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ABSTRACT

A study investigated the effect of word processing on the quality of children's writing. Subjects were 32 fifth-graders in a public school in the suburban town of Livingston, New Jersey. One sample had access to computers in their classroom everyday for writing. The other sample group used computers once a week in the lab; their daily writing instruments were a piece of paper and a pencil. Writing samples were taken as a pretest and posttest and scored holistically. Findings supported the hypothesis that there would be no significant difference in the achievement between the samples of students' writing. It should be noted, however, that the difference in the mean scores approached significance. The implication may be that if this study had been conducted over a longer period of time, the experimental sample that used computers may have shown more significant gains over the control group. This study, along with others previously conducted on this subject, does not provide statistical evidence for the advantage of writing on a computer over traditional methods. Nonetheless, as technology becomes an integral part of their personal, educational and business lives, students must be prepared for computer literacy. (Contains 2 tables of data, 25 references, and related research.) (TB)

The Effect of Word Processing on Writing Achievement

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In partial fulfillment of the requirements

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

This study investigated the effect of word processing on the quality of children's writing. The subjects were thirty-two fifth graders in a public school in the suburban town of Livingston, NJ. One sample group had access to computers in their classroom everyday for writing. The other sample group used computers once a week in the lab for writing. Writing samples were taken as a pretest and post test and scored holistically.

Findings supported the hypothesis that there would be no significant difference in the achievement between the samples of students' writing.

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Thank you to my parents, Inez and Harold Goldstein, and my grandmother, Rose Gatov, for being so very proud of me. I can always count on you.

I am fortunate to have such a strong support system.

Teaching children to become effective writers is a major goal for educators today. Teachers must use all resources available to develop writing skills. Research is being conducted on the use of word processors for all phases of the writing process and the possibility that computers are a powerful supporting tool for improving the quality of children's writing.

Linda Polin (1991) explains that skilled writers plan, write, and revise in overlapping, recursive sequences marked by pauses to reread and think. Less skilled writers rarely engage in these tasks. Students learn to plan using prewriting techniques such as clustering, and students learn to distinguish between editing surface level or "deeper" feature of the organization and meaning of their writing. A major stumbling block in getting students to revise is the pain of rewriting paper and pencil versions of their work. Computers carry some of the burden of revising and editing.

Roberta Young and Barbara Erickson (1989) describe the establishment of computer writing laboratories in Spring Woods High School in Texas. The authors state that rather than being simply an add-on to traditional instructions, the computers were seamlessly woven into the curriculum. The labs proved to be an exciting environment where students are engaged in several activities. Students gather ideas together, get the ideas down on paper, get suggestions for improvement from peers, revise and edit, then evaluate their work. These activities are

the key steps of the writing process. Writing is published in anthologies or newsletters. Publishing validates writing. The Spring Woods High Writing Lab has received much attention since raising the ninth grade passing rate on the state writing competency test by 22% in the first year of its implementation. Changes were noted in the students. Weaker students wrote more than teachers expected, and average and honor students seemed to manipulate text more extensively and more frequently. The authors conclude by reminding the reader that the computer is a tool-only teachers can teach writing.

Rob Staats, district technology coordinator for the West Windsor-Plainsboro School District commented, in reference to computer use in his district, that children who used to hate writing, some because of poor handwriting, are flooding the teachers with lengthy word processed essays. Whatever was inhibiting them was gone.

Robinson - Stavely and Cooper conducted a study with community college English composition students. Some students did their writing on computers and some with paper and pencil. Essays were scored holistically as well as with a computer program called *Writer's Workbench*. The analysis showed that in the areas of readability, spelling, grammar, number of sentences, number of words, number of complex sentences, and average sentence length, the essays of students who worked on the computer were rated significantly higher

than those of non-computer using peers.

Marcia Halio (1990) notes that many composition/computer researchers have noted that the effects that using computers have on student writing are more revisions and a better attitude toward writing. However, she warns that students may "play" with the effects of graphics and fonts at the expense of quality writing. She feels that the neat appearance of word processed essays but can fool writers who do not read their writing carefully. Evidence on this topic however, is no clear cut since other studies exist which indicate little or no difference in writing quality. None of these anecdotal data lends itself to statistical certainty.

HYPOTHESIS

To provide some such evidence, the focus of this study was to determine if the integration of computers into writing instruction would improve students' writing. It was hypothesized that no mean differences in achievement between two samples of pupils will exist when taught writing with or without the computer.

PROCEDURES

The subjects of this study were thirty-two fifth graders enrolled in a public school in the suburban community of Livingston, New Jersey.

Sixteen students from one classroom became the experimental

sample designated Sample A. Sixteen students from another classroom became the control sample designated Sample B.

The samples were taught by different classroom teachers. The same computer skills and writing skills were taught to each class as outlined by the district curricula.

Sample A had daily access to a Macintosh Computer mini-lab in the classroom. Students were able to write on the computer approximately three to four times a week using the ClarisWorks Word processing program. Students integrated writing with the computer in all curriculum areas. Activities included free writes, specific assigned writing topics, "written conversation" (Calkins), literature responses, and social studies and science research.

Sample B had their computer class once a week in a separate computer lab. The computer activity may or may not have involved writing. The daily classroom writing instrument was pencil and paper.

Both samples were asked to produce a writing sample upon entering fifth grade in September. Students wrote for twenty minutes on a topic of their choice. All samples were written with pencil and paper. The writing samples were holistically scored using *The Student Friendly Guide to Writing With Traits* developed by the Northwest Regional Educational Laboratory, Portland, Oregon. The essays were assessed for the following traits: ideas and content development, organization, voice, word choice, sentence fluency and conventions.After five months of writing instruction and access to the computers as described for each

class, students were assigned a second writing sample. The same procedure was followed in January as in September with all students using pencil and paper and compositions holistically scored using the same instrument. Data was collected to see if the frequent access to computer technology in the classroom mini-lab improved students' writing techniques. Data was analyzed then interpreted for statistical significance.

RESULTS

As shown in Table I, the Pretest mean score for experimental Group A was 18.4, and for control Group B was 16.25. The difference in the mean scores was 2.15 percentile points which, as shown by the t, was not significant. This indicates that both samples in the study were of relatively similar abilities.

TABLE I

MEAN SCORES, STANDARD DEVIATION, AND TOTAL SCORES FOR THE PRETEST OF SAMPLE GROUPS A AND B.

samples	mean score	standard deviation	t score	significance
sample A	18.40	3.48	1.56	NS
sample B	16.25	4.37		

The results of the post test following treatment are shown in Table II. As can be seen, the mean score for the experimental Sample A was 22.38, and the mean score for Sample Group B was 18.3. The post test results indicate that both the experimental Sample A and the control Sample made gains, (roughly 4 and 2 points, respectively), although the gain by sample A was larger. The difference between the mean scores was 4 percentile points which was not a significant difference. It should be noted, however, that this difference is approaching significance.

TABLE 2

MEAN SCORES, STANDARD DEVIATION, AND TOTAL SCORES FOR THE POST TEST OF SAMPLE GROUPS A AND B

samples	mean score	standard deviation	total score	significance
Group A	22.38	5.76	1.59	NS
Group B	18.3	5.15		

CONCLUSIONS AND IMPLICATIONS

The Post test results showed no significant difference between the means of the two samples. Therefore, the null hypothesis that there would be no difference in the improvement of students' writing skills when instructed with computers or traditional pencil and paper was accepted.

It should be noted, however, that the difference in the mean scores was approaching significance. The implication may be that if this study had been conducted over a longer period of time, the experimental Sample A, which used the computers, may have shown more significant gains over control Sample B.

This study, along with others previously conducted on this subject, does not provide statistical evidence for the advantage of writing on a computer over traditional pencil and paper methods. Nonetheless, as technology becomes an integral part of our personal, educational, and business lives, we must prepare our students for computer literacy.

REVIEW OF RELATED RESEARCH

Computers have been used for reading and writing instruction for many years. During the late 60's and 70's, large scale language instruction projects were developed for mainframe computers. Early computer aided instruction was based on a part to whole, sub skill theory of language instruction. Most programs were drill and practice.Although the programs, were enhanced with graphics, animations, and sound, CAY, computer assisted instruction ,was little more than glorified workbook exercises.

During the 1980's, there was considerable research on the writing process. Leaders in the field of process writing proposed a meaning centered emphasis around which conventions of writing will evolve (Graves 1983; Calkins 1983). Attention to spelling, grammar, and punctuation grows out of a need to express meaning (Murray 1980). Today, educators are convinced that good writing comes not by chance, but through a process that involves planning, drafting, revising, and publishing .

People began to recognize the potential for furthering students' writing development by using the word processor in an instructional context which focuses on the process of writing. Newman states that learners have little difficulty learning to use a word processor when the emphasis has been on exploring the meaning of what is being written and not on the technology itself. Meaningful instructional uses for word processing have grown as educators have come to value writing as a thinking process. Newman states that a word processor can be a

powerful tool for helping students develop as writers. It allows them to produce text which looks professional, it permits the correcting of mistakes without having to start over again, it lets revision become an integral part of the writing process, it fosters collaborative writing. Wepner (1987) states that word processing encourages and motivates students to create and experiment with communication and writing without having to worry about the mechanics of writing. Shaw (1987) states that computers allow students to create, organize, experiment and revise without having to rewrite the whole paper. This makes writing and rewriting easier. Schwartz (1989) says that word processing encourages students to take risks with writing. It helps students to formulate ideas and to edit and review their work. It helps students organize ideas and see the structure of the essay before and after the fact. Mittricker (1989) states that the word processor helps in brainstorming, editing, moving text and deleting while still retaining information. The word processor makes revision fun and easy. The word processor can be used to enhance all stages of the writing process.

Research tells us that both expert and novice writers do not spend much time in planning before writing. While expert writers may be able to skip this step, prewriting may be beneficial for inexperienced writers. Teachers present many prewriting ideas such as clustering and brainstorming to get children to do some planning about their topic. Brenda Schynal used a word processor to develop a list of topics about

which to write. She prepared a text file called "Topics" which contained half a dozen headings such a "People in my neighborhood," "Things that make me happy, "Sports I know about." She left spaces between the headings, then saved the file on discs. Each student was given a chance to use the text file and to list things which might fit under the headings. The students were also encouraged to create categories of their own. They saved their topics on their own disks and referred to it before starting on a new writing piece. This was a way of generating ideas. A number of computer software programs, called "idea processors," have been developed to assist students in this aspect of the writing process. Steven Tchudi (1983) prepared a brainstorming program called *The Write Idea.* In addition to creating a topics list, the program helps students generate ideas about a specific topic. Students are prompted to list details about the topic such as sights,smells, tastes, and feelings. The program continues by asking questions about actions, people involved, the audience, and questions like," what would you like the audience to learn from your writing?" " how would you begin? "how would you end?" At this point, students are invited to begin drafting. *Calliope* (Invasion, Los Altos, CA), *Writer's Helper II* (Conduit, Iowa City, IA), and *MORE II* (Symantec, Cupertino, CA), are some other programs available. These idea processors allow writers to save and later retrieve their ideas.

Revision is commonly regarded as a central and important part of writing (Lownethal, 1980; Murray, 1978). Revision is important because it enhances the quality of final written work. In addition, when writers use

revision to rework thoughts and ideas, it may affect writers' knowledge. Earlier views of revision focused on sentence level polishing, or what today would be called editing. In the 1970's, writing was viewed as a linear model consisting of prewriting, writing, and post writing (Britton, Burgess, Martin, McLeod, and Rosen, 1975). Murray (1978) talked about revision as literally re-vision, "seeing again," and he discussed two forms of revision. " Internal revision is everything writers do to discover and develop what they have to say, and external revision is what writers do to communicate what they have found." Murray's ideas were a transition from a time when revision meant editing to the present when revision includes reflections of ideas and meanings. This was a paradigm shift from a product-focused view of revision to a process-oriented one. Jill Fitzgerald offers the following definition of revision.

> Revision means making any changes at any point in the writing process. It involves identifying discrepancies between intended and instantiated text, deciding what could or should be changed in the text , and how to make desired changes, and operating, that is, making the changes. Changes may or may not affect meaning of the text and they may be major or minor. Also, changes may be made in the writer's mind before instantiated in written text, at the time the text is first written, and/or after the text is first written.

According to Lucy Calkins (1980) interactive revising involves considering a draft text closely and working with it as the ideas and wording evolve into a finished product-sometimes after several drafts. Evidence supports the belief that writers mainly make surface and mechanical revisions. Linda Polin states that without the assistance of word processing, students treat revision as a surface modification of their writing.They make word or sentence level changes. Genuine revision requires the willingness to reorganize large pieces of text, add or delete sentences, or change the tone or style. A major stumbling block in getting children to revise is the pain of rewriting paper and pencil versions of their work. Supporters of using word processors for writing instruction believe that the computer encourages student revision of this deeper structure by making these tasks easier. With features such as spell-checker and thesaurus and the ease of moving text around, students are more likely to to engage in serious revision. Computers carry some of the burden of revising and editing. Interviews with writers indicated that writing on the computer was more fun and was easier because they did not have to recopy to make changes (Daiute 1985; Birdwell, Sirc and Brooke 1985; Womble 1985; Selfe 1985).

Computer prompting programs have been designed to help writers expand and monitor their thinking as they compose and revise. These programs provide direct guidance in the cognitive activities involved in writing. Such prompting programs activate self-:nonitoring

and the metacognitive processes necessary for effective revising.

Polin describes text analyzing programs that can help students analyze their own prose. Such programs provide information on specific features such as the frequency of certain words, counts of sentence length, frequency of passive constructions with "to be" verbs, and errors in punctuation. *MacProof* (Salt Lake City, UT) and *Writer's Helper II* (Conduit) are two such programs.

Desktop Publishing provides an audience for young writers and authentic purposes for writing. With computer software, students can produce publications such as books, newspapers, pamphlets, signs, posters, banners, and cards. Classroom publishing centers can be extremely motivating to students as they reinforce and strengthen the children's communication skills. Marcia Halio agrees that computers have a powerful effect on the appearance of student writing. She cautions the reader, however, to not confuse neat appearance with quality. Halio is concerned that students will become too interested with the fun of experimenting with features such as fonts, styles, and graphics and that the quality of writing may suffer.

Many educators have found success with using computers with at-risk learners. According to John Amato, "Technological tools breed instant success in the classroom and mobilize even the most reluctant learners."Teachers can make positive progress with children with low self-esteem and low expectations of themselves by plugging into computer programs that give them output and immediate positive

feedback. With even a minimal amount of computing experience, students can experience immediate successful results that motivates them to want to participate more. What a child expects as his or her outcome can predict how he comes to the learning experience ready to accept a new concept. Once a child visualizes his work on a computer monitor and out of the printer, the child has far greater expectations of being noticed as an achiever. Electronic media motivates children to experiment with the technology. Through this experimentation, the teacher can raise the student's threshold of readiness for learning. Vicky Hackett's writing class for high school seniors who had not been previously successful writers was held in a computer lab. When the students saw their writing appear on the screen, wonderful things began to happen. Students naturally asked their peers to read their work and make suggestions. They began to check their spelling, and they were interested in improving their papers, revising and sharing ideas. These students, who had been poor English students, had developed into a community of writers.

Word processors can be used for may different writing purposes. Levin and Boruta (1983) used a word processor for creating an electronic newspaper. They also describe how they used the word processor for sending and receiving electronic mail between schools. Newman describes an activity called "written conversation." Two children held a "conversation" by typing a comment or a question on the computer and another student responds. The informal atmosphere in which the writing

is taking place gives the students the opportunity to focus on the meaning of the exchange. This activity can be extended to conversations about literature, or about an historical event or a science experiment. Children can use this technique to create original dialogue. Susan Church used wordless picture books as a motivation for writing. Students create storyline and then share the various versions of the story. Journal writing can be done on the computer. Newman found that when her students wrote their journal entries on the computer, they were willing to take more risks. In a high school class in which journal writing was being done on the computer, one student commented,

> "When using the word processor the attempts to make meaning seem like much less of a commitment than when working by hand-it is so much easier to change, or even get rid of the whole thing if you decide you haven't really said what you want. Knowing it isn't going to be a tremendous pain to make alterations or start over is liberating."

Computers can be used as tutorials to teach and reinforce specific declarative knowledge. They can also be used as a tool to make lower order tasks simpler so that the student is free to concentrate on higher order tasks. An interesting program is *Write On!* (Humanities Software, Hood River, OR). This software guides the student through various

literature related activities. "You are the Editor" provides the student with a text to proofread and revise. "Writing a Character Sketch" guides student through the strategies authors use to develop characterization ie. descriptive language, dialogue, setting, and interaction. Bill Briggeman, an English teacher at Cincinnati Country Day School, has children writing research papers using interactive multimedia tools. This project involves reading, writing, and researching, and integrates music and art. Briggeman says about a literature project, "The computer enables the students to understand the concepts of Romanticism, Realism, and Modernism far more vividly, poignantly, and lastingly than ever before. Students loved doing this project and want to do more like it." Students have used the motivating HyperCard to write poetry and to respond and report on books. A child looking for reading suggestions can use HyperCard to browse through descriptions, written by students, of different literature. Joni Chancer uses *HyperCard* with her six grade language arts class. Chancer feels that the students are motivated by writing for a real audience. They are also integrating and internalizing what they've learned. Chancer has noticed that her students are synthesizing what they've learned as they figure out how to present

the information with *HyperCard.* Chancer has always taught with an integrated curriculum, but now with *HyperCard*, the children are making the connections themselves. She states, "The students are making connections and are at the synthesis level of handling information. That's critical thinking, and goes beyond the literal facts. Using *HyperCard* encourages students to be responsible for their own work. It is a tool for facilitating ownership." Stephen Marcus has an interesting perspective of the relationship between technology and text. He states

> "Text simulates thought. Text is a working model of what's of what's on our minds, and we can interact with and affect text through reading and writing. Text is virtual thought. Many peoples's thinking includes pictures and sounds as well as words. Therefore, multimedia and hypermedia programs are steps toward fulfilling the potential of virtual texts."

Marcus alludes to future visions. Such visions include word processing programs that learn your writing style and adjust to your needs. A book could become a fluid object that is shaped by each reader with interaction between the text, the reader, and the previous reader who have become contributing authors. Perhaps sound tracks for books are in the near future. Stephen Marcus believes that the future of technology will enrich

and expand the teaching of reading and writing.

Many school districts have committed to the integration of computer technology. In Parsippany-Troy Hills, New Jersey, the district philosophy is to make technology a tool to deliver instruction. In reference to writing, one English teacher said that students are using computers to move text quickly in order to learn how to organize their thoughts while writing. There are computer labs in each elementary school and writing labs in each middle school and high school. Rob Staats, District Technology Coordinator for West Windsor-Painsboro, New Jersey, states that computers are not merely electronic analogs of books. They change the way we learn and interact. Things happen so much more quickly and fluidly on computers. Teachers report that children who used to hate writing are turning in lengthy word-processed essays. Children who have poor handwriting find that that obstacle is now gone and they are free to write without the worry of penmanship. In 1986, 55% of the ninth grade class at Springs Woods High School in Houston, Texas, got a passing score on the writing portion of the statewide proficiency exam. By 1987, 77% of the ninth grade students passed the test. The district attributes this 22% rise in score to the implementation of a computer writing lab. The computer lab was used as a vehicle to improve writing skills.

Numerous research studies have been conducted on the effect of computers on writing. Tonja Caster's article, "The Use and Effectiveness of Computers in the Elementary Classroom" (1983) discusses practical

classroom uses for computers. She states that computers can be used for word processing to type original stories, or for teachers to record language experience stories. The stories can be easily saved, edited, and printed out. Caster mentions two studies which compare the quality of students' writing using a computer with that of using paper and pencil. Bradley (1982) used first graders in her study which researched the use of computers in language experience lessons. She found that the stories were longer than usual, students suggested changes and corrections as they told them, and the students reread the stories immediately after receiving printed copies of them. Woodruff and Bereiter (1981-82) used sixth graders to study a computer program designed to offer editing assistance. Results showed that using the computer took more time than using paper and pencil because of the time spent using the prompting program. No significant differences were found between the two writing conditions for the number of words produced or for the quality of papers. Students indicated that they liked writing on the computer better than using paper and pencil. Caster's study concluded that findings for the effectiveness of CAY in the teaching of writing were mixed.

Janet Kane's study investigated how eighth grade students used a computer word processing system for writing. Five students, with a range of writing skills, used the technology for ten class sessions. Data were gathered through interviews with students, classroom observation, and the finished text that they produced. A conclusion from this study was that students initially used the technology as they would use paper and

pencil. Their writing process was basically linear and sequential. Most revisions were in spelling and punctuation. This study concluded that the word processor can not teach students to be better writers. It only provides a means to write more easily. It will not respond to the author's message, it cannot critique, it cannot recommend particular improvements. Unless students have standards of good writing and can evaluate and revise their own work, their changes will only be surface level and not improve the quality of their writing.

Linda Jackson studied the relationship of learning styles to performance on writing using the computer vs. the traditional handwritten method. Subjects for the study consisted of twelfth grade students in a public school in Mississippi. The Canfield Learning Style Inventory was administered to both groups. A Mechanics of Writing Checklist was used to obtain scores for the compositions. Analysis of data indicated no; significant differences between achievement of the two groups. Learning style preference correlated significantly with achievement within the groups.

Christine Hult, (1985),Director of Composition and Rhetoric and Texas Tech University, designed a study to determine the effects of word processing on the correctness of student writing. Hult analyzed the correctness of papers produced using word processing as compared to those produced without word processing. Subjects in the study were randomly placed into sections of freshman English at Texas Tech University. Students were taught word processing through the lab user's

guide, but were not given explicit instruction in word processing in class. Also available to students using the computer was a proofreading program, a stylistic analysis program that analyzes features such as vagueness, and a comment program which interprets that data from the analysis program for the students. The teacher attempted to keep the teaching method and curriculum in both experimental and control sections the same as possible. Hult analyzed the last papers produced by both groups for thirteen features of correctness. The findings were that both groups were nearly alike in all of the correctness features except spelling. This difference was due to the computer-using group's access to the spell checker. The computer group had fewer editing errors which could be accounted for by the ease of proofreading that comes from a printed copy as compared to a handwritten copy. A positive attitude toward computers by many students had been noted by several researchers.Hult concluded that the grammatical and usage errors made by students do not disappear when they use computers. With the exception of spelling, the errors students made were the same in the hand-written group and the computer group.

Joyce Fitch (1985) studies the effect of word processing on revision and attitude toward writing. The study used seventh graders enrolled in a required writing course. Students in both groups completed seven on-paragraph assignments during a nine weed period. The experimental group used word processing for all aspects of writing , and the control group used pen and paper. Attitude toward writing was

measured by the Fitch Attitude writing Survey. No significant difference in the students' attitude toward writing as a result of word processing was found. The Stanford Achievement Test was used to measure of students' ability to recognize spelling and punctuation errors. The 1884 and 1985 scores from each of these test were compared. The data showed that the use of word processing has no effect on students' spelling and punctuation. When the number of revisions made between rough and final copy was analyzed, the computer using group make significantly more higher level revisions. This study concluded that word processing helps students write better. Seventh grade students revised more and at a higher level when using a word processing program. Word processing did not have an effect on students' attitudes toward writing or their ability to recognize incorrect punctuation or spelling.

Jill Fitzgerald's study on revision (1987) included research about the relationship of word processing and revision. Fitzgerald feels that the effects of word processors are unclear. She cites the work of earlier researchers on the subject. Some reports indicate that Jr. High students revise more with the word processor than with pens or typewriters (Bradley, Sirc, and Brooke 1985; Collier 1983; Daiute 1986; Gould 1980; Levin, Riel, Rowe, and Boruta 1985). However, other studies indicated that less revisions were made with word processors (Harris 1985;Hawisher 1987). More consistent results are shown for effects of using word processors on the kind of revisions make. More surface revisions tended to be made with word processors as compared to

handwritten texts (Bradley, Sirc, and Brooke, 1985; Daiute 1986; Gould 1980). More expanded revising may occur with pens (Daiute 1986; Harris 1985). A few researchers report no effect on quality of writing (Collier 1983;Gould 1983; Hawisher 1983). Only Daiute (1986): found slight improvement in quality from the first to the last drafts written using word processors.

Colette Daiute (1986) conducted a study on the physical and cognitive factors in revising. This study contrasted the revising patterns of junior high school students when they used a word processor and when they used pen and paper. The study also compared the effects of a word processor alone with those of a word processor equipped with a prompting program to guide revising. The study included time for learning keyboarding and word processing so that the computer knowledge would not be a factor. The participants were seventh and ninth grade students in New York City. Throughout the year, each student wrote on the computer for at least one hour a week, and worked alone or with peers using pen to do other writing and vocabulary activities. The writing samples used for analysis involved personal topics and were composed during class time.The results showed that students who used a word processing program added more words to the ends of their draft texts and corrected more word and sentence level errors, but they did not make more global text revisions that they did when they used pen. In contrast, a similar group of students make more revisions when they used a revision prompting program attached to the word processing program.

These different revision patterns suggest that the word processing program made it easier for students to skim their drafts and then add words to the end. The students who used a prompting program,interacted with their drafts, and made more changes of all kinds. This study suggests that word processing features for revising are most useful for writing development when combined closely with cognitive and instructional aids that draw students into reading their texts and developing revising strategies such a s self-questioning.

Robert Banger-Drowns (1993) conducted a meta-analysis about word processing and writing. Banger-Drowns says that the conclusions in previous studies are ambiguous and contradictory. The results are difficult to interpret because the studies were done in a variety of contexts using a variety of research methods. For example, studies have included instructional and non-instructional settings, students of various levels of writing abilities, varied durations of the studies, etc. Banger-Drowns limits his research to studies using a consistent research method in similar educational settings. All the studies compared two groups of students receiving the same instruction on the writing process except that only one group used word processors. He collected a larger group of studies than had been previously gathered, and he used meta-analysis to explore the effects of word processing on writing. Bangert-Drowns found that 66% of the 28 studies that measured writing quality reported that improvement after instruction with the word processor. Although the frequency was positive, the median magnitude of this improvement was small (0.21 sd).

Studies of remedial instruction indicated greater improvements from word processing experience. Basic writers tended to have less variance in writing quality after experience with word processing and duration of this experience did not appear related to writing quality. This suggests that the word processing experience has a motivational impact on basic writers. Bangert-Drowns concluded that instruction with the computer can have a small positive effect on performance probably attributed to motivational aspects.

According to David Reinking (1994), educators must expand their concept of literacy to include electronic technology. Until recently, reading and writing activities were confined to printed materials. However, reading and writing can now be done on a computer. Computers are being used to create and revise texts, to send and receive mail electronically, and to present instructional texts on-screen instead of in printed books, and to access large databases of texts. Electronic texts are becoming more prevalent as computers become an integral part of everyday experiences. Reinking concludes, educators must include reading and writing of both electronic and printed texts in their definitions of literacy as well as in their approach to helping children become literate.

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