



Using Software to Enhance the Writing Skills of Students with Special Needs

Jennifer Cullen
Dayton, Ohio Public Schools

Stephen B. Richards
Catherine Lawless Frank
University of Dayton

This study used a modified multiple-baseline design to determine the effects on the writing performance of seven students with special needs when a talking word processor with spell checker software was used independent of and in conjunction with word prediction software as accommodations in daily writing exercises. Results indicated that, in general, the impact of using writing software was positive. The group mean for number of misspellings decreased, accuracy percentage increased, number of words increased, and overall district writing rubric scores increased. Further, the software had different benefits for different students and students expressed preferences for particular software functions. Implications for practice and research are presented.

"The race whe a vere fun The car whez vere fass he loss the race" (translation: The race was very fun. The car was very fast. He lost the race).

This sample of writing is typical of that produced by many students with special needs, many of whom experience difficulties in spelling, written expression, punctuation, capitalization, and organization. MacArthur, Graham, Haynes, and DeLaPaz (1996) found that students with special needs were two to four times more likely to have spelling errors than their general education peers. Mayes, Calhoun, and Crowell (2000) found that 65% of 119 students referred to a clinic for suspected learning disabilities had a written expression disability, twice the percentage of students who had a disability in reading, math, or spelling. Further, Brooks, Vaughan, and Verninger (1999) found that for 15 of 17 students with learning disabilities referred for writing intervention, their spelling, composition, and word recognition scores were significantly below their verbal intelligence quotient scores. DeLaPaz (1999) noted that students with learning disabilities were more likely to demonstrate errors in spelling, punctuation, capitalization, and

word usage and that their writings were more likely to be shorter and illegible.

Students with special needs are regularly included in general education classrooms that require development of literacy skills, including writing. Assistive technology accommodations such as computer software could "enhance productivity as lifelong learners ... and it has important implications for special education and related services personnel when considering how to help students with disabilities achieve high standards" (Edyburn, 2000, p. 15). Research suggests computer software can be a beneficial accommodation for improving students' writing with the use of personal computer spell checkers, talking word processors, and word prediction software.

Personal Computer Spell Checkers

Spell checkers may help to identify misspelled words and provide suggestions for the target word. MacArthur (1996) found that when the target word was in the list of suggested words provided in the program, students



could correctly select the target word in 81% of the opportunities. However, spell checkers have limitations in providing writing assistance. Suggested spellings tend to include the desired word only when the initial letters of the word are typed correctly at the outset (MacArthur, 1996; Montgomery, Karlan, & Countinho, 2001). Thus, in a study examining nine different spell checkers, the effectiveness of spell checkers was limited because the software was less helpful for students who grossly misspelled words (Montgomery, Karlan, & Countinho, 2001).

Talking Word Processors

A talking word processor translates text into speech and gives students the opportunity to hear the words spoken as they are typed. This may help students monitor and correct their writing (MacArthur, 1996, 1999). MacArthur (1996) used a talking word processor with a sixth grader named Mark. Mark had a severe reading disability that hindered his writing, in part because his spelling was difficult to decipher. At times, Mark himself was unable to read what he had written. Mark increased his spelling accuracy by using a personal dictionary combined with the use of a talking word processor. MacArthur (1996) concluded that the talking word processor benefited Mark by providing a verbal check to see if it was his intended word and if it was spelled correctly.

Borgh and Dickson (1992) investigated the use of a talking word processor with 48 elementary students. Overall, the group improved in editing and motivation for writing. Forty of the students thought it was more fun to write with the software, and students' attempts at editing with the software improved.

Word Prediction Software

Word prediction software programs may also be helpful in writing tasks (Edyburn, 2000; MacArthur, 1999; Merbler, Hadadian, & Ulman, 1999; Williams, 2002). Word prediction software programs create a personalized word bank for each user. Words that are frequently typed by the user appear on the list of possible spellings generated by the software, meaning the program "learns" what words the writer more frequently uses and hence, the software "predicts" what word the writer is attempting to spell.

In a case study involving three participants, MacArthur (1999) concluded that word prediction software could be more valuable than spell checkers in certain respects. For example, if a student typed the initial sounds correctly, he or she could get the correct spelling for the word with the word prediction software, and thereby avoid at least some errors from the outset. Further, Williams (2002) studied the use of word prediction software by a seventh grade student who produced writings at a preprimer level. As a result of using the word prediction software, the length of this student's daily journal entries went from an mean of 36.9 words to 60.28 words, and the quality rose from a 2.78 out of a possible 7.0 points during baseline to 3.5.

In summary, as suggested above, computer software accommodations may be helpful to students with special needs in writing activities. For example, word processors with spell checkers have been shown to assist students in spelling, but due to the necessity of spelling words close to their correct spelling, such assistance is limited, particularly for students who grossly misspell words. Word prediction programs have also been found helpful, but in a limited number of studies. To date, the research literature in this area is somewhat limited. The studies cited focus on one specific software accommodation and use samples consisting of one to three participants.

It has been suggested that word prediction programs could be used in tandem with talking word processors, which may help by providing audio feedback on what students are typing in addition to the benefits of word prediction functions (MacArthur, 1996). Because word prediction programs also have spell checker functions, students would have three means of potentially improving writing performance. Research on how students perform when multiple software functions are available could help determine which software (and combinations of software functions) provides benefits to students with disabilities.

This study evaluated the use of multiple software programs to assist seven participants with special needs in writing. The software used was Write:Outloud Version 3 (1993-1998), a talking word processor with spell checker function, and Co:Writer 4000 Version 4.1 (1992-2003), a word prediction program. These programs were select-



ed because they are readily available to schools, including the district in which the study was conducted.

The study addressed the specific research question: “What are the effects on the performance of seven students with special needs when a talking word processor with spell checker software is used independent of and in conjunction with word prediction software as accommodations in daily writing exercises?”

Methodology

The study was conducted in an elementary school in a diverse, urban school district in Ohio. Permissions were obtained from parents, student participants, the district administration, and a university institutional review board prior to the study. Fictitious names are used to ensure the anonymity of the participants.

Participants

Participants were seven fifth grade students with mild disabilities, identified through multidisciplinary evaluations and determined eligible for special education and related services. All of the students received services in resource and inclusion classrooms. All had written expression goals included on their individualized education programs (IEP). Participants were enrolled in the same fifth grade general education classroom and resource room. Information on students’ experience with computers was obtained from their general education teacher as well as performance on producing a computer-generated version of a handwritten essay that was provided to the students. Students’ writing performance was evaluated using a rubric (see Appendix A) designed by their school district to evaluate several aspects of written expression. Table 1 lists individual characteristics of the participants.

Table 1

Student Characteristics				
Name	Age	Disability	Reading Level	Prior experience with computers
Bethany	11	Learning Disability	Beginning 4 th grade	Comfortable typing short writing assignments on word processing software
Kari	10	Mild Mental Retardation	Middle 2 nd grade	New to computer use; types final drafts on word processor by looking at each letter on handwritten rough draft and then typing it
Jesse	11	Learning Disability	Middle 4 th grade	Uses computer occasionally for typing final drafts in general education classroom
David	11	Learning Disability	Late 3 rd grade	Uses computer for producing final drafts in general education classroom; types final drafts by looking at phrases and then typing them
Aaron	10	Learning Disability	Middle 1 st grade	Struggles to use the computer; types final drafts by looking at each letter in a word from the rough draft and then typing it
Pat	11	Learning Disability	Beginning 3 rd grade	Uses computer for producing final drafts in general education classroom; types final drafts by looking at phrases and then typing them
Daniel	11	Mild Mental Retardation	Ending 1 st grade	Uses computers for producing final drafts in general education classroom; types final drafts by looking at each word and then typing it



Design and Data Collection

The researchers used a case study approach with a modified multiple baseline. Multiple baseline designs typically would include data depicted on A-B graphs when the number of participants is three or fewer. Given the number of participants, data in this study would be presented in table form for ease in reading. The study contained three phases: baseline, intervention using a talking word processor, and intervention using word prediction software in conjunction with a talking word processor (See Table 2). In order to best meet the participants' academic needs in a more immediate timeframe, the modification of the multiple-baseline design also involved simultaneous implementation of the intervention phases with each participant rather than in a staggered fashion as in the traditional multiple-baseline design. The writing samples were obtained during the participating district's mandated daily writing assignment. The case study approach involved collecting qualitative data through field notes and interviews, conducted by the first author, to obtain participants' views on the use of software accommodations.

The baseline writing samples were converted from handwritten to word processed text to eliminate the possibility of scoring bias between the two forms. Some research has suggested that scores can vary when writings are scored in handwritten versus word processed formats (Bridgeman & Cooper, 1998; Powers, 1994). The baseline phase involved collecting three handwritten writing samples from each participant over a one-week period. Instruction provided during baseline did not involve computer software usage but only the instruction typically provided in the general education classroom and resource room, such as how to construct and edit handwritten products.

The second and third phases (the intervention phases) lasted for three weeks each, with a maximum of nine writing samples per participant in each phase. In Phase Two, students used Write:Outloud Version 3 (1993-1998), a talking word processor with spell checker function computer software program. Students learned to use the software through direct instruction in the resource room. This involved working through a mock assignment with the teacher. At the end of the instruction, students were given 10 minutes to "experiment" with the software. The next day, students received a brief reminder of how to use the software. Students then used the software for their daily journal writings in both the general education classroom and the resource room. Students had the choice to do a new written sample each day or to edit their product from the day before. Students were not allowed to spend more than two days on a single sample. This allowed two or three writing samples to be collected for each student per week.

After three weeks of using only Write:Outloud, the talking word processor with spell checker function, the word prediction program Co:Writer 4000 Version 4.1 (1992-2003) was added to the intervention for Phase Three. Write:Outloud was used in conjunction with Co:Writer for this phase. Students again received direct instruction in the resource room on the use of the new software. They continued to use both software programs in their daily journal writing for the three weeks in Phase Three. During Phases Two and Three, students wore headphones to hear the audio feedback.

The software accommodation interventions were quantitatively assessed on (a) mean number of words, (b) mean number of misspellings, (c) accuracy percentage, and (d)

Table 2

Phases in the Modified Baseline Design

Phase	Duration of Phase	Accommodation
1. Baseline	1 week	No accommodations; students handwrite all writing samples.
2. Intervention	3 weeks	Students use Write:Outloud, a talking word processor for all writing samples.
3. Intervention	3 weeks	Students use Co:Writer, a word prediction software in conjunction with Write:Outloud for all writing samples.



total rubric score (see Appendix A) per writing sample and across each participant's total writing samples in each phase. Number of words represents the total number of words and abbreviations in the sample. Number of misspellings represents the total number of misspelled words in the sample. Accuracy percentage represents the percentage of correctly spelled words in the sample. Total rubric score represents the mean score obtained on the writing sample based on the district writing rubric, as scored by three educators: the student's homeroom teacher, the student's special education teacher, and an elementary literacy coach. Averaging the rubric scores of three educators decreased the likelihood of researcher bias.

The resulting data were included in Tables 3-6. Data were compared on each dependent variable across baseline and intervention phases to examine possible impacts on the interventions. Data were not statistically analyzed, but were analyzed for changes in trend and magnitude, which is acceptable for single subject or small N research (Richards, Taylor, Ramasamy, & Richards, 1999).

Additionally, the first author conducted interviews with the student participants to obtain insight into how they reacted to the accommodation software. She also maintained personal notes and conducted interviews with the general education teacher.

Results

The purpose of this study was to determine whether computer software would help students with special needs improve their performance in writing. The research question that guided the study was, "What are the effects on writing when a talking word processor with spell checker software is used independently of and in conjunction with word prediction software as accommodations for students with special needs in daily writing exercises?" There were four quantitative dependent variables on which the study focused—mean number of words, mean number of misspellings, mean accuracy percentage, and mean total rubric score.

Group and Individual Performances

We will first examine the overall performance of the participants as a whole group and then individually. As

a whole group, the participants improved on each dependent variable during both intervention phases (see Tables 3-6). However, individual performances did not necessarily follow this trend. Phases Two and Three will be referred to by the software programs introduced during those phases. That is, Phase Two will be referred to as Write:Outloud to indicate only the use of that talking word processor with spell check function during this phase. Phase Three will be referred to as Co:Writer, indicating the use of Co:Writer's word prediction in conjunction with Write:Outloud's text-to-speech feedback during this phase.

Number of words. The group mean for the number of words during baseline where students created handwritten writing samples was 47.06 words (see Table 3). This increased to 50.00 words with Write:Outloud, and to 52.32 words with Co:Writer. Five of the seven students improved in the number of words written from baseline to Co:Writer. Two students (David and Jesse) performed slightly better with Write:Outloud than with Co:Writer. For two students, Kari and Bethany, the number of words decreased from baseline, regardless of which software was used.

Number of misspellings. The group mean for misspellings during baseline was 6.09 (see Table 4). With Write:Outloud, this mean decreased to 2.44. With the additional use of Co:Writer, the group mean decreased to

Table 3

Mean Number of Words Across Phases by Individual Student and the Group

Student	Phases		
	Baseline	Write:Outloud	Co:Writer
Aaron	28.80	34.71	45.29
David	43.80	52.00	46.57
Daniel	33.00	42.86	53.25
Jesse	45.60	58.14	56.29
Pat	38.20	41.83	52.00
Kari	73.80	55.57	61.14
Bethany	66.20	64.89	51.67
Group	47.06	50.00	52.32



Table 4

Mean Number of Misspellings Across Phases by Individual Student and the Group

Student	Phases		
	Baseline	Write:Outloud	Co:Writer
Aaron	6.60	2.86	3.30
David	8.60	4.43	2.29
Daniel	2.40	1.00	1.13
Jesse	4.00	0.86	1.14
Pat	10.40	3.83	4.86
Kari	4.80	2.57	0.86
Bethany	5.80	1.56	1.14
Group	6.09	2.44	2.10

Table 5

Mean Percentage Accuracy of Words Across Phases by Individual Student and the Group

Student	Phases		
	Baseline	Write:Outloud	Co:Writer
Aaron	77.08%	91.76%	92.71%
David	80.37%	91.48%	95.08%
Daniel	92.73%	97.67%	97.89%
Jesse	91.23%	98.52%	97.97%
Pat	72.77%	90.84%	90.65%
Kari	93.50%	95.38%	98.59%
Bethany	91.24%	97.60%	97.79%
Group	87.07%	95.11%	95.98%

2.10. For all seven students, the number of misspellings decreased from baseline compared to Write:Outloud. All students also demonstrated a decrease in the number of misspellings from baseline compared to Co:Writer. Further, there was a decrease in number of misspellings for three of the students (David, Kari, and Bethany) when using Co:Writer as compared to Write:Outloud, while the other four students had fewer misspellings with Write:Outloud than with Co:Writer.

Accuracy of words. Accuracy percentage is the mean percentage of correctly spelled words (see Table 5). The accuracy percentage for the entire group during baseline was 87.07%, with an increase to 95.11% with Write:Outloud, and a further increase to 95.98% with Co:Writer. All seven students increased in accuracy from baseline to Write:Outloud and from baseline to Co:Writer. Five students increased in accuracy from Write:Outloud to Co:Writer, but two students (Pat and Jesse) very slightly decreased between these phases.

Writing rubric scores. The mean total group score on the writing rubric during baseline was 9.38 out of 20 points (see Table 6). This score increased to 9.90 with Write:Outloud, and increased to 11.25 with Co:Writer. Four students (Aaron, Pat, Kari, and Bethany) increased

in total rubric score between baseline and Write:Outloud, but three (David, Daniel, and Jesse) had a decrease in score. Finally, six students increased their mean rubric scores between baseline and Co:Writer, but one student's score (Daniel) decreased. Six students also increased their scores between Write:Outloud and Co:Writer, but again one student's score (Bethany) decreased slightly.

Individual Student Performance

Tables 3-6 depict the data for individual students for the dependent variables as well as for the overall group. Here, we highlight results and provide examples of individual student's performances across the three phases of the study.

Aaron. Aaron made improvements in all areas when comparing baseline to both Write:Outloud and Co:Writer. When comparing baseline to Co:Writer, Aaron had the greatest increase in rubric score of the group, an increase from 6.04 to 9.81. A sample of his baseline writing compared to his Co:Writer writing helps to illustrate his improvement. Aaron's baseline sample included a section in which he wrote about his fist:

"My fish is. Is Tiley. Rist. It hish but it. Not Bab it ron. It pass a puch. It hape alate it. Cool."



Table 6

Mean Total Rubric Scores Across Phases by Individual Student and the Group

Student	Phases		
	Baseline	Write:Outloud	Co:Writer
Aaron	6.04	7.62	9.81
David	10.10	8.97	10.37
Daniel	13.10	11.75	12.21
Jesse	10.60	9.95	12.82
Pat	8.00	9.62	11.17
Kari	7.97	8.91	10.12
Bethany	9.87	12.47	12.24
Group	9.38	9.90	11.25

Aaron's Co:Writer sample included a section in which he wrote about walkie-talkies:

"What ime going to do with my walkie-talkies. I'm going to give my grandma one. And I can call her. And she will not be alone. She is in trouble so she can call me. So we are can talk. And we and my grandpa can talk. And my cousin can talk to."

As seen in the samples, Aaron's writing illustrates improvements in all four areas (e.g., number of words, reduced misspellings, greater accuracy, and writing quality) with the use of Co:Writer in conjunction with Write:Outloud (i.e., word prediction in conjunction with talking word processing).

David. David made improvements in all four areas from baseline to Co:Writer. David's total rubric score increased slightly from baseline and Co:Writer. He had a decrease in total rubric score between baseline and Write:Outloud, but had improvements in the number of words, number of misspellings, and accuracy percentage during this phase. David also made improvements in all four areas between baseline and Co:Writer. Overall, the software combination of Co:Writer with Write:Outloud was most effective for him.

Daniel. Daniel showed improvement in number of words, number of misspellings, and accuracy percentage while using both software accommodations. From baseline to Write:Outloud, he increased the number of words from 33 to 42. This further increased to 53 with Co:Writer. Number of misspellings decreased from baseline to Write:Outloud, but then slightly increased between Write:Outloud and Co:Writer; however the misspellings were still fewer than during baseline. Daniel showed improvement in accuracy percentage from baseline to Write:Outloud and baseline to Co:Writer, but he did not show improvement in total rubric score with either intervention. In fact, he decreased by almost one point from baseline to Co:Writer. For reasons identified in the discussion section, conclusions concerning which condition was most effective for him are the least clear of any of the participants.

Jesse. As compared to baseline, Jesse showed improvement in all four areas when using Write:Outloud and Co:Writer. It is interesting to note that while his highest total writing rubric score was when he was using Co:Writer, it was during the Write:Outloud Phase that he showed the greater improvement in three areas—reduction of misspellings, and increases in the number of words and accuracy percentage. Write:Outloud alone seemed to be the most beneficial to Jesse.

Pat. Pat showed improvement with the use of the software in all four areas. His scores increased from 72.77% to 90.65% in accuracy percentage from baseline to Co:Writer—the highest increase in the group. He also had the greatest decrease in the number of misspellings, 10.40 to 4.86, from baseline to Co:Writer. The mean number of words Pat produced during baseline increased with Write:Outloud, and further increased with Co:Writer. His total rubric score increased by 3.1 points between baseline and Co:Writer. Samples of his baseline writing and one produced with Co:Writer illustrate these improvements. During baseline he wrote:

"I will play with my renocerral car and corg it and play my gam and my friend."

By comparison, during Co:Writer, he wrote:

"I had a dog. His name is rock he was good. We used to have fun and jump on the tramp alien at nite. We used to run in the field. And he used to play foos ball. And he ran a way two weeks a go. I fill so sad and I went off on my sister."



Co:Writer seemed to be the most beneficial to Jesse.

Kari. Although Kari showed no increase in number of words during either intervention phase, she made improvement in reducing the number of misspellings, and increased her percentage accuracy and total rubric score from baseline to Co:Writer. Number of misspellings decreased by two from baseline to Write:Outloud, and further decreased by two with Co:Writer for a total improvement of almost four fewer misspelled words, on mean. Her accuracy percentage improved from baseline to Write:Outloud, and further improved when using Co:Writer. Kari's most significant improvement was in the total rubric score, which increased from 7.97 during baseline to 8.91 with Write:Outloud, and to 10.12 with Co:Writer. Overall, Co:Writer was most effective for Kari.

Bethany. Bethany showed improvements in reduction of misspellings, and increases in accuracy percentage and total rubric score. Her scores in number of words decreased during both intervention phases. This may have occurred because it was observed that it took her longer to complete her writing assignments when using the computer, causing her to write fewer words in order to get the assignment completed. It is difficult to determine which software was most effective for Bethany, since number of words and her rubric score were higher with Write:Outloud, but the number of misspellings decreased and accuracy percentage improved with Co:Writer.

Discussion

This study focused on the effects of a talking word processor with spell checker alone and in conjunction with word prediction software on students with disabilities during journal writing in an inclusive classroom and resource room. The question guiding the study was, "What are the effects on writing when a talking word processor with spell checker software is used independent of and in conjunction with word prediction software as accommodations for students with special needs in daily writing exercises?"

In general, the impact of using writing software was positive for most of the seven students. As mentioned at the beginning of the results section, as a whole group, the participants improved on each dependent variable during

both intervention phases. The group mean for number of misspellings decreased, and their accuracy percentage, number of words, and rubric scores all increased. However, the effects on writing when using a talking word processor with or without word prediction does not appear to yield uniform outcomes or experiences across students. Information that was collected through interviews and field notes may provide additional insight why certain differences occurred.

One student, Daniel, experienced a decrease in rubric scores compared to baseline. Daniel was found with his headphones off on at least three occasions. Although he was quickly reminded to use them, not wearing his headphones on occasion may have prevented him from receiving auditory feedback during his writing, which in turn may partially explain why his rubric scores decreased during the Write:Outloud phase. He also had to be reminded several times to use the word list feature during Co:Writer. At one point, Daniel stated, "I do not want to use the list, I just want to type." He was also found closing out Co:Writer and using just Write:Outloud (e.g., verbal feedback but no word prediction) during the Co:Writer phase. In his words, "I want to get done faster, and Co:Writer takes me longer than Write:Outloud." Daniel's performance may be an indication that some students' orientation toward (and the effectiveness of) using talking word processing and/or word prediction may be influenced by individual student-related traits.

David also struggled to use the word list in Co:Writer. On a number of occasions he was observed typing several more letters than necessary, before noticing the sought word was appearing on the list. David stated that when he first started using Co:Writer he "did not like watching the list." His rubric scores only improved slightly, from a baseline of 10.10 to 10.37, with Co:Writer.

While Kari improved in three areas, she decreased in number of words during both intervention phases. This may have helped her total rubric score because her baseline samples were repetitive, often stating the same idea or phrase multiple times. Her writing samples during the Write:Outloud and Co:Writer phases were less repetitive and of higher quality, as reflected by improved rubric scores.

Bethany was already a relatively better writer than the other participants when the study began. Although she



showed improvement in two areas (reduction of misspellings and increased accuracy) between baseline and Write:Outloud, her Write:Outloud scores remained higher than her Co:Writer scores in all but one area (reduction of misspellings). During the intervention phases Bethany made several positive comments while using Write:Outloud such as, “I like typing with this software,” “This software helps me spell words right,” and “This is fun, typing on this program, can I type two stories today?” While Bethany still appeared motivated, she spent less time typing. She also said that she did not like Co:Writer because it was hard to look at the list when she already knew how to spell most of the words. For Bethany, Write:Outloud was extensive enough as an accommodation.

Aaron stated that writing was difficult during baseline. He struggled to spell simple words, and often asked the teacher to help him sound out words so he could write the letters. During Phase Two, Aaron independently discovered the dictionary function of Write:Outloud and showed other students how to look up a word in the dictionary. For Aaron, Write:Outloud helped him express himself in writing without the major difficulties he exhibited during baseline. Aaron stated that using Write:Outloud also helped him with punctuation, mainly knowing where to put periods and spaces, because periods had to be used in order for the computer to say his sentence. His sentence structure (e.g., rubric scored) showed further improvement with Co:Writer, and his spelling remained low as compared to baseline. Write:Outloud and Co:Writer both helped, making his writing easier to read.

The students also made other comments about the software and their writing. For example, Pat said that Write:Outloud helped him with his spelling because the computer says the word wrong when it is misspelled. Daniel also commented about the benefit of Write:Outloud in spelling, saying that the software makes a noise when a word is misspelled. Aaron, Jesse, and Pat all stated that they thought the software would help their reading because they heard the words when they typed them. Overall, these students reacted positively to the use of the software.

The writing software helped all the students in at least one area of writing. Four of the students (Aaron, David, Jesse, and Pat) improved in all four areas—number

of words, reduced number of misspellings, accuracy percentage, and total rubric score. Beyond what the numerical results suggest, the students appeared excited about using the software and, therefore, excited about writing. These same students had very limited entries in their notebooks during their five days of journal writing prior to the study.

The classroom teacher also responded positively to the use of the software and noted improvements in her students’ writing. The teacher stated during the baseline that some of the students’ writings were very difficult to decipher, and she sometimes had to ask the students to read their written products in order for her to understand them. She found the audio feedback of Write:Outloud to be very helpful, noting that Write:Outloud was easy to use and more helpful for her students than a general non-talking word processor. In fact, she had both her general education and special education students use it to produce a Black History research project. The teacher concluded that Co:Writer appeared to be the most beneficial for students with severe written expression problems, and she believed that it helped Pat, Kari, and Aaron the most. She stated that she would continue to use the software with the students.

Limitations of the Study

This study is limited in several ways. The primary limitation is the small sample size, making external validity limited. A second limitation is that only two types of software were used. A variety of software is available that may have been even more beneficial than the two chosen for this study. A third issue is that only students with learning disabilities or mild mental retardation were included. Further, no interrater reliability data were collected on writing sample ratings. However, averaging ratings across the three educators did serve to reduce any bias from selecting only one rating or variability among the three educators’ ratings. The modification of the multiple-baseline design reduced unnecessary wait time in the introduction of the intervention phases that may have resulted from withholding an effective intervention. However, this could also have made potential cause-effect relationships between the interventions and the dependent variables less evident. The Write:Outloud software was used by the students for six weeks, whereas Co:Writer was only used for three weeks (Write:Outloud was available to students in both Phase Two and Phase



Three). This may have led the students to become more comfortable and proficient with Write:Outloud than Co:Writer. The baseline samples also were collected for only one week as opposed to three weeks in the other two phases. This may have impacted the baseline data used as a comparison for the other two phases. Finally, students may have possessed varying levels of word processing skills at the onset of the study. This variable was somewhat controlled by providing direct instruction in the use of each software program when it was introduced. Despite these limitations, we believe the results do provide an interesting investigation as to how commonly available and relatively cheap software programs can impact the writing samples of some students with special needs.

Implications for Instruction

As illustrated, the results of this study suggest that computer software that provides writing accommodations can benefit students with disabilities and help them be effectively included in writing activities in the general education classroom. The results also underscore the necessity of looking at the individual child's strengths and weaknesses when choosing software accommodations. When writing an IEP, students' individual needs in terms of assistive technology are required and they should be carefully considered in the context of writing supports.

Students also should be consulted to determine their needs and which software, if any, works best for them. The students in this study were generally able to identify how their writing was deficient (e.g., spelling errors or the need to write more words) and which program worked best for them. For example, the students who did not prefer Write:Outloud did better with Co:Writer. They were able to identify what was helpful about the software and what they learned from it.

Clearly, software can be used as an accommodation in the general education classroom. The cooperative relationship between the resource room teacher and general education classroom teacher helped make the software use successful. Disks of student writings were carried back and forth between classes, and scheduling was flexible enough to allow students to finish their writing assignment. Indeed, the accommodations in this study were later extended to include students without disabilities.

Implications for Research

Several areas should be considered in future research involving the use of writing software for students with disabilities. Obtaining student comments through interviews and field notes was useful and helped explain some of the numerical data trends for some students. Future studies could focus on larger sample sizes and other software, including dictation software. Teachers' attitudes toward software accommodations also could be evaluated as well as the attitudes of the students. Researchers could investigate the comparative benefits of software programs in relation to cost, ease of use, and availability. Finally, quantitative and qualitative methods could be explored further to determine if one or both are preferable to determining such benefits.

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Author Notes

Jennifer Cullen is a special educator in the Dayton, Ohio, public schools. Stephen Richards is an associate professor and coordinator of special education candidate preparation programs at the University of Dayton. Katie Lawless Frank is an adjunct faculty member at the University of Dayton.

Correspondence should be addressed to Steve Richards, 300 College Park Avenue, Dayton, OH 45469-0525. Email to stephen.richards@notes.udayton.edu.



Appendix

Writing rubric

Name _____

Teacher _____

Date _____

Title of Work _____

Criteria	Points				Score
	1	2	3	4	
Punctuation	Has frequent and blatant errors in basic punctuation	Shows knowledge of the conventions of punctuation	May have occasional punctuation errors that do not interfere with the message	Contains correct end punctuation	
Capitalization	Has frequent and blatant errors in capitalization at the beginning of sentences and for proper nouns	Shows knowledge of capitalization at the beginning of sentences and for proper nouns	Has correct capitalization at the beginning of sentences and for proper nouns	Exhibits the use of capital letters at the beginning of sentences and for proper nouns	
Sentence Structure, Word Usage, and Spelling	Uses limited or inappropriate vocabulary that obscures meaning and has gross errors in sentence structure, word usage, and spelling that impede communications	Uses limited vocabulary and has word usage and spelling errors that interfere with the message	May have occasional word usage and spelling errors that do not interfere with message	Shows an awareness of word usage and spelling patterns in commonly used words and uses a variety of words	
Beginning, Middle, and End	Exhibits little or no evidence of an organizational structure; the beginning, middle, or end of the response may be poorly defined or nonexistent	Shows an attempt at organizing the paper around a beginning, middle, and end	Has a logical order with an apparent beginning, middle, and end, although some lapses may occur	Has a logical structure that flows naturally with a beginning, middle, and end	
Topic	Offers few details and the topic of the writing is not clear	Attempts to follow a topic and has some supporting details, but may exclude extraneous or loosely organized material	Has a topic that generally addresses and contains adequate supporting details	Focuses on the topic, clearly addresses the topic, has ample supporting details	
				Total Score	

Note. Format based on the writing rubric at www.teach-nology.com/cgi-bin/writing.cgi. Criteria derived from Ohio Department of Education's 4th Grade Writing Rubric.

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