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Muktuk Meets Jacuzzi: Computer Networks and Elementary School Writers

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Introduction

Computer word processing systems are now coming into widespread use by adults. For the past several years, we have been conducting research on how such systems can be used to help elementary school students write and learn to write.

Many people who use word processing systems view them as just a better tool for accomplishing the same old tasks. We started with a similar viewpoint: Initially we viewed a computer word processing system as just a better tool for collecting data on the processes of writing. However, it soon became apparent that the use of word processing in conjunction with electronic message systems forms a new communication medium with distinct properties from the conventional medium of paper-and-pencil and with important implications for the ways children can learn to write. With this in mind, we framed our research with a number of basic questions:

- Can young children learn to use computer word processing systems for writing?
- Will students *want* to use a word processing system instead of paper and pencils?
- How will the use of word processing systems affect student writing?
- In what instructional settings can word processing systems be effectively used?

To answer the first two questions, we developed a word processing system called The Writer's Assistant for use by school children. Children from a variety of different settings have demonstrated that such a system can be used with positive results. We have observed students varying in age from 4 to 14 effectively using this word processor in regular classrooms (Levin, Boruta, & Vasconcellos, 1983; Miller-Souviney, 1984; Rowe, 1983), in resource room settings (Riel, 1985), in after-school clubs (Laboratory of Comparative Human Cognition, 1982; Levin & Kareev, 1980), and in homes (Levin & Kareev, 1980).

In this study, students in two classes used The Writer's Assistant for a full school year and were interviewed at the end of the year. One of the questions was "Which

do you like better: writing with the computer or writing by hand with pencil and paper?" Of 30 students interviewed, 26 preferred the computer, 2 preferred writing by hand, and 2 were uncertain.

The students were then asked why they preferred one medium over the other. The answers given by the students were fairly insightful and somewhat surprising. Although we had gone to considerable effort to provide them with tools for high-level planning and revision of their writing, the students' answers almost entirely focused at a much lower level. The most common reason given for preferring to use the computer was some variant of "It doesn't hurt your hand." While "writer's cramp" is not likely to be a major problem for elementary school students, the problem of fine motor control for many students *is* significant.

Reading and writing are complementary skills, yet children usually develop the eye coordination necessary for reading prior to the development of fine motor skills necessary for printing or cursive writing. Improvements in writing technologies in the past such as typewriters did not change this asymmetry. The keys of typewriters jam under the fingers of very young children. The computer keyboard, however, is easy for small hands to use, and the text is displayed as well-formed text on a display screen, which makes monitoring what is being written easier. We have observed young children in a kindergarten–first-grade classroom work productively with computer keyboards (Black, 1983). These differences in the medium of writing may allow students to begin writing at the same time they begin reading.

The next most common reason for preferring to use a word processor was some variant of "When you erase, you don't rip your paper." Students valued the ability to revise more easily and to produce neat, professional-looking text. The Writer's Assistant, like most current word processors, is a "screen editor" so that when you erase text, it disappears from the screen.

A sixth-grade teacher (Rowe) observed that his students were correcting their text with the computer with greater enthusiasm than he had seen in their previous paper-and-pencil editing. To further explore this phenomenon, he conducted a small experiment on editing in the two different writing media.

A Cross-Media Experiment on Editing

In a class of 29 sixth-grade students at an elementary school in San Diego County, a writing assignment was given, based on a story about the way in which glass is made. The students were given this story starter: "Think about what it would be like to be a grain of sand. Write a story about you being a grain of sand and going through the process of becoming a piece of glass. Start it like this: One day I was sitting on the beach, minding my own business when suddenly. . . ."

A few weeks later, the teacher passed the stories back to the class with no marks or comments on them. The teacher announced that he read the stories and felt that they were very good. He went on to explain that he wanted them to edit their own papers and rewrite them in their best handwriting. Almost all the students had done editing before and knew what to do without any further instructions.

Later, a similar assignment was arranged, but with the use of an Apple computer and the Writer's Assistant word processing system. The students used a computer-based story starter for newspaper articles to generate a story. Then the students were shown how to use the editing capabilities of the word processing system. When they finished writing their original drafts on a computer printout, they were asked to use the system to edit their stories so we could send them off to other classes.

The data from the 10 students who completed all four writing tasks were selected by the teacher for analysis. The paper-and-pencil drafts were longer (average length of 101.9 words) than the computer texts (58.8 words), so we will report both average numbers of errors and average error rates. Errors are defined here as only incorrect spelling of words, incorrect capitalization or punctuation, and incorrect syntactic structures.

In the paper-and-pencil first drafts, there were 14.2 errors or 0.14 errors/word; in the computer first drafts there were 7.3 errors or 0.12 errors/word. In their rewritten versions, the students corrected 43.7% (6.2) of the paper-draft errors and they corrected 78% (5.7) of the computer-draft errors.

More importantly, the students made 5.5 *new* errors when recopying on paper with pencils. Nine of the 10 rewritten copies contained one or more new errors. Using the computer, students introduced only 0.4 new errors (more than a factor of ten less). Only 3 of the 10 computer-revised papers contained new errors.

The final drafts recopied on paper still contained a large number of errors (10.6 or 0.10 errors/word), since corrected errors were balanced out by new errors. The final drafts edited on the computer contained a much smaller number (2.0 or 0.03 errors/word).

To verify that this finding was not related to the difference of topic, the teacher analyzed a second paper-and-pencil writing exercise in which the students were prompted to write on the same topic as the previously described computer writing exercise, a newspaper article. Ten of these compositions were selected at random. The first drafts averaged 86.1 words; the "corrected" versions were about the same (79.2). The students made 8.5 errors (0.10 errors/word) on the first drafts; on the corrected versions they made *more* errors (9.2 errors; 0.12 errors/word)! While they fixed an average of 3.3 of the errors that they made in the first draft, they introduced 4.0 new errors in rewriting their compositions. Nine of the 10 students introduced new errors.

When the class was told about these results they responded by saying that it made sense, because when they edited on the computer all they had to deal with was the mistakes and the computer would print out what was already correct. In contrast, when they had to edit and write their stories over with paper and pencil they not only had to correct their errors, but also had to redo everything that was originally correct. They went on to say that with paper and pencil they had to think not only about what was wrong, but also about what was right and redo it. With the computer, they could concentrate solely on the problems and the computer would take care of the part that did not need corrections.

The conclusion suggested by this experiment is that editing with paper and pencil

is difficult for elementary school students to adopt as a working strategy because it has a small (in some cases *negative*) value for improving a piece of text, since new errors are introduced in the new version at about the same rate as old errors are corrected. On the other hand, editing with the computer has a much more positive value, since inadvertent new errors are introduced at a much lower rate.

The Blank Screen Problem: Writer's Block and Dynamic Support

Even though computers make editing easier, their use does not guarantee that interesting writing and revision will occur. The use of computers alone does not solve the problem of teaching students how to write. The blank screen is just as intimidating as the blank page. In fact, some people find a blinking cursor more intimidating than a newly sharpened pencil and yellow pad.

However, the computer can provide for three types of interactions that can be important support for the novice writer. First, computers enable collaborative writing among pairs of children that is difficult to create in the pencil-and-paper medium. The presence of another peer writer during the writing process provides for problem-solving help in idea generation and immediate response to the written text. Second, computers are interactive media. This means that they can be used to provide the student with a great deal of prewriting or idea formation help (Collins, Bruce, & Rubin, 1982; Daiute, this volume; Levin, 1982). Finally, computers can be used to create "functional" writing environments which provide students with an audience for their work. When students realize that people will be reading their work not merely to evaluate it but for real communicative purposes, they take a very different approach to writing and actively engage in the revision and editing of their own writing and the writing of their peers (Collins, 1982; Levin et al., 1983; Riel, 1985).

Cooperative Peer Writing and Revision

Most approaches to computer use and writing presume a lone individual, working in at least temporary isolation. We have uncovered many reasons for challenging this presumption. Many people have suggested the value of collaborative writing, but it is difficult to share a pencil or to write a text collaboratively on a piece of paper. It is much easier to divide up the work of writing on a word processing system. The display is more public and legible, the keyboard extends in space more than a pencil, and in fact some writing actions require simultaneous multiple keypresses (capitalized letters, special punctuation marks). Elementary school students spontaneously come up with many different ways of dividing up the work of writing collaboratively (Levin & Boruta, 1983).

One of the values of cooperative peer writing is that it provides social resources to confront the blank screen. Even when neither student begins with an idea of what to write, the discussion of the problem often presents solutions. In the process of

entering the text, one partner often takes prime responsibility for typing, and the other takes more of a monitoring role, pointing out local typing errors but also maintaining the global context for newly inserted text. Thus, when the new text piece is entered, the pair can continue on, while an individual novice writer could have lost the global view and become blocked at that point. In this social system the task of writing can be distributed across the cooperative peers.

An equally important function of cooperative peer writing is the immediate audience (the partner) who can respond to the text as it is being written. A partner's response of "That doesn't make sense!" can be far more effective for encouraging revision than red marks on a paper a week later.

Interactive Text Prompters

Another approach we have developed to the "blank screen" problem is based on "interactive text," text which explicitly shares the initiative for interaction between the original writer of the text and the "readers" (Levin, 1982). Using a system which we have called the Interactive Text Interpreter (ITI), we have provided students with a dynamic range of support for writing. For example, we have used a newspaper prompter which helps students write different kinds of newspaper articles. The prompter starts by asking the "reader" (the student writer) what kind of article is to be written, presenting a list of possibilities: news, sports, weather, fun, life, sharing, or something else. Once the writer chooses a topic area, for example, news, the prompter then asks whether the writer knows how to write a headline. If the student says "no," advice is given. Then the prompter accepts any headline the writer types in, saving it with the accumulated article. This process of offering help, prompting for sequencing, providing alternatives, and uncritically accepting and saving input continues, until the writer specifies that the article is finished.

This kind of prompting is useful for overcoming the initial blank screen, but does not produce finished text. The responses to prompts and suggestions that a writer types in have the quality of rough notes. So at the end of this "prewriting" process, the writer can take the saved text and revise it, using the Writer's Assistant word processing system.

We have developed prompted writing activities in the domains of descriptive, narrative, and expository writing as well as poetry, letter writing, and story writing. The ITI system is simple enough to use that people with no programming experience (but with expertise in writing instruction) can produce sophisticated branching prompter texts in a short time (Levin, 1982).

Functional Writing Environments

Functional writing environments are those in which one is writing for real communicative purposes rather than just as an exercise (Heath & Branscombe, this volume). Most school writing is performed as an exercise, with the teacher as the sole audience. With the aid of word processing systems, it is possible to create "func-

tional" writing environments in classrooms in which the writer is focusing on communicating with someone else. In these environments, concern with the mechanics of writing is secondary to, but instrumental for, communicating clearly. The most interesting writing we have seen in our research has occurred when, working closely with teachers, we have been able to jointly construct such functional writing settings.

For example, one successful functional writing environment has been a classroom newspaper. Students in several classrooms we have worked with have used the prompting and editing systems described earlier to create and revise articles that are put together and printed out as a class newspaper. Although the notion of a class newspaper is not new, computer word processing systems make it plausible for elementary school students to revise text and the newspaper setting makes revision a sensible and desirable activity.

Computer Networks and Extended Audiences

As an extension of the functional writing environment of a class newspaper, we have been exploring the ways that computer text-message networks can be used to help children learn to write. In the fall of 1982, we interconnected two classrooms in San Diego County with four classrooms in Alaska, including two rural Eskimo villages.

Our first guess on how to organize this network was to model it on pen-pal letters. So we set up a "computer pals" network. This communication network provided the kind of audience we were looking for. Children found themselves writing to other children from quite diverse backgrounds. For example, here is one electronic message from a child in one of the Eskimo villages to a child in San Diego.

DEAR COMPUTER PAL:

I AM IN MR. VANCIL'S 5TH GRADE CLASS HERE IN WAINWRIGHT. IT IS VERY COLD OUTSIDE TODAY. OUR TEMPERATURE IS 14 DEGREES BELOW ZERO. WHAT IS IT LIKE IN YOUR TOWN ? THE SUN WENT DOWN ON NOVEMBER 18 AND WILL NOT BE BACK UNTIL JANUARY 24. IT IS LIKE NIGHT ALL DAY LONG. TO DAY OUR JANITOR SHOT A RABID WHITE FOX ON OUR BACK STEPS. I'M GLAD WE WERE NOT OUT AT RECESS.

WE LIKE TO EAT MUKTUK AND FROZEN FISH. WE ALSO LIKE WARMED CARIBOU BLOOD TO DRINK. MUKTUK IS WHALE SKIN . TO US IT TASTES GOOD. WE HAD A FEAST AT THE HIGH SCHOOL ON THANKSGIVING. WE HAD DUCK SOUP, CARIBOU SOUP, FROZEN FISH AND MUKTUK. WHAT DID YOU EAT?

WELL I DON'T HAVE ANYTHING ELSE TO SAY. WRITE TO ME ON THIS COMPUTER. MR. VANCIL SAYS HE WILL HELP ME READ YOUR LETTER.

GOODBYE

FRITZ

In contrast, here is a computer pal message from one of the San Diego students to an Alaskan student:

MY NAME IS MICAH.I LIKE TO PLAY FOOTBALL. I PLAY OFFENSIVE TACKLE AND DEFENSIVE END. WHATS YOUR SPORT? MY HOUSE ADDRESS IS ⟨his home address⟩. I DO NOT LIVE IN A TWO-STORY HOUSE. I HAVE A JACUZZI BUT NOT A POOL.DO YOU LIVE IN A TWO-STORY HOUSE?DO YOU HAVE A JACUZZI OR A POOL? WE HAVE SIX PEOPLE IN MY FAMILY. HOW MANY PEOPLE DO YOU HAVE?WELL I HAVE TO GO NOW BY. YOUR FRIEND MICAH

While there are many benefits from this form of communication, it lacked some crucial features of the social writing environment that we sought to create. The computer pal network depended on a one-to-one matching of students. When students were matched, responses to letters needed to appear regularly enough so that students did not lose interest, something difficult to ensure for all students. The writing of personal letters was only one of many forms of writing in which we wanted the students to gain expertise. Finally, and most importantly, letter writing did little to encourage students to revise and edit their own work. Since revision was an important goal of ours, we continued to search for a different form of a computer network.

The computer pal network was transformed in January of 1983 into a student "news-wire" service known as The Computer Chronicles. Within this framework we were able to explore more fully the influence of "audience" on students' writing and revision.

The Computer Chronicles Newswire

The Computer Chronicles Newswire is a computer supported functional writing system, which encourages children to work together on a school newspaper project. It is a larger network of communication between children who know little about each other personally, but who are sharing conceptions of their life styles and worlds. This news network is explicitly modeled on the international news wire services that are important to adults. Whenever possible, we help students see the parallels between their work and the work of newspaper reporters and editors.

The Computer Chronicles News Wire began with students from two San Diego schools and from two Alaskan schools exchanging news articles. Each classroom generated and edited articles on their own computers, which were sent to all the other classrooms. Then each classroom chose the articles they wanted for their own local version of the Computer Chronicles Newspaper, which they assembled and edited on their class computer.

The students from one of the schools in San Diego were participating in one of our research projects called the Mental Gym (Riel, 1985). In this project we have been investigating the effectiveness of computer-supported social environments for helping students who trail behind grade level in their academic studies. The children

who came to the Mental Gym to work on reading and writing difficulties were made reporters and editors responsible for the production of the Mental-Gym version of the Computer Chronicles. These children began working on the computer with some vague notions of a newspaper and of sending stories to kids in Alaska, New York, and other places. Their understanding and interest grew as they became more aware of what it meant to participate in such a network. To describe how this social support system for writing operated, we will begin with the computer and then widen the frame of reference.

Computer Chronicles Prompter. We have already briefly described the development of the Interactive Text Interpreter system and its use in the writing process. The Computer Chronicles Prompter (CCP) is an Interactive text designed to help students write newspaper articles. Students select a section of the newspaper and are given guidelines and suggestions for the type of writing they have selected. The power of interactive texts is that they can be easily modified. The different sections of the CCP differ in terms of how much support is provided in the writing activity. For example, in the beginning, students coming to the Mental Gym did not know how to respond to a prompt calling for a description. It was easy to modify the file so that students could, at this junction, indicate that they needed more help. A series of questions then suggested some of the relevant dimensions of a description of the topic they were working with. As the students became more skilled, they relied less on these prompts for organizing their ideas. The teacher's ability to tailor the prompter to meet the specific needs of the students is what makes it such a valuable aid in the writing process (Riel, Levin, & Miller-Souviney, 1984).

Team Work on Computer Chronicles. Students in the Mental Gym always work on the computer in pairs. As already mentioned, we feel that this teamwork is helpful in the writing process. Students' discussions of the computer prompts help to organize their thoughts to begin the writing process. Their immediate reaction to the prose of their partner can have an immediate impact on the quality of their writing. Often, incomplete idea fragments produced by one student were completed by the student's partner.

Students themselves are aware of the influence of cooperative work on their writing. In a posttest interview, Daemon, one of the students working at the writing center at the Mental gym, said that what he liked least about school was language and writing. Later, when asked which activities he liked most in the Mental Gym, he said writing and editing stories for the Computer Chronicles. When the contradiction in these statements was pointed out, his response was to give a good description of the social dimensions of learning: "Me and Juan are a team, we get to do it together. In the class we don't get to discuss anything. Juan gives me ideas."

In a later interview, Daemon was able to identify skills that his partner had learned from him. For example, when asked what Juan had learned from him, he said, "How to spell words, because when he came to the Mental Gym he had trouble spelling. I just helped him and now he is a good speller." The pretests on

these students indicated that Juan and Daemon began with different strengths and weaknesses. The posttests suggest that these students were able to improve their writing skills by learning from one another. We are currently doing a detailed analysis of the process of these changes in writing and editing done by these pairs of students over the 12-week period.

Computer Coaches. In addition to computer and peer support in the Mental Gym, the students had the help of "computer coaches." The coaches at the gym were university undergraduates who knew little about computers but who could provide encouragement and serve as "adaptive experts" when problems arose. As the students in the Mental Gym became more skilled, they became less dependent on help from coaches. We are currently analyzing the form and frequency of the help provided by the computer coaches.

Sending and Receiving Articles. Students used the Computer Chronicles Prompter to generate the articles, then would immediately edit their text with the Writer's Assistant. Their editing at this point mainly consisted of making sure there were complete sentences and correct punctuation. In general, there was not much content revision at this point. These articles were then sent out on the Newswire. At the same time, the students received stories written at each of the other locations participating in the network. Students who came to the Mental Gym to work on reading would read and edit some of the incoming stories. They were eager to read the stories that were received, taking copies home to review and evaluate these potential newspaper articles. Since they frequently disagreed, a vital component was added to the writing system: editorial board meetings.

Editorial Board Meetings. Students were invited to come to the Mental Gym as soon after lunch as they wished to take part in these meetings. All the students *willingly* gave up part of their recess to participate in editorial board meetings to read and evaluate stories. Each story from the news service, including their own, was read by one of the students. Then the group made a decision either to reject the article or to accept it with or without revisions. A decision was based on a majority vote and the formulation of a "good" reason for its acceptance or rejection. The role of the adult participant was only to record the results and to judge whether or not the given reason was acceptable.

The students began with simple reasons such as "too short" but soon found a short article that was acceptable because it had "good details." The students quickly determined whether they liked or disliked a story, but they were less aware of why they made these evaluations. Having to find a reason helped them understand their evaluations. When one of the articles that was written by a pair from the Mental Gym was about to be read, the authors withdrew the article and said that they would fix it. They saw their own writing in the context of the evaluative framework that they had helped create. It was not acceptable and they knew it. But

more importantly, they knew how to fix it. It needed more details. They took the typed copy of the story and used the Writer's Assistant to write a new version of the story. When the story was finished it was much improved, but contained one unclear sentence. When this problem was identified in a subsequent board meeting, they went back to the Writer's Assistant and dropped the unclear sentence. They were pleased when the story was accepted.

The students were also proud of their ability to locate errors and fix problems in the articles written by other students. When a story was found to need editing, all the students wanted to be the ones to edit it. Contributions of stories written by children in Alaska (for whom English was a second language) gave the students practice in correcting a variety of grammar errors. Students felt a real sense of accomplishment when they could improve on articles written by other students. While they were well aware that their own writing skills needed improvement, editing of these articles helped them see that they had skills that other children found difficult.

The editing and revision done at this stage was more likely to deal with larger units of text. For example, a sentence at the end of a story was deleted because it duplicated a sentence in the middle of the text. The major concern of the editorial board was that an article "make sense" as well as be well written. When students were satisfied with an article, it was accepted. Since students saw this as *their* newspaper, they accepted the responsibility for locating errors and collectively worked to improve the articles.

While evaluation and editing were an important outcome of the editorial board, there was another important kind of learning taking place. Students were learning about life styles and customs that were different from their own. They were beginning to understand the role that newspapers play in a society and how such communication networks function. Students were forming their ideas about what makes a story "newsworthy," they were dealing with issues of what is appropriate and inappropriate for this medium, and they were beginning to understand what things about their own environment were special or different.

The editorial board meetings then served a number of important functions. They set new standards for stories that students would write in the future as well as guides for how old stories might be rewritten. They provided motivation and suggestions for the editing of stories. And they provided a learning environment in which students learned about themselves, others, and communication.

The writing that takes place in the Computer Chronicles Newswire activity can be summarized in Table 1. Each level is important, but the total system provides an exceptionally rich learning environment for literacy skills.

Summary

Writing with microcomputers and in message networks is definitely different from writing with pencil and paper for a teacher in a classroom. One important way in

which writing with a word processor is different from writing with pencil and paper is that revision is much more productive with a word processor. The vast majority of the elementary school students we worked with preferred using a word processor, and their most common reasons were the ease of text input and editing. The power of a text editor is that it makes revision a real option for beginning writers.

Even with a powerful word processing system, novice writers still face the blank-screen problem. We have examined two approaches to helping writers deal with this problem. In the first approach, we have designed and studied the use of "dynamic support" systems of writing prompters. In these systems, the dynamic properties of the new computer media are used to supply a range of reading/writing experience, spanning the gap to help a novice writer become an expert.

In a second approach, we have created "functional" environments for writing, those in which the main goal of the writing process is to communicate with some other rather than to accomplish some classroom exercise. We have used computer networks to allow students in different schools to communicate with each other, organized as a news network. Students in each school composed and edited news-paper articles which were sent over the Computer Chronicles Network to other schools. Each classroom then organized an editorial process by which some of the articles coming in from the Network were selected and edited for their own newspaper.

There are ways in which this new communication medium offers unique, new opportunities for writing instruction and for writing research. However, to take advantage of the medium, we have to examine carefully not just the properties of the software and hardware but also the social and instructional contexts for learning.

Table 1. The Computer Chronicle Newswire

Activity	Purpose
Cooperative use of the Computer Chronicles Prompter (CCP)	Prewriting ideas, writing the articles with immediate response
Cooperative use of the Writer's Assistant following CCP	Revision and editing of articles
Completed articles are sent out and received on the CC newswire	Postwriting
Editorial board meetings	Evaluation of articles
Cooperative use of the Writer's Assistant on accepted articles	Revision and editing of selected articles
Editorial board meetings	Reevaluation
Local editions of the Computer Chronicles are produced and exchanged with other schools using the CC newswire	Postwriting
Whole class	Evaluation of newspapers of other schools

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