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AUTHOR Strickland, K. James
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ABSTRACT

Computers, if programed to respond to writer-generated content with heuristic strategies, can guide the writer in the prewriting stage. Heuristics are problem solving strategies that can aid the writer in exploring a topic either through a systematic posting of relevant questions or through an unsystematic process of free-association. To date the only experimental research linking computers and heuristics has been Hugh Burns's "Stimulating Rhetorical Invention in English Composition through Computer-Assisted Instruction," which found that, in a 30-minute period, computer assisted systematic heuristics generated a greater quantity of ideas than traditional unsystematic heuristics. However, the study never determined if the use of computer assisted instruction (CAI) to stimulate rhetorical invention actually helped the writer to write. In a current study, CAI instruction in invention is being compared with traditional classroom invention instruction. The study makes a distinction between systematic and unsystematic heuristics and will look at the quality of the ideas produced by measuring the proportion of ideas used in the actual writing that were produced in the heuristic exercises. This study may show not only that CAI employed during the invention stage helps writers write, but that CAI using systematic heuristics will provide the most beneficial combination. (A list of questions about computers, along with their answers, is appended.) (HOD)

THE COMPUTER AS A TOOL FOR THE INVENTION STAGE OF WRITING

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K. James Strickland
Associate Professor
Trocaire College

THE COMPUTER AS A TOOL FOR THE INVENTION STAGE OF WRITING

K. James Strickland

With the advent of inexpensive personal microcomputers, many school systems and colleges are acquiring computer hardware and software at a rate reminiscent of the acquistion of science equipment in the Sputnik-inspired clamor for "science in the schools." Unfortunately, much of the computer's use has been relegated to eliciting lower order responses from users: matching multiple-choice or fill-in-the-blank answers. In composition instruction, CAI has been used for those areas most suited to lower order elicitations: grammar and spelling drills. The "thinking machines" are being employed as nothing more than "electronic workbooks" (Selfe, 1983). Obviously, such instruction, concentrating on skills necessary in the later editing stages of composition but often inhibiting in the earlier generating stages (Rose, 1980), is far removed from our present understanding of the composing process (Flower & Hayes, 1981). The use of CAI in the important pre-writing stage, the planning or generating stage, has largely been ignored. Computers have the potential for guiding the writer in this pre-writing stage by executing heuristic strategies programmed to respond to writer-generated content. Burns (1979) demonstrated the potential of CAI in pre-writing, but he did not evaluate actual writing by the subjects. I am presently involved in a study

attempting to evaluate the writing produced after the use of heuristic strategies taught by either computer-assisted instruction (CAI) or traditional instruction to determine the interaction between type of heuristic strategy, systematic or unsystematic, and mode of instruction.

As many of you know, a heuristic is a problem-solving strategy employed to aid a writer in exploring a topic under consideration. It is distinguished from the other problem-solving strategy, the algorithm, a rule of algebraic precision, yielding a correct answer whenever applied. Heuristics are thought of as rules of thumb which often but not always yield successful answers.

The distinction which I am maintaining between heuristic types is taken from Nancy Rabianski's dissertation at the State University of New York at Buffalo (1979). Rabianski claimed, "Of the various [heuristic] procedures, there are two . . .that . . .appear to be potentially effective, yet they differ distinctly in structure. One procedure, . . .the tagmemic heuristic procedure, provides a student writer with a systematic approach to a writing task. Before beginning a draft, the writer must design and answer relevant questions based upon a set of probes. In contrast, the other, Elbow's free writing procedure, requires the writer to approach a writing task in a relatively unsystematic way by continuously writing whatever relevant ideas and/or digressions are brought to mind by the topic" (pp. 2-3).

Systematic heuristics are characterized by the positing of a number of relevant questions asked as probes to examine a

topic. The three most popular systematic heuristics cited by Richard Young (1976) are the tagmemic heuristic of Richard Young, Alton Becker and Kenneth Pike (1970), the _topoi_ of Aristotle, and the Pentad of Kenneth Burke (1945). Interestingly, aside from the tagmemic of Young, Becker and Pike, the other two popular heuristics are most often used in forms adapted from their original sources: the _topoi_ are reformulated in Richard Larson's (1968) heuristic series of questions, and the Pentad is really William Irmscher's (1970) application of it for his _Holt Guide to English_.

Unsystematic heuristics are characterized by the free-association exploration of a topic. Rather than posing a set of pre-determined questions, this heuristic relies on the chain of associations in the memory of the writer to retrieve information about a topic. Two unsystematic heuristics are free-writing, popularized by Peter Elbow (1973) and Ken Macrorie (1970), and journal keeping, advanced by Gordon Rohman (1964) and James Moffet (1968).

Research on the Effectiveness of Heuristic Strategies

Following Richard Young's (1978) call for studies of the comparative effectiveness of the four major theories of rhetorical invention, there have been only two comparing what I have been calling systematic and unsystematic heuristics, both done at Indiana University of Pennsylvania, and one comparing all four types of invention, done at the University of Texas at

Austin.

Susan Nugent (1980) compared an Odell (1976) heuristic, a variation on the tagmemic systematic procedure, with a Rohman-Wlecke (1965) pre-writing procedure, comparable to Elbow's later development of free writing. Nugent found that the Odell heuristic seemed to receive a higher "quality of writing" ranking over the Rohman heuristic, while the Rohman heuristic seemed especially strong in engaging all thirty types of cognitive processes in writers, as measured on the Guilford (1962) matrix. The Odell heuristic seemed insensitive to certain cognitive processes such as analogy creating. And so, the analogy component has been added to the systematic heuristic used in my study (Hartwell, 1982).

In the other study, done by William Dutch (1980), a student-generated heuristic was compared with a Larson-generated heuristic. As mentioned earlier, the Larson heuristic is an application of the Aristotelian <u>topoi</u> into an extremely detailed question format, qualifying it for consideration as a systematic heuristic. The student-generated heuristic was individually created by each student by trying to abstract questions from each preceding paper for use as the basis for writing future papers. Although somewhat systematic, the idiosyncratic nature of each heuristic makes it far more unsystematic, in the sense used here. Student-generated heuristics seem to rely, for the most part, on a free association generated in each writer's mind. Leibowicz (1983) guesses that "given the nature of the composing process and the way that students learn from teachers, student-generated

heuristics may be more effective than either ready-made or teacher-created ones" (p. 121). And yet, Dutch found that the students given the Larson heuristic did better, rated on a Diederich (1974) type Analytic Scale measuring ideas and mechanics, than those who used their own self-generated heuristics. This finding would seem to confirm what we know of the cognitive processes of writers: good writers might be able to construct a self-generated heuristic and continue to write well, but poor writers are not only unable to write well but are also unable to construct what planning scheme would be helpful for writing (see, for example, Flower & Hayes, 1980; Rose, 1980).

The third study, done by Hugh Burns (1979), set out to compare the effectiveness of three of the four schools of invention: tagmemic heuristics, the topoi and the Pentad. However, the nature of the control group was such that it would qualify as the fourth school, the Pre-Writing School. As a result, Burns' study compares all four types. The study was conducted with the aid of computer programs and so will more properly be addressed in the section below dealing with the issue of computers and heuristic strategies.

Computers and Instruction

There are many benefits cited for the use of CAI: individualization, self-paced learning, immediate feedback for the learner, active learning, a reduction in learning time, patient and tireless instruction, the possibility of simulation,

and the presentation of the learner's collective performance plotted over time or against peer performance. However, some authorities are now objecting to the types of software marketed for educators as a misuse of the instructional medium (Montague, 1983; Leiblum, 1982). These researchers point out the number of experiments that have concluded by finding "no significant difference" between CAI and some other instructional medium. And William Montague makes the point that "in most existing computer-assisted instruction (CAI), the nature of the instruction would not actually require a computer" (p. 1). He finds that the computer's capabilities for interactive task simulation are underused, and M. D. Leiblum agrees that this unique feature of CAI is what is most overlooked and underestimated. Montague further objects that the tacit compulsion felt by inexperienced and naive educatiors to program instruction and tests in <u>text</u> forms compounds the learning problems for many tasks. In fact, a number of articles appearing in educational journals advise those authoring instructional programs to consider the look of the screen and its unique features rather than to merely reproduce a block of text on the screen (Elliott, Gillette & Brandt, 1982; Hartman, 1982; Bourque, 1983). While most agree that computers will have a profound impact on education and instruction, many are still unsure of the form CAI will finally take.

Most of the articles written about computers and instruction make some attempt to categorize the types of uses to which computers can be employed. The most general classification

makes the distinction between learning about microcomputers and learning with microcomputers, including the practical applications of both types of learning (Miller, 1983). Learning with computers, in this case, means an alternative method of presenting, reviewing, and/or testing traditional course material. The literature specifically linking computers with writing instruction points out that "to date, English instructors have utilized microcomputers primarily for teaching repetitive tasks--drill work in grammar, punctuation, spelling and vocabulary" (Hocking & Visniesky, 1983, p. 218). This application, found in popular systems such as PLATO and TICCIT, seems in line with what Young (1978) characterized as current traditional rhetoric, which focuses attention "the composed product rather than the composing process," paying specific attention to "the analysis of discourse into words, sentences, and paragraphs," correctness of usage, and appropriateness of style, often measured only by readability (p. 31).

Beyond this simple distinction, most researchers (Jaycox, 1979; Leibowicz, 1982; Martin, 1982; Schwartz, 1982b; Wresch, 1983) cite four major types of interactive CAI:

(1) drill and practice--essentially programs which function as an electronic workbooks, arranged to calculate the performance as well as the difficulty of the problem given the user.

(2) tutorial--a step beyond drill and practice, the programs can actually direct the presentation in response to the student's performance. This sophistication is achieved by the

use of "branching" (if-then) structures in the program.

(3) text-editor--in this capacity the computer programs function as an editor, often relying on readability formulas and spelling lexicons. Of course, a text-editor cannot judge comprehensiveness, persuasiveness, or other higher-order concerns.

(4) dialogue systems--programs which seem to engage the user in human interaction through encouraging remarks, noncommital phrases and programmed questions. This fourth category, variously named "simulation" by Martin and by Schwartz, "feedback" by Jaycox, and "dialogue system" by Wresch after Atkinson, asks the user for active participation, clearly the most important feature of computer-assisted instruction.

The dialogue type of CAI involves the computer and the user reacting to each other, much like the structure of human dialogue, whereas the other types are more mechanical: drill and practice programs only evaluating the correctness of the response and proceed in a linear fashion, and tutorials only branching to different levels based on the response given, and the text-editor only correcting text generated on the computer. I would now like to discuss the application of the dialogue system of CAI to rhetorical theory, specifically concerning the pre-writing stage of the composing process, invention.

Computers and Heuristics

In the area of writing instruction, Cynthia Selfe (1983) feels CAI must address the larger issues of writing, become process-centered, and involve active writing rather than choosing multiple-choice selections. Selfe would agree that CAI must move beyond the limited concerns of the current-traditional rhetoric.

The lack of commercially prepared software packages which deal with rhetorical invention is confirmed by a check of the _Index to Computer-Based Learning_ (Wang, 1981) or any computer/education journal, such as _Electronic Education_ or _The Computing Teacher_. Hugh Burns' (1979) TOPOI and TAGI programs, which he used in his study, are available from him for main-frame computers but not for microcomputers; Cynthia Selfe (1983) is working on a composing program, WORDSWORTH II, which includes a planning component; Helen Schwartz (1983) is currently engaged in striking a text/computer software deal with a commercial publisher for her SEEN (Seeing Eye Elephant Network) program. But, with these exceptions, there is nothing available for ready classroom use. The reason is that there has been very little research done concerning the application of CAI to rhetorical invention.

One of the earliest applications of CAI to rhetorical invention came with Ellen Nold's "Fear and trembling: the humanist approaches the computer" (1975), which included a sample heuristic. Nold pointed out that computer programs can call forth creativity because they provide a patient, non-threatening, and provocative environment and mentioned that even drill and practice programs can teach with humor and encouragement.

In 1979, James DeGeorge made the connection between computers and rhetorical invention by stating that the action of heuristics is like that of a computer terminal, retrieving stored information and generating new ideas by the novel combination of previous propositions. But neither Nold nor DeGeorge cite any experimental research to support their speculations.

To date the only experimental research linking computers and heuristics has been Hugh Burns' "Stimulating rhetorical invention in English composition through computer-assisted instruction" (1979), done at the University of Texas at Austin. The experiment was of a pre-test/post-test control group design using 69 volunteer student-subjects from four sections of an upper level English Composition course. The four sections were each given two hours of lecture by the experimenter concerning their assigned heuristic strategy. The three experimental groups learned either Aristotle's topoi, the tagmemic heuristic, or the Pentad, while the control group was given a problem-solving lecture concerning preparation, incubation, illumination and verification, probably derived from Polanyi (1958). The three experimental groups were also given practice time on the computer to familiarize themselves with the computer commands and keyboard functions. A post-test was administered the week following the lectures, consisting of a thirty minute test during which the subjects were to generate ideas for a paper using their assigned heuristic. The experimental groups were told that in responding to the computer, "if you think it, type it" (p. 11). The control group was directed "to list any and all ideas they had about the

topic of their research paper" with a similar command, "if you think it, write it" (p. 11). Thus encouragement to write was computer-generated for the experimental groups and self-generated for the control group.

Some of Burns' findings are quite general: noting that students had a positive attitude toward heuristics and computer-assisted instruction and that many students demonstrated a sustained use of the computer for the thiry minute testing time. But some of Burns' other findings merit further scrutiny and discussion. Burns reports that all three experimental "computer" groups showed statistically significant gains in the quantity of ideas produced while the control group, the "traditional" group, showed a decrease. Yet this finding is not as striking as it appears to be at first. A closer examination of Burns' conclusions is in order. The pre-test given all four groups directed them to list ideas for a topic in fifteen minutes and then the resulting idea count was doubled for comparison with the thirty minute post-test. In the post-test situation each of the experimental groups was given systematic heuristic questions to answer which, not surprisingly, produced a statistically significant increase in ideas. The control group, on the other hand, was given the same pre-test directions but twice the pre-test time to list ideas. Burns concludes that the control group "interestingly . . . [did] not even double the ideas they were able to write in the fifteen-minute exercise" (p. 18). But what these findings actually seem to indicate is that the systematic heuristics used in the post-test are better

quantitative generators of ideas than unsystematic heuristics (which is what all four groups used in the pre-test and the control group used in the post). Therefore what Burns really finds is that, in a thirty minute period, computer-asssisted systematic heuristics generate a greater quantity of ideas than traditional unsystematic heuristics. More importantly, it might be concluded from Burns' study that unsystematic heuristics, such as idea-listing and brainstorming, by their very nature, do not generate ideas as a function of time; that is, the number of ideas produced does not necessarily increase with more time. In fact, Peter Elbow (1973) seems to find ten minutes as a comfortable time period, with twenty minutes as a maximum, for his unsystematic heursitic, free writing. And therefore, it is not enough to merely count the number of ideas produced, where systematic heuristics have the advantage, but there must be some compensation for the quality of the ideas, as perhaps demonstrated by the number which are actually used in the writing. Regretfully, Burns never looked at the resulting piece of writing.

Burns also finds that "the CAI-invention treatments made these three experimental groups more alike . . .with respect to their collective insightfulness, comprehensiveness, intellectual ability and overall qualitative performance" (p. 22). Perhaps the reason these three groups became more alike is due to the similarity of the heuristic--each of the heuristics could be categorized as a systematic heuristic, as defined in this study--and not to the use of CAI.

Burns also points to the elaboration of answers to non-data conditioned questions in the heuristics and remarks, "the topoi groups most easily extended their answers" while "the pentad group did not greatly elaborate their initial remarks" (p. 16). This finding would seem consistent with the nature of the heuristics involved rather than the use of computer-assisted instruction: the questions asked by the topoi system would require more by way of response than the pentad questions which only ask answers to questions such as "who" or "what."

Indeed, Burns admits that the study never addresses the question of whether or not the use of CAI to stimulate rhetorical invention "actually helps writers write" (p. 27). Burns admits that the "gains experienced by the three heuristic groups in quantity and quality of 'raw material' did not significantly carry over to the 'arrangement' phases" (p. 25) where the control group actually ranked better than the tagmemic or pentad groups in the compositition plan quality rating. There was no analysis of a final written product produced from any of these heuristic exercises.

Burns concludes that it remains to be decided "whether or not these CAI modules stimulate invention as well as (or better than) current instruction in invention" and "whether they effectively supplement current invention instruction" (p. 27). My study will make some attempt to answer the first question by comparing CAI instruction in invention with traditional classroom invention instruction. Further, my study makes the important distinction between the two types of heuristics, systematic and

unsystematic, which Burns used as his experimental and control groups. Finally, my study will look at the quality of the ideas produced by measuring the proportion of ideas used in the actual writing which were produced in the heuristic exercises.

Helen Schwartz (1982b) conducted an experiment comparing in-class essays produced by a small group of students (n = 40) using a heuristic computer program matched against an equal number of students' essays produced without benefit of the computer program. The computer program employed in this study was one specifically developed by Schwartz to analyze a literary character. Although the essays produced by the computer group were not statistically different, Schwartz says that the CAI never seemed to harm the students' writings, that the computer group wrote longer and more detailed essays, and that marginal students did improve. However, Schwartz, like Burns, fails to consider certain aspects of her experiment: she does not consider why the longer and more detailed essays produced by the CAI group were not qualitatively "better" essays; she does not consider the novelty effect for the computer group, that the attraction of a new tool will entice some students, perhaps those characterized as marginal, to try harder and work longer; she does not consider the effect of the additional time/instruction afforded the computer group; and, she does not consider the reliability of her measurement of improvement in writing, the grades the essays received from her alone.

Schwartz is presently integrating her CAI invention program into a more complete interactive composing program which

she refers to as MARSYEBB--Mentor and Recorder for the System and Electronic Bulletin Board (1982a). In another paper (1982b), she explains that this program combines solo computer work on an interactive heuristic, described earlier, with network computing, as advocated by Thomas Dwyer (1980). Schwartz is now calling her program SEEN--Seeing Eye Elephant Network (1982b; 1983), but it still contains the solo and network modes used in her MARSYEBB program. The network aspect, the Electronic Bulletin Board, is Schwartz's real contribution to CAI and to writing instruction. Through the Electronic Bulletin Board, other users, classmates and/or teachers, can read what has been written and leave a note or ask a question, as in a real dialogue.

A major problem with Schwartz's heuristic is that it is discipline specific (the literary analysis of a fictional character). Lauer (1979) cautions that a heuristic should be transcendent: its operations and questions should transcend the subject rather than arise from it. After all, the trick of intellectual inquiry is to learn what questions to ask (Emig, 1982a), and, if the work of applying the heuristic to the discipline is done by the computer programmer, then the worth of the heuristic is restricted and its success or failure must be attributed to the combined efforts of programmer and user. Burns and Culp (1980) conclude that a major problem in adapting rhetorical invention to CAI is to find "how to shift the entire burden of content to the user and still make the inquiry representative of how the human mind works when inventing" (p. 6).

My Present Study

I'd like to conclude by briefly describing the study I'm presently involved in. My study employes a 2 x 2 factorial design with the independent variables being the mode of instruction (computer-assisted or traditional classroom) and the type of heuristic (systematic or unsystematic), and the dependent variables being the difference between the quantity of ideas generated, measured by the number produced and the number used in the subsequent writing, on a pre instruction versus post instruction evaluation and the difference in holistic quality of the writing produced on a pre instruction versus post instruction evaluation.

Each of the four groups have been given two hours of instruction concerning computer literacy in general and training in the operation of the computer and its keyboard functions. During the following class the groups received instruction in their designated type of heuristic, systematic or unsystematic, and have been directed to use this heuristic at the beginning of each writing assignment.

The computer programs for the study were written by myself but are based on our present understanding of rhetorical invention. The systematic CAI heuristic examines an item/event by asking questions about definition (change, sequence, and context), classification, illustration, and comparison and contrast (including analogy). The unsystematic CAI heuristic, based on Elbow's (1973) technique, involves free writing about a

subject for a short period (five minutes at first) and then reading the free writing to find a central focus (center of gravity in Elbow's terms). This center then becomes the subject for another free writing. The cycle of writing and synthesis then continues according to the writer's inclinations.

The traditional heuristics will be the same as those used for the CAI programs and will be presented as handouts with the appropriate questions/directions.

The students in the computer groups will receive computer printouts of their work to serve as aids for their subsequent writing drafts. The students in the traditional groups will have available their handout sheets, containing directions for their heuristic and space for completion of the exercise. The students will use the heuristic exercises for each of their writings throughout the semester and the instructors will check that the heuristic exercise was completed when conferencing with the students about their writings. Thus, when the heuristics are collected with the writings, it will be in keeping with the normal classroom practice.

I hope that my study will show that CAI employed during the invention stage of writing not only actually helps writers write but that CAI using systematic heuristics will prove to be the most beneficial combination.

COMMON QUESTIONS ABOUT COMPUTERS

Q. Can computers think?
A. Computers have been called "thinking machines" but whether or not they actually think depends on what we mean by thinking. Computers can think if by thinking we mean the acquisition of new knowledge, the integration of that knowledge with what was previously known, and the manipulation of old and new knowledge. Though in fairness thinking probably involves more than that.

Q. Does a computer think in words and sentences or math and formulas?
A. The smallest bit of information, which is still meaningful, is something which can be represented as yes or no, true or false, on or off. Mathematically it can be represented by a binary digit, either 1 or 0. This little piece of information is called a bit (short for binary digit). A bit by itself is not very useful but when we put eight bits together, we have a byte, which can now represent 256 different combinations. Anyone knowing probability theory can figure all the combinations from 00000000 to 11111111. Each of those 256 combinations represents an individual location in the computer's memory and the combination of two bytes produces 65,536 locations. In "computer talk" this is 64 K bytes of memory (K= 1024 bytes).

Q. Do computers have memories?
A. Computers have two types of memory: permanent and working. The computer's permanent memory tells it what to do when we turn it on, what all the electronic 1/0 switches mean, and how to relate to peripheral connections. The permanent memory is called ROM (read only memory) in "computer talk" because it can only be read, it cannot be manipulated or erased. The computer also has a working memory which allows us to make calculations and run programs. The working memory is called RAM (random access memory) because not only can it be read but it can also be written to. Working memory, because it is nothing more than a series of electronic 1's and 0's, will be erased as soon as the power gets turned off. To preserve work done in working memory, the information must be transferred to some external storage area: a hard disk (which looks like what Tupperware might design to hold a pizza), a floppy disk (which looks like a square 45 record), or a cassette tape (which has electronic beeps instead of Michael Jackson). The disk drive should never be opened and the disk should never be removed when the red light is on because valuable information could be lost. And if the the power is turned off before the work is stored on the disk, it is gone forever. Computer disks are very sensitive: they should never be exposed to heat or humidity; they should never be bent or have anything stored on top of them; they should only be handled by the paper cover.

Q. Why does a computer look like a typewriter?
A. Most computer keyboards are set up to resemble a typewriter keyboard, with some extra function keys, and the shift key is needed to get certain characters, but the similarity ends there. A typewriter works by striking a metal relief character against an inked surface; the computer monitors the keyboard and when a letter is "hit" by the typist, the computer senses that the switch has been thrown (from off to on) at that location. This can be accomplished with touch-sensitive membranes (like those on the Timex computers on sale at the supermarket) but our slow and clumsy fingers seem to work more accurately with a typewriter-style keyboard to press.

Q. What are all those other things hooked up to the computer?
A. Basically, they are input or output mechanisms. The keyboard is an input device--allowing us to send information in to the computer. The television screen (actually a monitor--it only gets one channel) is an output device--allowing the computer to send information out to us. The printer works like the monitor, except it produces a permanent, "hard" copy (one we can take home with us). The disk-operating system is both input and output--it can enter information from the disk storage area into working memory and it can accept information to be stored from working memory. Some computers come with a joystick or a paddle, an input device to do what a group of keys on the keyboard do while giving that arcade feeling. Some computers can even talk on the telephone: messages are received and transmitted in much the same way that those touch-tone phones can dial numbers.

Q. How come there are some many types of computers and why can't one system run on another brand of computer?
A. Quite frankly, there's too much money to be made by each company. Imagine if the only records you could play on your stereo were those manufactured by the stereo maker. However, the languages used are similar enough to be understandable once the specialized needs and requirements of any particular system are considered. The standard language for small home and business computers is called BASIC and each computer's version of BASIC could be considered a regional dialect.

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