*Abstract*

In post-secondary education, the computer presence has the potential to transform curriculum as it is presently understood. An example of this transformation would be a shift from the dominance of declarative knowledge to an emphasis on procedural knowledge. To date, however, computers are utilized to further entrench learning objectives. They are adaptations that serve curricula which is product oriented and divided into discrete units for efficiency. Institutions of higher learning confront an electronic technology that could alter traditional approaches to knowledge. A rejection of this technology, or at least a rejection of what can be learned from it, will limit the social relevance of Canadian institutions of higher learning.

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# Computers in Institutions of Higher Learning: A Casual Affair or a Marriage of True Minds?

To address the ramifications that are involved in the use of computers in post-secondary education one inevitably treads on unfamiliar ground. Because computer assisted and computer based education is an emergent phenomenon discussions on its worth are tentative. Little attention in the scholarly realms has been devoted to this subject, and this discussion attempts to initiate the examination of computers in Canadian higher education.

Although a large body of scholarship in cognitive psychology could be seen to suggest that mental activities such as planning ahead, pursuing goals, and distinguishing meaningful figures from backgrounds are most fruitfully understood as information-processing and thus characterized by a man-machine analogy the hypotheses are suggestive. They work through analogies that do not exactly capture the precise meaning of reasoning or distinguishing or planning.[1] Indeed it is unlikely that a suitable vocabulary exists for describing the complex interactions that occur in reasoning or distinguishing or planning. Even mental activities of storing and retrieving information by humans (as opposed to machines) lack an established theory of explanation. In the area of computer science, however, the development of concepts pertinent to the acquisition, storage, and retrieval of information and knowledge could change not only the understanding of cognition but also influence approaches to learning. These concepts of cognition and the models of systematic procedures derived from computer science inform ideas about knowledge and its acquisition in all intellectual activities -- from solving problems to generating ideas.

The purpose of this discussion is not to examine the concepts of computer science but rather to survey the post-secondary educational landscape which is likely to have a computer presence if not a computer basis. This presence could alter the current conceptions of curriculum and instruction; it will certainly challenge the accepted divisions of knowledge (e.g. Science and Arts) and the accepted approaches to knowledge.

All sectors within Canadian post-secondary education have encountered an electronic technology that promises to be the provider of extensive alterations to the way those in education do business. The most frequent encounter now focusses on the microcomputer, and the area of change most directly affected in none other than the mainstay of institutional education -- teaching. To date, more questions than answers are expressed on this subject. More emphasis is placed on the computer's capabilities to make the present form of education effective and efficient than on the transformation of education itself that the computer can engender if employed both as an object for learning and a

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subject of learning. The increasing presence of computers and the serendipitous discoveries by the users, however, have a far greater effect on learning than the present proclaimed use of computers to assist in the learning of a predetermined curriculum, one that was devised prior to the introduction of computers.

Student attitudes toward learning, for example, have shown dramatic change at the college/university level with the introduction of computer assistance. Colorado State University's adaptation of Writer's Workbench (a collection of thirty related computer programmes) for composition students has become an effective tool in improving student writing.[2] More significantly, perhaps, the results of studies at Colorado State University indicate that the major effects for students are affective ones, such as subject interest and motivation to learn.[3] A computer oriented curriculum-education by and about computers -- is a radical departure from a curriculum that utilizes computers to further entrenched learning objectives. But a computer oriented curriculum is what is required if post-secondary educational institutions are to stave off obsolescence.

The maintenance of present curricula requires that the new technologies serve the old instructional methods: the use of films, video tapes, calculators, overhead projectors, and audio-tutorial systems are variations of the same theme. Like the text book, they enhance the predetermined learning objectives. Procedural knowledge is secondary to prescribed, declarative knowledge. The end of a chemistry experiment has already been determined, and the learner must reach that end: procedures are means to an end rather than an end in themselves. Mathematics is generally the most frequently identified learning area where computers are designated for usefulness. This is likely because the quantitative functioning of computers can be easily attached to the drill and practice orientation of 'school math': the computer can be used to reinforce the quantitative side of mathematics by allowing more complex calculations. The present and proposed use of educational technology is, thus, largely as a tool for the further and more effective inculcation of existing curriculum and the theories of learning underlying that curriculum.[4]

"Computers in education" is a glossy reaction to manifestations of an emergent understanding about how the mind works, a comprehension articulated by those in the field of computer science. This reaction ignores the significant learning potentials of computers; it results in an adaptation of computers to serve curricula which is product oriented and divided into discrete units for apparent efficiency.

The use of computers for qualitative thinking is to transform the curriculum. The area of computer science is rich with concepts pertinent to the acquisition, storage, and retrieval of information and knowledge. Scholarship in computer science and artificial intelligence indicates that procedures in the acquisition of knowledge are inseparable from knowledge itself.[5] The distinctions between 'how' and 'what' we know, between a process and a product, and between an object to think with and a subject of study are derived from convenient but dubious constructs: the separation of what we know from how we know is an artificial one. The use of computers for syntonic learning, learning coherent to and associated with the learner, is at odds with the division of knowledge into either scientific and humanistic worlds or discrete disciplines such as Psychology or Physics. As models for understanding reality, the scientific or humanistic approaches and discipline knowledge are confused with reality itself. Moreover, the maintenance of this division of knowledge and this structuring of a supposed reality ensure that this knowledge and this reality are accessible to a minority. This maintenance is assured with centralized control by scholars, researchers, educators, and by the organization of educational institutions and governing bodies. Computer advances, however, will lead to an erosion of centralized control over education. Papert has noted that with computers as the private property of individuals, the power to determine patterns of education will shift from educational systems to individual learners. The greater the spread of microcomputers and the greater the variety of methods to communicate with and through machines the less the control that can be exerted by a centralized authority on what and how individuals learn.

In computer science and artificial intelligence research and scholarship, concepts of thought, and models of systematic procedures have the most radical implications for education. Hofstadter argues that these concepts and models indicate that the acquisition and manipulation of knowledge (the manufacture and manipulation of complex descriptions) are activations of symbols by other symbols. Mental activities are not bound by actual events or objects; complex interactions of symbols are activated in thinking whether the object of thought is imaginary or actual. Complex thinking, such as problem solving and idea generation, involves symbols which are themselves vehicles by which other symbols are conveyed and gain their meaning.

> Symbols are the hardware realizations of concepts. Whereas a group of neurons triggering another neuron corresponds to no outer event, the triggering of some symbol by other symbols bears a relation to events in the real world -- or in an imaginary world. Symbols are related to each other by the messages which they can send back and forth, in such a way that their triggering patterns are very much like the large--scale events which do happen in our world, or could happen in a world similar to ours.[6]

Moreover, for complex thinking, at least, it is suggested that the mind functions symbolically:

> My belief is that the explanations of 'emergent' phenomena in our brains -- for instance, ideas, hopes, images, analogies, and finally consciousness and free will--are based on a kind of Strange Loop, an interaction between levels in which the top level reaches back down towards the bottom level and influences it, while at the same time being itself determined by the bottom level.[7]

Hofstadter's analysis in *Gödel, Escher, Bach* (1980) by implication breaks down long held assumptions by institutions of higher learning about the division of knowledge into, for example, scientific and humanistic worlds. In a salient example he refers to the population of a major city and the number of chairs in a living room -- both references pertain to the numerical or quantitative realms: 3 million people in Toronto and 6 chairs in the living room. But, one output (3 million people) is stored information available for retrieval, internalized as a concept one has of Toronto. The other output (6 chairs) involves a procedure -- counting chairs, either physically or mentally. Although both outputs have a numerical form and both can be classified as quantitative information, ostensibly more scientific that humanistic and more mathematical than anthropological, the knowledges required for this information are radically different. I am suggesting that as knowledge, these outputs are different from one another and the difference here is dependent upon the knowledge one has about how one classifies knowledge. In one case, knowledge is a procedural method (6 chairs) ; in the other, knowledge is conceptual ( 3 million people). The distinctions are neither scientific and humanistic, nor mathematical and anthropological. Knowledge here is more properly termed metaknowledge, and our metaknowledge provides us with avenues to knowledge. In response to the question, "How many people in Toronto?", we use our knowledge of how we stored or remembered this knowledge; to the question, "How many chairs?", we use our knowledge of a method to arrive at this knowledge. In Artificial Intelligence, the distinctions are between declarative and procedural knowledge.

The confrontation between educational institutions of higher learning and electronic technology, at present the microcomputer, is in progress. Current adaptations of microcomputers to curriculum and instruction are a temporary appeasement. Computer managed learning replaces a teacher with a patient machine for the assessment of student achievement. Computer assisted instruction adds a machine to the instructor's arsenal of learning resources. As Papert points out, whatever the scholarship and research reveal about the learning potentials of computers, the use of computers is limited by the attempt to adapt them to the old instructional methods.[8] Further, a far greater impediment to the realization of computers' contributions to the educative process resides with the educators themselves who are fearful of change. In this sense, microcomputers are representative images, not of new approaches to learning or new areas of knowledge, but of an erosion in the control of education and job security. Thus, many who do embrace the electronic technology do so out of fear -- few educators want to be left behind. This embrace is an attempt to accommodate the new technology within the established structures of learning so that the technology is compatible with accepted learning objectives. If the embrace results in nothing more that a casual affair, then institutions of higher learning will reject a marriage of true minds and accept a cloistered existence.

Notes

[1] Robert Shaw and John Bransford, "Introduction: Psychological Approaches to the Problem of Knowledge," in *Perceiving, Acting and Knowing* (Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1977), pp. 1-39; and Marvin Minshy, "Computer Science and the Representation of Knowledge," *The Computer Age* (Cambridge, Mass: M.I.T. Press, 1980)

[2] William Wresch, "Computers and Composition Instruction: An Update," *College English*, Vol. 45, #8 (December 1983): 794-799

[3] Kathleen Kiefer and Charles Smith, "Textual Analysis With Computers: Tests of Bell Laboratories' Computer Software", *Research in the Teaching of English*, Vol. 17, #3 (October 1983): 201-214

[4] Seymour Papert, *Mindstorms* (New York: Basic Books, 1980).

[5] Douglas Hofstadter, *Godel, Escher, Bach* (Toronto: Random House, 1980).

[6] Hofstadter, p. 350.

[7] Hofstadter, p. 709.

[8] Also see Alan Turning, "Computing Machinery and Intelligence," in *Perspectives on the Computer Revolution* (Englewood Cliff, N.J.: Prentice Hall, 1970); and Walter B. Weimer, "A Conceptual Framework for Cognitive Psychology: Motor Theories of the Mind," in *Perceiving, Acting and Knowing*, pp. 267-311.