This method of scoring has been used in previous studies (e.g., Barnett et al., 2011). Although most studies included additional criteria, such as size, this was not part of scoring in the current study. Connelly, Campbell, MacLean, and Barnes (2010), suggested that size was not helpful for distinguishing legible letters in their sample of university students because most letters produced were generally the same size. A standard set of letters publicly available from Prince Edward Island Department of Education and Early Childhood Development (PEIDEECD; see Appendix D) was used to judge whether all parts of the letters were present and if the letter was in the correct style. A correctly produced letter received a score of 1, while an incorrectly produced letter received a score of 0. The range of possible scores for each condition (lower-case print legibility, upper-case print legibility, lower-case cursive legibility, and upper-case cursive legibility) was from 0 to 26, with higher scores indicating more legible handwriting.

**Handwriting Experiences Questionnaire**. Students' memories of handwriting instruction as well as their current and past handwriting use were explored using the Handwriting Experiences Questionnaire (HEQ). The HEQ is a questionnaire designed specifically for this study. It was divided into two sections: one for handwriting instruction and one for handwriting use.

***Handwriting instruction.*** The amount of evidence-based handwriting instruction received by students was explored using Section A: Handwriting Instruction. This section was comprised of 5 'yes/no' questions regarding students' memories of the components of evidence-based handwriting instruction and one qualitative question regarding students' general memories of learning to handwrite. There was one question about each of the five components of evidence-based handwriting instruction (explicit instruction in pencil grip, explicit instruction in letter formation, visual cues, teacher feedback, and daily, independent practice). A 'yes' response was scored as a 1, while a 'no' response was scored as a 0. A total score for number of evidence-based practices recalled by each student was calculated by adding these scores. Possible total scores ranged from 0 to 5 with higher scores indicting a higher number of evidence-based practices recalled. Responses from the qualitative questions were reproduced in an Excel file and coded based on theme.

***Handwriting use.*** Students' use of handwriting was explored using Section B: Handwriting Use. This section contained a series of questions regarding their use of handwriting in high school, in university, and in other contexts. The students were presented with several different academic tasks (e.g., note-taking). They were asked to estimate what percentage of time they used handwriting and typing for that activity. They were informed that the total percentage of time for each activity had to equal 100%. They completed these questions twice: once for high school and once for university. The participants were also asked a qualitative question about their use of handwriting outside of school.

Finally, an optional open-ended question was included at the end of the HEQ for the participants to mention anything related to their use of handwriting or handwriting instruction not accounted for by the rest of the survey. The full HEQ can be found in Appendix C.

## Procedure

**Data collection.** Students in a variety of first-year undergraduate courses at a small, primarily undergraduate university in Canada were invited to participate. Interested students emailed the author, who screened for eligibility. Students who were eligible to participate were provided with several dates and times to participate in group data collection sessions. Each data collection session was run by one of two graduate students. Once consent was obtained, participants completed the (timed) sentence copying task using the handwriting they would typically use to copy notes in class. After the first handwriting fluency condition was completed, the participants completed the print and cursive conditions. Once the sentence copying task was completed, the participants completed all other measures (alphabet writing task, demographic questionnaire, HEQ), which they completed at their own pace. Once they completed all measures, participants completed ballots to be entered into a draw for a $25 gift card. Data collection for each session took approximately 20 to 30 minutes.

**Scoring.** All handwriting (letter writing and sentence copying) tasks were scored by the author. To ensure accuracy and reliability, another graduate student was trained on scoring. The second scorer was provided 10 randomly selected completed letter writing and sentence copying tasks. The two scorers agreed on 88% of the letters from the letter writing task, and 95% of the letters on the sentence copying task.

# Results

## Handwriting Use

**Use of handwriting for academic tasks in high school and university**. Data from the HEQ was analyzed to explore what first-year university students reported about their use of handwriting in high school and in university. See Tables 2.1 and 2.2 for detailed statistics. On

average, participants reported that in high school, they used handwriting for academic tasks overall about 80% of the time and typing about 20% of the time. Most of the participants reported that they used handwriting between 50% and 100% of the time for most categories of academic tasks. The exceptions to this were writing papers and essays and completing other types of assignments, where most participants reported using handwriting 50% of the time or less. In university, students reported that on average, they used handwriting about 60% of the time and typing about 40% of the time. Again, most participants reported using handwriting more than typing for most academic tasks, with the continued exception of writing papers and essays and completing other assignments.

**Changes in handwriting use for academic tasks between high school and university.** A paired-samples t-test was run to determine whether average reported handwriting use differed between high school and university. The t-test was significant ($t$ (28) = 6.45, $p < 0.01$, Cohen's $d$ = 1.23), indicating that students reported using handwriting less in university than they had in high school.

**Handwriting use for non-academic tasks**. Students were also asked an open-ended question about their use of handwriting for non-academic tasks. Twenty-five (86%) of the participants reported at least one example of using handwriting for non-academic tasks, three participants (10%) reported no use of handwriting for non-academic tasks, and one participant (4%) did not respond to the question. Of the 25 participants who reported at least one example, 56% ($n$ = 14) reported using handwriting for keeping themselves organized or to remember information (e.g., to-do lists, schedules), 32% ($n$ = 8) reported using handwriting at work (e.g., taking orders, reporting scores at hockey games as a referee), 20% ($n$ = 5) reported using handwriting to communicate with others (e.g., writing letters to family), 16% ($n$ = 4) reported

using handwriting in a journal or a diary, and 12% ($n$ = 3) reported using handwriting to engage in a hobby (e.g., writing poetry).

## Handwriting Quality

**Legibility of upper-case, lower-case, print, and cursive letters.** To explore first-year students' handwriting legibility, data from the alphabet writing task was analyzed. See Table 2.3 for detailed statistics for the alphabet writing task. Generally, students were able to correctly form almost all of upper- and lower-case print letters ($M$ = 24.79 and 24.31 respectively) but correctly formed only just under two-thirds of lower-case cursive letters ($M$ = 16.83), and less than half of upper-case cursive letters ($M$ = 10.55).

A 2 (style; print vs. cursive) X 2 (case; lower-case vs. upper-case) factorial repeated-measures analysis of variance (ANOVA) was used to explore differences in legibility between upper-case, lower-case, print, and cursive letters. There was a main effect of case ($F$ (1, 28) = 72.53, $p < 0.01$, $\eta_p^2 = 0.61$), with contrasts that showed the total number of correctly formed lower-case letters ($M$ = 20.81, $SE$ = 0.37) was higher than the total number of upper-case letters ($M$ = 17.43, $SE$ = 0.54). There was also a main effect of style ($F$ (1, 28) = 211.75, $p < 0.01$, $\eta_p^2 = 0.88$), with contrasts showed that the total number of print letters ($M$ = 24.55, $SE$ = 0.21) was higher than the total number of cursive letters ($M$ = 13.69, $SE$ = 0.73). Finally, there was also a significant interaction between the case and style of the letters ($F$ (1, 28) = 32.96, $p < 0.01$, $\eta_p^2 = 0.54$), which indicated that the case of the letters had different effects on the number of correctly formed letters between print and cursive. No significant difference was observed between the mean total number of upper-case and lower-case print letters participants were able to correctly form, but both were significantly higher than the mean total number of lower-case cursive letters

correctly formed and this was significantly higher than the mean total number of upper-case cursive letters correctly formed.

**Handwriting legibility errors.** The types of errors made on each of the four conditions were also examined. Errors were categorized into five different types: incorrect style, incorrect case, identifiable, but missing a part (e.g., the dot above an 'i' was missing), globally incorrect (e.g., the letter that was written was not clearly identifiable as the target letter), and omitted. Detailed statistics for the number of errors for each condition is reported in Table 2.4. Most types of errors occurred in lower-case cursive legibility, and upper-case cursive legibility. Most of the errors were the result of the use of incorrect style (e.g., participants often formed a print 'z' rather than a cursive 'z' or formed letters such as 'k' in a way more like print than cursive) or being globally incorrect. Additionally, no participants omitted any of the letters on lower-case print legibility, and upper-case print legibility, but several participants omitted one or more cursive letters; letters that completely changed form between styles, such as the letters 'z' and 's', were those more frequently omitted.

**The effect of style on handwriting fluency.** To explore the effect of handwriting style (print, cursive, typical) on first-year university students' handwriting fluency, participants' scores on the sentence copying task were examined. Detailed statistics for each condition of the sentence copying task (typical fluency, print fluency, and cursive fluency) are presented in Table 2.5. When asked to copy the sentences using their typical handwriting, participants most often used a mix of cursive and print letter forms; however, the majority of letters were much more similar to print than cursive forms. Across all three conditions, the vast majority of letters were formed correctly and, therefore, variations in fluency are related primarily to the speed with which participants wrote during each task condition.

A one-way ANOVA was used to examine whether style (typical fluency, print fluency, and cursive; independent variable) affected the number of letters formed correctly per minute (dependent variable). Scores on all three conditions showed sufficiently normal distributions (i.e., mean and median similar, skewness and kurtosis less than double their standard error and Shapiro-Wilk statistic above .80; Field, 2013). However, the assumption of sphericity had been violated ($W$ (2) = 0.60, $p$ = 0.01). As a result, the Greenhouse-Geisser estimate ($\varepsilon$ = 0.72) was used to correct for sphericity.

The test of within-subjects effects was significant ($F$ (1.43, 40.04) = 51.32, $p < 0.01$, $\eta_p^2 = 0.65$), indicating a significant effect of style on the letters correctly copied per minute. Pairwise comparisons indicated significant differences ($p < 0.01$) between each condition; scores on typical fluency were significantly higher than those on print fluency which were significantly higher than cursive fluency.

## Handwriting Instruction

**Components of evidence-based handwriting instruction received.** All participants (100%) reported that they remembered having received at least one of the five components of evidence-based practice that have been established as necessary for the development of good handwriting. When asked about the specific components of evidence-based handwriting instruction, 37.9% ($n$ = 11) reported explicit instruction in pencil grip, 69% ($n$ = 20) reported explicit instruction in letter formation, 69% ($n$ = 20) reported receiving daily, independent practice, 79.3% ($n$ = 23) reported using visual cues, and 79.3% ($n$ = 23) reported receiving teacher feedback.

Only one participant (3.4%) reported receiving only one of the components, 24.1% ($n$ = 7) reported receiving two components, 20.7% ($n$ = 6) reported receiving three components,

31.0% (*n* = 9) reported receiving four components, and 20.7% (*n* = 6) reported receiving all five components. The mean number of evidence-based practices reported was 3.5 (*SD* = 1.18), and the median number of evidence-based practices reported was 4, meaning that most of the sample reported receiving handwriting instruction that incorporated most of the components of evidence-based handwriting instruction recommended by research.

In response to open-ended questions on the HEQ, 13 participants (45%) made at least one comment that was related to the perception that their handwriting instruction was poor. The participants reported a variety of different potential variables that may have been a barrier to receiving evidence-based handwriting instruction. For example, participants reported that the period of time that they received handwriting instruction was brief (e.g., their teachers taught handwriting for only a few weeks in the early grades), the feedback they received was ambiguous (e.g., only being told they were forming letters in correctly, but not being told how to fix their formation), the emphasis on the practice and use of cursive diminished suddenly (e.g., students were told they no longer needed to use cursive after first being taught it), and that not all students were able to consistently partake (e.g., students who needed extra time for other tasks or learning other academic areas did so during periods where handwriting was taught).

**Additional types of non-evidence-based handwriting instruction.** Data from the open-ended questions on the HEQ were examined to determine whether participants reported receiving types of handwriting instruction that could not be categorized as one of the evidenced-based components. Of the 29 participants, 38% (*n* = 11) mentioned that their family was involved in their handwriting instruction in someway. Participants reported a variety of reasons for family involvement; for example, several students reported that at least one of their family members (e.g., their mother) was a teacher and that their family members felt they needed to provide

additional instruction at home. Another student reported that her parents were interested in her handwriting because she was left handed. Finally, another reported that her brother had been diagnosed with a learning disability and her parents provided instruction to her in hopes of preventing her from developing one. Additionally, 14% of participants ($n$ = 4) mentioned that they used workbooks and/or worksheets to practice handwriting, and 7% of participants ($n$ = 2) reported that they learned letter formation as part of learning the sounds of language. Finally, 3.5% ($n$ = 1) reported receiving handwriting instruction in England and having to pass a test before she could use a pen.

## Discussion

### Handwriting Use

**Use of handwriting for academic tasks in high school and university**. A common argument against the inclusion of handwriting instruction and handwriting-related outcomes in curricula is that handwriting is a "dying art" in the 21st century, and that handwriting is no longer used by youth (e.g., Sharp and Titus, 2016). Previous studies by Mogey and colleagues (Mogey & Fluck, 2015; Mogey & Hartley, 2013; Mogey, Patterson, Burk, & Purcell, 2010) have found that students tend to choose to use computers to write tests when given the choice. As such, it was anticipated that students in the current study would report using handwriting less than typing for academic tasks. However, this hypothesis was not entirely supported by the data. Instead, students reported using handwriting more than typing for handwriting tasks overall and for most specific categories of academic tasks in both high school and university, with the exception of writing papers and completing other assignments.

There are several reasons why students may report using handwriting more than typing for most academic tasks. First, research suggests that memory and comprehension of notes taken

using handwriting are stronger than those taken by typing (Mueller and Oppenheimer, 2014). Students may either be aware of this research or may notice that their comprehension of and memory for information is better when they use handwriting than when they use typing. Consequently, they may choose to use handwriting to better support their learning. Secondly, instructors may have explicit requirements for how certain academic tasks are to be completed in their classes. For example, instructors may not allow students to use laptops in class, unless required to accommodate for a disability, and require students to take notes or tests using handwriting. This would explain why the students in Mogey and colleagues' studies (where students were given a choice) chose typing more often than handwriting for tests, yet the students in the current study reported using handwriting more often than typing for tests. Finally, some of the academic tasks students need to complete require specific spatial arrangement and formatting, such as math questions or diagrams in notes. Previous research has supported that students report handwriting to be more flexible than typing or laptops when completing these tasks (Anthony et al., 2007) and, therefore, students in the current study may also be using handwriting for the flexibility it provides for these tasks. This possibility is supported by the fact that students in the current study reported using handwriting for nearly 100% of the time for math. Overall, it is likely that students use handwriting more than typing for most academic tasks for a combination of the above reasons.

Although students reported using handwriting more frequently than typing for academic tasks overall and for most categories of academic tasks, students did report using typing more frequently for writing papers and completing other assignments. The fact that writing papers was reported to be completed using typing more than handwriting is to not surprising. Teachers and university instructors often require students to type papers for their classes to increase readability

(Sharp & Titus, 2016). As such, students would need to use typing to write papers as they may otherwise lose marks or not have their assignment accepted at all. Although the current study did not ask participants to specify the nature of the other assignments they were completing, it is likely the type of assignment would play a role in whether a student used handwriting or typing. For example, students would need to use typing for an assignment such as responding to a discussion post on an online course website. Alternatively, if students are asked to complete a worksheet in class, it is likely they would need to complete the task using handwriting. If this rationale is accurate, it would appear that a most other academic tasks that require some form of written communication are completed on a computer using typing.

**Changes in handwriting use for academic tasks between high school and university.** Building on Sharp and Titus's (2016) assertion that modern day students rely on typing in university, the current study also examined whether there was a change in the amount of reported handwriting use between high school and university. It was anticipated that students would report a decrease in handwriting use between high school and university (and, consequently, an increase in typing use). This hypothesis was supported, as students' reported handwriting use for academic tasks overall in university was lower than it was in high school.

This change in handwriting use may be the result of numerous factors. First, technology in the high school environment may not be as available as it is in the university environment, as high school students may not be allowed to use laptops/computers in school except when required by a specific assignment or to accommodate for a disability. As well, differences high school teachers and university instructors' preferences for how assignments are completed may affect handwriting and typing use. University students may choose typing over handwriting, which would be consistent with research (e.g., Mogey & Fluck, 2015; Mogey & Hartley, 2013;

Mogey, Patterson, Burk, & Purcell, 2010). Additionally, academic demands increase greatly in university, especially the volume of text needed to be written (Connolly et al., 2017). Consequently, students may opt for laptops to improve the speed with which they can complete writing assignments. Undoubtedly, a combination of these factors likely results in a decrease in handwriting use between high school and university.

It is important to note that, despite a reported decrease in handwriting use between high school and university, students continue to report using handwriting more frequently than typing for academic tasks overall and for most categories of academic tasks in university. Consequently, these results indicate that handwriting continues to be used by university students, despite arguments that handwriting is "dying" (Sharp & Titus, 2016).

**Handwriting use for non-academic tasks**. Data from the NCWAFSC (2003; 2004) and anecdotal evidence has suggested that handwriting continues to be used in occupational settings and at home to communicate with others, record information, and participate in hobbies. As such, it was anticipated that students would report using handwriting for similar non-academic tasks. Indeed, most students (86%) reported using handwriting for non-academic tasks. Students reported using handwriting for non-academic tasks such as keeping themselves organized or to remember information (e.g., by using handwritten to-do lists), for tasks at work such as taking orders or reporting scores at hockey games as a referee, writing letters to family, journaling, and writing poetry, tasks similar to those suggested by the NCWAFSC (2003; 2004).

Students may use handwriting for non-academic tasks for several different reasons. Forms they need to complete at work or school may only be completable using handwriting. Additionally, communicating using handwritten notes may provide more flexibility or make it easier to ensure the recipient receives the message in a timely manner as compared to typing.

Further, students report using handwriting to write letters to family. This may be due to students and their family members perceiving value in this type of communication, rather than emails, texting, or phone calls. Additionally, students report that they use handwriting for activities and hobbies such as journaling or writing poetry, which could also be completed by typing. However, it appears students opt to complete these tasks by handwriting, suggesting they perceive value in doing these activities using handwriting or find some connectivity between handwriting and the creative process that does not exist when typing. These results suggest that participants continue to find handwriting valuable in their everyday, non-academic, life.

The results in this research area support the notion that handwriting is not a "dying art" as authors such as Sharp and Titus (2016) argue. Instead, young people report using handwriting for a wide-variety of academic and non-academic tasks. Students continue to need to know how to handwrite to participate fully in school, work, and at home.

## Handwriting Quality

**Legibility of upper-case, lower-case, print, and cursive letters.** Previous research has indicated that handwriting is often not included in curriculums (e.g., Alexander, 2015) and many teachers report not knowing about the components of evidence-based handwriting instruction (Nye & Sood, 2018). As well, anecdotal evidence has suggested that the little handwriting instruction that students do receive is on print handwriting rather than cursive handwriting. As such, it was anticipated that students would have more difficulty legibly forming cursive letters than printed letters. This hypothesis was supported by the data. On average, students were able to legibly form almost all upper- and lower-case print letters. They had much more difficulty with lower-case cursive letters and struggled most with upper-case cursive letters, legibly forming, on average, less than half of these.

The students' difficulties with legibly forming cursive letters is consistent with previous research that suggests that students struggle with cursive handwriting (Bo et al., 2014a), possibly due to a lack of instruction specifically in cursive handwriting. The fact that students struggled most with upper-case cursive letters is unsurprising due to the fact that the rules of grammar and capitalization lead to capitals being used less frequently in text.

**Handwriting legibility errors.** The current study also looked at the types of handwriting errors students made. Previous research has indicated that many students have received little explicit instruction in letter formation (e.g., Vander Hart et al., 2010). Therefore, it was anticipated that most errors would result from omissions of letters, using incorrect style, or be globally incorrect due to a lack of knowledge of correct letter formation. This hypothesis was supported by the data. Further, the students made most errors when forming cursive letters than when they were forming print letters. Additionally, no students omitted any print letters while completing the alphabet writing task, but multiple participants omitted one or more cursive letters.

The types of errors that students made while forming letters is important because it allows for theorizing about why students had difficulty. The fact that many students formed letters in the incorrect style may suggest that they lack knowledge in the differences between the cursive and print style of handwriting. Alternatively, participants may have knowingly chosen to chose the print style of a letter instead of cursive style to include an item in the spot, rather than leave it blank. When students omitted or formed letters very incorrectly, they were most likely to be those that were formed very differently in print than in cursive (e.g., 's' or 'z'). This suggests that students may not have received good explicit instruction in letter formation and/or not had sufficient time to practice these different forms.

**The effect on style on handwriting fluency.** Previous research had indicated that children's handwriting fluency is highest (i.e., children write most quickly and legibly) when they use a mix of print and cursive. They are somewhat less fluent when they use only print, and their handwriting fluency scores are lowest when they use only cursive (Graham et al., 1998b; Morin et al., 2012). As such, it was anticipated that the university students in the current study would follow a similar pattern. Consistent with the previous research, students' handwriting fluency scores were highest when using their typical handwriting (which was, as predicted, a mix of print and cursive), somewhat slower when using only print, and slowest when using only cursive.

The current study adds to the body of literature on the effect of handwriting style on fluency in several ways. First, the current study is one of the few that explored handwriting skills in a population who are past elementary school age. These results provide evidence against the argument that children's difficulties with cursive are due to their fine-motor skills being not yet sufficiently developed to allow them to fluently form the curvy lines that are representative of cursive (Bo et al., 2014a). An alternative possibility as to why individuals struggle with cursive may be due to a lack of explicit instruction in cursive. This is consistent with the difficulty that participants in the current study had with legibly forming cursive letters. Being less familiar with letter formation in cursive would mean students would spend more time thinking about and forming each letter, which would reduce the number of letters they could produce in one minute. This may also explain why students were fastest with their typical handwriting, which was usually a mix of print and cursive. Using a mix of the two styles would mean that these students would not have to attend to forming a letter in a specific style; instead, they could choose which style is more automatic for each letter allowing them to produce more letters per minute. Further,

students in the current study reported that their teachers only taught cursive briefly or stopped encouraging the students to practice it after initial instruction. Consequently, students may not have had as much instruction in cursive handwriting as compared to print.

Lack of explicit instruction does not completely explain why students have more difficulty with letter formation in cursive than in print, as others have pointed out that handwriting instruction in both styles is usually not included in most curriculums and that teachers usually lack an understanding in the components of evidence-based handwriting instruction (e.g., Alexander, 2015; Nye & Sood, 2018). However, there are some additional reasons why students might struggle more with forming cursive letters compared to print. First, print is more similar to the text used in most of our reading material (e.g., books, signs). As such, we are exposed more to printed letters than we are to cursive letters, so students' knowledge of printed letters is greater. Second, in the open-ended questions, several students reported that they often did not use cursive handwriting frequently and instead often opt for print or a mix of the two styles. These reports are consistent with the appearance of the students' typical handwriting, which, for most students, was a mix of the two styles or much more similar to print than to cursive. Consequently, knowledge that they may have had about cursive handwriting may have diminished over time due to a lack of practice.

## Handwriting Instruction

**Components of evidence-based handwriting instruction received**. Previous research has identified five key components of evidence-based handwriting instruction (explicit instruction in pencil grip, explicit instruction in letter formation, visual cues, teacher feedback, and daily, independent practice). Previous literature has suggested that the components of evidenced-based handwriting instruction are not always included in curriculums or in the

classroom (e.g., Alexander, 2015; Nye & Sood, 2016; Vander Hart et al., 2010). As such, it was hypothesized that first-year students would report receiving few components of evidence-based handwriting instruction when they were children. In contrast, the current study found that over half of the participants reported remembering receiving at least four of the five components of evidence-based handwriting instruction, and approximately 20% of participants reported receiving all five components of evidence-based handwriting instruction. This suggests that some teachers are knowledgeable about the components of evidence-based handwriting instruction and are providing this instruction in the schools.

Although participants reported receiving a high number of components of evidence-based handwriting instruction, almost half of the students in the current study indicated that they perceived that they had received inadequate handwriting instruction. For example, participants reported that the period of time that they received handwriting instruction was brief, their teachers' feedback was ambiguous (e.g., only being told they were forming letters incorrectly, but not being told how to fix their letter formation), the emphasis on the practice and use of cursive diminished suddenly (e.g., students were told they no longer needed to use cursive after first being taught it), and that not all students were able to consistently receive this instruction (e.g., students who needed extra time for other tasks or learning other academic areas did so during periods where handwriting was taught). Consequently, students reported that they felt their handwriting was not as strong as it could be, and they specifically noted that they had difficulty with cursive style.

Students' perception that their handwriting instruction was inadequate is further supportive of the hypothesis that students are not receiving instruction that consistently incorporates evidence-based practices. As noted previously, handwriting instruction is not

included in many jurisdictional curriculums (e.g., Alexander, 2015; Nye & Stood, 2018). As such, teachers are not always required to teach handwriting, and those who do teach handwriting do not have guidance in doing so. This is concerning as many teachers do not have education or training in the components of evidence-based handwriting instruction (Nye & Stood, 2018). Therefore, there would be variability in the handwriting instruction provided between teachers which can lead to difficulty with handwriting (Asher, 2006). This is supported by the fact that students' qualitative responses indicated that expectations for handwriting use and instruction differed between teachers.

**Additional types of non-evidence-based handwriting instruction.** Previous research (e.g., Nye & Sood, 2018; Vander Hart et al., 2010) has found that teachers lack knowledge of the components of evidence-based handwriting instruction, and, consequently, sometimes use approaches to handwriting instruction that are not supported by the literature. As such, it was anticipated that the students in the current study would report receiving components of non-evidence-based instruction. Indeed, students' qualitative responses indicated that their handwriting instruction included workbooks and/or worksheets, occurred as part of learning the sounds of language, and required them to take a test before they were allowed to use a pen in class. Although these components are not specifically evidence-based, they may provide some benefit as they provide students with additional handwriting practice. Future research may wish to explore these components and their role in the development of handwriting skills.

Interestingly, many students reported that their families were actively involved in the students' handwriting instruction. Students' reported various reasons why their families were involved in their handwriting instruction. One common reason was that their families perceived

that the student was not receiving enough handwriting instruction, and the families wished to provide additional handwriting instruction to support their child.

Although more family involvement in children's education usually leads to higher academic achievement for children (Castro et al., 2015), there are some concerns about having families involved in handwriting instruction. First, if family members may not have knowledge of the components evidence-based handwriting instruction, leading to further variability in students' handwriting instruction. Asher (2006) noted that variability in the amount of components of evidence-based handwriting instruction different teachers provide can lead to children developing poorer handwriting skills, due to conflicting methods of instruction. Similarly, if family members do not have a background in child development and/or education, they may set up expectations for students' handwriting that are unrealistic for these students to meet. As such, students may feel put off by their handwriting instruction and may be opposed to using handwriting, or engaging in written expression, in general. Further, it is possible that the family members involved in handwriting instruction may not have quality handwriting skills to demonstrate correct letter formation.

**Limitations and Future Directions**

One limitation of the current study is that the sample size was quite small ($N = 29$) and the sample was relatively homogenous; most participants were female, spoke English as their first language, and were high achieving (most students reported average grades above 80%). Additionally, most participants graduated from high school in Nova Scotia. As such, it is difficult to generalize the findings of the current study to university students broadly. Future studies should aim to recruit a larger, more diverse sample including participants from a variety

of provinces to explore the differences in handwriting instruction, handwriting quality, and handwriting use in students across the country.

Another limitation is the fact that data regarding students' handwriting use was collected by self-report. The proportions of handwriting and typing use self-reported for each academic task certainly reflect how students perceive their use of handwriting and typing; however, they may not be completely accurate, as students may overestimate or underestimate how often they use either modality when completing academic tasks. Similarly, students were asked to report on the components of evidence-based handwriting instruction that they recalled received when they were children. It is possible that their memories of the handwriting instruction they received may not be completely accurate as their memories may have faded over time. Further, considering that all of the participants had graduated from high school in either 2016 or 2017, they were reporting on components of instruction they had received in at least 10-13 years earlier. As Alexander (2015) noted, the written expression curriculum has changed greatly in recent years. As such, the components of handwriting instruction that the participants in the current study reported may not be similar to the components that students who are currently in elementary school currently are receiving. Future studies may wish to explore the handwriting instruction being provided in the current classroom. This may be completed using questionnaires and/or interviews with current teachers, parents, and students. These methodologies can provide a more comprehensive understanding of the components of evidence-based handwriting instruction students received. Additionally, observational studies can provide a more accurate description of the handwriting instruction students have received, and they can provide researchers the opportunity to explore the fidelity of teachers' provision of the components of evidence-based handwriting instruction.

The students in the current study indicated that they had received many of the five components of evidence-based handwriting instruction. However, additional information about the handwriting instruction they received, such as the frequency of receiving these components or the fidelity of teachers' provision of these components, may also need to be considered to explore whether receiving these components of evidence-based handwriting instruction are related to university students' handwriting skills. Future studies may need to explore this question using data collection methods such as interviews and observations, where variables such as frequency of instruction using these components can be probed further.

As well, the current study did not explore why students reported used handwriting more frequently for certain academic tasks and typing more frequently for others. Future research might build on this by asking students about the factors that led to them using handwriting or typing for certain academic tasks.

The current study found that students' handwriting legibility scores were lowest with cursive letters, especially with upper-case cursive letters. Additionally, students' handwriting fluency scores were highest when using their typical handwriting, followed by when they only print, and lowest when they use only cursive. However, these findings are somewhat limited by the fact that students completed the tasks in the same order, and the cursive conditions were last in the procedure. It is possible that students scored lowest on these tasks due to fatigue. Future studies may wish to counterbalance the conditions to reduce the possibility of fatigue and/or practice effects.

The current study found that handwriting style has a similar effect on university students' handwriting fluency as it did with children's handwriting fluency in previous studies (Graham et al., 1998b; Morin et al., 2012), indicating that children's difficulty with handwriting fluency

using cursive is not necessarily the result of their underdeveloped fine-motor skills. It is possible that university students' difficulty with cursive may be due to a lack of practice since childhood. Future studies may wish to compare handwriting fluency between young adults, who may have had less practice with handwriting due to availability of technology growing up, and older adults, who may have had more handwriting practice growing up due to a lack of technology available, to explore whether practice plays a role in the development of handwriting fluency.

The fact that the sample was homogenous may be due to the recruitment procedure. In the current study, students in first-year classes were told that the study was related to handwriting and to contact the graduate student researcher if interested in participating. As students knew the study was on handwriting, students who had poor handwriting skills and/or felt self-conscious about their handwriting may not have contacted the graduate student researcher to participate due to a feeling of discomfort over having an individual with whom they are not familiar reading their handwriting. As such, it is possible that the handwriting skills that were observed and the handwriting use and instruction reported by the participants in the current study may be biased to students with stronger handwriting skills or who are less self-consciousness about their handwriting. Future research should attempt to recruit participants using a method where students less confident in their handwriting skills are encouraged to participate.

## Implications

**Teachers.** The current study has several implications for teachers. First, the current study provided evidence that students continue to use handwriting more than typing for academic tasks overall and for most categories of academic tasks. As well, students reported using handwriting for various non-academic tasks at work and at home. This supports the argument that handwriting is not a "dying art" as suggested by some authors (Sharp & Titus, 2016). Instead, the

current study supports the notion that handwriting instruction should continue to be included in the classrooms of children to prepare them to use handwriting in high school, university, work, and their personal lives.

Participants reported a perception that their handwriting instruction was inadequate and there was a deal of variability between teachers when it came to handwriting instruction and use. Educators should be aware of the frequency with which they are providing these components in their handwriting instruction, and whether they are providing them with fidelity. Additionally, the current study found that students had a specific difficulty with legibly forming cursive letters and fluently handwriting in cursive. These findings indicate that educators should be particularly cognizant of the instruction they are providing for cursive handwriting.

**Educational policy makers.** The current study also has implications for educational policy makers. The results of the current study highlight that young people continue to use handwriting for academic and non-academic tasks, contrary to arguments that handwriting is a "dying art" (Sharp & Titus, 2016). Previous research has highlighted that one reason why teachers have difficulty with providing the components of evidence-based handwriting instruction is due to a lack of guidance from jurisdictional curriculums (e.g., Nye & Sood, 2018). As such, it is important that policy makers include handwriting in curriculums. Further, policy makers must look to the scientific literature and include the components of evidence-based handwriting instruction in their curriculums. Doing so will best support students in developing the handwriting skills needed for academic, occupational, and personal success.

**Pre-service and in-service teacher education**. Another barrier to teachers being able to provide evidence-based handwriting instruction is due to a lack of focus on handwriting instruction in their pre-service and in-service education (Nye & Sood, 2018). As such, it is

important for pre-service teacher programs (e.g., Bachelor of Education) and in-service education (e.g., professional development days) to develop a focus on evidence-base handwriting instruction. Additionally, there continues to be a notion that handwriting is a "dying art" (Sharp & Titus, 2016), despite the fact that research has shown that handwriting has more cognitive and academic benefits than typing (e.g., Cunningham & Stanovich, 1990; Mueller & Oppenheimer, 2014; Medwell & Wray, 2014; Wicki et al., 2014). It is important for pre-service and in-service teacher education programs to highlight research supporting the cognitive and academic benefits of handwriting. Doing so will increase teachers' and pre-service teachers' awareness of the importance of handwriting for children's academic achievement.

**Typing instruction and research**. Although the current study focused on the benefits of handwriting and handwriting instruction, the data indicates that typing is a skill in which students should also receive instruction, so that they may prepared for these types of activities and requirements in school. Educators and policymakers should also be aware of the fact that there is an increase in typing demands in the postsecondary environment and should aim to provide typing instruction for students to prepare them for these demands. However, at present, there is a paucity of research on the components of evidence-based typing instruction (Poole & Preciado, 2016). Future research needs to explore the components of effective typing instruction to help develop an evidence-based typing curriculum, whether students are receiving these components, and whether students have the typing skills needed to meet the demands in post-secondary and in occupational environments.

**School psychologists**. The current study has several implications for school psychologists. One of the primary roles of many school psychologists is to provide consultation about and assessment for students who have difficulty learning, and to sometimes diagnose

learning disabilities (Bramlett, Murphy, Johnson, Wallingsford, & Hall, 2002). Considering that difficulties with written expression are the second most common reason for referral to school psychology services (Bramlett et al., 2002), and handwriting difficulties are the most common reason for referral to school-based occupational therapy services (Hammerschmidt & Sudsawad, 2004), school psychologists are likely to spend a significant portion of their time working with children and youth with written expression and handwriting difficulties.

In Nova Scotia and other parts of Canada, many school psychologists adhere to the Learning Disability Association of Canada (LDAC) definition of a learning disability (Alexander, 2015). A key component of the LDAC definition is that difficulties in academic areas, such as written expression and handwriting, cannot be the result of a lack of instruction or poor instruction in that domain. The results of the current study provide some support that students are receiving many components of evidence-based instruction for handwriting. However, considering the differences in the amount of components reported between the current study and previous studies, there is a great deal of variability in the provision of these components of evidence-based handwriting instruction between teachers. It can be difficult to determine whether a diagnosis of a learning disability can be made when it is unclear whether a student's difficulty with learning is due to a deficit in a cognitive skill (e.g., working memory) or due to inadequate instruction. School psychologists need to be aware of this variability and should ask teachers and former teachers about the components of evidence-based handwriting instruction that they have provided to the student. It will also be important for school psychologists to probe the frequency and fidelity with which the students' teachers have provided the components.

School psychologists are often asked to complete assessments to provide support for applications for students to receive assistive technology, such as laptops, to alleviate handwriting demands for students. As such, it is important that school psychologists are aware of the benefits of handwriting over typing during consultations with school personnel, parents, and students about students who are experiencing difficulty with handwriting and written expression. Further, school psychologists are sometimes asked why they assess for handwriting difficulties in an age where laptops and other technology are available and that students do not use handwriting anymore. The findings from the current study indicate that this argument is not accurate, as the students in the current study reported using handwriting more frequently than typing for all academic tasks in high school, most academic tasks in university, and for non-academic reasons such as communicating with family and to complete tasks at work. It is important for school psychologists to know that handwriting is still commonly used, so they can advocate for students to receive evidence-based instruction and intervention for their handwriting difficulties.

## Conclusion

The current study provides support for the contention that handwriting is still commonly used by university students in school, at work, and in their personal lives and that students choose to use handwriting more frequently than typing for some tasks. The current study found that university students have received many of the five components of evidence-based handwriting instruction (explicit instruction in pencil grip, explicit instruction in letter formation, visual cues, teacher feedback, and daily, independent instruction). However, participants perceived their handwriting instruction as inadequate, noting that the period of time that they received handwriting instruction was brief, their teachers' feedback was ambiguous, the emphasis on the practice and use of cursive diminished suddenly, and not all students were able

to consistently receive this instruction. The findings of this study indicate that students have a particular difficulty with cursive handwriting indicating the handwriting instruction they received was not effective for the acquisition of cursive handwriting. The findings of the current study provide support for handwriting to be included in school curriculum, for pre-service and in-service teachers to be taught the components of evidence-based handwriting instruction and the importance of handwriting, and for school psychologists to advocate for appropriate services to be provided for students with handwriting difficulties to help prepare students for the demands of post-secondary education and for work.

**Table 2. 1**. *Detailed statistics (N = 29) of reported percentage of time spent using handwriting and typing for categories of academic tasks in high school and in university.*

| Academic task | Handwriting | | | | | | Typing | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | High School | | | University | | | High School | | | University | | |
| | *M* | *SD* | Range | *M* | *SD* | Range | *M* | *SD* | Range | *M* | *SD* | Range |
| Class notes | 93.34 | 10.97 | 50-100 | 65.41 | 35.80 | 0-100 | 6.66 | 10.97 | 0-50 | 34.59 | 35.80 | 0-100 |
| Notes from reading material | 84.66 | 22.36 | 20-100 | 72.59 | 34.91 | 0-100 | 15.34 | 22.36 | 0-80 | 27.41 | 34.91 | 0-100 |
| Math | 98.45 | 5.84 | 70-100 | 87.21 | 26.56 | 0-100 | 1.55 | 5.84 | 0-30 | 5.90 | 11.17 | 0-40 |
| Tests and/or exams | 96.72 | 8.89 | 60-100 | 86.55 | 18.76 | 10-100 | 3.28 | 8.89 | 0-40 | 10.34 | 11.80 | 0-40 |
| Essays, papers, lab reports, or other reports | 41.55 | 30.30 | 0-100 | 13.28 | 21.97 | 0-100 | 58.45 | 30.30 | 0-100 | 86.72 | 21.97 | 0-100 |
| Other assignments | 58.03 | 28.26 | 0-100 | 32.93 | 26.71 | 0-100 | 41.97 | 28.26 | 0-100 | 67.07 | 26.71 | 0-100 |
| Overall | 78.79 | 13.20 | 53-100 | 60.83 | 15.87 | 33-92 | 21.21 | 13.21 | 0-47 | 39.17 | 15.88 | 8-67 |

**Table 2. 2.** *Number and percentages of participants reporting different amounts of handwriting use for each academic task in high school and university (N = 29).*

| Academic task | High School | | | | University | | | |
|---|---|---|---|---|---|---|---|---|
| | 100% of the time | >50% of the time | 50% of the time | < 50% of the time | 100% of the time | >50% of the time | 50% of the time | < 50% of the time |
| Class notes | 15 (51%) | 14 (44%) | 1 (3.5%) | 0 | 11 (38%) | 6 (21%) | 3 (10%) | 9 (31%) |
| Notes from reading material | 15 (51%) | 8 (27.5%) | 2 (7%) | 4 (14%) | 10 (34.5%) | 11 (38%) | 2 (7%) | 6 (21%) |
| Math | 26 (90%) | 3 (10%) | 0 | 0 | 17 (59%) | 10 (34.5%) | 0 | 2 (7%) |
| Tests and/or exams | 24 (83%) | 5 (17%) | 0 | 0 | 14 (48%) | 15 (51%) | 0 | 0 |
| Essays, papers, lab reports, or other reports | 3 (10%) | 3 (10%) | 9 (31%) | 14 (48%) | 1 (3.5%) | 0 | 2 (7%) | 26 (90%) |
| Other assignments | 3 (10%) | 10 (34.5%) | 8 (27.5%) | 8 (27.5%) | 1 (3.5%) | 3 (10%) | 6 (21%) | 19 (65.5%) |
| Overall | 2 (7%) | 27% (93%) | 0 | 0 | 0 | 20 (69%) | 2 (7%) | 7 (24%) |

*Note*: Percentages do not necessarily equal 100% due to roundi

**Table 2. 3**. *Descriptive statistics of correctly formed letters for the letter writing task (N = 29).*

| | Print | | | Cursive | | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | Range | *M* | *SD* | Range |
| Lower-case | 24.79 | 1.32 | 21 – 26 | 16.83 | 3.67 | 9 - 24 |
| Upper-case | 24.31 | 1.28 | 21 – 26 | 10.55 | 5.61 | 2 – 24 |

**Table 2. 4.** *Means and standard deviations of each type of error for each condition on the letter writing task.*

| | Incorrect style | | Incorrect case | | Identifiable but incomplete | | Globally Incorrect | | Skipped | |
|---|---|---|---|---|---|---|---|---|---|---|
| Condition | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Lower-case print legibility | 0.17 | 0.60 | 0 | 0 | 0.28 | 0.59 | 0.76 | 0.95 | 0 | 0 |
| Upper-case print legibility | 0.07 | 0.07 | 0.10 | 0.31 | 0.48 | 0.63 | 1.00 | 1.10 | 0 | 0 |
| Lower-case cursive legibility | 2.14 | 1.92 | 1.55 | 2.01 | 0.86 | 1.38 | 4.21 | 2.14 | 0.21 | 0.77 |
| Upper-case print legibility | 7.66 | 6.05 | 1.03 | 1.29 | 0.59 | 1.18 | 4.41 | 3.46 | 1.48 | 3.46 |

**Table 2. 5**. *Descriptive statistics for the number of letters copied per minute on the sentence copying task (N = 29).*

| Condition | *M* | *SD* | Range | Median | Skewness (*SE*) | Kurtosis (*SE*) | Shapiro-Wilk Statistic |
|---|---|---|---|---|---|---|---|
| Typical Fluency | 123.65 | 14.21 | 90 - 148 | 123.00 | -0.25 (0.43) | 0.27 (0.85) | 0.96, *ns* |
| Print Fluency | 111.31 | 17.42 | 76 – 762 | 111.00 | 0.41 (0.43) | 1.81 (0.85) | 0.96, *ns* |
| Cursive Fluency | 76.00 | 32.42 | 24 - 157 | 73.00 | 0.63 (0.43) | 0.15 (0.84) | 0.97, *ns* |

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## APPENDIX A: ELIGIBILITY QUESTIONS

**Eligibility Questions Confirmation**

Did you learn an alphabetic language, such as English or French, before school entry, **and** was an alphabetic language the primary language used in grade school?

NO YES

Are you in your first year of post-secondary study?

NO YES

Do you have a medical condition that affects your motor control in your hands and/or arms, such as carpal tunnel syndrome or arthritis?

NO YES

APPENDIX B: DEMOGRAPHIC QUESTIONS

**Please let me know if you have any questions.**

**You may leave any or all questions blank.**

1. Please complete the following table.

| **Age** | **Gender** |
|---|---|
| | |
| **Program** | **First Language** |
| | |

2. With what hand(s) do you primarily write?

Right Left Both

3. Please estimate your ***overall*** average during ***high school***.

90-100 80-89 70-79 60-69 Below 60

4. Please estimate your ***overall*** average in the courses you have taken so far ***in university***.

90-100 80-89 70-79 60-69 Below 60

5. Please list the province where you graduated from high school: _____

APPENDIX C: HANDWRITING EXPERIENCES QUESTIONAIRE

**SECTION A: Handwriting Instruction**

1. If someone asked you when you learned how to handwrite, what would you say?

_____

_____

_____

_____

2. Do you remember someone specifically teaching you to hold a pencil?

YES NO

**Comment (optional):** _____

_____

_____

_____

3. Do you remember someone specifically teaching you how to form the letters of the alphabet **and** explaining how some letters look very alike and/or very different from each other?

YES NO

**Comment (optional):** _____

_____

_____

_____

4. Do you remember being taught or encouraged to practice handwriting for 10 to 15 minutes per day?

YES NO

**Comment (optional):** _____

_____

_____

_____

5. Do you remember having visual cues (an example is below) to help guide you when you were learning how to handwrite?


YES NO

**Comment (optional):** _____

_____

_____

_____

6. Do you remember someone pointing out when you formed the letters of the alphabet correctly and/or noting your errors and encouraging you to rewrite them correctly?

YES NO

**Comment (optional):** _____

_____

_____

_____

**SECTION B: Handwriting Use**

7. Please estimate the approximate proportion of time that you would have used ***handwriting*** or ***typing*** for each listed task in ***high school***.

Please note that both columns for each task should equal 100%. Please see first row for an example. If you did not experience a certain task during high school, please write N/A.

| Task | Handwriting | Typing | Total |
|---|---|---|---|
| ***EXAMPLE***: Writing shopping lists | 40 | 60 | 100% |
| Taking notes in class | | | 100% |
| Taking notes from something you read | | | 100% |
| Doing math | | | 100% |
| Writing tests and/or exams | | | 100% |
| Writing essays, papers, lab reports, or other reports | | | 100% |
| Other assignments | | | 100% |

8. Please estimate the approximate proportion of time that you would have used ***handwriting*** or ***typing*** for each listed task in ***university so far***.

Please note that both columns for each task should equal 100%. Please see first row for an example. If you have not experienced a certain task during university so far, please write N/A.

| Task | Handwriting | Typing | Total |
|---|---|---|---|
| ***EXAMPLE***: Writing shopping lists | 40 | 60 | 100% |
| Taking notes in class | | | 100% |
| Taking notes from something you read | | | 100% |
| Doing math | | | 100% |
| Writing tests and/or exams | | | 100% |
| Writing essays, papers, lab reports, or other reports | | | 100% |
| Other assignments | | | 100% |

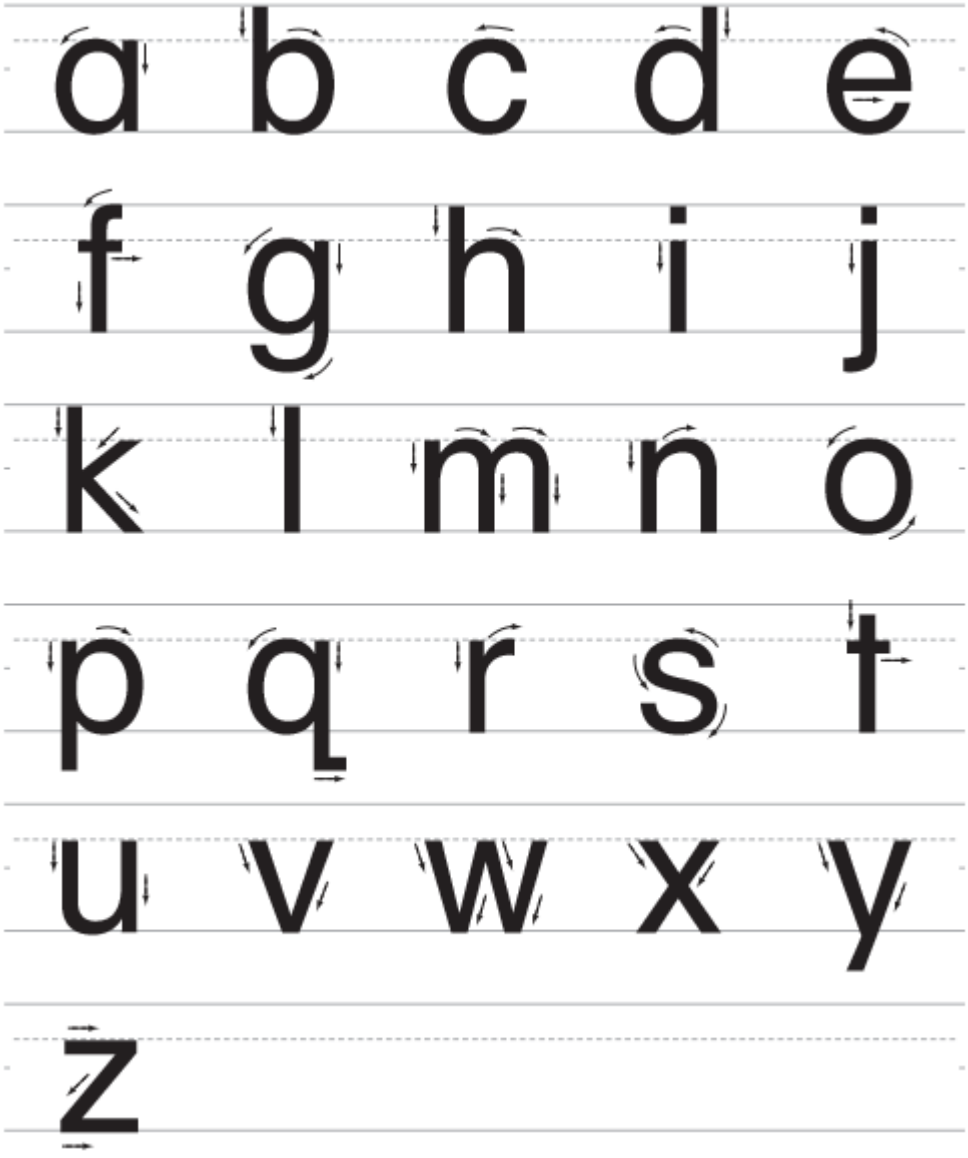
9. Do you use handwriting outside of school? If yes, please comment on your use of handwriting for non-school tasks.

10. ***Optional:*** Is there anything else that you would like to comment on regarding what you remember about learning to handwrite or your use of handwriting?

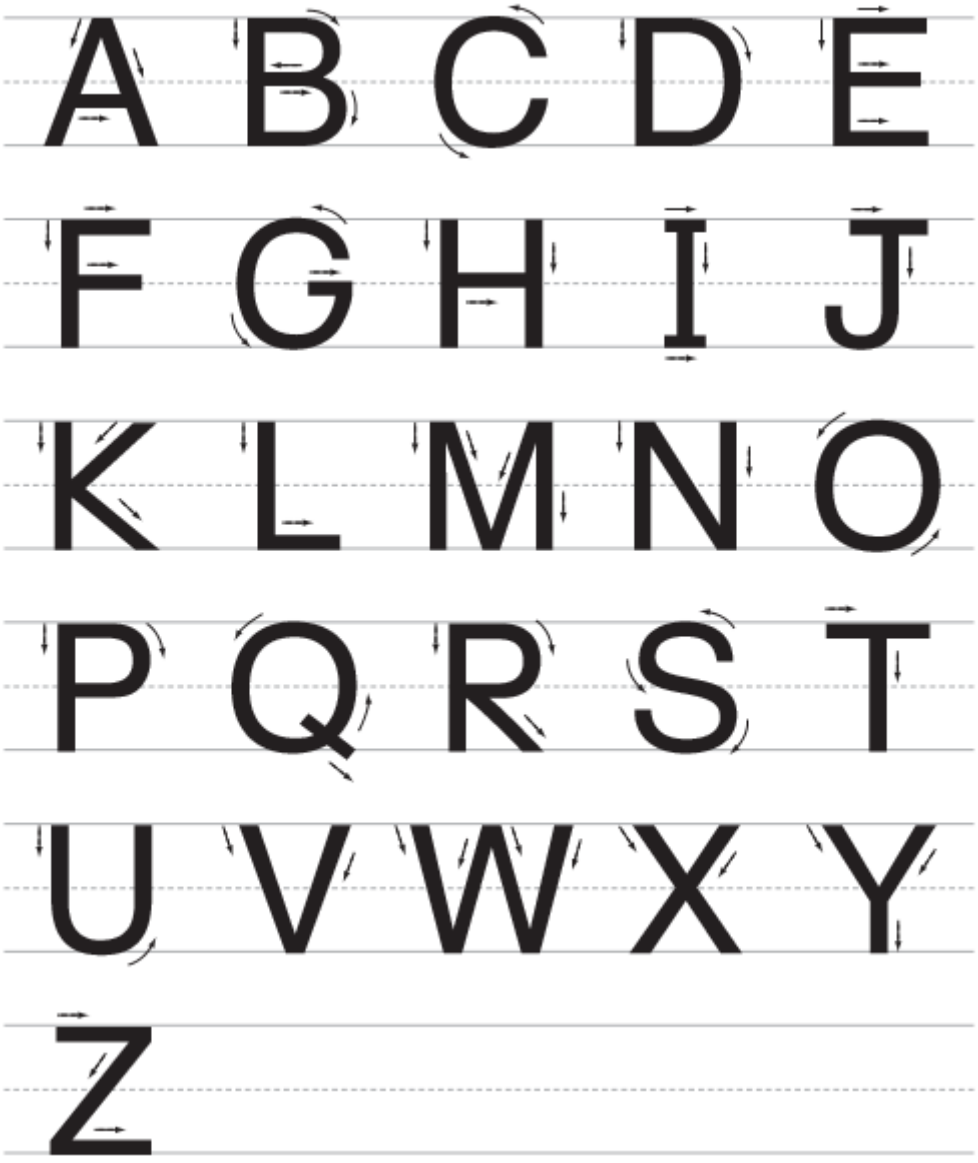
APPENDIX D: MODELS OF LEGIBLE LETTERS

(PEIDEECD, 2012)

**Lower-case, print letters**



**Upper-case, print letters**



**Lower-case, cursive letters**

**Upper-case, cursive letters**