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ABSTRACT

Noting that many language arts teachers have rejected tutorial software because of its inability to interact effectively with students, this paper explores implications of artificial intelligence research for human/computer interaction in reading instruction. Limitations of "exact match" curriculum designs in contemporary attempts to provide computerized interaction are surveyed and critiqued, and the importance of drill and practice to the development of language skills is emphasized. It is proposed that open-ended curriculum designs, which are process oriented, may help counter the limitations in developing adequate interactive programs. Finally, research questions in the development of artificial intelligence natural language systems are presented as central to the problem of "intelligent" human/computer interaction. The concluding comments assert that computers must be taught to simulate the same cognitive processes as occur in humans if meaningful interaction is to take place. (JD)

IMPLICATIONS OF ARTIFICIAL INTELLIGENCE RESEARCH FOR HUMAN-COMPUTER INTERACTION IN READING INSTRUCTION

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Teacher-trainers in the field of microcomputers-in-education are aware of a great deal of resistance among teachers to learning about computer applications (Stillman, et al, 1981, Griswold, 1985). While some teachers have latched onto the microcomputer boom with great enthusiasm, the great majority have not. Their skepticism about the importance of computers to education has been occasionally described as a latent "computer phobia," but a closer analysis suggests a general feeling of disappointment with computer applications in the classroom. Indeed, there is a rising tide of criticism against many computer applications (e.g., Sloan, 1985).

Additional evidence for the disenchantment about computers-in-education rests in how computers are being used in classrooms. Primary applications in the teaching of reading and language arts appear to be in two major areas: 1) use of computers as tools for information processing, such as word processing (Schwartz, 1985), and 2) use of computers as motivational drill devices (Balajthy, 1984). Very few teachers appear to be using computers for direct teaching purposes (i.e., use of tutorial software). A 1985 listing of best-selling educational software consisted of 9 of 10 programs relating to the language arts. None were tutorials. 8 of the 9 involved "computer tool" applications. The remaining one program was a video drill game (Classroom Computer Learning, 1985).

The basis for this rejection of tutorial software--the use of computers to provide direct instruction and modeling in skills--appears to be the computer's inability to effectively interact with students (Balajthy, 1985; Scandura, 1981). So-called "interactive" software is, at best, capable of only very low-level interactions. The flexibility of response characteristic of human teachers, a capability vital to individualization of instruction and to meeting the needs of specific students, is sorely lacking. This lack is felt keenly by teachers in the language arts, where holistic language models (Goodman, 1967; Graves, 1983; Moffett & Wagner, 1983; Smith, 1978) of teaching have become increasing dominant in the past twenty years.

This paper begins with a survey and critique of contemporary attempts to provide computerized interaction. The problems involved in developing adequate interactive programs are then discussed, and some existing programs are described. The final part of the paper deals with research on the development of artificial intelligence natural language systems.

Limitations of "Exact Match" Curriculum Designs

The basis of construction for the majority of existing tutorial programs is the capability of the computer to look for an "exact match" between a user's input and material in the program code. Design of instruction based on such exact matches can be carried out in a wide variety of ways. The common multiple choice paradigm in which the user is presented a question followed by a series of options and the instructions to "Type A, B, C or D" is one example. The programming code includes instructions as to identity of the correct choice and as to what should be done if the correct choice is identified (e.g., to print "GOOD WORK!" on the monitor screen). The code would also contain instructions as to procedures to carry out if the incorrect choice is identified (e.g., state "Try Again" and give the user another chance if it was the first try, or provide the correct answer if it was the second). A third necessary set of code would provide instructions to be carried out in the event an inappropriate response is made (e.g., if the 3 key is pressed).

A related "exact match" paradigm involves input of an entire word, such as a spelling or vocabulary word. The computer scans the input to ascertain whether it matches the correct response coded by the programmmer. At heart, this paradigm is little different from the single-letter paradigm. Even common video game formats are based on computer recognition of exact matches, though the graphics involved make such programming a good deal more complex than simple text recognition programs. In a vocabulary game such as Word Attack!, for instance, the computer looks for a match between the location of the correct target word at the top of the monitor screen to match a definition provided at the bottom of the screen with the location of the projectile launcher. If the two locations match when the user fires the projectile, a correct word identification has been made by the user.

This exact match paradigm lends itself to two types of computer instruction: Drill and practice exercises and behaviorally-oriented programmmed instruction. Much of the existing empirical research on computer-based reading instruction has been of the former type (e.g., Atkinson & Hansen, 1966; Swinton, et al, 1978) and most manuals for computer-assisted instructional design deal specifically with it (e.g., Chan & Korostoff, 1984; Landa, 1984). Teacher utility software such as

PILOT (various publishers) is designed to facilitate construction of these computer-assisted instructional lessons. This format involves presentation of small bits of information in strictly sequenced frame-by-frame fashion and requires the user to periodically input single letter or one- or two-word answers to questions. Once considered the educational format of the future, non-electronic forms of programmed instruction never fulfilled the promises made by educational technologists of the 1950's and 1960's and are in low repute today among educators. While computer-assisted programmed instruction continues to have many advocates among computer specialists (e.g., Pogrow, 1983) and is increasingly used in business and in the military, virtually no one of influence within the field of reading supports its use on a widespread scale.

The importance of drill and practice to the development of language skills is generally recognized today by many in the field of reading (LaBerge & Samuels, 1974; Osborn, 1984). Computers can provide some particularly effective methods of providing such practice exercises, especially because of their motivational qualities and their ability to provide immediate feedback for low-level exercises (Balajthy, 1984). Most teachers, however, look askance on the replacement of drill and practice workbooks with drill and practice computer programs. The increased cost and classroom management problems involved with use of computers seem to overcome the instructional advantages offered by computerized drills. In addition, whole-language advocates who suggest that increased instructional time be spent in actual reading (e.g., Smith, 1978) and in actual writing (e.g., Graves, 1983) are becoming increasingly influential in the fields of reading and language arts.

Open-Ended Curriculum Designs

In an effort to avoid the limits imposed by the exact match paradigm of computer curriculum design and to allow for greater divergency of response, a limited number of efforts have been made to develop computer reading programs which allow for open-ended inputs. These programs pose problems or questions and allow students to type in their responses to the computer, but the programs are not capable of actually analyzing these responses in any way. By careful structuring of directions to the students, the program attempts to lead the students through a meaningful appraisal of the inputs.

While some teachers are dissatisfied with the assumption of student competence and the inability of the computer to assess the success or failure of such instruction, the purpose of such programs must be recognized as being process-oriented rather than product-oriented. That is, the aim of these programs is not to arrive at the correct answer--a product. Instead, the purpose is to model effective <u>processing</u> involved in the development of a product.

The Puzzler (Sunburst Communications) serves as an example of open-ended reading instructional software. Its creators suggest that the program improves readers' ability to use predicting, confirming and integrating strategies during reading. According to psycholinguistic theory (Goodman, 1967), readers use their reading and prior background knowledge to predict words, sentences, and concepts. The predictions are confirmed or disconfirmed by ensuing reading.

In an attempt to foster these "guessing game" skills, The Puzzler presents a story. After reading each page of the story, readers are asked an inference question and are allowed to type their predictions into the computer, which records them for future reference. The instructions warn students that a variety of responses are acceptable: "There are many good answers to every puzzle. You can have fun talking about your answers with your friends."

As the story proceeds, each page adds information and allows the readers to narrow down their responses by eliminating predictions made invalid by the new information and by adding new predictions. By the end of the story, the predictions have become somewhat convergent, but the program's authors avoid the temptation to provide a final answer. The students are left to discuss their final predictions with one another and with the teacher. While both students and teachers often find the lack of a final answer somewhat frustrating, the message that predicting is not an exact process is conveyed clearly. Different readers take different interpretations away from the texts they read.

The key advantage of such programs is that they structure the readers' thinking processes to encourage greater inferencing and predicting. Improvement of these higher level skills is crucial to comprehension improvement (Thorndike, 1973-1974). The Puzzler is one of the very few reading programs to encourage such divergent cognitive processing. The key disadvantage is that interactive computer feedback on quality of student responses is lacking. The program serves primarily as a impetus for small group or teacher-led class discussion.

The inability of computers to carry out human-like dialogues is a critical weakness. Without such abilities, and as long as the language-process theoretical orientation remains in place within the fields of reading and language arts--and this orientation shows every sign of increasing in acceptance for the foreseeable future--instructional applications of computers will be severely limited.

The Problem of "Intelligent" Computer-Human Interaction

Place an individual in a room with a keyboard and monitor. Inform the individual that he or she may communicate using the keyboard and receive communications printed on the monitor. The "person" at the other end, however, may be either another human or a computer. If, after a conversation, the individual is not able to determine with whom he or she had been communicating with a better than 50% accuracy rate, the computer is "intelligent."

This simplified version of a classic test is called the "Turing Test" after Alan Turing, one of the leading early computer developers, who suggested it (1950). The challenge in meeting the goals of this test is enormous. Ability to communicate with language is among the most complex of all human processes. In order to successfully carry out such a deception, a computer must be able to read and write like a mature reader and writer--for input must be "read" and output must be "written."

As a result, researchers in the field of artificial intelligence (AI) and researchers in cognitive processes involved in language communication have a good deal to say to one another. How is background information stored in the mind for ease and effectiveness of access? How is this information activated and used as a basis for drawing conclusions and making inferences about material being read? How does the mind make decisions as to levels of importance of ideas being read? How is new, incoming information integrated with the background information already in the mind? All these questions are central to an understanding of how the human mind operates during reading. They are just as central to the objective of programming an "intelligent" computer.

Consider the following sentence (Balajthy, 1985): "As Mary Ann sat back against the tree staring at the clouds, she heard a slither in the grass near her foot and a rattling sound."

How does a human being "read" this sentence? It is certainly true that a variety of interactive cueing systems (Rumelhart, 1977) aid in letter and word recognition and sentence-level syntactic and semantic analysis. But the reading task does not succeed if limited to those levels.

A mature reader draws upon his or her background schemata to "fill in the blanks" assumed by the sentence's author (Anderson, Reynolds, Schallert & Goetz 1977; Pearson, Hansen & Gordon, 1979). What are Mary Ann's feelings as she sits back against the tree? Is she relaxed or tense? Is she at peace with the world or is she bitter and depressed? What kind of day is it? Are the clouds the grey rain clouds of an overcast day or a warning of a threatening snow storm? A mature reader would read "Mary Ann sat back against the tree staring at the clouds" and immediately develop some expectations of the situation. Mary Ann might be, for instance, resting peacefully on a warm day, watching a few white clouds floating past in a brilliant blue sky.

Additional "blanks" would be filled in (schema theorists speak in terms of "assign default values" during instantiation of the schema--e.g., Anderson & Pearson, 1984) as the action occurs to make predictions as to the immediate future situation. Does the slither and rattling sound come from a snake? Will Mary Ann freeze in fear or jump up and run? What happens if there is a snake and it bites her? These possibilities immediately come into the mind of a mature reader. Each demands a wealth of background knowledge about people and snakes.

If the reading-communication task is to succeed, computers must be programmed to understand--to comprehend--at all the varying levels of comprehension of humans. They must be programmed to recognize facts, to reorganize information into coherent patterns, to make inferences, to think critically, and to appreciate literary techniques. In essence, they must be taught to simulate the same cognitive processes as occur in human beings.

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