

The Effect of Writing with Computers versus Handwriting on the Writing Achievement of First-graders

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The written work of 18 first-grade students of mixed ability was compared under two conditions: word processing with computer writing programs and writing by hand. An intact first-grade classroom alternately used computers and handwriting to produce writing samples over six months of a regular school year. Additionally, event recording of academic-engaged behavior was conducted for each different writing condition. Over 750 writing samples, distributed between computer and handwriting conditions, were analyzed using repeated measures analysis of variance. Students exhibited significant differences favoring use of computers over handwriting despite no differences observed in off-task behavior. The significance of these results is discussed.

The use of computer word-processing and computer assisted instruction in building early-grade writing skills has yielded mixed results over the past 10 years. In earlier years, young students' writing achievement was examined through the use of specific computer-assisted instruction programs such as *Writing to Read* (Martin, 1986) or of computer word processors found in early computer models such as Apple's IIGS. In general, computer-based writing programs did not produce sufficiently strong results to convince researchers and practitioners of the superiority of computers in enhancing writing achievement (Mavrogenes, 1989; Olson & Johnston, 1989; Singh, 1990; Shaver & Wise, 1990).

Other studies focused on the differences inherent in writing with computers (Heap, 1986; Kurth & Kurth, 1987). Of particular importance has been the observation that for students to benefit from computer usage, they must become acclimated to the properties of text as it appears on computers (Olson and Johnston, 1989). Teaching computer usage skills to ensure facility with keyboarding and the editing features of word processors is recommended (Leonardi & McDonald, 1986). Using computers to improve writing achievement was found particularly effective if combined with appropriate teaching strategies and learning environments (Anderson-Inman, 1986; Kahn, 1987; Kuechle, 1990).

In more recent years, research on writing with computers suggests the viability of developing writing skills through computers as early as the preschool years (Moxley, Warash, Coffman, Brinton, & Concannon, 1997). Moxley et al. examined the writing development of 12 preschool children aged three and four years. They found that keyboarding facilitated writing for the following reasons: (a) Students who lack the fine motor skills necessary to form manuscript letters can produce letters with finger-strokes; (b) The writing children produce with a computer is the same as writing they read in books and allows them to recognize misspellings more easily; (c) Erasing or revising a letter or word is much more readily accomplished on a computer word processor than on paper; and (d) Graphics representation software allows for self-selected pictures to aid students in their writing.

Although evidence exists that supports the use of computers to improve student writing, some of this data may be flawed. First, many of the early studies examined writing achievement among older elementary students, typically at the fourth-to sixth-grade levels. Findings for students of those ages are difficult to generalize to earlier grades given differences in student maturation and curriculum emphasis. Second, because the cycle of computer innovation and obsolescence proceeds rapidly, many studies supporting computer use in the early grades quickly become dated (Woodward, 1993). As computer technology improves (changes), such improvements may produce

different effects. For example, whereas early studies on the *Writing to Read* program (noted previously) yielded mixed or negative results, a follow-up study of later versions of the program found significant improvement in writing of participating students over peers not using the program (Childers & Leopold, 1993).

At the same time, later studies have contradicted the positive results reported in earlier studies. Keetley (1995), for example, found no differences in writing achievement among first-graders using word processors compared to paper and pencil. Higher scores for computer users were attributed to higher writing skills of the experimental group. These findings lead to a third problem in current research. Research designs among many of these studies may be inadequate because of relatively short data collection periods and group differences in ability or curriculum exposure. In some of the investigations (Singh, 1990; Shaver & Wise, 1990), the studies were program evaluations where the results may be suspect because of the potential for uncontrolled variables (curriculum exposure, different student ability) to affect results.

Other investigations (Moxley, et al., Keetley, 1995; Kuechle, 1990) used quasi-experimental designs for short “snapshot” studies involving different groups of students. Despite the potential generalizability of such designs (especially the appropriate use of pre- and posttest results), they also exhibit a potential deficit in accounting for group differences and rather small data sets.

Between-group studies, while an improvement over evaluation studies or case studies, may be limited in their interpretation because one cannot reasonably be assured that immediate results in writing gains or losses can be extrapolated to longer-term progress in writing (treatment maintenance procedures are often omitted in such studies). Thus, observed superior results for one group within the experimental setting may not “last” over longer periods. Additional studies are needed, therefore, to provide data where long-term progress in writing can be compared across computer-based and manual writing conditions. Such work is also needed to provide fresh data using more current computer technology as well as results in which inter-student effects can be minimized.

To gain such information, the current study examined the effects of writing on the computer versus writing by hand across the same students in a first-grade classroom. The central research questions were:

1. Does use of computer word processing demonstrate improved long-term results among first-grade students when compared with manual writing?

2. Are there different levels of academic-engaged time exhibited under the two conditions?

It was hypothesized that students that used computers to write compositions would generate more words and sentences. It was also hypothesized that students would be more engaged in writing activities when using computers.

METHOD

An equivalent time samples design (Campbell & Stanley, 1973) was used to collect writing samples of first-grade students using computers and writing by hand. Initial drafts of student writing were collected as students rotated between conditions. Rotation of computer and handwriting was undertaken over a period of six months during the 1998-99 academic year. Forty-eight of these writing assignments, with 24 using a computer and 24 handwritten, were collected. Repeated measures of analysis of variance were conducted to examine the effects of computer-generated and handwritten products.

Sample Population

The sample population consisted of all 18 students of mixed ability in a self-contained first-grade classroom at a semi-rural elementary school in southeastern Idaho. Table 1 shows characteristics of the sample population. Additionally, their kindergarten teachers had previously rated students for academic achievement. Five of the students were classified as high achievers, eight were judged as average achievers, and five were seen as low achievers.

Table 1
Characteristics of the Sample Population

N	Gender		Lunch Status		Title 1	Race/ Ethnicity	Special Education
	m	f	Free	Reduced Cost			
18	6	12	4	4	5	1 Hispanic 17 Caucasian	0

Computer Use

The teacher taught computer skills, including keyboarding, and allowed the students to become familiar with computers during September. The classroom contained six computers that were in use most of each day. The teacher integrated use of instructional software within the curriculum thereby maximizing student exposure to computer use in the classroom. Each student spent about an hour a day at a computer working on a variety of subjects. In addition, students were able to use the computer lab for two, 25 minute periods a week. Many of the computer-based writing compositions were created during this lab time, but some of the early assignments were accomplished by having groups of students rotate through the six computers in the classroom.

Students used three different programs for writing at the computer: *Writing and Publishing Center* (IBM, 1998), *Wiggle Works* (Scholastic, 1997), and *Stories and More* (IBM, 1998). Students acquired word-processing skills completing assignments with the *IBM Writing and Publishing Center*, obtained ideas and motivation for writing while using *Wiggle Works*, and focused on editing when using *Stories and More*.

Writing Instruction

In September, students learned to compose class stories during whole group instruction. The teacher modeled writing techniques and phonetic spelling skills. In October, students were ready to write stories and other compositions individually. All students participated in writing instruction time that included teacher-led prewriting preparation, 10 minutes for individual prewriting experience activities, and a full 20 minutes of writing where they were prompted to write as much as possible during the allotted time. Prewriting experiences included providing students with information that could be used in their writing. For example, when the writing topic was "Cats," students viewed a video on cats and their habits and participated in a class discussion of personal experiences with cats. Then they had 10 minutes to draw pictures of cats and gather their thoughts before writing their compositions. For computer assignments, students chose a clipart photo or graphic instead of drawing (learned previously in September).

All students began writing concurrently except for the first few computer assignments during which students took turns at the classroom computers in three groups of six students. All students were encouraged to write

as much as possible during the allotted time of 20 minutes. The teacher carefully monitored the amount of individual help she offered so that each student received equal attention. She spent about 30 seconds per period with each student making suggestions, making notes about illegible or indecipherable words, helping with spellings, and/or giving encouragement. Upon completion of assignments, each student read his/her composition to two peers for reactions and suggestions.

Handwritten assignments completed in the classroom alternated with computer written assignments done in the computer lab. Generally, except as noted earlier when classroom computers were used, children worked on the same assignments during the same twenty-minute period.

After 18 minutes of a writing period had elapsed, the teacher alerted students to the fact that only two more minutes remained so that they could complete their thoughts. Handwritten assignments were dated and collected while computer manuscripts were saved in files, then printed for later analysis.

Data Collection

Data were collected from weekly writing assignments during October through May of 1998-1999. The writing topic for each day was chosen at random from a bank of possible subjects for each month. Topics were related to current events, classroom literature, curriculum topics, or student interests.

Table 2 lists topics used. Originally, four assignments were anticipated for each week, but the intervention of holidays and special school events precluded students completing writing assignments at the planned rate. Often, only two assignments were undertaken during a week, with remaining projects carried forward, resulting in a total of 48 writing assignments being completed over the school year. About once each quarter, one of the assignments was sent home to demonstrate learner progress to parents, thereby removing it from the study. Additionally, absences and technical difficulties resulting in some lost files contributed to a small loss in available handwritten and computer assignments for analysis.

Across all students, a range from 40 to 44 different writing assignments per student, within the total 48 assignments actually written, was available for analysis. All available assignments were used and they represented material evenly and chronologically distributed throughout the year. With minor exceptions, each student had matched pairs of assignments per week included in the analysis. This distribution resulted in 383 handwritten and 374 computer assignments for 18 students.

Table 2
Writing Assignments

Computer Writing		Writing by Hand	
Tell about your favorite foods.	Tell about your family.	What did the bunny do in the story?	Tell about your pets you have or have had.
Free choice	What are you doing on Halloween?	Free choice	Write about monsters.
Pick a graphic, choose a font, and write 2 sentences. *	Thanksgiving is...	Tell about rain and rainbows.	Free choice
Choose a graphic and write about it	What do you know about babies?	Draw a picture and write about it.	What are you thankful for?
What do you like about Christmas?	Tell about Santa Claus.	What do you do on Thanksgiving?	Tell about chickens.
What are your favorite Christmas foods and why do you like them?	What do you do in the snow?	What do you want for Christmas? *	Tell how you get ready for Christmas.
What do you like to do at school?	Tell about bears.	What did you get for Christmas?	Tell how everyone is the same.
Tell about dogs.	Free choice *	What do you want to do better this year?	Tell what you are good at doing.
Free choice	Write about sounds you hear.	Tell about cats.	Tell about yourself.
What do you do when you get home?	Free choice	Tell a favorite story.	Write about a fairy tale.
Write about birds.	Tell a favorite fairy tale.	Tell about bunnies.	Apologize to the Principal about an incident.
Tell what you like to do.	Choose a graphic and write about it.	What do you do at the park? *	Tell a friend about Idaho.

*Assignments not included in the study because they were sent home to parents to demonstrate learner progress.

Dependent Measures

Students' writing scores were used to assess differential effects of computer word processing and handwriting of assignments. Each of these measures is described later.

Written Measures

Measures of writing included number of words and sentences written and event recording of off-task behavior during writing periods. The number of words written by hand or keyboard was counted on each student composition. If the work was illegible or unclear, the student was asked to clarify by reading the composition. For word counts, misspelled words were counted the same as correctly spelled words.

The number of sentences per composition was also tabulated. Complete thoughts were counted as complete sentences regardless of punctuation. A random sample of six compositions (a handwritten and a keyboard composition each from November-December, January-February, and March-April) for each of six randomly selected students was scored by a second person independent of the study. Interrater reliability coefficients (Pearson r) for the original scores and set of scores generated by the second scorer were $r_{\text{word counts}} = +.99$ and $r_{\text{sentences}} = +.95$.

Off Task Behavior

The teacher monitored on- and off-task behavior of students during writing. Off-task behavior was defined as (a) sitting without writing for more than a minute, (b) playing, or (c) talking to other students about non-writing issues. The teacher kept a tally during each lesson of the number of times she interacted with students about off-task behaviors. If the teacher had to remind the student to continue working more than five times during a writing period, the child was scored as "off-task" for that lesson.

RESULTS

Table 3 shows the average number of words, sentences, and ontask behavior of students under both writing conditions: manual and computer. Tables 4 and 5 describe repeated measures analysis of variance results for students

under the two conditions. Table 4 shows the effects of pairwise comparisons of student writing samples and off task behavior according to condition—hand or computer writing. Table 5 shows effects over repeated measures analysis of variance for sentences, words written, and off task behavior.

Results were significant favoring computer writing in number of words ($F_{47, 699} = 6.875, p < .05, R^2 = .316$) and sentences ($F_{47, 699} = 7.985, p < .05, R^2 = .349$) written. Off-task behavior of students between conditions was not significant ($F_{47, 699} = .842, p > .05, R^2 = .054$).

Table 3

Descriptive Statistics of 1st-grade Students Writing Samples, by Hand or Computer: Words Written Per Assignment, Number of Sentences Per Assignment, and On-task Behavior

Dependent Variable	Hand V Computers	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Sentences	Hand	5.323	.192	4.947	5.700
	Computer	5.983	.194	5.601	6.365
Words	Hand	38.445	1.507	35.486	41.404
	Computer	44.794	1.529	41.793	47.795
Identified on task	Hand	.844	.020	.804	.883
	Computer	.857	.020	.817	.897

Table 4

Pairwise Comparisons of Treatment Means—Hand vs. Computers ($N = 48$)

Dependent Variable	(I) Hand V Computers	(J) Hand V Computers	Mean Difference (I-J)	Std. Error	<i>p</i>
Sentences	Computer	Hand	.660	.273	.016
Words	Computer	Hand	6.349	2.147	.003*
Identified on task	Computer	Hand	1.312E-02	.029	.646

Based on estimated marginal means

† Indicates the total number of assignments involved in analysis, a range of 46 to 48 assignments were available for each student.

* The mean difference is significant at the .05 level.

Table 5
Effect of Repeated Measures—Hand vs. Computers for Words/Sentences
Written and Off-Task Behavior

Dependent Variable		Sum of Squares	df	Mean Square	F	p ^a	R ²
Sentences	Contrast	3887.378	47	82.710	6.875	> .001	.316
	Error	8408.887	699	12.030			
Words	Contrast	278946.066	47	5935.023	7.985	> .001	.349
	Error	519548.537	699	743.274			
Identified on task	Contrast	5.211	47	.111	.842	.766	.054
	Error	92.085	699	.132			

^a Computed using alpha = .05

DISCUSSION

The first hypothesis, that computer use would result in significantly more writing, was confirmed in this study. When students used computers to generate written compositions, they consistently wrote more words and sentences. These quantitative results supplement the teacher's (the third author of this paper) observations of writing improvement and of the different kinds of activity students exhibited. Of note are the teacher's reports that in her 20+ years' experience this group of students made better progress in overall writing competence than she had come to expect of first-graders.

The second hypothesis, whether student use of computers would produce more ontask behavior, was not supported by results of this study. This observation raises important conclusions both about the validity of this study and about the nature of student activity while using computers.

First, that there were no significant differences in academic-engaged time spent regardless of condition, underscores the significance of the findings regarding computer use to improve writing. For example, it could be argued that computer use would show better results simply because it provided new motivation to engage in the same curriculum. Indeed, there is evidence that such a "newness" effect often occurs when students are provided with an alternative approach to the same task, but this effect is temporary and subsides as students become used to the new setting or approach (Mitchell, 1993).

Although previous research has demonstrated the positive effect on achievement of writing with computers, the lack of differences in observed off-task behavior seems to indicate that students in the current study performed better using computers not because computers were more engaging,

but because computers offered features that supported student writing. That is, as far as their attention to task is concerned, students in the current study did not show any particular bias favoring computer use or writing by hand. The classroom teacher, in addition to keeping track of on- and off-task behaviors, made continuous observations of the students' activities as they worked. These observations may provide insight into the features of each condition that support or undermine writing achievement.

Classroom Observations

Student activity was monitored and described by the classroom teacher in an anecdotal journal. Two kinds of verbalization could be discerned in observing students under different conditions. When students worked at the computers, they often re-read their compositions aloud to themselves before writing the next sentence, whereas when they wrote compositions manually, they did not. Students enjoyed reading the uniform text on their computer screens. This re-reading may have helped students keep their trains of thought, therefore facilitating more writing. Another benefit of this practice occurred when students read their stories orally to peers. Students were better able to remember and interpret the words they had written by keyboarding because they had repeatedly read them while writing.

Students writing by hand verbalized in a different way. Instead of re-reading their compositions, they spoke to peers about their work. The most frequent on-task interaction involved asking neighbors how to spell words. In contrast, students at the computers made a greater attempt to transcribe words as they sounded them out alone. The ease with which letters could be erased and replaced on the computer may have been a factor that supported this practice.

A second observation was that there was a marked difference in attitude and strategy toward writing between the two conditions. Students using pencil and paper frequently asked the teacher, "Is time up yet?" while those at the computer groaned when told they had only two minutes left. Students writing on paper began to make their words larger so that the page looked "full" with fewer words. Those using the computer used the same size font and were motivated to write more to fill the screen or page.

Finally, the teacher found that having students edit printouts of their keyboarded compositions was not as effective as sitting with students and editing work on the screen. Students who actively revised sentences and corrected spellings at the computer seemed to retain that knowledge and apply it in future compositions.

Additional Observations

A particularly interesting development was the teacher's observation that students' reading fluency, comprehension scores, and interest in independent reading had significantly improved when compared to classes of first-grade students the teacher had previously taught. A parallel assessment of reading was conducted during the study in which the reading skills of the students were measured using the reading program *Accelerated Reader* (Advantage Learning Systems, 1998) and three curriculum-based measures of reading fluency. Reading scores on both measures during this time registered significant growth among the students. The teacher also reported that students during this period independently read an unprecedented amount of books.

Results of the potential interaction between reading and writing activities are congruent with current research on the positive relationship between the two skills (Adams, 1997). Although it is not the authors' purpose here to discuss reading growth related to computer use, future analysis of this correlation is warranted.

CONCLUSION

This study examined the effects of first-graders' writing competency when using computers or writing by hand. In particular, this study was conducted to determine the effects of continued use of computers to promote writing in contrast to writing by hand among the same students. These findings should be interpreted in conjunction with other work supporting the use of computers to promote writing for children at young ages. Of particular note is the finding that students consistently wrote more when using the computer despite equitable amounts of time engaged in writing in both conditions. There were no discernible advantages with respect to writing by hand or with a computer in students' on-task behavior. Of course, additional work is needed in this area to verify and reinforce the results of the current study.

References

- Accelerated Reader* [Computer software]. (1998). Wisconsin Rapids, WI: Advantage Learning Systems.
- Adams, M.J. (1997). The great debate: Then and now. *The Annals of Dyslexia*, 47, 265-276.

- Anderson-Inman, L. (1991). The reading-writing connection: Classroom applications of the computer, Part I. In R. Boone, (Ed.). *Teaching process writing with computers* (pp. 27-30). International Society of Technology Educators. (ERIC Document Reproduction Services No. ED 338218)
- Campbell, D.T., & Stanley, J.C. (1973). *Experimental and quasi-experimental designs for research*. Boston, MA: Houghton-Mifflin Co.
- Childers, R.D., & Leopold, G.D. (1993). *A follow-up study of the ARC/IBM Writing to Read project in Kentucky, Virginia, and West Virginia. Final Report*. Appalachia Educational Lab, Charleston, WV. (ERIC Document Reproduction Services No. ED363474)
- Heap, J.L. (1986). *Collaborative practices during computer writing in a first-grade classroom*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, California. (ERIC Reproduction Services Document No. ED273979)
- Kahn, J. (1991). Learning to write with a new tool: young children and word processing. In R. Boone, (Ed.), *Teaching process writing with computers* (pp. 15-16). International Society of Technology Educators. (ERIC Document Reproduction Services No. ED338218)
- Keetley, E.D. (1995). *Comparison of first-grade computer assisted and handwritten process story writing*. Master of Education Thesis, Johnson and Wales University (ERIC Reproduction Services Document No. ED 384 882)
- Kuechle, N. (1991). Computers and first-grade writing: A learning center approach. In R. Boone, (Ed.), *Teaching process writing with computers* (pp. 49-52). International Society of Technology Educators (ERIC Document Reproduction Services No. ED338218).
- Kurth, R.J., & Kurth, L.M. (1987 April). A comparison of writing instruction using word processing with voice synthesis, and no word processing in kindergarten and first-grade. Paper presented at the annual meeting of the American Educational Research Association Washington, DC. (ERIC Document Reproduction Services No. ED 283 196).
- Leonardi, E.B., & McDonald, J.L. (1991). In R. Boone, (Ed.), *Teaching process writing with computers* (pp. 7-9). International Society of Technology Educators. (ERIC Document Reproduction Services No. ED 338218)
- Martin, J.H. (1986). *Writing to Read* [Computer software]. White Plains, NY: IBM Corporation.
- Mavrogenes, N. (1989). *A comparative study of three methods of promoting literacy in kindergarten and first-grade*. Department of Research, Evaluation, & Planning: Chicago Public Schools.
- Mitchell, M. (1993). Situational interest: Its multifaceted structure in the secondary school mathematics classroom. *Journal of Education Psychology*, 85, 3, 424-436.

- Moxley, R.A., Warash, B., Coffman, G., Brinton, K., & Concannon, K. (1997). Writing development using computers in a class of three-year-olds. *Journal of Computing in Childhood Education*, 8, 133-164.
- Olson, K., & Johnston, J. (1989). The use of the computer as writing tool in a kindergarten and first-grade classroom.
- Shaver, J.C., & Wise, B.S. (1990). *Literacy: The impact of technology on early reading*. Paper presented at the 11th annual meeting of the American Reading Forum, Sarasota, Fl. (ERIC Document Reproduction Service No. ED327832)
- Singh, B. (1990 November). *IBM's Writing To Read program: The right stuff or just high tech fluff?* Paper presented at the annual meeting of the Florida Education Research Association. (ERIC Reproduction Services Document No. ED 339 015)
- Stories and More* [Computer software.]. (1998). White Plains, NY: IBM Corporation.
- Wiggle Works* [Computer software]. (1997). New York: Scholastic.
- Woodward, J. (1993). The technology of technology-based instruction: Comments on the research, development, and dissemination approach to innovation. *Education and Treatment of Children*, 16(4), 345-60.
- Writing and Publishing Center* [Computer software]. (1998). Novato, CA: The Learning Company.

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