

Handwriting instruction: a commentary on five studies

Steve Graham^{1,2}

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Abstract Handwriting is still a prominent mode for composing for both children and adults. As a result, it is important that developing writers acquire fluent and legible handwriting. This article examines the five investigations that were presented in this special issue on handwriting instruction, providing a summary of their collective contributions as well as the limitations of each paper.

Keywords Handwriting · Writing · Composition

Handwriting is alive and healthy!

During the last 20 years or so, I have been asked to share what I know about writing with members of the print, digital, and visual media. More often than not, these queries have focused on handwriting. The topics of discussion have ranged from satirical (the John Daley show seeking information for a possible comical send up of legislators demanding children be taught cursive handwriting), to farcical (a print reporter writing a story on a possible legislative demand that doctors be required to take a course in handwriting), to scholarly (the host of a television show asking why handwriting is important to children’s development as writers). The most common query though has centered on the death of handwriting.

When faced with this question, I sometimes jokingly reply: “Do you know where handwriting is buried?” or “Did you see the death certificate?” While this

✉ Steve Graham
steve.graham@asu.edu

¹ Learning Sciences Institute Australia, Australian Catholic University, Brisbane, Australia

² Arizona State University, Tempe, AZ, USA

sometimes catches the interviewer by surprise, these queries most often produces a polite chuckle and a rephrasing of the question before we get started.

While I am obviously taking a light hearted poke at questions concerning the demise of handwriting, it is not an inappropriate inquiry. Before the commercial success of the typewriter towards the end of the 19th century (Cortada, 2015), writing by hand had a virtual lock on how we transcribed our ideas into print. With the invention and proliferation of personal computers in the late 1970s, composing moved from writing by hand or typewriting to include composing with a keyboard. The field became even more crowded recently, as tools for creating writing directly from speech became available and popular in common devices such as personal computers and phones. While most of us still write by hand, much of the writing we do in our daily lives now involves digital devices (Freedman, Hull, Higgs, & Booten, 2016). So, all in all, this reoccurring concern about the death of handwriting does not seem so farfetched after all.

This is not to say that handwriting is unimportant in the world today or likely to disappear any time soon. Pen, pencil, and paper are very affordable, transportable, and usable (Graham, 2009/2010). In some settings, such as schools, these are the most dominant writing tools worldwide (see for example the special issue on writing education around the globe edited by Graham & Rijlaarsdam, 2016). Many of us also prefer to use handwriting for certain types of writing tasks such as notetaking. There is an emerging body of research demonstrating that taking notes by hand can be more beneficial to learning than taking them on an electronic writing device such as a word processor (Mueller & Oppenheimer, 2014). Further, the line between writing digitally and by hand is becoming blurred, as there is an increasing number of digital devices that allow writers to handwrite and draw their messages (e.g., digital handwriting pads). Take a look around though, and you will see that handwriting is quite common, especially in schools. As a result, inquiries about the demise of handwriting are overwrought and premature.

The importance of fluent and legible handwriting

In settings where handwriting is the primary mode for writing or settings where we use handwriting along with digital tools (e.g., jotting down ideas on paper while writing on a digital tool), it is important that our handwriting is both fluent and legible. If our writing hand is not fast enough to keep up with our thought production when writing, we are likely to lose ideas before we can commit them to paper (Berninger, 1999). On the other hand, if handwriting is so illegible that it is unreadable, our audience will not be able to read our message.

The impact of legibility though is not just whether handwriting can or cannot be deciphered. The impact of legibility is subtler than this, as readers can form a negative opinion about the quality of our ideas when handwriting is decipherable but difficult to read due to poor legibility. In a recent meta-analysis (Graham, Harris, & Hebert, 2011), we examined studies that took the same composition and made it more or less legible. These different versions of the same paper were then randomly assigned to raters who were asked to independently judge the quality of the ideas in

the composition. Papers that were more legible versus less legible ones evidenced a full standard deviation difference in assigned scores for quality of ideas, favoring the more legible paper. This occurred even though these two versions of the paper contained exactly the same words. Thus, the legibility of one's writing can bias evaluations of compositions written by hand, leading to lower scores or grades. Unless preventive measures are put into place, such as typing all compositions in advance of scoring, this legibility effect also influences the scoring of handwritten text on high-stakes standardized measures of writing as well as the scoring of handwritten text produced by participants in writing research studies (Graham et al., 2011). Without such precautions, it is difficult to know how much of a writing score is due to text legibility or the quality of the message.

It is further important to note that there is a reciprocal relation between handwriting legibility and fluency (Graham and Miller, 1980). How quickly we produce letters slows when our goal is to write as neatly and legibly as possible. In contrast, if we speed up our handwriting so we can get ideas down as quickly as possible, there is a negative effect on legibility. This presents a dilemma for students and others when writing under timed situations. If one slows down to write more legibly, the reader is likely to judge the message more positively as the negative bias of illegibility is removed or minimized. This strategy has a downside, however, as the writer runs the risk of not completing the task. On the other hand, if one writes more quickly so the task is completed on time, readers are more likely to judge the resulting text more harshly due to decrements in legibility.

Handwriting and writing development

Learning to master handwriting early is especially important for young children. Primary grade children who experience difficulty learning to produce letters legibly and fluently by hand can form a negative attitude towards writing. They often avoid writing whenever they can and develop a mindset they cannot write (Berninger, Mizokawa, & Bragg, 1991). This increases the likelihood that they will become poor writers, as they have less opportunity to apply the writing skills they are learning in the classroom and less opportunities to develop new skills through writing (Graham, Kiuahara, McKeown, & Harris, 2012).

While early handwriting difficulties do not ensure a child will become a poor writer, it is clearly one of the paths that can lead to this outcome (Berninger, 1999). Even for children who do not have early difficulties with handwriting, this seemingly simple skill influences writing development in other important ways. Of all the skills and knowledge that are needed to write skillfully, handwriting places the earliest constraints on writing. Until children can form letters with reasonably legibility and speed, much of their writing concentration and effort is consumed with letter production.

In an earlier paper, I provided an analogy to illustrate how handwriting constrains the writing of young students (Graham, 2009). This involved using a Chinese typewriter to compose text. This is a very complicated writing tool, containing close to 6000 characters, where even someone who has mastered its use types only about

11 characters per minute. Imagine yourself trying to type a paper using this machine. As you very slowly write your composition, some of your ideas will be lost as they slip from memory before they can be committed to paper. Any time you need to hunt for the next character on the typewriter, your working memory will be taxed further, resulting in even more ideas being forgotten. The act of composing with such a tool is so demanding that the cognitive resources you could devote to other important aspects of writing, such as evaluating and sharpening text as you compose, are not readily available, as you are so preoccupied with transcribing your ideas into text.

The formidable impact of handwriting on the composing of developing writers can further be illustrated without the use of special tools such as a Chinese typewriter. Try doing this. First, write about a topic you are interested in for 10 min. Then take a breather and repeat this process, but switch your pen or pencil to your non-dominant hand (or the one you do not typically write with). Compare the results, and you will find that when you write with your non-dominant hand versus your dominant one you produced less text, focused less attention on text evaluation and sharpening, experienced more difficulty persevering for the full 10 min, and enjoyed writing less.

For young children, handwriting plays a role in shaping how they go about the process of composing. For beginning writers, the physical aspects of handwriting are cognitively demanding, as children are still learning how to write letters correctly and fluently (Graham, Berninger, Weintraub, & Schafer, 1998). Consequently, a considerable amount of their effort and thinking when writing is devoted to forming legible letters. Handwriting is not the only demanding aspect of writing when children compose text by hand (Graham, 2018). Other activities such as spelling, sentence construction, and processes like planning and evaluating that involve reflection and thought are cognitively demanding too. Collectively, these various writing processes and skills are so demanding that something must be minimized so the child can reduce possible cognitive overload (McCutchen, 1988). Since children cannot eliminate the physical act of writing, they must minimize the use of other attention and resource demanding processes. For example, they may treat writing as a knowledge-telling activity, where an idea is generated and written on paper, with each new idea serving as a stimulus for the next one (Scardamalia & Bereiter, 1986). With this approach, little attention or thought is given to the constraints imposed by the topic, the organization of text, or the needs of the readers. Children may also minimize other production processes such as spelling by using words in their writing they already know how to spell or deciding not to worry if a word is spelled incorrectly (Graham & Santangelo, 2014).

An important goal in writing instruction, therefore, is to help young children become legible and fluent enough with handwriting so that the cognitive resources it requires during composing are minimal and do not interfere with other writing processes (Graham, 1999). This is not to say that such instruction eliminates the potential negative effects of handwriting completely. Handwriting fluency still accounts for considerable variability in college students' writing performance (Connelly, Dockrell, & Barnet, 2010), and in certain circumstances anyone can produce a paper with poor legibility.

Teaching handwriting

Researchers became interested in scientifically testing the effectiveness of various procedures for teaching handwriting around 80 years ago (e.g., Kimmons, 1937). Since then, about 10 large-group handwriting intervention studies (published and unpublished) have been conducted on average each decade (Santangelo & Graham, 2016), with an undetermined number of single participant design interventions undertaken during the last 50 years or so (examples of such studies can be found in reviews by Graham, 1999; Graham & Weintraub, 1996).

The research conducted during this time has taught us much about how to effectively teach handwriting to school-aged children. In terms of big picture conclusions (see Santangelo & Graham, 2016), explicitly and directly teaching handwriting enhances both fluency and legibility; individualizing handwriting instruction as well as using technology to teach it can improve handwriting performance; interventions designed to improve handwriting through enhancing motor skills are ineffective; and handwriting instruction results in general improvements on other aspects of writing such as sentence construction, text length, and text quality.

At a more micro-level, handwriting instructional research has identified a variety of procedures that are important for teaching handwriting effectively. These include but are not limited to: modeling how letters are formed when teaching them; using visual cues such as numbered arrows to guide letter formation; providing practice tracing, copying, and writing letters from memory; encouraging students to evaluate and correct their letter production efforts during practice; reinforcing students' successful letter production efforts; providing corrective feedback; giving students plenty of opportunities to write to enhance handwriting fluency; asking children to set goals for improving their handwriting; implementing appropriate learning procedures for left-hand writers; teaching students how to position their paper and how to hold their pencil or pen in a comfortable and efficient manner; allotting 75–100 min of handwriting instruction per week in grades one through four; and providing extra handwriting instruction to students who experience difficulty mastering this skill (Graham, 2009/2010, 1999; Graham & Weintraub, 1996; Graham & Miller, 1980; Santangelo & Graham, 2016).

Despite the advances made in scientifically identifying effective practices for teaching handwriting, there is much still to be learned. First, the handwriting instructional database is generally thin. For instance, in their comprehensive review of true- and quasi-intervention studies, Santangelo and Graham (2016) found only 20 investigations that tested the effectiveness of providing explicit and direct handwriting instruction, and there were less than 10 studies testing the effectiveness of each of the following: individualization, technology, and motor instruction. Second, Graham and Santangelo found only seven studies examining if handwriting instruction resulted in better writing performance (quality, length, or sentence construction). Third, most studies reviewed by Graham and Santangelo were not conducted with students experiencing difficulties with handwriting or with older students beyond the primary grades.

This brings us to this special issue on handwriting instruction edited by Limpo, Alves and Connelly for *Reading & Writing: An Interdisciplinary Journal*. This collection of papers includes five research studies that examine if: (1) teaching handwriting to younger and older students who experience difficulty mastering it was effective, (2) teaching handwriting in conjunction with other forms of instruction was beneficial, (3) providing practice in writing number symbols improved handwriting, and (4) teaching handwriting resulted in improvements in writing and reading.

The special issue

Teaching handwriting to younger and older students with handwriting difficulties

Three of the five studies in this special issue examined if teaching handwriting to students experiencing difficulties mastering this skill was effective. Using a multiple-probe design across participants, one investigation (Limpo, Parente, & Alves) assessed the effectiveness of providing 5 h of one-on-one handwriting instruction to three-fifth grade Portuguese students with slow handwriting. Previous research has focused mostly on younger students in the primary grades, where handwriting is still a part of the regular school curriculum (formal handwriting instruction mainly occurs in grades 1 and 2 in Portugal). The handwriting instruction provided to these three students was designed to promote fast access to letter representations in memory as well as improve handwriting accuracy and speed. This relatively short intervention had one of the desired effects, as students' handwriting became more fluent. We do not know however if there was a decrement or increase in handwriting legibility or access to letter representations, as these skills were not measured. Even so, this investigation demonstrated that the handwriting fluency of older students with slow handwriting can be improved. It should be noted that an upward trend in baseline scores was observed on three consecutive probes for one to two students for each measure (handwriting fluency as well as other writing measures), casting some doubt on whether experimental control was established in these situations.

A second study (Reybroeck and Michiels) conducted with five French students with language difficulties and poor handwriting (7–10 years of age) examined if embedding practice tracing the shape of letters within the context of phonological awareness training enhanced students' graphomotor skills and handwriting quality. The tracing practice provided to the three students randomly assigned to the treatment condition was relatively minimal, as they practiced tracing letters in only 10 of the 35 exercises. The two students in the control condition were asked to visually discriminate between the target letters traced by treatment students and other distractor letters. Despite the minimal amount of tracing instruction, two of the students in the treatment condition made statistically significant gains in handwriting quality. None of the students made statistically significant gains on the measure of graphomotor skills however. It is difficult to determine if this was an issue, as the

graphomotor test assessed some skills that did not seem directly relevant to the letter tracing practice provided, such as drawing loops, straight lines, and curved lines. Of course, the findings from this study must be interpreted cautiously, as it involved such a small number of students. In addition, the authors did not establish the reliability of their measures (this is a fundamental principle in experimental research; see Graham, 2015). Even so, this study provides an important first step in examining the teaching of handwriting to students with language impairments. I hope it spurs additional handwriting research with this population.

A third study conducted in the United States (Graham, Harris, and Adkins) examined the impact of providing a supplemental package of 16 h of one-on-one handwriting and spelling instruction to first grade students who were not acquiring these skills as rapidly as their peers. In this randomized control trial, students who received this instruction made statistically greater gains in handwriting fluency and spelling than students in the control condition who received one-on-one phonological awareness instruction. Because we did not include a group that just received handwriting or spelling instruction in this study, it was not possible to determine the specific effects of handwriting on the handwriting or spelling measures administered. In addition, even though we found that students in the handwriting/spelling treatment outperformed control students on a measure of handwriting legibility, this was likely due to a decrement in the legibility of control students' writing from pretest to posttest (the handwriting/spelling treatment students' scores remained relatively constant across these two testing times). Finally, no differences were found between the two treatment conditions in terms of improved spelling in context. This was not a target of instruction, but it is the ultimate measure of spelling improvement.

In summary, these three studies (despite their limitations) add to a small but growing body of literature showing that we can improve the handwriting of younger and older students who experience difficulties mastering it. Two of the three studies also demonstrated that the teaching of handwriting can be combined or embedded in other forms of instruction and still be effective.

Teaching handwriting with other forms of instruction

While two of the studies reviewed in the last section found that combining the teaching of handwriting with other forms of instruction can be beneficial for students experiencing handwriting difficulties, the study by Lichtsteiner, Wicki, and Falmann in this special issue did not find a similar positive effect with typically developing students. In this investigation conducted with third grade children in Switzerland, students and instructors were randomly assigned to one of four instructional groups: handwriting/spelling instruction, handwriting instruction, spelling instruction, and reading fluency instruction (the inclusion of separate handwriting and spelling instructional groups corrected for a weakness in the Graham, Harris, and Adkins study discussed earlier). Each instructional group received 5 h of instruction. Unfortunately, there was no statistical differences between any of the groups on a copying measure of handwriting fluency, a test of spelling, or all but two handwriting fluency measures obtained via a digitizing tablet

(one of these two effects favored the two groups with handwriting instruction, but the effects dissipated over a short period of time).

While it might be tempting to attribute these disappointing findings to several weaknesses in the study (reliability was not reported for all measures, treatment fidelity was not established, and the nested nature of the data was not accounted for in the statistical analyses), I think several other explanations are more likely in terms of the findings for handwriting. First, the primary focus of handwriting instruction was on making connections between cursive letters. It is possible, as the authors noted, that students in this study already knew how to form letters and use the corresponding link between letters. Thus, handwriting fluency was already high at the beginning of the study and, consequently, there was little room for improvement. It is also possible that the handwriting practice students undertook made them more deliberate (and slower than they might normally be) in forming letters on the assessments which were administered after instruction (again as noted by the authors). It was surprising, therefore, that the authors did not examine the legibility of students' performance on the 5 min copying task they administered or with the composition students wrote. This may have provided data relevant to this concern.

The influence of providing practice in writing numbers

Perhaps the most intriguing as well as the most controversial finding in this collection of five studies comes from the investigation conducted by Zemlock, Vinci-Booher, and James. Their study conducted in the United States involved randomly assigning children who were approximately 4 years old to one of four conditions: practice writing letters, practice writing numbers, practice viewing letters, and practice viewing numbers. The two viewing groups (letters and numbers) were the control conditions and the two writing groups were the interventions (letters and numbers). The outcome measures involved three assessments of letter knowledge. One involved naming the 26 letters of the alphabet (letter naming). A second measure asked students to put letter cards into a corresponding slot with the letter printed on it (letter sorting). The third task required students to match a letter with one of four choices (letter recognition).

The primary purpose of their study was to determine if practice writing letters (handwriting instruction) or a more general effect of practice producing symbols (practice writing numbers) was responsible for improvements in letter knowledge. In essence, they thought writing letters would improve young children's letter knowledge, but such improvements may not be a direct consequence of writing letters as they may occur as a result of improvements in visual-motor integration brought about by practicing symbols other than letters (such as numbers). If this is the case, then both letter writing and symbol writing should improve letter knowledge. In analyzing their data for each letter knowledge measure, they conducted a 2 (condition: writing practice vs. viewing practice) \times 2 (symbol: letters vs. numbers) \times 2 (time: pretest vs. posttest) ANCOVA with age as a covariate. For the most important measure in my opinion (letter naming) only age and time were statistically significant. This was also the case for the letter sorting measure.

For the letter recognition measure, age, time, and the interaction between time and instructional condition (writing vs. viewing) were statistically significant. Authors interpreted these findings as follows. Since the writing condition (which combined students from the writing letters and writing numbers groups) outperformed the viewing condition (which combined students from the letter and number viewing group), and the letter writing group did not improve more than the number writing group (as indicated by no other statistical differences in their analysis beyond age, time, and the interaction by time and condition), then visual-motor practice with any type of symbol can lead to increases in letter recognition.

While this is a relatively sound study (even though treatment fidelity and reliability of measures were not established), I have a number of reservations about the interpretations of the findings. First, there was no statistical relation between treatment conditions and outcomes for two of the measures. This raises questions about the generalizability and strength of the authors' conclusions beyond the single letter recognition measure. Second, I was surprised that the authors did not apply statistical procedures where they directly assessed differences in letter knowledge growth between practice writing letters and practice writing numbers for their three measures. This could have been done with a 4 (condition: practice writing letters, practice writing numbers, practice viewing letters, and practice viewing numbers) X 2 (time: pretest vs posttest) ANCOVA with age as the covariate. They indicate in their discussion that future work is required to determine to what extent visually guided motor practice needs to be matched to the symbols tested. They could have tested this effect directly in their study, but for some reason did not. This last point is not unimportant, as the writing numbers group recognized three letters more than students in the two viewing groups, but the writing letters group recognized nine more letters than students in the control conditions.

In designing future studies looking at this issue, it would also be a good idea to include measures of number naming and recognition. This would have strengthened the Zemlock, Vinci-Booher, and James study published here, as it would have shown that this effect applied more generally.

Generalization effects of handwriting instruction to writing and reading

It was gratifying to see that all five studies looked at whether instruction improved students' reading and other aspects of students' writing beyond handwriting. While Lichtsteiner, Wicki, and Falman reported that both spelling and composition quality did not statistically improve as a result of handwriting instruction, this was not unexpected as their instruction did not statistically enhance students' handwriting either (possibly due to already strong handwriting skills at the start of the study as noted earlier). The findings from the other four studies are more promising, as improvements were found for letter recognition (Zemlock, Vinci-Booher, and James); grapheme reading and spelling (Reybroeck and Michiels); word spelling, sentence construction, and composition vocabulary (Graham, Harris, and Adkins), as well as grammar, story elements, and writing self-efficacy (Limpo, Parente, and Alves).

When these findings are considered along with the positive generalization effects documented in the true- and quasi-experiments reviewed by Santangelo and Graham (2016), they strengthen the claim that it is important to teach handwriting because it makes students better writers. They also provide a window into the possibility that handwriting improves reading skills (at least at the grapheme level). Nevertheless, it is important to recognize that the studies in this special issue do not provide a strong claim for these contentions for two reasons. One, in some studies, the effects of handwriting could not be isolated for many of these findings, as the teaching of handwriting instruction was paired with other forms of instruction (e.g., spelling). Two, while some measures of reading and writing improved in some studies, others did not (e.g., writing output and writing quality). The impact of handwriting instruction on reading and writing likely depends on the type of instruction provided, the dosage of the treatment, and the skills measured. Additional research is needed to gain a better understanding of how handwriting instruction impacts writing and reading growth.

In conclusion

The studies presented in this special issue of *Reading and Writing* provide new insights and important directions for future research in handwriting. I want to commend all of the author teams for their efforts to make a difference in the lives of the children who participated in their study and to advance our understanding of handwriting and its role in literacy growth. I further hope that the concerns or issues raised for each study (including my own) will help us do even better research in this area in the future.

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