An Evaluation of the Handwritten and Typed Writing Performance with Instruction and No-Instruction Conditions of Students with Disabilities

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Abstract

This study evaluated the effect that the availability of a laptop computer, in addition to specific word processing instruction, had on the writing performance of 4 students with emotional and/or learning disabilities. Writing performance indicators consisted of latency to writing task initiation, words spelled correctly, total number of words written, and correct word sequences. All four students who participated in the study benefited from the availability of a laptop computer and the ability to type their writing responses. The word processing instruction paired with computer availability appeared to be beneficial for one of the students, however, post-instruction writing performance (typed or written) did not improve significantly for the other three study participants.
Over the past 25 years computers have become prevalent in nearly all aspects of society: the home, the work place and the school. Estimates indicate that three quarters of American households have a computer and two thirds of American households have a computer with internet access. Computers are utilized in nearly every work environment. Schools have invested substantial resources in computers leading to an estimated 91% of students (K-12) using computers in schools (U.S. Census, 2003). Computers, as instructional tools, have been incorporated throughout the K-12 educational system; however, there have been few well-designed studies to evaluate how this technology affects learner outcomes.

Goldberg, Russell and Cook completed a meta-analysis of the effects of computers on student writing in 2002. Their analysis of 26 studies conducted between 1992–2002 found significant mean effect sizes in favor of computers for quantity of writing ($d=.50$, $n^2=14$) and quality of writing ($d=.41$, $n^2=15$). They went on to report that the results of the meta-analyses suggested that, on average, students who use computers when learning to write are more engaged in their writing, more motivated to write, and produce written work that is of greater length and higher quality than produced with pen and paper. Similarly, Penuel (2006) reported in his research synthesis that positive effects for laptop computer use included increased scores in the areas of literacy and writing. However, he went on to point out how few outcome studies have been done on school laptop programs and how inconsistent the study designs were.

The effects of other computer-related technology on writing performance have been documented as well. Porritt, Burt and Poling presented some evidence for the use of internet technology in increasing performance on writing tasks (2006). Using a multiple baseline design across groups, they found that the internet interventions, including individualized web page-based feedback in
addition to group and individual email recognition for achieving goals (based on word count), were successful in increasing the number of words written by participants. Computer-based spelling instruction has also been shown to improve the spelling of individuals with developmental disabilities. Vedora and Stromer (2007) reported that after computer-aided spelling instruction, students were able to spell more accurately on written assignments; additionally students showed improvement in reading aloud. MacArthur and Graham (1993) reported that integrating strategy instruction and word processing into a process approach to writing instruction can be valuable in meeting the cognitive and motivational needs of students with learning disabilities. Together these studies indicate that computers may serve as a component of useful academic interventions specifically in the area of writing.

In 2002, Maine initiated a middle school laptop program with the aim to:

…transform Maine into the premier state for utilizing technology in Kindergarten through [sic] grade 12 education in order to prepare students for a future economy that will rely heavily on technology and innovation.


Beginning in the fall of 2002 the State of Maine, through the Maine Learning Technology Initiative (MLTI), implemented a one-to-one middle school laptop program by providing all 7th and 8th grade students and teachers with laptop computers, and providing all schools and teachers with technical assistance and professional development for integrating laptop technology into their curriculum and instruction. Group design research methods have provided some initial evidence of the impact the MLTI program has had on student performance, specifically in work
done at the Maine Educational Policy Research Institute (MEPRI). Silvernail and Gritter (2007) released a research brief documenting the relationship between implementation of MLTI and student writing proficiency as measured by the Maine Educational Assessment (MEA). Results reported in this brief indicated that more frequent and “better” (i.e., using computers for writing both drafts and final copies) use of computers resulted in increases in MEA writing scale scores. While significant results were found for all groups evaluated, the results were especially apparent for economically disadvantaged students who indicated “best use”. Best use refers to using the computer for both drafting and revising written work. As a group these individuals scored higher than advantaged students who reported “no computer use” for writing.

Importantly, studies have shown that it is not the computer itself, but how it is used, that improves writing outcomes (for a discussion see Brown-Chidsey, Boscardin, & Sireci 2001). While evaluating the effects of computer use for students with Learning Disabilities, MacArthur (1996) reports that no significant qualitative differences in final product were found between handwritten and typed writing across several separate studies. He goes on to describe that the combination of revision instruction and word processing can improve writing for students with learning disabilities. Prior research has made it clear that specific instruction methods can be very effective for improving students’ writing skills (Graham & Harris, 2005). The research on effective writing instruction has shown that direct and systematic methods reliably yield improvements in student writing. The bulk of the research on effective writing instruction has been conducted with paper and pencil tasks and it has not incorporated computer use. There is a lack of research evidence concerning the value of adding computer use to writing instruction. This absence of research is anomalous when considered alongside the widespread use of computers in schools. The example of Maine’s MLTI initiative is but one example of how the
presence of computers in schools has moved ahead of research documenting how the laptops can benefit students for specific computer-based tasks. An added factor in the extant research is that it has included primarily group-based designs.

While group research designs, such as the one conducted by Silvernail and Gritter (2007), have provided some initial evidence of the effects of laptop computer programs, the validity of such studies can be compromised by threats to internal validity, statistical validity, construct validity and external validity. Single case research designs can be used in conjunction with group designs to provide experimental evidence of the relationship between the independent and dependent variable(s), and to control for some of these threats to validity. This study, which utilizes a multiple-schedule design, demonstrates the relationship between the independent variables (laptop computer availability, and laptop computer availability plus instruction) and the dependent variable (writing performance) via single case design. This type of design has been shown by Steege, Brown-Chidsey and Mace (in Thomas & Grimes, 2002) to accurately evaluate the relative effectiveness of technology-based treatments as compared to hand-written products. This information can then be used to make instructional decisions for students. Baker, Chard, Ketterlin-Geller, Apichatabutra and Dodabler (2009) report that only 6% of students with disabilities nationally scored at or above the proficient level on the 2007 NAEP writing assessment. They then go on to evaluate the quality of recent single subject and group-designed studies that looked at the evidence for Self-Regulated Strategy Development and found relatively few studies (group or single subject) met all of their quality indicators suggesting that there exists a need for additional quality research on writing instruction.

Robinson and Howell (2008) point out in their chapter on Best Practice Regarding Written Expression Curriculum Based Measures, that deficits in the areas of reading and written
expression are the largest source of referrals to special education and that limited written expression skills is a major contributor to lack of school success. Students with Emotional Behavioral Disorder (EBD) may be especially at risk as they tend to become more resistant to intervention as they get older and there is a general lack of research on how to improve academic skills for this population of students (Lane, Harris, Graham, Weisenbach, Brindle, Murphy 2008). Fitzpatrick and Knowlton (2009) reiterate this lack of research regarding academic skill development for students with EBD and then go on to point out even further the lack of investigations involving technology use in instruction for this population of students. Of the 13 handicapping conditions identified through IDEA, the combination of EBD and technology related terms returned the fewest hits in their searches of research based databases. This points out the importance of accurately determining written performance levels early on for all students. Linking accurate writing assessment with evidence-based writing interventions ensures that the interventions to be utilized are well matched to a student’s current levels of performance thus addresses the appropriate level of challenge referred to by Burns, VanDerHeyden and Boice (2008). The Aimsweb Written-Expression Curriculum Based Measures provide an easily administered norm referenced assessment that can be used to establish baseline writing ability and track changes in writing performance through progress monitoring (Powell-Smith & Shinn 2004). As such this assessment was utilized to evaluate and monitor student writing performance during the study.

Given the paucity of research data concerning the relative benefit of computer use above and beyond effective writing instruction, this study addresses the following research questions:
1. Does the use of a laptop computer alone (without specific word processing instruction) improve writing performance as compared to pen and paper performance?

2. Does the use of a laptop computer in addition to specific word-processing instructions improve writing performance as compared to pen and paper performance?

In order to address these questions, several research hypotheses were formed:

1. Using a laptop computer without providing specific word processing instructions will lead to writing performance similar to pen and paper performance across all indicators of performance.

2. Using a laptop computer and providing specific word-processing instruction will lead to writing performance that is improved over pen and paper performance. This will be evident through a decrease in latency to task initiation, an increase in words written, an increase in words spelled correctly and an increase in correct word sequences.

Method

Design

A multiple-schedule experimental design was used to evaluate the effects of laptop interventions on writing performance. Throughout the experiment all students received strategic writing instruction using a method known as PLEASE (paragraph writing instruction) as described in Writing Better by Graham and Harris (2005). The teaching script for this instruction can be found in Appendix A. During baseline, the medium used to produce the writing was counterbalanced to demonstrate baseline levels
of writing performance using both the computer and pen and paper for each participant. The intervention phase (word processing instruction) was introduced sequentially based on each student’s establishment of stable baseline scores (minimum of 5 sessions). The word processing instruction consisted of instruction in how to spell-check a document and how to cut and paste text within a document. This instruction was continued until each student demonstrated mastery (10 correct trials in succession) in both components. The teaching script for the computer instruction can be found in Appendix B. The computer plus specific word-processing instruction administration was then alternated with pen and paper writing prompt administration and the results compared. A school psychology doctoral student, with 5 years of previous teaching experience, led the study.

Participants and Setting

Four students, between the ages of 13 and 17, were identified to participate in the study. The participants were a sample of convenience however each had a history of academic difficulty and writing skills that were below average for their respective grade level. One student was below the 10th percentile, two students were below the 25th percentile and one student was below the 50th percentile on the correct word sequences measure. The 8th grade spring 50th percentile norm score was used as the benchmark for all 4 students. Each was at risk for failing due to a combination of skill and performance deficits and had been removed from their home schools and placed at ACHIEVE! by their respective IEP teams after other intensive special education services had been tried. All four students had academic goals in the area of writing in their IEPs and thus were receiving writing instruction as part of the Language Arts curriculum. The students had various diagnoses including but not limited to Learning Disability, Emotional Behavioral Disorder, Multiple Disabilities, Cognitive Disability and Other Health Impairment.
The doctoral student provided the Language Arts instruction during which the writing activities were conducted. The study took place at the ACHIEVE program. ACHIEVE is a comprehensive day treatment program for students needing behavioral and academic supports to succeed in regular education. Students range in age from 8 to 18. All have special education needs and various DSM-IV-TR diagnoses requiring behavior management, academic intervention, individual psychotherapy, and in-home family support. The program is specifically designed to reward students’ efforts to improve their social skills, academic performance, and self-regulation of their emotions to enable them to participate fully and successfully in regular education classes.

Resource classrooms were used as the setting for the study. Each measured approximately 6 m x 10 m and contained 4 to 5 tables, 8 to 10 chairs and file cabinets. Approval of the study design was obtained from the University of Southern Maine Institutional Review Board (IRB) prior to implementation of any study procedures. Informed consent to participate in the study was provided by a parent of each student; student assent also was obtained.

Apparatus

Apple G4 i-Books were used for the intervention. Each laptop contained software including AppleWorks, NeoOffice, web browsers, email software, iMovie, iPhoto, and NoteShare. For the study, students used the AppleWorks and the NeoOffice software to create, edit, revise, and save their written work.

Target Behaviors and Data Collection

Data were collected on the four elements of writing performance that were hypothesized to be affected by the use of a computer: (a) latency to writing initiation, (b)
total words written, (c) words spelled correctly, and (d) correct word sequences. Latency
to task initiation can be used to evaluate response equivalence (Fazio, 1990) while total
words written, words spelled correctly and correct word sequences accurately detect
improvements in written performance (Smith-Powell & Shinn, 2006) in students with
different levels of writing skills.

Latency was defined as the time elapsed from the direction to begin until the first
keystroke or pen stroke. It was measured in seconds using a stopwatch. Total words
written (TWW) was measured for all writing samples by counting the number of words
the student wrote during the timed writing sample. Words spelled correctly (WSC) was
defined as the number of words spelled correctly in each sample and was measured by
subtracting the number of misspelled words from the total number of words written.
Correct word sequences (CWS) was defined as the number of words used with the correct
syntax in each sample and was measured by a count.

The specific writing probes and measurement rubrics used in this study were from
the AIMSweb CBM system (AIMSweb, 2009). The AIMSweb Writing Evaluation (WE-
CBM) writing probes are “story starters” which are read out loud to the student under
timed conditions. Once the story starter has been read, the student has 1 minute to think
about what to write, followed by 3 minutes to write a story based on the story starter.

Writing onset latency was measured each time a probe was administered to a
student; the researcher used a stopwatch to measure how many seconds elapsed from
when the student was told to begin writing and when writing commenced. To score the
other writing measures (TWW, WSC, and CWS), the published AIMSweb scoring
rubrics were used.
Procedures

Student laptop possession was dependent on both parent and student written agreement with the district's technology acceptable use policy. Additionally, students had to use the laptop as instructed by the researcher in order to retain possession and continue participating in the study.

Baseline

During baseline and throughout the study, students were provided with the paragraph writing instruction according to the method described in Appendix A. Following this instruction the writing assessment began. Each student was provided with either a pen and paper or laptop computer running the AppleWorks word processing program. This application was chosen because it does not identify misspelled words while typing. Each student sat at a desk and the researcher initiated the AIMSweb standardized writing prompt. In addition to following the standardized instructions for the WE-CBM prompt, a stopwatch was used to measure the latency to first pen stroke/keystroke following the directive to begin writing. After the student completed each session’s writing probes, the researcher continued with other regularly planned instructional activities for the remainder of that period. The writing products were scored by the researcher, according to the AIMSweb WE-CBM administration and scoring manual to determine the total word count, words spelled correctly and correct word sequences. The baseline condition continued until stability in writing scores (within a range of 36 points) was established for each subject.

Intervention

Once a stable baseline was observed, the computer intervention phase began; intervention was implemented sequentially as stability in baseline scores was established for each student.
The intervention consisted of specific instruction in how to use two specific tools within a word-processing program—spell check, and cut and paste procedures (see Appendix B). Students were introduced to spell check capabilities of NeoOffice (misspelled words are identified by a red underline while typing). Students were given text files with incorrect spelling and they used the spell check function to correct those passages. Students practiced this until they could successfully complete this procedure 10 consecutive times. Secondly, students were taught how to use a cut-and-paste procedure to move sentences around in a document. Again, each student was provided with a sample passage text file with directions for how cut-and-paste procedures could be used to make the passage easier to read and understand. Students practiced the cut and paste procedure until they were able to demonstrate the procedure correctly 10 times in succession. The sample passages used for the spelling and cut and paste procedures are included in Appendix D.

Interobserver Agreement

Each of the writing probes was scored by the researcher. Thirty percent of the probes were scored by another teacher trained to use AIMSweb WE-CBM. Treatment and assessment accuracy were calculated on an interval basis by dividing the number of agreed upon items by the number of agreed upon plus disagreed upon items and multiplying by 100. In addition the researcher was observed 4 times while delivering the writing prompt and the AIMSweb Accuracy of Implementation Rating Scale (AIRS-WE-CBM) was used to evaluate the implementation of the writing probe.

Results

Student data were analyzed to evaluate the differences in student writing performance based on the writing medium and presence or absence of specific word-processing instruction.
Scores on the WE-CBM measures (TWW, CSW, CWS) and latency to task initiation were compared across computer/no-computer and across instruction/no-instruction conditions in order to determine if computers should be utilized further in the language arts instruction for these students, and, if so, how best to use the computers.

*Interobserver Agreement.* Interobserver Agreement (IOA) scores were calculated for TWW, WSC and CWS. Results are listed in Table 1. Scores were averaged over the total number of sessions observed in each response medium in order to evaluate any differences in agreement rates based on the response medium. The IOA data were uniformly strong and reflected adequate agreement among the observers. Agreement between response media was nearly identical for TWW and WSC while CWS agreement was higher on the typed responses.

*Latency.* Across all four students, latency to task initiation was not found to change significantly based on the assessment medium or the instruction/no-instruction conditions. Latency ranged between 0 and 8 seconds across all writing prompts. No significant trend was observed between latency and total words written for any of the students. Figure 1 shows the latency to task initiation for each student. In each case the latency to task initiation was less variable during the instruction phase. No further evaluation of latency was deemed necessary.

*Total Words Written.* The number of Total Words Written (TWW) ranged from 16 to 116 across all 123 sessions. Average scores across assessment medium and instruction/no-instruction conditions were calculated for all four students and are listed in Table 2. Three of the four students obtained higher average scores on the TWW measure when they had the opportunity to type their responses in the baseline phase. In the instructional phase all four students had higher average TWW scores when they were able to type responses. The percent improvement from written to typed responses was calculated for both the baseline and instruction phases and results
are listed in Table 3. This calculation shows how much better students A and D did on the TWW measure when they had the opportunity to type rather than write their responses. Additionally, Student C’s average typed TWW scores showed gains over written responses following the instruction intervention.

*Words Spelled Correctly and Correct Word Sequences.* Similar analyses were completed with the number of Words Spelled Correctly (WSC) and number of Correct Word Sequences (CWS). The total number of Words Spelled Correctly ranged from 10 to 107 across all 123 sessions. Tables 4 and 5 show the WSC data. The number of CWS scores ranged from 2 to 82 across all 123 sessions. Tables 6 and 7 show the CWS data. Note that all students either had equal or higher average typed scores on the WSC measure during the baseline phase and all four students had higher average typed scores during the instruction phase. Again Students A and D showed markedly higher WSC scores when they were able to type responses. Students C and D showed an increased gain in average typed score over written score following the instruction intervention.

Typing responses improved the average CWS scores for all four students in both the baseline and instruction phases. Average CWS scores showed a gain of at least 25% for Students A, C and D in both the baseline and instruction phases. Students B and D both had gains in average typed scores over average written scores following the instruction intervention.

In order to evaluate the effect of the instruction intervention on TWW scores for each student, scores during the instruction phase were graphed as a percent of baseline. Each typed and written score during the instructional phase was divided by the mean baseline for the respective response medium. TWW as a percent of baseline graphs for each student are presented in Figure 2. Students A and D had scores that were consistently higher than baseline
during the instruction phase. Student A had higher scores only on the written responses while student D had higher scores only on the typed responses. For the other students, scores during the instruction phase were similar to or slightly lower than during baseline. Again, similar analyses were completed for the WSC and CWS measures. Figures 3 and 4 show the results for those measures.

Students A and D showed consistent improvement in their WSC scores over baseline during the intervention phase. Student A’s written response scores were higher than baseline for all but the last session while Student D’s typed response scores were higher than during baseline for the final 6 sessions. Students B and C had scores that were either similar to or slightly lower than during baseline.

Similar to the results of the other measures, CWS scores showed consistent improvements for Students A and D following the instruction intervention. Student A had written response scores higher than baseline for all of the instruction phase sessions and Student D had typed response scores higher than baseline for all of the instruction phase sessions. Students B and C had scores that were either similar to or slightly lower than during baseline.

A secondary analysis of non-overlapping data points (NDP) was used to evaluate the effect size of the intervention across each student. The intervention did not yield any significant increases in performance over baseline for any of the students. This relates directly to the variability in performance during baseline and general decline in overall performance across students during the study. Only Student D showed a trend toward improved performance when typing responses following the instruction intervention; however the highest NDP result for that student was that 37% of CWS scores during the instruction phase were higher than the highest baseline score. Generally percentages of greater than 70% are required to describe an
intervention as effective. Figures 5 through 7 show the TWW, WSC and CWS scores for each student during the study.

The results can also be summarized across students rather than measures. AIMsweb has national aggregate norms for its writing prompts. These norms were used to compare each student's writing performance for TWW, WSC, and CWS. Student A had baseline writing scores below the 10\textsuperscript{th} percentile score for eighth grade in TWW, WSC, and CWS. This student clearly struggles with written expression and while the intervention did not significantly improve his scores, access to a computer did. Over the course of the study, this student averaged ten additional words written (40% improvement), ten additional words spelled correctly (50% improvement) and seven additional correct word sequences (64% improvement) when typing responses. Notably, student A had downward trending scores on both typed and written responses toward the end of the study suggesting a reduced response effort as the study progressed.

Student B’s baseline written TWW, WSC and CWS scores were just below the 25\textsuperscript{th} percentile score for eighth grade, and while scores did not improve significantly following the writing intervention, typed responses over the course of the study resulted in higher TWW, WSC and CWS scores. There was an average of six additional words written (13% improvement), five additional words spelled correctly (11% improvement) and five additional correct word sequences (13% improvement) on typed responses. Student B also had downward trending scores on both typed and written responses toward the end of the study and may also have displayed reduced response effort as the study progressed.

Student C had baseline written TWW and WSC scores that were above 50\textsuperscript{th} percentile score for eighth grade, but this student’s CWS score was below the 50\textsuperscript{th} percentile. However, this
student’s average typed response during baseline was above the 50th percentile benchmark, indicating that access to the computer alone was enough to meet the benchmark standard. Again no significant improvement in scores was found following the writing intervention and again scores on both written and typed responses dropped off toward the end of the study.

Student D was the only student whose scores on typed responses improved following the writing intervention. This student’s handwritten baseline scores on TWW, WSC and CWS were slightly below the 25th percentile score for eighth grade. However, the average typed scores during baseline on TWW and WSC met or exceeded the 50th percentile benchmark score indicating that access to a computer was enough to meet these benchmark standards before any writing intervention was provided. Following the writing intervention, student D’s typed response scores including CWS continued to rise well above the 50th percentile benchmark while handwritten responses remained steady and below the benchmark on the three measures.

Discussion

Over the course of the study it became clear that written and typed responses were not equivalent as hypothesized. Three of the four students averaged higher scores on TWW, WSC and CWS across baseline and instruction conditions when they typed their responses while the fourth student had higher typed scores on CWS during baseline and on TWW, WSC and CWS during the instruction phase. The highest score for all four participants, on each of the measures, was obtained on a typed response. In some cases access to a computer alone was sufficient to meet national benchmark standards.

Three students showed improvement in percent gain of typed over written responses on at least one of the measures following the computer instruction intervention. Student D gained across TWW, WSC and CWS, Student C gained on the TWW and WSC measures, and Student
B gained only on the CWS measure. Only Student A’s percent gains actually dropped after the intervention. This drop may have due to the possible confounds of practice effect, outside instruction that may have benefited written performance more than typed performance and/or inconsistent response effort. For example, Student A’s baseline writing scores were quite low and given the opportunity to practice writing, scores were likely to improve. Because the scores were so low to begin with any improvement on the written responses that was not equally captured by the typed responses would quickly cut into the percent gain. In addition Student A’s typed responses scores were quite variable following the instruction while written response scores were steady leading to average scores that were closer together than during baseline. It is worth noting that there was a general trend toward lower scores in the final sessions across response medium for three of the four students indicating that response effort may have decreased as the end of the school year approached and students began to tire of participating in the writing sessions. All of the students had completed between 26 and 33 writing prompts during the study and care should be taken when progress monitoring with WE-CBMs to ensure that students continue to put their best effort into their responses.

The results for Student D indicated responsiveness to the computer writing medium and instruction and as such it was recommended during that student's IEP team meeting that the individual should have access to a computer to type assignments. Given that the other three students did somewhat better to begin with when typing responses further evaluation should be done to examine what additional instruction on using the computer may improve their writing outcomes. Perhaps these students would benefit from a combination of interventions that include both computer use and reinforcers. Alternatively, the students' might respond to a reinforcer
condition alone, thus, it would be important to try each condition to identify the best intervention for each student.

The effects of the computer condition in this study were mixed. The heterogeneity in scores following the intervention provides external validity for the study. For some of the students, access to the computer was linked with improvements in writing above and beyond those observed within the writing condition. This result supports prior research that indicates that quantity and quality of writing can be increased through the use of computers (Goldberg, Russell & Cook, 2002). Yet, for another student the computer condition in addition to word processing instruction yielded significant improvements in the students' writing skills beyond those observed within the writing condition. This finding was consistent with prior research which has shown that it is the combination of computers and how they are used that influences school performance (MacArthur, 1996, Silvernail & Gritter, 2007). It is important to keep in mind the combinations of learning disabilities and emotional behavioral disorder present in the population studied and to recognize the complex interactions of skills, motivation and emotional state that influenced each individual writing response. Clearly, there is a need for additional research on how to utilized technology in improving academic outcomes for this population of students.

There were several factors that limited the level of control in this study and should be addressed through future research. A first limitation was the level of instructional control. This study was conducted during an ongoing Language Arts class so there was additional unrelated instruction and direction provided to each student that may have differentially influenced writing performance across the writing media. Secondly, while writing curriculum base measures are efficient estimators of writing performance, the three minute writing probes used in this study may have been too short to capture changes in performance related to the instructional
intervention. For students who were already writing and typing at relatively high rates and with accurate spelling and grammar, there was not much room for improvement during this limited amount of time. Extending the amount of time for writing may give a more accurate picture of the effects of computer and no-computer conditions on writing performance.

Although the results of this study did not lead to major improvements in the students' writing, there were other elements that may have implications for teachers. As Response to Intervention (RTI) and the use of data-based decision making increases in schools, the amount of data that teachers will gather, evaluate and store will increase dramatically. Having digital copies of student work may be more efficient for teachers. The ability to manipulate the typed responses by double spacing and enlarging the font made the scoring process easier and more efficient than scoring the hand written responses. In addition there is the potential to allow the computer to calculate the TWW and number of misspelled words. Interobserver agreement was higher on the typed response CWS scores indicating another potential advantage for the computer condition. It may also be valuable to evaluate which medium provides students with the opportunity to generate their best writing. A counterbalanced comparison of written and typed responses provides an opportunity for students to demonstrate which medium they are more comfortable with and provides responses that best reflect their writing potential. The results of this study suggest that optimal school computer use may vary by student, thus, allowing students to try out and use the method which yields their best writing may be the best way to use computers effectively in schools.

Summary

This study and others before it demonstrate that integrating computer technology with effective instructional strategies and opportunities to practice can lead to better writing
performance but no one of these factors alone guarantees success. Given the continued growth of technology integration into schools, the workplace and society, providing students with access to and instruction on computers becomes imperative to their success. Beginning in 2011, the National Assessment of Educational Progress (NAEP) will assess writing for students in grades 8 and 12 on computers instead of with the traditional pencils and paper assessment. This fact provides further evidence of continued technology integration in school and increases the importance of providing students with word processing instruction and practice.

This study provided an evaluation of writing performance for four students across writing media and compared their written responses from computer/no-computer and instruction/no-instruction conditions. Further evaluation of individual strengths and weaknesses that address both writing skills and computer skills will be necessary in order to develop effective instructional strategies that improve each student’s individual writing performance. At an individual level, it was recommended that those students who performed better on their typed responses be given the opportunity to complete their writing assignments on computers whenever possible.
References


Table 1.

Interobserver Agreement

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<th></th>
<th>TWW</th>
<th>WSC</th>
<th>CWS</th>
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<tbody>
<tr>
<td>Overall (n 46)</td>
<td>99%</td>
<td>97%</td>
<td>92%</td>
</tr>
<tr>
<td>Typed (n 23)</td>
<td>99%</td>
<td>97%</td>
<td>94%</td>
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<tr>
<td>Written (n 23)</td>
<td>99%</td>
<td>97%</td>
<td>89%</td>
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Table 2.

Total Number of Words Written

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<th>Baseline Mean</th>
<th>Instruction Mean</th>
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<tr>
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<td>Written</td>
<td>Typed</td>
</tr>
<tr>
<td>A</td>
<td>23</td>
<td>36</td>
</tr>
<tr>
<td>B</td>
<td>46</td>
<td>54</td>
</tr>
<tr>
<td>C</td>
<td>75</td>
<td>73</td>
</tr>
<tr>
<td>D</td>
<td>47</td>
<td>66</td>
</tr>
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</table>
Table 3.

Average Gain in TWW Score from Written to Typed Responses

<table>
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<th>Student</th>
<th>Baseline</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>56%</td>
<td>25%</td>
</tr>
<tr>
<td>B</td>
<td>18%</td>
<td>9%</td>
</tr>
<tr>
<td>C</td>
<td>-3%</td>
<td>3%</td>
</tr>
<tr>
<td>D</td>
<td>41%</td>
<td>80%</td>
</tr>
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</table>
Table 4.

Number of Words Spelled Correctly.

<table>
<thead>
<tr>
<th>Student</th>
<th>Baseline Mean</th>
<th>Instruction Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Written</td>
<td>Typed</td>
</tr>
<tr>
<td>A</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>45</td>
<td>52</td>
</tr>
<tr>
<td>C</td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td>D</td>
<td>46</td>
<td>64</td>
</tr>
</tbody>
</table>
Table 5.

Average Gain in WSC Score from Written to Typed Response.

<table>
<thead>
<tr>
<th>Student</th>
<th>Baseline</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>65%</td>
<td>32%</td>
</tr>
<tr>
<td>B</td>
<td>14%</td>
<td>11%</td>
</tr>
<tr>
<td>C</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>D</td>
<td>38%</td>
<td>80%</td>
</tr>
</tbody>
</table>
Table 6.

Number of Correct Word Sequences

<table>
<thead>
<tr>
<th>Student</th>
<th>Baseline Mean</th>
<th>Instruction Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Written</td>
<td>Typed</td>
</tr>
<tr>
<td>A</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>B</td>
<td>39</td>
<td>43</td>
</tr>
<tr>
<td>C</td>
<td>47</td>
<td>61</td>
</tr>
<tr>
<td>D</td>
<td>39</td>
<td>45</td>
</tr>
</tbody>
</table>
Table 7.

Average Gain in CWS Score from Written to Typed Response

<table>
<thead>
<tr>
<th>Student</th>
<th>Baseline</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90%</td>
<td>49%</td>
</tr>
<tr>
<td>B</td>
<td>12%</td>
<td>17%</td>
</tr>
<tr>
<td>C</td>
<td>30%</td>
<td>27%</td>
</tr>
<tr>
<td>D</td>
<td>14%</td>
<td>81%</td>
</tr>
</tbody>
</table>
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Figure 1. Latency to First Pen/Keystroke for each Student

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Figure 4. CWS as a Percent of Baseline

Figure 5. TWW Scores by Student

Figure 6. WSC Scores by Student

Figure 7. CWS Scores by Student
Figure 1. Latency to Task Initiation

Student A

Baseline

Instruction

Written  Typed

Student B

Baseline

Instruction

Written  Typed

Student C

Baseline

Instruction

Written  Typed

Student D

Baseline

Instruction

Written  Typed
Figure 2. TWW as a Percent of Baseline
Figure 3. WSC as a Percent of Baseline
Figure 4. CWS as a Percent of Baseline
Figure 5. TWW Scores by Student

- **Student A**
  - Baseline
  - Instruction
  - Number of Words vs. Session
  - Graphs showing written, typed, and 50% norm data.

- **Student B**
  - Baseline
  - Instruction
  - Number of Words vs. Session
  - Graphs showing written, typed, and 50% norm data.

- **Student C**
  - Baseline
  - Instruction
  - Number of Words vs. Session
  - Graphs showing written, typed, and 50% norm data.

- **Student D**
  - Baseline
  - Instruction
  - Number of Words vs. Session
  - Graphs showing written, typed, and 50% norm data.
Figure 6. WSC Scores by Student

Student A

Student B

Student C

Student D

Session

Number of Words

Written
Typed
50% Norm
Figure 7. CWS Scores by Student
Appendix A

PLEASE—Paragraph Writing Strategy as described in *Writing Better: Effective Strategies for Teaching Students with Learning Difficulties* (Graham & Harris, 2005).

1. TEACHER SAYS: “PLEASE is a mnemonic that reminds students to carry out the following steps when writing a paragraph. A mnemonic is a one-word reminder of steps to use to do something. The letters in PLEASE can be used to remind us of the steps to use when writing a paragraph:

   Pick—the topic, audience and type of paragraph to be written
   List—ideas that might be included in the paragraph
   Evaluate—the ideas to determine if the list is complete
   Activate—the paragraph with a short declarative topic sentence
   Supply—or construct sentences that support the topic sentence
   End—with a concluding sentence that rephrases the topic sentence”

1. TEACHER SAYS: “Let’s practice using the PLEASE system together. I am going to read a sentence for you to use to write a short story.”

2. TEACHER READS STORY STARTER OUT LOUD TO STUDENT.

3. TEACHER SAYS: “Let’s use the PLEASE steps to write a story. You can use this paper to help you write down your ideas before and while you write.

4. TEACHER HANDS **PLEASE** WORKSHEET TO STUDENT.

5. TEACHER SAYS: “The first letter in PLEASE is P and it stands for Pick—pick the topic, audience and type of paragraph to be written. What topic will you write about?

6. STUDENT TELLS TEACHER THE TOPIC.

7. TEACHER SAYS: “Write your topic on the handout next to the P step.”
8. TEACHER SAYS: “The second letter in PLEASE is L and it stands for List—list ideas that might be included in the paragraph. What ideas will you write about?”

9. STUDENT TELLS TEACHER THE IDEAS.

10. TEACHER SAYS: “Write your ideas on the handout next to the L step.”

11. TEACHER SAYS: “The third letter in PLEASE is E and it stands for Evaluate—evaluate the ideas to determine if the list is complete. Is your list complete?”

12. STUDENT TELLS TEACHER IF LIST IS COMPLETE.

13. TEACHER SAYS: “Check off complete on the handout next to the E step.”

14. TEACHER SAYS: “The fourth letter in PLEASE is A and it stands for Activate—activate the paragraph with a short declarative topic sentence. Write your topic sentence next to the A step on the handout.”

15. STUDENT WRITES TOPIC SENTENCE.

16. TEACHER REVIEWS TOPIC SENTENCE AND PROVIDES CORRECTIVE FEEDBACK TO STUDENT.

17. TEACHER SAYS: “The fifth letter in PLEASE is S and it stands for Supply—supply or construct sentences that support the topic sentence. Write your supporting sentences next to the S step on the handout.”

18. STUDENT WRITES SUPPORTING SENTENCES.

19. TEACHER REVIEWS SUPPORTING SENTENCES AND PROVIDES CORRECTIVE FEEDBACK TO STUDENT.

20. TEACHER SAYS: “The sixth letter in PLEASE is E and it stands for End—end with a concluding sentence that rephrases the topic sentence. Write your ending sentence next to the E step on the handout.”
21. STUDENT WRITES ENDING SENTENCE.

22. TEACHER REVIEWS ENDING SENTENCE AND PROVIDES CORRECTIVE FEEDBACK TO STUDENT.

23. TEACHER SAYS: “Now let’s review and edit your paragraph. Please read your paragraph out loud to me.

24. STUDENT READS PARAGRAPH OUT LOUD.

25. TEACHER SAYS: “If you see anything in your paragraph you want to change, make those changes. Be sure to check your spelling, punctuation, and grammar.”

26. STUDENT CHECKS PARAGRAPH AND MAKES AND ANY CHANGES.

27. TEACHER SAYS: “Good job working hard on your writing today. We will use the PLEASE mnemonic each day when we work on writing.

28. TEACHER SHOWS PLEASE MNEMONIC CARD TO STUDENT AND SAYS: “Here is a card with the PLEASE steps on it. You can have this on your desk each day when we work on writing.”

FOR ALL WRITING SESSIONS AFTER THE FIRST ONE WHEN THE ABOVE IS INTRODUCED USE THE FOLLOWING:

29. TEACHER SHOWS PLEASE MNEMONIC CARD TO STUDENT AND SAYS: “Here is a card with the PLEASE steps on it. You can have this on your desk today when we work on writing.”
PLEASE Paragraph Writing Worksheet

**P =** Pick a topic: ______________________________________________________________

**L =** List ideas that might be included in the paragraph:

1. __________________________
2. __________________________
3. __________________________
4. __________________________
5. __________________________

**E =** Evaluate the ideas to determine if the list is complete; Check when list is complete ____

**A =** Activate the paragraph with a short declarative topic sentence:

Topic sentence: ______________________________________________________________

_________________________________________________________________________

**S =** Supply or construct sentences that support the topic sentence:

1. _______________________________________________________________________
   _______________________________________________________________________
2. _______________________________________________________________________
   _______________________________________________________________________
3. _______________________________________________________________________
   _______________________________________________________________________

**E =** End—with a concluding sentence that rephrases the topic sentence:

Ending sentence: ____________________________________________________________

_________________________________________________________________________
Appendix B

Instructional script for word processor instruction

1. TEACHER SAYS: “NeoOffice provides a spell checking tool to help you polish your writing. You can check all the text in the document, or specific text that you select.”

2. TEACHER SAYS: First we need to enter some text so that we can practice using this tool. Please enter the following sentence as written into your word processing document.

3. TEACHER SHOWS STUDENT A CARD WITH THE FOLLOWING SENTENCE WITH SPELLING ERRORS AND READS: “Please check the spelling of this text. There are seven errors that must be fixed.”

   Please check the spelling of this text. There are seven errors that must be fixed.

4. STUDENT TYPES THE TEXT AS WRITTEN INTO THE DOCUMENT.

5. TEACHER SAYS: “NeoOffice automatically checks the spelling of this text. Notice that the misspelled words are underlined in red.”

6. TEACHER SAYS: “You can use your track pad to select the correct spelling of ‘Please’ from a list of alternatives hold down the control button and click on “pleese”. You’re your track pad to select the correct alternative and click it.”

7. STUDENTS SELECT THE FIRST ALTERNATIVE AND CLICK ON IT.

8. TEACHER SAYS: “Repeat this process until all of the misspelled words have been corrected.”

9. STUDENT CORRECTS THE SPELLING OF THE OTHER SIX MISSPELLED WORDS.

10. TEACHER SAYS: “NeoOffice also provides cut and paste tools to help you move blocks of text within your document.”
11. TEACHER OPENS THE DOCUMENT WITH PRACTICE PARAGRAPHS.

12. TEACHER SAYS: “Move your cursor to the beginning of the section of text you would like to move, then hold the button down as you scroll across to highlight the section. When you have reached the end of the section to be moved, release the button.”

13. TEACHER DEMONSTRATES THIS PROCEDURE ON COMPUTER.

14. STUDENT PRACTICES HIGHLIGHTING TEXT.

15. TEACHER SAYS: “Once text has been highlighted, click on the ‘Cut’ command in the Edit menu.”

16. TEACHER DEMONSTRATES HIGHLIGHTING TEXT FOLLOWED BY CLICKING ON ‘CUT’ IN THE EDIT MENU.

17. STUDENT PRACTICES HIGHLIGHTING AND CUTTING PROCEDURE.

18. TEACHER SAYS: Move your cursor to the point where you want to paste the text. Then click the ‘Paste’ command in the Edit menu.”

19. TEACHER DEMONSTRATES THIS PROCEDURE.

20. STUDENT PRACTICES PASTING PROCEDURE.

21. TEACHER SAYS: Follow the directions as written in the paragraphs to complete the spell check and cut and paste procedure.”

22. STUDENT COMPLETES THE SPELL CHECK, CUT AND PASTE PRACTICE EXERCISE.
Appendix C


Written Expression Curriculum-Based Measurement (WE-CBM) Standardized Directions

1. Select an appropriate story starter.

2. Provide the student with a pencil and a sheet of lined paper.

3. Say these specific directions to the students:

   *You are going to write a story. First, I will read a sentence, and then you will write a story about what happens next. You will have 1 minute to think about what you will write, and 3 minutes to write your story. Remember to do your best work. If you don’t know how to spell a word, you should guess. Are there any questions? (Pause).*

   *Put your pencils down and listen.*

   *For the next minute, think about ... “(insert story starter).”*

4. After reading the story starter, begin your stopwatch and allow 1 minute for students to “think.” (Monitor students so that they do not begin writing).
After 30 seconds say: *You should be thinking about* (insert story starter).”

5. At the end of 1 minute say: *Now begin writing.* Restart your stopwatch.

6. Monitor students' participation. If individual students pause for about 10 seconds or say they are done before the test is finished, move close to them and say *Keep writing the best story you can.* This prompt can be repeated to students should they pause again.

7. After 90 seconds say: *You should be thinking about* (insert story starter).”

8. At the end of 3 minutes say: *Stop. Put your pencils down.*

If students want to finish their story, it is allowable to do so as long as they complete it on a separate piece of paper or computer file.
Appendix D

Sample Paragraphs for use in word processor instruction:

There are several sentences in this paragraph that are in the wrong order. In addition some words are misspelled and need to be corrected. Follow the directions to clean up this paragraph. Second use the cut and paste procedure to put the directions in order by moving ‘first’ ‘second’ and ‘third’ to their correct locations. Third use the spell check to identify and correct misspelled words in the paragraph. First, go back and make sure that each sentence starts with a capital letter and ends with a period. Lastly please move the entire last sentence to the beginning of the paragraph. Please let your staff person know when you have completed moving this sentence.

Uses the cut and paste procedure in addition to the spell check to make some changes in thesee paragraph. Thise sentence should be the fourth sentence in the paragraph. This sentence should be the first in the paragraph. This sentence should be the third sentence. This sentence should be the laast. When you have completed correcting the spelling in addition to cutting and pasting the sentences into the correct order please raise your hand.