DOCUMENT RESUME

ED 226 709 IR 010 588

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TITLE Computers in Composition Instruction. The Proceedings of a Research/Practice Conference Held at SWRL Educational Research and Development (Los Alamitos, California, April 22-23, 1982).
INSTITUTION Southwest Regional Laboratory for Educational Research and Development, Los Alamitos, Calif.
SPONS AGENCY National Inst. of Education (ED), Washington, DC.
PUB DATE 82
NOTE 85p.
AVAILABLE FROM Southwest Regional Laboratory for Educational Research and Development, 4665 Lampson Ave., Los Alamitos, CA 90720 ($4.00 per copy).
PUB TYPE Collected Works - Conference Proceedings (021) -- Viewpoints (120) -- Reports - Descriptive (141)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Computer Assisted Instruction; Computer Programs; Demonstration Programs; *Design Requirements; Instructional Design; Media Selection; Prewriting; *Teaching Methods; *Writing (Composition); Writing Evaluation; *Writing Instruction; *Writing Processes

ABSTRACT

Suggestions for integrating computer technology and composition instruction are presented in four conference papers, summaries of four conference courseware demonstrations, a paper describing computer-based evaluation of textual responses, and a reactor's address. In an overview of the current state of computer-based composition instruction, Robert Shostak discusses the problems that writing teachers have traditionally faced and offers some promising solutions. Hugh Burns then describes a computer-based dialog designed to assist students in generating writing ideas during prewriting. Earl Woodruff discusses the role that computers can play in helping students compose text, and Ann Lathrop presents criteria for consideration when selecting courseware for purchase. The varied courseware materials demonstrated at the conference are then described. The conference reactor, Alfred Bork, suggests principles that should guide the development of computer-based learning materials and stresses the need for a solid research foundation. In an appendix, the editor outlines problems that instructional developers may encounter in designing programs for teaching writing and discusses the need for interactive programs that can evaluate the form and content of textual responses. (LMM)

COMPUTERS IN COMPOSITION INSTRUCTION

The proceedings of a research/practice conference held at SWRL Educational Research and Development, Los Alamitos, California, April 22-23, 1982.

Edited by

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The material in this publication was prepared under a contract with the National Institute of Education, Department of Education. Its contents do not necessarily reflect the views of the National Institute of Education or of any other agency of the United States Government.

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INTRODUCTION

Recent advances in computer technology are bringing about dramatic changes in education. Surveys indicate that school districts across the country are investing in microcomputers, peripheral devices, and educational software at an ever increasing rate. Clearly, the electronic revolution in education is no longer something that exists in the distant future. It is a reality now.

Interestingly, these developments in the field of computer-based learning are paralleled by similar advances in composition research, which is currently providing new insights into the complex processes that writers employ as they compose written text. And practitioners are using this research as a basis for developing new strategies for teaching writing.

What are the connections, though, between these two seemingly dissimilar fields--computers and writing? On April 22-23, 1982, the Southwest Regional Laboratory for Educational Research and Development (SWRL) sponsored a conference to examine the role of computers in composition instruction. This book includes five papers that were presented at the conference. Also included are summaries of courseware demonstrations held at the conference, as well as a description of

SWRL's work in developing computer-based materials for teaching writing.

The first paper in the volume provides an overview of the current state of computer-based composition instruction. Robert Shostak discusses the problems that writing teachers have traditionally faced and describes some "promising practices" that may help overcome these problems.

Hugh Burns describes a computer-based dialogue that he developed to assist students in generating ideas for writing. Earl Woodruff discusses the role that computers can play in helping students compose text. Ann Lathrop outlines criteria that should be considered when selecting courseware for purchase.

The courseware demonstrated at the conference included a variety of materials. Descriptions are provided for programs demonstrated by Michael Southwell, Stephen Marcus, Irene and Owen Thomas, and Shirley Keran.

Alfred Bork served as the reactor for the conference, and his presentation includes a discussion of the principles that should guide the development of computer-based learning materials. He also discusses the need for a solid research foundation.

In an appendix to the book, the editor describes some of the problems that instructional developers are likely to encounter as they design programs for teaching writing. The paper discusses the need for interactive programs that can evaluate the form and content of textual responses.

The purpose of this book is to present some new ideas for integrating computer technology and composition instruction. The programs described here suggest that computers can be useful tools for teaching writing. However, we must remember that computer-based composition instruction is a new development--one that is likely to experience the "growing pains" associated with any new endeavor. In the course of developing computer-based writing materials, designers will undoubtedly test, revise, refine, and, perhaps, discard a variety of instructional strategies. Consequently, the work described in this book represents only a beginning. But it is our hope that this beginning will stimulate additional efforts--efforts to improve composition instruction, and, ultimately, to improve students' writing.

Joseph Lawlor
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COMPUTER-ASSISTED COMPOSITION INSTRUCTION: THE STATE OF THE ART

Robert Shostak
Florida International University

I believe that any state-of-the-art discussion related to computer-assisted composition instruction should consider first some of the general problems we face in teaching writing. We all know that the latest in the litany of things that Johnny (and Jane) can't do is write. We know this because Time and Newsweek have told us it is so. As professional teachers we have known what the pedagogical problems are for a long, long time.

Teachers of writing have always faced the problem of numbers. A writer needs an audience. Being the reading audience for between 100 and 180 English students in a typical secondary school is not my idea of an ideal situation for teaching writing. I grow tired of trying to fool my undergraduates and experienced teachers at in-service workshops by attempting to make this burden seem insignificant and then selling them on "cutesy" ideas for surmounting the task of reading a seemingly endless number of student papers.

The crowded curriculum is another serious problem that detracts from the teaching of writing. Elementary school teachers complain of the need to emphasize the basic skills of reading and arithmetic, while the teaching of writing competes, in the little time remaining, with science, social studies, art, music, health, career exploration, and what have you. Secondary English teachers echo similar complaints. Most owe their allegiance to literature but must also find time for basic skills, film, TV, language study, and writing.

Lastly and reluctantly, I must question our teaching practices in general. In a recent article, Anthony Petrosky cites compelling research that indicates that teachers tend

> to monopolize . . . classes . . . with talking and writing . . . while . . . students listen, regurgitate, and seldom engage in meaningful discussions or compositions that are free of hidden agendas and require the critical thinking skills of interpretation, judgment, analysis, synthesis, and documentation with evidence. (English Education, February, 1982)

I think Petrosky is right. We have fallen in with a system that emphasizes product over process. We go for the fill-in-the-blank or multiple-choice type of assessment. We engage students in exercises that are purported to teach writing but are actually easy-to-grade substitutes for the real thing.

We have other problems. In the introduction to Research on Composing: Points of Departure (National Council of Teachers of English, 1978), the editors, Charles Cooper and Lee Odell, challenge the basic assumption that teachers of writing have an adequate understanding of the term *composition*. They point to the work of Richard Meade and W. Geiger Ellis, who discovered that paragraph development as taught in textbooks could not be found in a large number of actual pieces of writing they examined. Cooper and Odell also cite Richard Braddock's study, which challenges certain conventional assumptions about the time-honored use of the topic sentence--a technique that recently has found its way down to the more prestigious suburban preschools. The editors also refer to Janet Emig's work, which poses a serious challenge to the admonition of every true believer that thou shalt not write before producing a complete outline.

My point here is that researchers who have systematically investigated the nature of the writing process and professional writers who have expressed their own thoughts about what happens when they write have not only caused us to reconsider our own views but have also provided us with new insights to understand the act of composing.

Research tells us that rather than teach writing as a set of discrete skills (which, when learned in some predetermined scope and sequence, will eventually become internalized to be applied to the task of writing) we need to teach writing as a process. We need to guide the developing writer carefully through the stage of prewriting, into the act of composing, and finally through the difficult period of rewriting and editing.

I mention these general problems at the outset as a word of caution. We cannot look at computer-assisted instruction as a panacea. Teachers are not going to become good writing instructors simply because they have a unique new technology available to them. They must first understand what it means to be a writer--to experience both the pain and the joy. They must understand the process, and they must be able to integrate the latest innovations in instructional technology into an already sound writing program.

It is probably much too early to talk about the state of the art in computer-assisted composition teaching. To me, state of the art suggests that the latest product, process, or technique has been preceded by at least one working model--itself the result of long-term planning, development, and field-testing. At this point in time, I believe that practitioners are just beginning to produce the first working models. Some may call them state of the art if they wish--I prefer to describe them as promising practices.

What then are these promising practices? For purposes of organization I would like to refer first to those kinds of programs that seem to best support the first stage of the composing process, prewriting, then move on to the writing stage itself, and finally explore those programs directed at the last stage, rewriting and editing.

PREWRITING

Story Maker

What appears to be an exceptionally promising piece of programming for teaching writing in the elementary school has been produced by Andee Rubin of Bolt, Beranek and Newman, Inc., a Boston educational consulting firm. The program is called Story Maker and focuses on the prewriting stage of the writing process--invention. I like Story Maker because instead of emphasizing drill with letters, words, or phrases, it encourages children to concentrate on a whole text. More specifically, children are guided to consider the logical flow of a narrative, the role of examples in an explanation, and the communication of characters' plans in a story.

The theoretical basis for this approach is found in cognitive psychology's investigation of children's writing and reading. Studies have shown that children, when faced with high-level cognitive tasks, tend to concentrate on lower-level processes such as decoding in reading, or spelling and handwriting in composing. Story Maker attempts to free young learners from attention to these details so that they may concentrate on higher-level cognitive processes.

Basically, the program engages students in a creative story-making exercise by allowing them to choose options from already written story segments. After all the decisions have been made, the child has produced a complete story which he or she can read and share with other students. The program also allows hard copy to be printed for further activities planned by the teacher.

What I especially like about this piece of courseware is that the child maintains control of the creative process while the computer handles the "bookkeeping" details. Through simple commands, the computer presents structured options to the child, keeps track of the choices, and displays and prints the completed story when the activity is finished.

The child controls the direction the story will take through the choices he or she makes. Very early in the program the child begins to learn that making one choice rather than another will influence how the story will flow as well as how it will end. Because this program provides an early experience with manipulating language at a high cognitive level, it seems to have a great deal of promise for developing the kinds of skills one needs to become an effective writer.

Aristotle's Topics

Another example of courseware that reflects the process approach to the teaching of composition is that developed by Hugh Burns of the Air Force Academy English Department.* Burns found that many of his freshman cadets were having a great deal of trouble at the pre-writing stage. They did not seem to have the time or ability to generate the ideas necessary as a precursor to composing.

To help his students become more productive at this preliminary stage of the writing process, Burns developed a computer-assisted program that permits students to interact with the computer for the purpose of stimulating the formation of ideas. The program uses a set of questions based on Aristotle's enthymeme topics to engage the student in a Socratic-type dialogue. The dialogue guides students through an explanation of their subjects in order to uncover new ideas, facts, opinions, or arguments that heretofore they were unable to recover from memory.

*See p. 19 for further discussion of Burns' program.

The State of the Art

I see this as a promising practice because Burns' findings suggest that students can be encouraged to increase the number and sophistication of their ideas, and that dialogue can help students express ideas more clearly. Any computer-assisted instruction that is effective in improving students' skills of inquiry will be welcomed by teachers of composition.

COMPOSING

Word Processors

The composing stage of the writing process is beginning to benefit greatly from several unique computer applications, although, strictly speaking, these applications might not be defined as computer-assisted instruction. It is no longer a secret that computerized word processing has become an important writing aid for authors, researchers, teachers, and students. The ease with which word-processing packages assist writers in creating and editing text, even to the point of checking syntax and spelling, can all but eliminate the need for typewriters, pens, pencils, and all the rest of the usual paraphernalia associated with the tedious task of editing.

Creative teachers of writing have found several very effective uses for word processing. Children at the elementary school level who find the production of handwritten text both difficult and painful are being taught to master the computer keyboard, making entry of text much simpler and freeing children to concentrate on the creative aspects of writing.

One of the most difficult tasks of a writing teacher is to convince students that revision is important. As a general rule, students believe that what flows from their pens the first time is exactly what they want to say and how they want to say it. Why tinker with perfection? Now teachers are reporting that students introduced to the power of word processing are beginning to take more kindly to revision. The ease with which words, sentences, and even entire paragraphs can be deleted, inserted, and shifted around has helped students gain a greater understanding of and appreciation for the value of rewriting.

Research has for a long time suggested that to improve writing, one needs to write. For several reasons, all of them well known to experienced classroom teachers, it is difficult for students to produce the number and variety of composition assignments necessary. Current reports suggest that the use of word processing in teaching writing is beginning to encourage students to compose more and longer texts. Although there is no clear-cut evidence yet that students are writing better, the motivation to write is high, and students' affective responses to writing assignments are positive.

Compupoem

Working in the second stage of the writing process, composing, but coming at it from another direction are two poets who have developed different approaches to teaching writing. Both techniques deserve serious consideration by teachers of writing.

The first one was developed by Stephen Marcus of the University of California, Santa Barbara.* Marcus has produced a poetry-writing program called Compupoem, which engages students in all stages of the composing process. Unlike many poem-generating programs that simply produce a poem from a data bank of poetic phrases randomly displayed, Compupoem asks students for choices. The program encourages students to think about what they want to say, and it even provides the opportunity to see instant reproductions of their poems in different formats. This computer-assisted approach to writing poetry permits students to generate ideas or think about what they want to say first. In addition, students can control how the various parts of the poem will fit together in the finished product.

The Electric Poet

The second poetry program I would like to discuss was developed by Edmund Skellings, director of the International Institute for Creative Communication at

*See p. 62 for additional information.

Florida International University. It takes the form of a very sophisticated piece of software called The Electric Poet.

For several years, Skellings has been working on a computer program that would display color-paired symbols, numbers, and letters, using an ordinary color television screen. He was recently awarded a patent for the process, which he calls the Binemic System. What the system does is to permit color to be placed on a video screen to produce color pairs or groups illustrating relationships between letters or symbols.

Other features of the system include the capability of displaying letters in an infinite variety of patterns on the screen (similar to the patterns e.e. cummings uses on the printed page) and producing animation. Thus, a poet can easily use a particular pattern for displaying words while at the same time controlling when, where, and how quickly these words will appear to the reader experiencing the poem. To add to the flexibility of the display, letters may be made to appear as if they are three-dimensional on the screen.

What Skellings has accomplished is a blissful marriage of technology and poetry to produce a truly unique literary experience. Perhaps a more appropriate term might be a "litermedia" experience. Skellings has released poetry from the limitations of the one-dimensional, black and white printed page. He has added a powerful new dimension to the creative process, increasing the poet's opportunity to appeal to multisensory experiences.

Skelling's computer poem, then, is one that is viewed rather than read or heard. It may be seen in various colors. It may appear on the screen in its entirety or take advantage of the time dimension and be displayed word by word, letter by letter, or thought by thought. Finally, the poem may even appear to move as it is presented on the screen. Computer poetry, for me, exemplifies the new rapprochement of technology and the humanities that we are seeing today in numerous university programs around the country.

Skellings believes that his Binemic System also has many practical applications for educators, especially those who teach language arts. He bases this belief on studies done by researchers in brain function imbalance. it is pretty well accepted now that the two halves of the brain control different functions--the left hemisphere specializing in spoken language, reading, and writing; the right hemisphere dealing with spatial relations and musical patterns. Skelling says that when both parts of the brain are fully activated and integrated with each other, optimal conditions for creativity exist.

Consequently, teaching methodology using the Binemic System can engage both brain hemispheres because it simultaneously displays text in a linear-sequential format and in a color pattern-recognition format. Such methodology produces optimal conditions for effective learning to take place.

Specific subject matter that Skellings would like to develop for field-testing his system includes figurative language, patterns of thought, poetry, grammar, and reading. He thinks that students who understand various kinds of figurative language will be able to make comparisons more vividly. Such students will also have options for using more than literal language in describing and in understanding descriptions. Skellings suggests using his program to define and illustrate by color-coding various figures of speech.

Because critical thinking is so important to becoming a wise consumer and thoughtful voting citizen, Skellings also hopes that teachers will use his program to color rhetorical devices used in advertising, persuasive writing, and political campaigns so that these devices may be identified, defined, and studied to determine their effect.

Another effective use of this program could be illustrating, by means of color analysis, the various patterns of thought writers use to express their ideas, i.e., exposition, persuasion, description, and narration. Many possibilities exist for developing color-coded writing models that could be visually taken apart and put together again instantly by the computer--a powerful tool for the teaching of writing.

Skellings has already demonstrated the viability of color-coding poems so that students can recognize the elements that lend meaning to poetry. This approach very effectively illustrates the relationship of language links and structure to meaning.

REWRITING AND EDITING

Next, let me describe for you what I think are some of the most promising practices for teaching the last stage of the writing process--rewriting and editing. Each program in this last group either deals directly with text that has already been created and needs to be revised, or may be used to help students develop a higher level of sophistication with specific skills they have already demonstrated in tneir writing.

The Navy Programs

The first program I would like to discuss deals with two important elements of writing--organization and development of style. Robert Wisher of the Navy Personnel Research and Development Center in San Diego has been working on both reading and writing programs over the past several years. One of his computer-assisted programs leads students through a procedure for organizing sentences into a meaningful paragraph. Students are presented with several sentences, each preceded by a number. First, students must identify which of the sentences they believe to be the topic sentence. Then they rearrange the remaining sentences by selecting the numbers preceding each sentence. The computer instantly displays the organized paragraph. Next, students are allowed to edit their paragraphs in a variety of ways in order to clarify meaning and provide stylistic effects. This is accomplished by a series of prompts that allow students to position the topic sentence, place short sentences before longer ones, delete unimportant sentences, and insert a single sentence of their own.

Wisher also developed a program to assist students in developing better control over a variety of sentence constructions. The program is based on some of the sentence-combining research conducted over the past several years. Similar to the paragraph-organization programs, this piece of computer-assisted instruction has the student combine phrases into meaningful sentences. The student can see immediately how phrases can be combined to form clauses, and how clauses can b combined to form sentences. There is even an option built into the program that allows the student to write a sentence with a particular style, for example, a sentence that begins with a specific verbal phrase or that contains both a dependent and independent clause. Both of these programs help a student to understand the organizational aspects of writing and appreciate the stylistic options open to the writer.

SWRL

Others working along similar lines are Bruce Cronnell, Ann Humes, and Joseph Lawlor, at SWRL Educational Research & Development.* Their approach is also one that recognizes writing as a process. Their developmental efforts have been concentrated on four specific elements of writing instruction: sentence combining, generating content for a particular discourse type, organizing content, and revising.

RSVP

Still another approach to assisting students in the rewriting and editing process is the very sophisticated RSVP (Response System with Variable Prescriptions), developed under the direction of Kamala Anandam at Miami-Dade Community College in Florida.

The best way to understand how RSVP is used is to assume that you have just collected 75 essays from three of your classes. First, you must read the essays holistically in order to place them in one of four levels, A, B, C, or D. These levels correspond to levels

*See p. 75 for a description of SWRL's project.

of writing skill: primary, basic, intermediate, and advanced. The next step is to read the essays analytically and identify those specific errors you wish to call to the attention of the student. At this point, you may include any written comments you deem appropriate on individual papers.

Once the readings are completed, you indicate on a computer card the kind of feedback you wish the student to receive. The computer then generates a personal letter for each student, reflecting the items that you coded on the computer card.

The feedback each student receives is written on a reading level that corresponds to the student's writing skill level, which was determined by the teacher in step one, i.e., fifth grade (primary), seventh grade (basic), ninth grade (intermediate), or eleventh grade (advanced). The feedback consists of written prescriptions that reinforce for the student what has been accomplished and provide instruction in how to avoid errors in future assignments. RSVP is capable of providing feedback in a variety of skill areas, including spelling, subject-verb agreement, sentence structure, and organization.

The system is also capable of generating individualized study/exercise assignments. These assignments are based on twelve major writing skill areas, which have been divided into over sixty subskills. Students are also given a selection of page references in specific texts to use as resources.

In addition to these instructional capabilities, RSVP also has management capabilities. The program accumulates students' errors from assignment to assignment, provides a status report to teachers, and contains an option to provide students with progress reports at times designated by the teacher.

The Writer's Workbench

Finally, I would like to describe to you what is perhaps the most advanced editing system in existence today, The Writer's Workbench, a creation of Bell Laboratory scientists in New Jersey. After a writer enters a piece of text, the 32-program system is able to correct spelling, punctuation, and grammar. It will also analyze style and provide feedback to the author on sentence length, cliches, wordiness, and jargon.

The program literally suggests editorial changes to the writer. Based on traditional guides to writing effective prose, such as Strunk and White's The Elements of Style, the system searches a text for stylistic breaches and suggests alternatives. For example, the program will detect split infinitives or forced expressions such as "the utilization of" and offer the writer specific alternatives for improving the text.

Yet another unique feature of the Workbench is its prose comparison program. Stored in the computer's memory is a set of written passages that have been developed by the program's designers to reflect some specific standard of effectiveness for certain kinds of expository prose, for the most part, articles written by scientists. Some points of comparison used are readability level, average sentence length, sentence types, and passive verb phrases. After the computer compares an original text to one of its benchmark selections, it produces a count of each point of comparison along with a suggestion. For example, a writer might receive the following kind of report:

1. Readability (years of education necessary to read your text): 13.2

2. Average sentence length: 32.4 words

3. Sentence types: simple, 13 percent; complex, 47 percent. Your text contains more complex sentences than is usual for this kind of writing. You could improve your writing by reducing the number of complex sentences.

4. Passive verb phrases: 10 percent

Obviously, there are some real limitations to this approach to editing. The Workbench system reminds me of a brief program I wrote with my dissertation advisor many years ago. I was taking a criticism course at the time and was eager to impress my professor with the computer's ability to analyze prose style. In a few short hours I had written a very simple counting program to which we submitted two passages--one from The Sound and The Fury, by Faulkner, the other from A Farewell to Arms, by Hemingway. The program was flawless in its ability to count words and sentence length. It was less than spectacular in the advice it gave to each author for writing more effective prose. Faulkner was asked to take lessons from Hemingway. And Hemingway, in turn, was asked to take lessons from Faulkner.

Whatever its shortcomings, though, The Writer's Workbench does represent the state of the art in providing editorial assistance for specific kinds of prose.

CONCLUSION

Computer-assisted composition instruction is still very new to most teachers of writing. The success of any new innovation in education depends on how well it is accepted by classroom teachers. I think that acceptance will largely depend on three things: (1) how creative we are in solving the problems related to numbers of students and time allotted for writing in the curriculum; (2) how successful teacher educators are in training teachers of writing to approach writing as a process; and (3) how convincing program developers are in demonstrating that computer-assisted instruction is, indeed, the state of the art in the teaching of writing.

COMPUTER-ASSISTED PREWRITING ACTIVITIES: HARMONICS FOR INVENTION

Hugh Burns
United States Air Force Academy

I expect to be teaching composition until at least 2011. Therefore, I expect to hear the question "What should I write about?" a few more times. Specifically, at 140 students for twenty-nine years at eight essays apiece--that's 32,480 times. Think of the challenge I'll have coming up with 32,480 different topics. I'm not prepared for that, but I do think the analytical engine that has crept into our humanities garden can help me. In fact, I cannot imagine my 9:30, Tuesday composition course in the spring of 2006 without computer terminals somewhere, maybe everywhere. I'll use computers to train teachers. I'll consult and advise student writers and some professional writers on disks. I'll accept software as I accept research papers today. Yes, the electronic revolution is here.

Now the most vital part of my work and my daydreaming is in envisioning and promoting the computer as a writer's tool, a tool to help writers discover, arrange, and style ideas. The research I've been most involved in thus far has to do with stimulating rhetorical invention in composition using computer programs that ask questions and motivate a systematic inquiry.

Not only have such programs modified my own writing, but I'm learning to think about the geometry of invention in new ways. Some writers invent in solos, others in duets, and some in orchestration.

INVENTION AS SOLO

Our students have voices. They have experience. What many of them don't have is the strategy or the confidence to amplify the voice or articulate the experience, so learning to inquire into their own experience challenges them. That elusive search for self-confidence short of wisdom often is the most difficult step in the writing process. We listen to our students' solos, wishing they had more time to practice. Invention is a solo--first a solo based on knowledge and experience.

But this solo uses invention techniques: Some we can describe and some we cannot. Those we can describe are often called heuristics, heuristics being strategies for discovering ideas or solutions. If the imagination is dark, an invention strategy is a way of flooding the stage with light and filling the auditorium with sound. The creative enterprise of stimulating the process of inquiry will challenge the student, whatever the curriculum--anthropology or computer science, English literature or organic chemistry. I don't envision a classroom without teachers, but I will not, cannot, must not "teach" the discoveries of prewriting. The prewriter is wrapped up in the undiscovered self, and the responsibility for solving the invention puzzle is ultimately each student's. But others can stimulate the process; others can make invention more of a duet.

INVENTION AS DUET

Needless to say, the life of the mind, too, can be a duet of language and thoughts, thoughts and language. However, the duet I'm speaking of is the duet with teacher and student. A teacher can direct students' attention and experience to the topic in a number of ways. And humanistic teachers can do that without knowing what students know about a topic, without caring as much as students care about a topic, and without actually partaking in the discoveries students will make about a topic.

Say I have a student who is the world's chief authority on indolebutyric acid, a plant hormone especially good for root development. As a teacher, I can ask him or her questions that will help stimulate thinking about that acid. For example:

> Who discovered the acid? When?
>
> Was the process in any way accidental?
>
> How does that acid change?
>
> What special experience made you select indolebutyric acid as your topic?
>
> How is that acid created?
>
> What systems benefit most from this acid?
>
> What implications does this acid have politically? Economically? Culturally?
>
> What is the opposite of this acid?
>
> How is this acid like an accomplice?
>
> Like a ruby-throated hummingbird?
>
> Like a hearth?
>
> What will you claim at the end of your essay about indolebutyric acid?

The suggestive power of such questions doesn't depend on the content or the topic but rather on the interrogative propositions themselves. The student must have the content. The student must be the person who has prepared, who has incubated, who has a felt need for the insight, and whose own curiosity will finally evaluate the quality of the findings.

Consequently, a teacher may ask these questions without fear of pretending to know the answers (though some of us probably couldn't resist the temptation to explore some of the more intriguing issues, say the analogy to the hearth, suggesting that the temperature variations caused by the acid could possibly change the developmental cycle of a root system for the better). Inquiry tempts us; inquiry should tempt us. Questions tempt most of us to answer; that, as a matter of fact, is a question's propositional value.

The difficulty with invention as duet is that a composition teacher's voice cannot, practically speaking, last that long. Our enrollments are too high; our time is not our own. It would be impossible to talk to all of our student writers in order to spur their creative processes. Consequently, if we wish to engage them in the prewriting process, we need help. That's where the computer entered for me. In January, 1977, in the midst of my doctoral research, I began to think about rhetorical invention as an electronic orchestra.

INVENTION AS ELECTRONIC ORCHESTRATION

I have designed, developed, and programmed three computer programs to encourage thinking, programs I call "artificial intuition." These programs ask writers questions based on particular systems of inquiry, specific heuristics--though at some point I hope students will say to themselves, "Wait a minute, I can ask myself such questions." The programs imitate three popular heuristics, specifically Aristotle's topics, Kenneth Burke's dramatistic pentad, and the tagmemic matrix developed by Richard Young, Alton Becker, and Kenneth Pike.

The strength of these programs is that they imitate a way to investigate a topic, not the way by any stretch of the imagination, just one way. Prewriting, moreover, has certain subroutines that a computer program can imitate rather well. What are they?

1. A program can ask the question.

2. A program can clarify the question.

3. Good software can define the dimensions of the question.

4. The software can call attention to the essay's purpose.

5. It can purposefully distract (for incubation's sake).

6. It can rephrase the question.

7. It can create random metaphors.

8. Invention programs can offer research suggestions.

9. A program can print a copy of the dialogue so a student can later evaluate the answers.

After a prewriter uses such routines, then the teacher can jump in more efficiently as an inquiry diagnostician and tell students what cognitive styles they have already used, suggesting others that may help them develop more ideas. Such conversations then become the motivation for furthering the inquiry.

Now you need to see an example. In the following computer-prompted dialogue between a senior enrolled in our literature seminar and the Aristotle TOPOI program, Peggy explores Thomas Pynchon's The Crying of Lot 49 and his symbolic use of the entropy concept. We join her after a few introductory remarks--directions and such. Peggy's remarks are underlined.

NOW I NEED TO FIND OUT WHAT YOU ARE WRITING ABOUT. SO WOULD YOU PLEASE TYPE IN YOUR SUBJECT. I AM LOOKING FOR ONE TO THREE WORDS.

ENTROPY IN MAXWELL'S DEMON

HOLY ELECTRONICS! THAT'S WEIRD, I USED TO DATE A COMPUTER INTERESTED IN ENTROPY IN MAXWELL'S DEMON.

A COMMENT ABOUT PURPOSE

DURING THIS EXPLORATION PROCESS, YOU WILL BE ASKED TO CLARIFY THE PURPOSE OF YOUR PAPER ON ENTROPY IN MAXWELL'S DEMON.

SO NOW WOULD YOU BRIEFLY DESCRIBE WHAT THE PURPOSE OF YOUR PAPER IS BY COMPLETING THIS STATEMENT: THE PURPOSE OF THIS PAPER IS TO . . . (LIMIT: ONE LINE)

DESCRIBE HOW THE ENERGY THAT IS PUT INTO THE "DEMON" VIA THE "SENSITIVE" IS TRANSLATED.

ANY MORE?

IF SO, TYPE WHATEVER IT IS. IF NOT, TYPE NO.

AND THEN LATER PUT TO USE AS ENERGY OUTSIDE THE CLOSED SYSTEM.

FINE, PEGGY, YOU AND I WILL TALK AGAIN ABOUT YOUR PURPOSE.

RELAX NOW, PEGGY, AND ENJOY THIS BRAIN-STORMING SESSION.

WHAT HAS BEEN DECIDED ABOUT ENTROPY IN MAXWELL'S DEMON TO DATE?

EXPLAIN!

DECISIONS HAVE BEEN MADE ABOUT ENTROPY IN MAXWELL'S DEMON.

WHAT WERE THEY ABOUT? WHO MADE THEM?

FOR EXAMPLE, IF I WERE WRITING A PAPER ABOUT INFLATION, I WOULD WANT TO WRITE A PARAGRAPH OR TWO ABOUT THE GOVERNMENT'S LEGISLATION TO DATE.

TRY ANSWERING THIS QUESTION NOW.

ENERGY IS PUT INTO THE "DEMON" VIA THE "SENSITIVE." NEXT THE DEMON WOULD TRANSLATE THE "COMMUNICATION" AND SEPARATE IT INTO DIFFERENT ENERGY FORMS.

GOOD, PEGGY, ADD TO YOUR RESPONSE NOW.

CONTINUE!

(IF YOU DON'T UNDERSTAND, JUST SAY SO NEXT TIME. I'LL HELP.)

WE'RE MOVING RIGHT ALONG. HERE IS QUESTION 2.

WHAT ARE THE GOOD CONSEQUENCES OF ENTROPY IN MAXWELL'S DEMON?

IT CAN CREATE ENERGY IN A CLOSED SYSTEM (WHICH DEFIES THE 2ND LAW OF &&

GO ON, PEGGY.

THERMODYNAMICS).

FINE, PEGGY. WRITE SOME MORE.

THIS "DEMON" CAN BE COMPARED (ON A VERY BROAD LEVEL) TO THE DEVIL IN . . . THE WORLD TODAY. THE DEVIL TAKES THE ENERGY COMMUNICATED TO IT . . . (BY PORNOGRAPHY, OR SIN FOR EXAMPLE) AND USES IT TO CREATE (CHANNEL) IT TO OTHER USES - TO WIDEN HIS CONTROL OF THE WORLD.

OUTSTANDING, PEGGY!

ANYTHING ELSE?

(YOU CAN ADD MORE INFO, ASK A QUESTION, OR GIVE A COMMAND--WHATEVER YOU WISH.)

CONTINUE!

OKAY.

DO YOU WISH TO NARROW OR CHANGE YOUR SUBJECT?

(MAYBE REVISE THE WAY IT SOUNDS IN THESE QUESTIONS?)

NO.

****

WHAT OBJECTS DO YOU ASSOCIATE WITH ENTROPY IN MAXWELL'S DEMON? HOW MIGHT THEY BE INCLUDED IN YOUR THEME?

EXPLAIN!

IF I SAY "BLACK," YOU SAY "WHITE."

IF I SAY "HEADACHE," YOU SAY "ASPIRIN."

NOW PEGGY, IF I SAY ENTROPY IN MAXWELL'S DEMON. WHAT DO YOU SAY?

WHAT ARE YOU THINKING NOW?

THE IMAGE OF THE PERPETUAL MOTION MACHINE COMES TO MIND-MAKING SOMETHING OUT OF NOTHING.

BY GEORGE, PEGGY, GOOD ONE. WRITE A LITTLE MORE PLEASE.

ARRRRGGGGG

FANTASTIC. ANYTHING ELSE?

HELP!

OKAY.

****

WHAT IS THE MOST LIKELY PLACE FOR ENTROPY IN MAXWELL'S DEMON TO EXIST?

<u>WHAT DO YOU MEAN?</u>

WHERE SHOULD I GO TO SEE ENTROPY IN MAXWELL'S DEMON? CAN I GO INSIDE? CAN I GO OUTSIDE? WHY OR WHY NOT?

YOUR TURN, PEGGY.

<u>OH MAN</u>

AHHHH, SHORT AND SWEET. NOW TELL ME WHY?

IN OTHER WORDS, ELABORATE A LITTLE.

<u>I GUESS THAT THIS REALLY DOES BROADEN THE WHOLE QUESTION. THE WHOLE . . . BASIS FOR THE ABILITY FOR THE DEMON TO WORK WOULD LIE IN THE PERSON . . . WHO WOULD BE TRYING TO "COMMUNICATE" TO THE DEMON. THIS WOULD . . . THEREFORE MEAN THAT WHOEVER WAS THE "SENSITIVE" WOULD ALREADY, TO AN EXTENT, BE UNDER THE DEVIL'S CONTROL. NOW I'M REALLY CONFUSED.</u>

****

<u>STOP!</u>

YOU EXPLORED 4 QUESTIONS OUT OF THE 11 I ASKED. THAT'S 36.3636 PERCENT. LET ME REMIND YOU THAT YOU ARE STILL IN THE FIRST STAGES OF THE CREATIVE PROCESS. THESE IDEAS MUST SIMMER NOW. ALSO, I HOPE YOU CAN CREATE SOME OF YOUR OWN "TOPIC" QUESTIONS. I WON'T ALWAYS BE AROUND TO HELP.

HOPE YOUR PAPER IS TERRIFIC!

GOOD BYE & GOOD LUCK!

Now I'll grant that Peggy's answers reflect a cer- in caring about her subject. She wasn't putting in "garbage," and she mentioned afterwards that she wished she had known more about the topic before she started the inquiry. Nevertheless, her computer-assisted dialogue lasted about forty minutes, and when she left the lab, she took twenty-one pages of printout. She had responded, and although she may not have fully comprehended it, she was now incubating--the classic second stage of the creative process. The orchestra was tuning up.

SOME FINAL HARMONICS

As for the research findings, I'll only mention two items.* First, one of the major dilemmas: the problem of "rhetorical overload." In the experiments using these programs, students had more ideas about their topics, for all of the quantitive gains were significant over a control group. But when these same students were asked to organize their ideas into some "arrangement," their arrangements were not significantly better than the control group's arrangements. Arrangement, for these students, did not develop naturally from lots of ideas. In fact, too many ideas made the arranging task more difficult and more time-consuming. Second, we also verified that invention doesn't end. Several students told us on the follow-up questionnaire that the best answers to the questions did not occur to them while they were on-line. They were stimulated to think about their subjects from new points of view. That's exciting.

The future of computer-assisted instruction, for me, depends on how well we can "open" the programs. The computer can be used creatively and suggestively in the invention process. And our work continues. These days, I'm designing composition programs using graphic analogies, for right- and left-brain connections are

*A summary of the dissertation research can be found in "Stimulating Invention in English Composition Through Computer-Assisted Instruction," Educational Technology, August, 1980, pp. 5-10.

worth investigating. Also, I'm trying to define the explicit link between invention and arrangement; I'm not as clear or as naive about that relationship as I once was. And what we'll be able to do with word processors in a composition setting will soon overwhelm us. As for the rest of the time? I daydream about the future.

So the year 2011 arrived. Somehow, I didn't think it would ever come. So here I am reading my last college theme. I'm so glad my students haven't asked me what to write about since 1997; if anything, they have learned to "look" inside themselves for their topics, to deal with their topics as curious inquirers. Look at this topic. Who would have ever thought that some sophomore would write an essay on "Indolebutyric Acid as Entropy" of all things. I wonder where she came up with that idea?

COMPUTERS AND THE COMPOSING PROCESS: AN EXAMINATION OF COMPUTER-WRITER INTERACTION

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Suppose you are asked to help a school child write a short composition. There are a number of different helping roles you could assume. One approach would be to act as a consultant, sitting quietly and only giving information or opinions upon request. At the other extreme you could actively suggest content and language, leaving the child with little more to do than select from your offerings. In between these extremes, you could avoid direct suggestions of what to write but try to help the child by asking questions. However, there is a range of possible questioning roles--from asking very leading questions of the "Don't you think . . .?" variety to asking more open questions that leave most of the thinking to the child. Deciding on what kind of helping role to assume depends on at least two considerations: First, what is your objective--to

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help the child produce a good composition in the short run or to help the child learn? Second, which of the possible roles does your own knowledge and ability equip you to handle? Although on principle you might favor the role of asking open questions, it might prove difficult to ask educationally productive questions unless you had an unusually deep understanding of the composing process.

In designing ways for a computer to help children write, we have to ask the same two questions in order to determine a reasonable and productive role for the computer. As to objectives, most current uses of computers as word processors are aimed at helping the child produce a good composition in the immediate instance and only indirectly with helping the student learn. The programs I shall discuss, on the other hand, were aimed at interacting with students in ways to produce learning and only secondarily in ways that might lead immediately to a better composition.

The possible roles for a computer are, however, severely limited by the computer's capabilities and by the extent of knowledge of the composing process that can be applied to program design. The first program that we of the York/OISE Writing Research project produced was one that took advantage of a consultative format by offering a "menu" of help selections. The second program we wrote used a questioning format. This program tried to lead the students to consider relevant questions as the composition developed. Finally, the third program we wrote assumed a collaborative role. The student had a set of responsibilities and so did the computer. Each of the three programs attempted to boost the students to a more analytic and comprehensive view of their texts.

THE COMPUTER AS CONSULTANT: CAC-1

Our initial program, CAC-1 (Computer-Assisted Composition), tried to assist students, not by taking over parts of the task, nor by specifying what to do and when to do it, but rather by helping students use knowledge they had, but were failing to use because of cognitive overload. This form of assistance, called procedural facilitation, grew out of our investigations of the cognitive processes underlying composing. Such facilitation has been shown to be an effective means of assisting the composing process (see Bereiter and Scardamalia, 1982).

CAC-1 was an attempt to reduce the mental burden that students are under while composing, by integrating various types of help with a text collector and a storage routine. The program displayed a menu of available types of help whenever the 'help' key was pressed. One of the types of help, for example, was a delineation of the genre elements a student could include. The program was tailored specifically to the opinion essay genre, and so the elements were things like statement of belief, reason, and example. Having selected one of these, the student would then receive further help in the form of an explanation of the element and suggested sentence openers such as "One reason is . . ." or "Some people think . . ." to introduce the element.

Specifically, CAC-1 acted as a text editor until the help key was pressed, and when it was, the program would ask, "May I help you?" If the student answered yes, CAC-1 could assist in the ways described below.

1. Following an argument plan. If this form of help was requested, the computer would indicate that the following list of elements could be included: a statement of belief, explanation of the belief, reasons for the belief, opposing beliefs and refutations, more reasons and examples for one's belief, and finally one or two summary statements. When the student indicated the element he or she would like to include, the program presented an elaborated explanation of the selected element with one or two sentence openers appended (see Figure 1 for an example of this elaboration).

Figure 1

An Elaboration, by CAC-1, of a Structural Element as Shown to the Student

REASON FOR BELIEF

In this section of the paper you tell the reader why you believe what you say.

These sentences usually have the word because in them.

After you tell why you believe what you say, it is always a good idea to give an example.

You can start your sentence with:

One reason ____ ____

or,

I believe this because ____ ____ ____

PRESS C TO CONTINUE

---

2. Help in producing the next sentence. This algorithm would search the student's last sentence for selected keywords and, upon finding one, would prompt the student to say more about it. For example, if the student had used the word "believe" in the sentence before she or he asked for this help, the computer would respond; "Let's say more about your belief so the reader will understand."

3. Help in changing words. When students asked for this help, the program would print out their texts while numbering

each of the words. Once the point of revision was identified by number, the students could enter or delete the appropriate word, or a section of text could be inserted.

4. Help in checking unsure words. This routine lowered the constraints of text production by using the '#' key to flag words the student was unsure of as to spelling or meaning. Whenever a student was in doubt about the spelling, meaning, or appropriateness of a particular word, he or she was instructed to type in a guess and end the word by typing the number-sign key. This routine then delayed the correction of such words until the text was completely entered, or until the student chose to correct them.

Experimentation with the above program, on grade six students, revealed mixed results (Woodruff, Bereiter, & Scardamalia, 1981-82). While the students used, enjoyed, and praised the program's beneficial effects, the overall quality of their papers was not improved. An apparent weakness of CAC-1 is that it is too easily assimilated to a low-level "What next?" strategy of composition (Bereiter & Scardamalia, 1982). This strategy is an overly simple, forward-looking approach to writing that fails to give attention to the whole text. Consequently, while the children found the program helpful in triggering ideas for what to say next, it did not seem to have engaged students in a higher-level consideration of composition choices. Although more experience and improved typing skills would likely have increased the program's beneficial effects, so might a program that takes a more active role in directing the students' attention between the higher and lower levels of the composing process.

THE COMPUTER AS QUESTIONER: CAC-2

Our second program, CAC-2, attempted to intervene more directly in the students' composing process, with the intention of leading students away from their characteristic "What next?" strategy. Instead of waiting for the student to call for help, CAC-2 intervened at the end of every sentence. In point of fact, students using the earlier program, CAC-1, typically asked for help at the end of each sentence. CAC-2 intervened without being asked. It guided the student through a question-and-answer sequence of variable length. The intent was to block use of the "What next?" strategy by getting the student to consider higher-level questions having to do with type of content, warrant for assertions, and possible reader reactions.

CAC-2 intervened with a question every time a sentence terminator was detected. The program contained 26 questions arranged in a branching sequence that depended on the answer to a preceding question. For instance, if the student responded yes to the question, "Do you have a reason for your opinion?" the computer would respond, "Okay, let's tell that to the reader." Upon detecting the next sentence terminator, the program would then display the question, "Have you made your reason clear to the reader?" The student could answer each question yes or no, or could press a key instructing the program to move on to the next question or to hold the question until another sentence was completed. The overall intent of the questioning procedure was to lead children to compose more carefully considered and more fully developed opinion essays by switching their attention back and forth between the high and low levels of the process. In short, the program tried to induce the student to consider many of the issues that mature writers consider, but that are not taken into account by users of the "What next?" strategy.

An example of the computer-writer interaction may clarify CAC-2's questioning routine. Suppose a student is asked to write approximately a page on the topic, "Should students be allowed to choose the subjects they study in school?" As soon as the student has signed on to the computer, the program asks, "Do you have an opinion on this topic?" (If the student answers no here, the program encourages the student to consider the question and formulate an opinion.) When the student answers yes, the computer responds, "Okay, let's tell your opinion to the reader," and the student is allowed to enter a sentence. At the termination of the student's sentence, the program halts the text collection and asks, "Would you always believe this no matter what happened?" in an attempt to get the student to clarify and elaborate the opinion statement. If the student answers yes, CAC-2 continues by asking, "Do you have a reason for your opinion?" The program becomes quite stubborn at this point. When the student does not have a reason, CAC-2 indicates that the student must have a reason to continue, and waits for him or her to develop one. Once the student indicates that she or he has a reason, CAC-2 encourages the student to include it. The program continues in this manner, leading the student through questions designed to encourage clarification of the reason, evidence and support for the reason and opinion, inclusion of more reasons, and, finally, a summarization of the paper.

Since there was no way of guaranteeing that the question branching routine would accurately direct the students, the interaction could not remain entirely compulsory. If, for example, the student included both an opinion and a reason in the first sentence, then the question, "Do you have a reason for your opinion?" is inappropriate. In this case, or in the case where students simply did not understand the question, they were encouraged to press the 'continue' key, and the program would then skip to the next question, assuming that the previous question had been answered favorably. At other times, the student could press the 'hold' key, which returned the control of the keyboard to the student and allowed another sentence to be included before the question that was on hold would be resubmitted. This option, of course, allowed students to write as many sentences addressing the preceding question as they wished.

In an attempt to investigate the effects that CAC-2 had on students' writing, we tested the program with 36 eighth-grade students. The study involved writing in three conditions, and the results, in terms of the rated quality of the essays, varied depending on the order in which the conditions were presented (Woodruff, Bereiter, & Scardamalia, 1981-82). The first condition had students produce a paper-and-pencil baseline essay. On a following day, half the students composed another essay using a version of the CAC-2 program that did not ask any questions, while the other half used CAC-2 as it is described above. On the third day, the students were slotted into the opposite condition so that the study was counterbalanced. Students who produced compositions in the order baseline, no-questioning, and questioning obtained approximately the same ratings under all three conditions. On the other hand, students who produced compositions in the order baseline, questioning, and no-questioning, obtained significantly lower ratings in the questioning condition. This finding suggested that the students were overloaded if they had to deal with the novelty of a computer keyboard and a questioning routine at the same time, but that this handicap was largely overcome by a single session of keyboard composing.

Subsequent analysis revealed that the arguments produced in the computer questioning condition were less well thought out, more one-sided, and less mature. A similar decline in performance was observed by Black and Wilkes-Gibbs (1982) with writers who were asked to plan aloud as compared to composing in silence. Apparently any such additional task demand diverts mental capacity from the main task and results in writing that appears simpler or less mature. Thus, while the immediate effects are clearly negative, the long-term effects remain to be tested. Presumably, with practice, the disruptive effects of the novel procedure would disappear; indeed, our results suggest that these effects largely disappeared after just one session. However, educational benefits from the kinds of questioning used in CAC-2 would not be expected until after extended use. For it is not the effects of questioning on the immediate composition that we are concerned with, but rather the change in basic composing strategy that would occur if students became accustomed to considering such questions in the normal course of writing.

Although no long-term testing of CAC-2 has yet been attempted, the response of students to the short-term trial suggests that long-term use is at least feasible. Students themselves rated the compositions they produced with CAC-2 as superior to those produced under the other conditions. In follow-up interviews, students also reported that they preferred CAC-2 to normal writing and that they found the questions made writing easier for them. Finally--and most encouragingly--most of the students reported that they never thought about the kinds of questions CAC-2 had led them to consider, but that they intended to consider such questions in future writing. We can be sure that it would take more than one trial for the questions to become internalized, but the intention speaks well for the likelihood that the questions would become internalized in the long run.

THE COMPUTER AS COLLABORATOR: EXPLORE

I have described one program that represents a consultative form of interaction and another that represents a more directive form of interaction. Our third program, EXPLORE, represents a collaborative form of interaction by sharing the composing task with the student. This program assumes the responsibility of producing the content and linguistic form of the individual sentences, while the student has the responsibility for the structure and style of the paper. Students are shown a variety of sentences that vary according to their structural function and stylistic form. The student's job is to create a text by evaluating, and then selecting or rejecting the presented sentences. EXPLORE has a data base of 308 sentences on the issue of whether or not T.V. is a good influence on young people. Half the sentences (154) are on the pro side of the topic and the other half are on the con side. Each set of the 154 sentences is further divided into cells representing structural elements of an opinion essay--statement of belief, reasons, elaboration and examples, and conclusion. Each cell contains seven sentences, each of which conforms to a particular style: ordinary (called OK), weak, exaggerated, unbelievable, unclear, wordy, or jazzy.

Once the student has signed on to EXPLORE, the computer asks whether the student would like to 1) start a new essay, 2) add to an old essay, 3) change the essay, 4) type the essay, or 5) read over the essay. When the student indicates that he or she wants to start a new essay, the computer asks the student to select either 1) a statement of belief, 2) a reason, 3) an elaboration, 4) an example, or 5) a concluding sentence. (The student also indicates whether she or he wants the pro or con side of the argument at this step.) At this point, EXPLORE retrieves a sentence from one of the indicated cells and presents it to the student along with a style evaluation list. (See Figure 2 for an example of EXPLORE at this stage.)

Figure 2

An Example Sentence and List of Style Choices as Presented by EXPLORE

Here is a possible sentence. What do you think of it:

T.V. is not exactly the best influence on most young people.

1. Keep this sentence.
2. It's too weak.
3. It's too exaggerated.
4. It's unbelievable.
5. It's unclear.
6. It's too wordy.
7. It's too jazzy.
8. I want to choose another sentence type.
9. Read over essay.

Type the number ?

If the student indicates that he or she wants to keep the presented sentence, EXPLORE adds the sentence to the paper and branches back to the structural element selection routine. On the other hand, if the student rejects the sentence as being too much of one style or another, the computer selects an alternative sentence for presentation. This selection is dependent upon the student's evaluation of the previous sentence. For example, if the student evaluated the previous sentence as too unbelievable, and indeed the sentence had been authored to be of that style, then EXPLORE presents the OK or ordinary version. If the student evaluates the previous sentence incorrectly, then the next presented sentence is selected to contrast the last evaluation. For instance, the student may call a sentence too weak, when in fact it was authored to be the OK version, so the computer would select the exaggerated version for presentation. The student continues in the above manner, selecting and rejecting sentences until she or he feels the essay is complete.

EXPLORE's contrastive attribute was also included in its editing options under the "translate" function. EXPLORE's editor allows the student to 1) change the order of the selected sentences, 2) delete sentences, 3) read the sentences with reference numbers, 4) translate a stored essay into a requested style, and 5) restore a stored essay to its original version (i.e., return the essay to the state it was in when the student entered the editor). The translate function is quite unique in that it allows the student to take a previously produced essay and translate it into any one of the seven different styles. This option allows the student to see, with ease, the rhetorical effects of style while the structure and content of the paper are held constant. (See Figure 3 for two examples of this function.)

EXPLORE is designed to ease the mental burden of composing. Since the computer is producing the content and linguistic form of the text, students are able to produce more essays per class than they would be able to under normal conditions. With this facility, students are allowed to concentrate on aspects of the composing task that are seldom made conscious. Furthermore, students are encouraged to experiment with novel forms of structure and to evaluate the relative effects of style. And it is through such efforts that we expect the users to construct some of the higher, more sophisticated, composing strategies.

Figure 3

Three sample EXPLORE Texts Showing the Original and Translated Jazzy and Wordy Styles of the Original

ORIGINAL

1. T.V. is a bad influence on young people.
2. Too much violence is shown on T.V.
3. The overemphasis on death and bloodshed has made violence an almost acceptable way of life.
4. Murder trials have recently taken place where the defendant pleaded T.V. addiction.
5. For these reasons, it is clear that T.V. is a poor influence on young people.

JAZZY

1. T.V. is the real pits.
2. Bang! Pow! Thud! Aaargh! That's what T.V. is all about.
3. People don't freak out about crime anymore, because they see so much of it on T.V.
4. If you see somebody getting mugged on the street, you stay cool and say, "So what else is new?"
5. So, now you can see that T.V. is the real pits, and you'd better believe it.

WORDY

1. Watching T.V. is definitely a bad influence on the young people of our modern world of today.
2. Television is a bad influence on our people because it shows far too much violence that is not healthy for young people to watch.
3. Because of people watching T.V. so much, they get used to what they see on T.V. and think it is normal, which is violence.
4. For instance, if you see a lot of robbery and shooting and kidnapping, etc., on T.V., then you start to think it's normal to have robbery and shooting and kidnapping, etc., in your own city where you live.
5. If you consider these facts and points, I am sure you will conclude that, as I said at the beginning, T.V. is a bad influence on the young people today.

Exploratory tests of the program on grade 12 students found some evidence suggesting that students will experiment with the style of the sentences and the structure of the text. This data, collected over eight successive classes, indicated that the distribution of sentence styles tended, in the EXPLORE essays, to be less weak, unclear, and exaggerated, but more wordy than students would normally write (Bereiter, Scardamalia, & Woodruff, 1982). This experimentation suggested that students were exercising skills they seldom have the time to concentrate on. One of the findings, as evidenced by the students' post-experimental impressions of the program, was that students increased their awareness of text structure. The interview data, collected from one of the classes involved in the study, indicated that over 90% of the students felt their experience with EXPLORE taught them something about the structure of a paragraph. A clear example of what most students felt they learned is extracted from one student's text and presented below:

> What I did learn, in fact, from the program was how to visualize an essay as a set of individual points that need to be correctly arranged in a sensible order, like constructing a building. The bricks of a building need to be placed properly in order to form a solid foundation, this is also true for an essay.

As a collaborative program, EXPLORE was a success. It did not try to move students through great leaps and bounds, but it did give them the opportunity to practice some of the skills that would normally have been difficult to exercise. The degree of EXPLORE's success is dependent upon the classroom teacher. The program is most successful when it is combined with challenging tasks. One such task is to give the students the goal of trying to make their papers sound as if they had been authored by someone else, such as an expert, someone genuinely concerned, someone overly emotional about the subject, or a pompous windbag. Another task is to convince different types of audiences. Alternatively, the teacher may wish to see the students manipulate the structure of the texts by giving them the goal of making one point, but making it clear, or of trying to balance arguments on both sides of an issue. The number of interesting tasks is limited only by the imagination of the teacher, and the more interesting the tasks, the more successful EXPLORE is likely to be.

CONCLUSION

In discussing EXPLORE, CAC-1, and CAC-2, I have presented three different modes of interacting as built into three different programs. The least intrusive program, CAC-1, simply acts as consultant. While this program has the advantage of helping to reduce the writer's mental burden, it has the disadvantage of being incorporated readily into a "What next?" composing strategy. CAC-2, on the other hand, can override the "What next?" strategy, but it appears to do so, at least during initial use, by dividing subjects' attention among more task features than they can handle as they compose. Finally our last program, EXPLORE, demonstrates one way of dividing up the composing process so that the student and computer can work collaboratively. This form of interaction appears to be best suited to situations where dividing the task affords the opportunity to develop mature strategies. EXPLORE concentrates only on selected aspects of the composing process, but it allows greater forms and amounts of exercise than can be experienced under normal conditions.

It seems clear that different forms of interaction influence different aspects of the composing process. In our current work, we are experimenting with a program that interacts with the student during planning rather than during writing a composition; yet another program we foresee is one that will provide procedural support to students as they evaluate, diagnose, and revise a previously written composition. As I noted at the beginning, the possible roles one may design for a computer are limited by the computer's capabilities and by our applicable knowledge of the composing process. But both of these areas are advancing rapidly. As computers become more sophisticated at interpreting language input and as we become more sophisticated in our understanding of what goes on in the minds of students when they write, we can expect to see subsequent generations of interactive programs that help student writers in increasingly educative ways.

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COURSEWARE SELECTION

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Educators have a crucial role to play in today's rapidly expanding field of instructional software. It is our responsibility to become skilled evaluators who look critically at courseware before we purchase it for use in our classrooms. We must demand excellence and reject that which is mediocre. We must be willing to write critical reviews in our professional journals. Finally, we must persuade those journals that have not yet added computer courseware to their reviews of instructional materials to do so.

The technology that can be used to set new standards of courseware excellence now exists. Creative designers and programmers are developing courseware that taps the interactive power of the computer and truly involves the student in the learning process. Merely placing workbook pages on the screen and asking occasional multiple-choice questions is no longer enough. We are well past the stage of being pleased simply because a program will load and run correctly. As we locate highly creative, interactive programs, we must publicize them to our associates for their own use and to the larger educational community as a new standard for instructional computing.

Approximately 4,000 programs are currently being advertised for sale in the education market. Probably less than 5% of the programs fall into the category of good to excellent; some more conservative estimates place this figure at less than 1%. It is our challenge to select courseware to meet our students' needs from among the relatively few good programs now available.

THE EVALUATION PROCESS

Prior to beginning a critical review of courseware, it is helpful to select an evaluation instrument, guidelines, or other standardized criteria. The Guidelines For Evaluating Computerized Instructional Materials, published by the National Council of Teachers of Mathematics, is one of the most carefully developed instruments. (See Heck et al., 1981, in Attachment A.) These guidelines are easy to read and have relatively simple forms. The guide is not geared only toward mathematics, so teachers in any subject area will find it useful. The MicroSIFT Evaluator's Guide For Microcomputer-Based Instructional Packages is more complex, requiring careful study before using the guide and a longer time to complete the forms. It is more appropriate for an in-depth analysis of a courseware package or for use by courseware developers or publishers. Each of these guides presents evaluation criteria and a thorough discussion of the evaluation process. Two shorter evaluation forms are also listed in Attachment A. (See Isaacson, 1979/1980, and The California Library Media Consortium, 1982.)

The next step is to select and obtain courseware for review. The journals listed in Attachment B all publish critical reviews that can be helpful in making initial selections. These critical reviews are not to be confused with the publishers' announcements that are often reprinted from advertisements without any evaluation of the actual product. Critical reviews should be used as a buying guide only as a last resort; previewing the courseware should be part of the selection process whenever possible.

Some courseware distributors offer a free 30-day return policy for materials ordered with an official purchase order or check. The primary advantage of ordering from such a distributor is that the courseware can be previewed in the classroom, where student reactions will frequently modify an instructor's original opinion of the material. Courseware not available from a distributor can sometimes be previewed at conferences, software demonstrations, computer stores, district or regional centers, or at other schools. Some sales representatives will bring courseware to a school or district for preview. One innovative approach is the "software fair" or preview day to which publishers, jobbers, and educators from a large region are invited for the specific purpose of previewing a wide variety of courseware. All of these alternatives should be thoroughly explored before any courseware is ordered from a catalog description, without the option of preview.

After a courseware package has been obtained, there are three questions to be addressed before beginning a serious evaluation. In most cases a negative answer to any of the three may well eliminate the courseware from further consideration.

1. Does the program run on my equipment?

2. Does it meet a curriculum need at my school?

3. Does it represent a valid use of the computer?

These questions may appear too obvious to warrant discussion, but they are all too often ignored. Courseware is <u>not</u> transportable from one system to another and must match the exact configuration of equipment available at a specific site, including any required peripheral devices. Most courseware is selected to meet one or more stated curriculum objectives and should be evaluated in terms of those objectives. Even an outstanding program may be of little value if it does not fit into the local curriculum. Finally, much of the courseware currently on the market appears to make only a trivial use of the computer. If the program merely replicates some task that is already being done well with a textbook, workbook, or other traditional medium, its purchase would seem to be a waste of courseware funds.

EVALUATING THE PROGRAM

Several teachers, students, and other staff members should become involved in the evaluation. Courseware is often used in more than one classroom and at several grade levels. Different teachers will emphasize different criteria. It is especially helpful for each teacher to use the package individually, preferably in the classroom, and then to discuss it critically with other reviewers before making a purchase decision. The evaluation steps outlined below are designed for one teacher, but they can be repeated by each person involved in the review.

1. Be yourself. Read the documentation, paying special attention to any stated or implied goals and objectives and to the instructions. When there is a management system as part of the courseware, try to assess how useful it might be and whether it will be easy to implement.

2. Be a "good" student. Go through the program in a positive manner. Follow instructions and try to do well. Ask the following questions:

> Can I follow the instructions and understand what I am supposed to do?
>
> Am I bored by the program or does it challenge me to perform well?
>
> As a good student, have I learned anything, developed new concepts, or felt that the program had any value for me?
>
> Was it fun? Would I want to run it again or use it with a friend?

3. Be a "poor" student. Make a great many errors. Get confused and try to return to the instructions for help. Miss the same problem/question several times in a row and see what happens. Then ask:

How do I feel about this program and about the computer?

How do I feel about myself? Did the program make me feel dumb or did it help me to feel successful?

Did the program help me when I made an error? Did it just say "try again" when I was already doing my best, or if I was guessing?

When I made an error, did the program branch to easier materials, present items more slowly, or explain the lesson in several different ways to help me?

Was there a beep or other noise that let the whole class know when I made an error?

Did I learn anything?

Would I ever want to use this program again?

4. Be a "negative" student. Try to "crash" the program by pressing RETURN/ENTER unexpectedly. Ignore the instructions and press all of the wrong keys. Put in a number when the program asks for a letter. Be uncooperative. See how the program handles your antagonism:

Could I crash the program?

Did I get any insulting responses or did I get only a patient prompt that suggested what I should do until I decided that it really wasn't any fun to try to crash the program?

Was it fun to fail? Did I get a more interesting graphic reward--the person was hanged, something exploded, the boat sank--when I gave the wrong answer?

Could I put a lot of crazy stuff on the screen or was the keyboard locked against unwanted responses?

Did I eventually get interested and become involved in the program almost in spite of myself?

These questions will help to identify truly creative and well designed courseware. Most programs deal fairly well with the good student, unless they are unfortunately boring. It is in responding to student errors, intentional or otherwise, that a program designer has the opportunity to show imagination and to use the power of the computer to present material in new and more helpful ways.

Once you are familiar with the program, you will want to use it with your students, either individually, in small groups, or with the entire class. Students can be asked to complete some type of evaluation form or can be informally polled in discussions following the use of the program. Their reactions will provide additional insight into the potential value of the program being considered. Note especially whether most students complete the program without urging, want to repeat the program, or seem eager to share it with their friends. Then complete the evaluation form you have selected.

The final purchase/non-purchase decision should be based upon the opinions of the teachers involved, the reactions of students, and the relevance of the program to the curriculum. High standards must be established, and our final decision should reflect our determination to select only the very best from among the many programs available.

New courseware is appearing almost daily and its quality is steadily improving. Any purchase should be deferred until there is enthusiastic agreement among the reviewers that this is indeed a superior courseware package that is appropriate to the objectives of the school and truly represents an effective use of the computer. We control the marketplace by our decision to purchase or not to purchase a specific program. It is our opportunity today to encourage the development of creative and interactive programs by our refusal to purchase anything less.

ATTACHMENT A

SOFTWARE EVALUATION: AN ANNOTATED BIBLIOGRAPHY

Ahl, David H., & Jane Berentson, "Sesame Place Style Manual," The Computing Teacher (September 1979) pp. 41-42.

These 20 guidelines, used in developing software for Sesame Place, can also be used as a valuable checklist for evaluating instructional programs.

The California Library Media Consortium for Classroom Evaluation of Microcomputer Courseware, "Checklist of Evaluative Criteria." Redwood City, California, 1982.

The Consortium developed this form with the goal of encouraging teachers to participate in the evaluation process by making the form as short and simple as possible. It is designed to be presented to teachers at a workshop, and there is no written documentation. The form may be reproduced and modified to meet local needs. (Available from Ann Lathrop, San Mateo County Office of Education, 333 Main Street, Redwood City, CA 94063.)

Coit, Lois, "Pick the Software that Helps Kids Learn," Executive Educator (March 1981) pp. 21-22, 37.

Users are reminded that the place to begin software selection is with their own curriculum goals, deciding what the program is to accomplish. Users are then encouraged to preview the software, using a checklist of eight technological and six educational criteria.

Corliss, Dennis, "Attributes of a 'Good' Instructional Program," The Computing Teacher (Fall 1979) p. 43.

Concise description of twelve factors to look for in quality software.

Eldredge, Bruce, & Kenneth Delp, "How to Evaluate Educational Computer Programs," Media & Methods (March 1981) pp. 4, 15.

Discussion of computer-assisted instruction, computer-managed instruction, simulations, and educational games.

Heck, William, Jerry Johnson, & Robert Kansky, Guidelines for Evaluating Computerized Instructional Materials. Reston, Virginia: National Council of Teachers of Mathematics, 1981.

This is a very usable booklet, especially for the novice. The evaluation criteria are well developed, with clear explanations and examples, and the evaluation forms are simple and easy to complete. The guidelines are not math-specific and may be used effectively with courseware for any subject area. (Available from the National Council of Teachers of Mathematics, 1906 Association Drive, Reston, VA 22091.)

Isaacson, Dan, "Courseware Review and Rating Form," The Computing Teacher (December 1979/January 1980) pp. 12-13.

This two-page form may be reproduced without further permission for classroom use.

Kleiman, Glenn, Mary M. Humphrey, & Trudy Van Buskirk, "Evaluating Educational Software," Creative Computing (October 1981) pp. 85-90.

Presents specific evaluation criteria, the instructional rationale for each, and illustrations of both good and bad applications.

Lathrop, Ann, "The Micro in the Media Center," Educational Computer. (regular column in each issue)

Includes review guidelines, sources of reviews, and sample reviews of library-related software, using various forms and checklists.

"A Level-headed Guide to Software Evaluation," Classroom Computer News (July-August 1981) pp. 22-23.

Presents sources of published reviews, plus guidelines for conducting evaluations of educational programs, with an index-card format that can be reproduced for use in any school.

MicroSIFT, The Evaluator's Guide for Microcomputer-based Instructional Packages. Eugene, Oregon: The Computing Teacher, 1981.

MicroSIFT has developed and thoroughly field-tested this comprehensive evaluation document designed to establish a model of excellence in courseware. The guidelines and forms are more complex than those from the National Council of Teachers of Mathematics, but the user who studies them carefully will learn a great deal about evaluation. Courseware developers will find this publication especially helpful. (Available from The Computing Teacher, Department of Computer and Information Science, University of Oregon, Eugene, OR 97403.)

Minnesota Educational Computing Consortium. Designing Instructional Computing Materials for Use with the Apple II Microcomputer. St. Paul, Minnesota.

This authoring guide is a valuable source of detailed information on the criteria used in evaluating and developing courseware. (Available from MECC, 2520 Broadway Drive, St. Paul, MN 55113.)

Peters, Harold, & James Johnson. Author's Guide: Design, Development, Style, Packaging, Review. Iowa City, Iowa: CONDUIT.

This publication is written for designers and programmers in the field of instructional computing. (Available from CONDUIT, P. O. Box 388, Iowa City, Iowa 52224.)

"A Simple Way to Select Software," Instructor (October 1981) p. 94.

The program description/evaluation form is designed to fit a large index card. The 23 questions about design and content are self-explanatory and provide an easy overview of selection criteria. (Evaluation form is the same as one described in the Classroom Computer News article above.)

Wade, T. E., Jr., "Evaluating Computer Instructional Programs and Other Teaching Units," Educational Technology (November 1980) pp. 32-35.

Evaluation criteria are described in terms of relevant learning theories; includes a one-page evaluation checklist and a bibliography.

ATTACHMENT B

SOURCES OF COURSEWARE REVIEWS

Educational Computing Journals

AEDS BULLETIN
Association for Educational
Data Systems
1201 Sixteenth Street, N.W.
Washington, DC 20036

AEDS MONITOR
(see AEDS BULLETIN)

CLASSROOM COMPUTER NEWS
Box 266
Cambridge, MA 02138

THE COMPUTING TEACHER
Department of Computer
and Information Science
University of Oregon
Eugene, OR 97403

EDUCATIONAL COMPUTER
Box 535
Cupertino, CA 95015

ELECTRONIC EDUCATION
1311 Executive Center Drive,
Suite 220
Tallahassee, FL 32301

ELECTRONIC LEARNING
902 Sylvan Avenue
Englewood Cliffs, NJ 07632

JOURNAL OF COMPUTERS IN
MATHEMATICS & SCIENCE TEACHING
Box 4455
Austin, TX 78765

MICROCOMPUTERS IN EDUCATION
5 Chapel Hill Drive
Fairfield, CT 06432

MICRO-SCOPE
JEM Research
Discovery Park
University of Victoria
Box 1700
Victoria, B.C. V8W 2Y2
Canada

Review Journals

BOOKLIST
50 East Huron Street
Chicago, IL 60611

JEM REFERENCE MANUAL
JEM Research
Discovery Park
University of Victoria
Box 1700
Victoria, B.C. V8W 2Y2
Canada

JOURNAL OF COURSEWARE REVIEW
(Apple)
The Apple Foundation
Box 28426
San Jose, CA 95159

MICROSIFT REVIEWS
Northwest Regional Educational
Laboratory
300 S.W. Sixth Avenue
Portland, OR 97204

PEELINGS II (Apple)
945 Brook Circle
Las Cruces, NM 88001

PIPELINE
Conduit
University of Iowa
Box 388
Iowa City, IA 52244

PURSER'S ATARI MAGAZINE
Box 466
El Dorado, CA 95623

PURSER'S MAGAZINE
(see PURSER'S ATARI MAGAZINE)

SCHOOL MICROWARE REVIEWS
Dresden Associates
Box 246
Dresden, ME 04342

SOFTWARE REVIEW
Microform Review
520 Riverside Avenue
Westport, CT 06880

Newsletters From Educational Users' Groups

CHICATRUG NEWS [TRS-80]
Chicago TRS-80 Users Group
203 North Wabash, Room 1510
Chicago, IL 60601

CUE NEWSLETTER
Computer-Using Educators
Box 18547
San Jose, CA 95158

MACUL JOURNAL
Michigan Association for Computer Users in Learning
Wayne County ISD
33500 Van Born Avenue
Wayne, MI 48184

MIDNIGHT SOFTWARE GAZETTE [PET]
Central Illinois PET Users' Group
635 Maple Court
Mt. Zion, IL 62549

USER'S: THE MECC INSTRUCTIONAL COMPUTER NEWSLETTER
2520 North Broadway Drive
St. Paul, MN 55113

Educational Journals

ARITHMETIC TEACHER
National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 22091

EDUCATIONAL TECHNOLOGY
140 Sylvan Avenue
Englewood Cliffs, NJ 07632

EPIE REPORT
EPIE Institute
Box 620
Stony Brook, NY 11790

INSTRUCTOR
7 Bank Street
Dansville, NY 14437

MATHEMATICS TEACHER
(see ARITHMETIC TEACHER)

MEDIA & METHODS
1511 Walnut Street
Philadelphia, PA 19102

Computer Journals

BYTE
70 Main Street
Peterborough, NH 03458

COMPUTE!
Box 5406
Greensboro, NC 27403

CREATIVE COMPUTING
Box 789-M
Morristown, NJ 07690

80 MICROCOMPUTING [TRS-80]
80 Pine Street
Peterborough, NH 03458

INFOWORLD
375 Cochituate Road
Box 880
Framingham, MA 01701

INTERFACE AGE
16704 Marquardt Avenue
Cerritos, CA 90701

MICROCOMPUTING
(see 80 MICROCOMPUTING)

PERSONAL COMPUTING
50 Essex Street
Rochelle Park, NJ 07662

POPULAR COMPUTING
(see BYTE)

SOFTSIDE
Box 68
Milford, NH 03055

SOFTALK MAGAZINE [Apple]
11021 Magnolia Boulevard
North Hollywood, CA 91601

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COURSEWARE DEMONSTRATIONS

The four demonstrations presented at the conference represented a variety of approaches to teaching composition and its related form skills. Sample materials ranged from a highly structured grammar module to an open-ended program for composing poetry. With the field of computer-based composition instruction still in its infancy, such diversity seems to be a healthy sign. The powerful capabilities of the computer allow--and even encourage--a variety of strategies for organizing instruction. The programs described below illustrate some of these strategies.

MICHAEL SOUTHWELL
(YORK COLLEGE, CITY UNIVERSITY OF NEW YORK)

Southwell's demonstration featured one of the ten computer-assisted grammar lessons that he has devised for developmental writers at the City University of New York (CUNY). These lessons are designed to be used in an autotutorial writing laboratory. Southwell and his colleagues at CUNY have found that basic writers who speak dialects other than standard English can benefit from direct instruction on the form and syntax of written English. Such instruction, they claim, is most effective in a laboratory setting, where the student controls the pace of the instruction and assumes primary responsibility for learning.*

Since the CUNY grammar lessons are designed for a laboratory environment, the programs are entirely self-contained, requiring little or no intervention by the teacher. The sequence of activities is carefully controlled, and students must complete each module successfully before going on to the next. This control is maintained through the use of a "password," which the program gives the student after he or she has successfully completed a module. This password must then be entered by the student at the beginning of the next lesson.

Although the CUNY grammar lessons were originally written for a mainframe computer, Southwell is currently adapting them for a microcomputer. The microcomputer versions of the lessons feature the use of color graphics and sound to reinforce learning. The programs present explicit instruction on identifying parts of speech, using correct word forms (e.g., noun plurals, verb tenses), and manipulating sentence structure. The programs rely heavily on students' entering complete sentences, and these sentences must correspond exactly to the desired response. Typographical errors and misspellings--as well as grammatical errors--elicit an "incorrect answer" response from the program. Southwell claims that this technique encourages students to be more attentive to the learning task. (For further information, see Southwell's article, "Using Computer-assisted Instruction for Developmental Writers," AEDS Journal, 1982, 15, pp. 80-91.)

STEPHEN MARCUS (UNIVERSITY OF CALIFORNIA AT SANTA BARBARA)

The writing program developed by Stephen Marcus illustrates a completely different strategy for using

*Additional information on the CUNY writing program is provided by Mary Epes in "Developing New Models of the COMP-LAB Course," in Moving Between Practice and Research in Writing, edited by Ann Humes; Los Alamitos, CA: SWRL Educational Research and Development, 1981.

the computer in composition instruction. Marcus has designed a program called Compupoem, which allows students to compose original poems on the computer.* The program asks students to supply various parts of speech, which are then formatted by the machine to produce a poem. Students have the option of revising the structure and wording of their poems, and they can also print out a hard copy of their creations. For example, the following poems were written by students using Compupoem:

Paul's Poem

The riveter,
Brawny, sweatcaked at Miller Time
Carefully slouches
Bethlehembound

Harold's Poem

The reptilian brain
sweet, juicy
in the nick of time's swamp
gracelessly
beckons.

Compupoem is a unique application of computer-based writing instruction because it encourages students to write without worrying about evaluation. Compupoem allows students to discover what they have to say as they are in the process of composing. Such experiences can help reluctant writers overcome their "writer's block," encouraging freer expression and experimentation. (For additional information on Compupoem, see The Computing Teacher, March, 1982, pp. 28-31.)

IRENE AND OWEN THOMAS
(IOTA, LAGUNA BEACH, CALIFORNIA)

Irene and Owen Thomas demonstrated several programs they are currently preparing for commercial

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*The original program on which Compupoem is based can be found in BASIC and the Personal Computer, by T. Dwyer and M. Critchfield; Menlo Park, CA: Addison-Wesley, 1978.

distribution. The Thomases' presentation featured several of their spelling programs, which are highly interactive, taking advantage of color graphics, sound, special character fonts, and a variety of response formats. The Thomases emphasized that the tone of a program's response to students' errors must be controlled carefully. Students need to be told that their answer is incorrect, but the message should not be insulting or negative. Another program demonstrated by the Thomases provides instruction on punctuation rules. Students practice applying these rules by punctuating a letter.

The Thomases also demonstrated a sentence-combining program, which teaches students how to combine several short sentences into one sentence. Since this program is designed for the elementary level, it attempts to minimize the need for typing skills by providing alternative response formats. For example, the student may construct a sentence by moving a box through a word list, selecting, in order, the words for the sentence; or the student may move an arrow through a sentence and press RETURN at the point where a specific word should be inserted.

Eventually, the Thomases hope to develop a comprehensive computer-based writing program, which will include prewriting activities, a word processor, and an "electronic handbook" for help in revising and editing.

SHIRLEY KERAN (MINNESOTA EDUCATIONAL COMPUTING CONSORTIUM)

Programs demonstrated by Shirley Keran, of the Minnesota Educational Computing Consortium (MECC), are designed primarily for elementary-level language arts instruction. Although these programs might not be strictly classified as composing activities, they do provide instruction on the form skills that are needed to prepare written documents. For example, MECC spelling drills provide practice in choosing a correctly spelled word to fit into a sentence. The program allows teachers to enter the words and sentences the student will use. In addition, the program also keeps track of each student's performance so that instruction can be modified to meet individual needs.

Other programs developed by MECC allow the teacher to design word games that are printed out in hard copy. Crossword puzzles, word mazes, and "hangman" games can easily be constructed and customized to fit the needs of the classroom. Such games can be useful for teaching vocabulary and spelling--subjects that many students may otherwise find tedious.

Also included in Keran's presentation was a demonstration of a computer-based social studies game called Voyageur. The game simulates the experiences of fur traders who traveled by canoe in the Great Lakes area during the 18th and 19th centuries. Students are required to organize and lead a trading expedition, and they must make critical decisions about how to proceed on their journey.

In addition to their obvious value in teaching content-area material, such simulations may also have additional benefits for teaching writing. First, simulations promote the use of problem-solving skills--the same kinds of skills that students must apply when they write. Moreover, simulations demand precise communication. Ambiguous or illogical commands cannot be processed by the machine, so students quickly learn that they must express their intentions clearly and simply.

REACTIONS

Alfred Bork
University of California at Irvine

I'm going to direct many of my comments toward issues of development, because I am assuming that many of you are developers or are going to become developers of computer-based learning material. I am also going to object a little bit to the title of this conference The title includes the word instruction--a word I have removed from my vocabulary. I think of things like instruction and teaching as very uninteresting. One of the problems in education is that we are much too concerned about teaching and not enough concerned about learning. So I'll concentrate on learning.

BAD PRACTICES

I want to start with a brief list of bad practices in computer-based learning. As developers, we must be aware of such practices so that we can avoid them in our materials. If you look at materials generally, you will find that these bad features are very common.

Screen Design

The first set of issues in my compendium of bad practices deals with screen design--particularly hindrances to readability on the screen. We have to remember that blank space is free on the computer, unlike print media. Many designers come into this field with a book mentality, and they tend to show things the way they would look in books. For example, long lines are something we don't need in computer-based materials. Readability research generally shows that short lines aid readability. We sometimes see words being split arbitrarily at the end of the screen. That should never happen in a student-usable program. A similar problem arises when users input text. Generally, the input does not use "word wrap" techniques. Developers of word processing systems learned long ago that this is a poor practice. It's easy to build software that automatically moves complete words to the next line on the screen.

We also frequently see computer dialogues putting almost all text at the left margin--another print technique. Many computer languages assume that you will always want to put text at the left margin. But when you start using more blank space, you will want to balance material on the screen, and you will seldom put anything at the left margin. More generally, there isn't much conscious placement of text in many materials that exist today. Most people are unfortunately just letting the system put text wherever it happens to put it.

Another thing we see frequently is splitting natural phrases across a line. Studies again show that this is a deterrent to readability. Given that blank space is free on the computer, there is no reason that we can't display text logically, keeping natural phrases together on a line.

In addition, much of the text we see is displayed too fast. Our studies have shown that novice users don't like this rapid text display. Given a choice of where to set the speed of text, such users set it at a much slower rate. Good programs will allow users to set the rate of the text display. This is not difficult to build into the software.

Timing

Timing is another important issue in the design of computer-based materials. In most environments, we cannot assume that people are going to be there forever. If a user doesn't know that he or she needs to press RETURN (or some other key) to continue, the machine should tell the user to press RETURN. In addition, there may be instances when you need to time the student's response. But this has to be done in a sensitive fashion. That is, if a student waits nine seconds, and then starts to type, we don't want to cut him or her off just because we were waiting ten seconds.

Content

Next, let me look at a few content issues that are also in my compendium of bad practices. First, it seems fair to say that the vast majority of the programs currently available are trivial programs. That is, they are not really serious curriculum efforts. This abundance of trivial programs has probably occurred because we are at a very early stage of development. As we gain more experience in designing computer-based materials, we should start moving away from trivial applications.

Another issue related to content concerns "help" sequences. For the most part, these sequences are not very helpful. They are usually completely noninteractive. Often a help sequence is simply a full screen of verbal material to read. Help sequences can be just as interactive as the rest of the material.

Media Issues

The fourth category in my compendium of bad practices includes media issues. Most computer materials we see today look like a book. Part of this comes from the fact that there is not enough visual material. Instructors are extremely verbally oriented, and they often [illegible] understand the visual needs of students. As many of you have undoubtedly discovered, not all students are verbally oriented.

Reactions

Another important media issue is solving design problems with other media. I get very worried when I am making a film and somebody brings up a problem and a designer says, "Oh, we'll put it in the student handbook." I get very worried when someone designing a computer program is asked a question about it and says, "Oh, that's covered in the teacher's guide." I get suspicious when designers have to solve problems with other kinds of media.

Another major media issue is the amount of interaction. The real advantage of the computer is that it is an interactive medium. However, most teachers tend to come from successful environments of lecturing, where they don't think and work interactively. Consequently, computer-based materials tend to look like books. Much more interaction is needed.

General Issues

In any interactive learning material, we ought to use English as the medium of communication. This business of using Y and N and special letters as responses seems to be a questionable strategy. The English language is a perfectly reasonable tool to use, and I don't think we need "computerese." If we don't use good form in the material, how can we expect students to use good form?

Another issue is the use of multiple-choice formats. Multiple choice came about as a tactic of desperation for dealing with large numbers of students. But we don't need multiple choice on the computer. This isn't to say that we might not occasionally want to use it just for variation, but as a general rule, multiple choice is a terrible strategy.

DEVELOPING MATERIALS

I would like to turn now to a discussion of the principles that should guide our development efforts. It makes sense to begin by examining the strengths of the computer as an instructional medium.

First, the computer is an interactive medium--and interaction is not just a word. In fact, I believe that we can measure interaction. We can look at computer material and talk about the quality of interaction. Interaction doesn't just mean that the user gets to say yes or no every few minutes while reading. We can look at how frequently interaction occurs, we can look at the types of interaction, and we can begin to arrive at measures of interaction.

The second major strength is the computer's capability for individualization. If computer material is good, it can really begin to do what we've always talked about in education--individualize the learning experience. We can make the learning experience different for different people.

Another strength of the computer is that it can present us with new ways to organize learning. This is probably the hardest thing for the conventional teacher to understand. Often the computer allows entirely different strategies for organizing our material.

The Development Process

Development is a serious process--not something that can be done casually. If one is going to develop learning material of any kind, one doesn't do it by finding a teacher and letting that teacher do it in his or her spare time. The notion that we can easily produce good learning material is an illusion.

In serious development efforts, we need groups. We can't assume that a good teacher is going to be a good programmer, just as we can't assume that a good teacher knows how to run linotype machines and printing presses if we are developing textbook material. We need to look at the places where serious curriculum development takes place. My favorite example is the Open University in England. The Open University typically spends a million dollars on developing a course these days. The University runs the course for seven years, and then scraps it and spends another million dollars. We are not going to get good computer-based learning material until we also begin to develop at that level.

Reactions

Instructional designers ought to stop thinking about programming. For the most part, the people who write textbooks don't learn how to run printing presses. And the people who are going to design good computer-based learning material are not going to be computer experts. Programming is a technical area, and as we get into commercial production, where issues of transportability to new machines are extremely important, we are going to have to separate instructional design from technical production, much as we do now with books, films, and almost every other kind of learning medium.

Research Needs

Perhaps the most important issue in developing computer-based materials is establishing a research basis. For example, this has been a conference on writing. What do we know about writing? What is the experimental evidence? What research do we need to conduct in order to design successful materials in this area? Who are the experts in teaching writing and who are the experts in research associated with writing?

Bob Shostak has already noted the problems in teaching writing. This seems to be a very solid place to begin our development efforts. We shouldn't start by saying, "What can I do with computers?" Rather, we should start by asking, "What are my pedagogical difficulties? What are the problems associated with teaching writing?" It may turn out that computers are going to be extremely useful (as I believe they will be) in dealing with these problems.

The Future

As developers, we need to have a very strong orientation toward the future. The problem is not what we can get into classrooms tomorrow. The really interesting things are future-oriented. We are at the threshold of a real revolution in the way people learn--a revolution that is going to influence our entire educational system. We ought to look very much into the future, and there are several implications to this orientation. For example, if you are a developer, you don't want to develop materials for the kind of hardware that is currently available. Such machines are likely to be obsolete within a few years.

We also need to think more about non-school environments. Too much of our thinking about computers concentrates on schools, and we often hear people say, "Will teachers accept this?" In fact, teacher acceptance may not be very critical in this area. As computers become more common in homes, learning material will become an important component in selling computers. Consequently, commercial interest in learning will be great, and our whole attitude toward education will change.

I would like to raise an additional issue for you to think about. I have already pressed the notion that the computer can really lead to new ways of organizing instruction, new ways of doing things. Now I raise the question of whether reading and writing really are separate activities. Or are they really things that can be done together on the computer, rather than being done separately? Interestingly, the most extensive early work involving the computer and typewriters, O. K. Moore's "talking typewriter" study, was really a reading project rather than a writing project. This early work showed that you can teach very young children to type, and that you can use typing as a vehicle for teaching reading. If we begin to think about the computer as a "combining" device, then perhaps we can approach reading and writing as fundamentally the same activity.

Finally, I always like to remind people that it is not clear that the computer is going to improve education. The computer, like any new technology, has the potential for improving education or weakening education. Everything in human technology has this dual potential. When humans first learned to use fire, they found that fire could be used for good or for bad. The technology itself doesn't determine whether it is going to be good or bad. People do. And we have to remember that the computer is a gift of fire.

APPENDIX: EVALUATING TEXTUAL RESPONSES

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Under a contract with the National Institute of Education, my colleagues and I here at SWRL have been investigating the use of microcomputers to teach writing. The purpose of our investigation has been to explore ways in which the computer might be useful for teaching the high-level skills that are associated with composing.* Although much of our work has been exploratory, our experiences in designing interactive writing materials may be of interest to developers--or potential developers--of computer-based writing instruction.

When we began our project, one of our first tasks was to find out what kind of instructional programs were currently available for teaching writing. Not surprisingly, we found the field to be very limited. Most of the available courseware was of the drill-and-practice variety, dealing primarily with the form

*Additional information on this project can be found in "Using Microcomputers for Composition Instruction," by Bruce Cronnell and Ann Humes (ERIC Document Reproduction Services No. ED 203 872).

skills of writing, such as spelling, usage, and capitalization. Although such programs can be useful, very few of them require the student to write anything longer than a single word. In fact, since many of the programs employ multiple-choice formats, the student commonly responds by simply typing a single letter or number.

However, when students write, they are expected to produce sentences and paragraphs, not single words or letters. Consequently, we decided to focus our efforts on designing computer-based materials that would require the actual production of text. And we also felt that our programs should be able to evaluate that text.

After exploring a number of ideas for instruction, we decided that our initial effort would be to design a program for teaching sentence combining. There were several practical reasons for this decision. First, sentence combining has been shown to be an effective technique for improving the sentence structure of students' writing. Second, after reviewing the research on sentence combining, we had a pretty good idea of what the scope and sequence for such a program should be. And finally, we felt that while sentence-combining instruction would allow us to work with textual responses, it would also allow us to limit the range of those responses, making the evaluation task more manageable.

EVALUATING STUDENT RESPONSES

As the framework for our sentence-combining program began to take shape, we soon discovered that evaluating students' responses was not going to be an easy task. The computer--for all its remarkable electronic sophistication--hasn't the faintest idea of what a sentence (or even a word) is. When a computer stores text in its memory, it stores the text simply as a "string" of characters, that is, a particular sequence of letters, spaces, and symbols. Although the machine does not "know" what the string means, it can compare one string to another and determine whether or not the two are equal (i.e., whether or not the strings contain exactly the same characters in exactly the same sequence). Consequently, the easiest way to evaluate the student's response would have been to compare the student's sentence to the correct answer. If the two strings were not equal, the machine could then tell the student that his or her answer was wrong and branch to some type of remedial instruction.

However, we felt that there were degrees of "rightness" and "wrongness" that had to be considered in evaluating the student's response. For example, in the following item, a student who had correctly combined sentences (1) and (2) would produce sentence (3):

(1) Tom fell to the ground.

(2) Tom ripped his uniform. (and)

↓

(3) Tom fell to the ground and ripped his uniform.*

But consider the following hypothetical responses:

(4) Tom fell to his uniform.

(5) tom fell to the grond and ripped his unifrm

To the computer, both of these responses would look equally wrong; neither of them would match the correct answer. Yet there are important differences between the two responses. A student who enters the first sentence evidences little or no understanding of the sentence-combining instruction. But a student who enters the second sentence seems to comprehend the material; errors in the second sentence reflect spelling, capitalization, or typing problems--not problems with sentence combining.

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*This item format was originally developed by Frank O'Hare (Sentence Combining: Improving Student Writing without Formal Grammar Instruction. Urbana, IL: National Council of Teachers of English, 1973). The parenthesized word is a "signal" that tells the student how to combine the sentences. In this case, the student is to conjoin the two predicate phrases with and.

Clearly, a simplistic evaluation of the student's response was not appropriate for our sentence-combining program. What we needed was a system for "parsing" the student's sentence--a system that would examine the sentence and distinguish among the various types of errors a student might make.*

DESIGNING THE PARSER

We began specifying the functions of our parsing system by classifying the errors that students might make into two broad categories. The first we called "syntax" errors--errors that reflected a misunderstanding of the sentence-combining task, as exemplified by response (4) above. The second category included errors of form (spelling, typing, capitalization, punctuation), as illustrated by response (5). A student whose response contained a syntax error was to be routed back through remedial instruction. However, a student whose sentence contained only errors of form was to be allowed to fix those errors until the sentence matched the desired response.

Several of the parsing routines were relatively easy to specify. As it is now written, the program first checks for a capital letter at the beginning of the student's sentence. If the first letter is not a capital, the program asks the student to make the neccessary correction. If the student does not change the letter at this point, the program will automatically make the correction. A similar routine checks for the presence of a period at the end of the sentence.

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*The term parsing as used here does not refer to formal grammatical analysis. Although computer programs have been developed that can perform such analyses, these programs normally require extensive amounts of computer memory--more memory than is available in the microcomputer with which we were working. For a review of recent developments in the field of computer-based grammatical analysis, see Hendrix, G., and Sacerdoti, E., "Natural Language Processing: The Field in Perspective," Byte, September, 1981.

The next parsing routine checks for the presence of the sentence-combining "signal" in the student's sentence. If the signal is not present, the program asks the student to add it. At this point, if the student does not add the signal, the program detects a syntax error and branches to the remedial instruction.

Next, the program counts the number of words in the student's sentence. (A word is defined as a series of letters followed by a space, or, in the case of the last word in the sentence, followed by a period.) If the number of words in the student's sentence does not correspond to the number of words in the correct response, the student is informed of the discrepancy and asked to revise his or her response. Failure to revise the sentence correctly results in a syntax error and a branch to remedial instruction.

At this point in the evaluation--if the student has not been routed back through the remedial instruction because of a syntax error--the student's sentence now contains an initial capital letter, a terminal period, the sentence-combining signal, and the correct number of words. All that remains now is to check for spelling errors. Although checking for such errors would seem to be a relatively straightforward task, we found that this was actually one of the most complicated routines in the whole program. We wanted the spelling routine to examine each word in the student's sentence, compare it to the corresponding word in the correct answer, point out any word that was misspelled, and ask the student to correct the misspelling. We also wanted the routine to include a spelling corrector--that is, if the student did not correct the word on the first attempt, we wanted the program to correct the word automatically, so that students would not get bogged down in endless editing tasks, which would contribute little to the primary purpose of the instruction.

The major problem we encountered in designing this routine was defining a spelling error. Consider, for example, the following responses to the item listed above. Both of these responses would have passed through the previous parsing routines:

(6) Tom fell to the ground and he fell down.

(7) Tom fell to the grond and ripped his unifrm.

Obviously, the errors in sentence (6) are not spelling errors. But to the computer they might appear to be. For example, when the machine compares the seventh word in the student's sentence (he) to the seventh word in the correct answer (ripped), the computer will detect only that the two words are not identical. Without additional programming, the computer cannot tell whether the student's word is misspelled or whether it is simply the wrong word. Consequently, we had to develop an additional parsing routine to examine each word in the student's sentence, letter by letter. We then defined "spelling" errors as discrepancies that resulted from one of the following conditions:

- The word contains one letter that is different from the corresponding letter in the correct word (e.g., grount for ground).

- The word contains one letter too many (e.g., geround) or one letter too few (e.g., groun).

- The word contains one pair of transposed letters (e.g., gruond).

All other discrepancies in the student's text are treated as syntax errors. Thus, when the computer encounters the word he in sentence (6), the student is sent to the remediation routine. However, the discrepancies in sentence (7) are treated as spelling errors: The student is asked to correct the errors, and the program then proceeds to the next activity in sequence.

CONCLUSIONS

Our experience in designing the sentence-combining program has led us to form several conclusions about computer-based composition instruction--conclusions that are likely to have important implications for subsequent development efforts in this field. First, designing interactive programs that evaluate textual responses is not a simple task. Programs that require only minimal responses from students--entering a single word, a letter, or a number--can evaluate those responses quickly and easily. However, extended textual responses demand more complex evaluation. Even in our sentence-combining program, where student input is reasonably constrained, evaluation must distinguish among many different types of errors, responding to each type in a different way. Imagine the complexity that would be involved in evaluating less constrained responses, for example, a narrative paragraph that must be checked for appropriate transitional expressions.

Another conclusion we have drawn from our experience is that no matter how sophisticated our evaluation techniques become, they will still not account for <u>all</u> the responses that students might possibly make. The best we can hope for is a reasonable compromise. An evaluation routine has to be flexible enough to handle a variety of error types, but it must not be so flexible that it allows faulty input, such as typing <u>grated</u> for <u>ground</u>. In evaluating textual responses, we have to remember that there are definite limits to what we can do.

Finally--and perhaps most importantly--we have found that the extra effort required to design sensitive evaluation routines pays off in the long run. Students who participated in pilot studies of our sentence-combining program seemed to appreciate the way their errors were handled. Most of the students were very willing to revise their sentences once the computer provided the appropriate prompt. Students tended to view the computer as a partner rather than as an adversary, and, after all, that is precisely what a good composition teacher should be.

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ACKNOWLEDGMENTS

The editor would like to acknowledge the following people for their special contributions to this project: Bruce Cronnell, Larry Gentry, and Ann Humes for their help in planning and running the conference, and particularly for their thoughtful suggestions for editing these proceedings; Carol Lamb and Eileen Macías for typing (and retyping) this document; Jerry Bailey and George Behr for their invaluable technical assistance; Susan Maag and Marilyn Speights for their careful handling of the conference arrangements; Dean Risco for recording and photographing the conference; Bessie Wiles for typesetting; and Anna Leong for cover design The editor especially wishes to thank the conference participants—whether formal speakers or not—for attending the conference and contributing to its success.