CREATIVITY AND LIBERAL LEARNING

PROBLEMS AND POSSIBILITIES IN AMERICAN EDUCATION

EDITED BY DAVID G. TUERCK

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edited by
David G. Tuerck
Suffolk University

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David G. Tuerck

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Contributors

John C. Berg is Professor of Government at Suffolk University, where he is a leader in experiential education. He received his Ph.D. at Harvard University and has published in the professional literature on seniority reform in Congress.

Gloria M. Boone is Associate Professor of Communications and Speech at Suffolk University, where she has participated in the debate and rhetorical communication program. She received her Ph.D. at Ohio University, is coauthor of *Rhetoric, Argument and Communication*, and has engaged in consulting for business and government.

Mark H. Curtis is President Emeritus, Association of American Colleges. He received his Ph.D. at Yale University and has been a Guggenheim Fellow and a Folger Shakespeare Library Fellow. He is an authority on undergraduate curriculum and adminstrative issues and is the author of many books and articles, including *Oxford and Cambridge in Transition.*

Daniel C. Dennett is Professor of Philosophy and Director, Center for Cognitive Studies at Tufts University. He received his D.Phil. at Oxford, has been the recipient of numerous fellowships and guest lectureships, and is a member of the editorial board of *Cognitive Science.* He has published widely in the fields of cognitive science and artificial intelligence and includes, among his publications, *Brainstorms: Philosophical Essays on Mind and Psychology* and *The Mind's I: Fantasies and Reflections on Self and Soul* (with Douglas Hofstadter).

Rebecca McBride DiLiddo is Assistant Professor of Biology at Suffolk University, where she has been coordinator of the biotechnology program and coordinator of the Eastern New England Biology Conference. She received her Ph.D. at Ohio State University and has published on the subject of plant physiology in the professional literature.

Leslie Epstein is Professor of English and Director of the Graduate Program in Creative Writing at Boston University. He received his D.F.A. at Yale Drama School and has been a Rhodes Scholar, recipient of a Guggenheim Fellowship, and a Fulbright Teaching Fellow. He has published five books of fiction in addition to many articles and book reviews.

Paul Ezust is Professor and Chairman, Department of Mathematics and Computer Science at Suffolk University. He received his Ph.D. at Tufts University.

Lillian Feder is Distinguished Professor of English and Comparative Literature at Queens College and at the Graduate School, City University of New York, where she has served as Executive Officer of the Doctoral Program in English. She received her Ph.D. at the University of Minnesota, has been the recipient of many honors and awards, and has written widely on classical and comparative literature. Her books include *Madness in Literature* and *Ancient Myth in Modern Poetry.*

Henry A. Giroux is Associate Professor, Department of Educational Leadership at Miami University, Ohio. He is an authority in the areas of curriculum theory, cultural studies, and the new sociology of education. He received his D.A. from Carnegie-Mellon University and includes among his many publications *Ideology, Culture and the Process of Schooling* and *Education under Siege* (with Stanley Aronowitz).

Stuart Goldkind is Member, Artificial Intelligence Group at Mitre Corporation. He received his Ph.D. from the University of Rochester and has served on the faculty of Washington University in St. Louis and as a Research Associate in the Computer Science Department at the University of Rochester. He has taught and published in the fields of computer science, philosophy, and artificial intelligence.

Ronda Goodale is Program Advisor, Support Services, Boston Public Schools. She received her Ph.D. at Boston College and has published and spoken widely on special education and on problems of minority students and disadvantaged children. She was a principal planner in the establishment of the first international high school program, which opened in September 1983 at Copley High School in Boston.

Kenneth S. Greenberg is Professor of History at Suffolk University, where he serves as coordinator of the program in Integrated Studies. He received his Ph.D. at the University of Wisconsin and has spoken and published widely on the history of the South. His publications include *Masters and Statesmen: The Political Culture of American Slavery.*

John C. Holley is Associate Professor of Sociology at Suffolk University, where he is a leader in the application of computer methods to the social sciences. He received his Ph.D. at the University of Edinburgh and has published widely on the subject of technology and society and on the effects of industrialization on women. His publications include *Romantic Capitalism in 19th Century S.E. Scotland.*

Laura Hourtienne is Associate Professor of Humanities and Modern Languages at Suffolk University, where she teaches art and German. She received her Ph.D. at Bryn Mawr College and is the recipient of many fellowships, awards, and prizes. She has shown her art in galleries and at exhibitions in Massachusetts, Michigan, and New York.

Ann D. Hughes is Assistant Professor of English at Suffolk University, where she has served as faculty advisor to *Venture* magazine. She received her M.A. at the University of Kansas and has published and spoken on biblical literature.

Kevin M. Lyons is Director, Learning Resources for Student Athletes at Boston College. At the time of the symposium he was Assistant Professor of Education and Director, Learning Resource Center at Suffolk University. He received his Ed.D. at Boston University and has directed numerous workshops in competency testing and learning style diagnosis.

Joseph M. McCarthy is Professor of Education and directs graduate programs in educational administration at Suffolk University. He received his Ph.D. at Boston College and has published and lectured widely on medieval history as well as on educational theory and practice. He has served on numerous editorial, advisory, and accreditation committees and has authored more than seventy books, articles, and scholarly reviews, among them *Humanistic Emphases in the Educational Thought of Vincent of Beauvais* and *Training School Administrators.*

Maria Teresa Miliora is Professor of Chemistry at Suffolk University, where she has chaired the Department of Chemistry. She received her Ph.D. at Tufts University. She recently completed a Master of Social Work program in preparation for work in psychotherapy. Her contribution to this volume is based on her experience in psychosynthesis, a nontraditional psychological system.

Zenon W. Pylyshyn is Professor of Psychology and of Computer Science and Director, Centre for Cognitive Science at the University of Western Ontario. He received his Ph.D. at the University of Saskatchewan and has published many scientific books and articles on cognition and artificial intelligence, including *Cognition and Computation: Toward a Foundation for Cognitive Science.* He serves on the editorial boards of several scientific journals and is advisor to several granting agencies in the sciences and humanities. He currently holds a Killam Research Fellowship as well as a Senior Fellowship from the Canadian Institute for Advanced Research. He is also Director of the Program in Artificial Intelligence and Robotics of the Canadian Institute for Advanced Research.

Gerald Richman is Associate Professor of English at Suffolk University. He received his Ph.D. at Yale University, has participated in a National Endowment of the Humanities Summer Institute on medieval civilization, and has published in the professional literature on the subject of old English.

David L. Robbins is Professor of History at Suffolk University, whose history he has chronicled in a number of pamphlets documenting the evolution of the University since its founding. He received his Ph.D. at

Yale University, is active in several Boston area historical societies, and has written on French history in the professional literature.

Michael R. Ronayne is Dean of the College of Liberal Arts and Sciences and former Chairman of the Department of Chemistry at Suffolk University. He is a member of the Town of Winchester School Committee, on which he has served as Chairman. He has served on a number of reaccredication visiting teams for the New England Association of Schools and Colleges and has authored numerous scientific and educational articles. He received his Ph.D. at the University of Notre Dame and has published widely on the subject of gamma-irradiated chemical systems.

Kevin Ryan is Professor of Education at Boston University. He received his Ph.D. at Stanford University, has been a Whitehead Fellow at Harvard University, and has published over fifty articles, reports, and reviews. He is contributing editor of the *Encyclopedia of Educational Research.* His books include *Those Who Can, Teach* and *Moral Education: It Comes with the Territory.*

Sarah Smith is Director of Documentation, Bachman Information Systems, Inc. At the time of the colloquium she was Director of Documentation, LMI (LISP Machine, Inc.). She received her Ph.D. at Harvard University, has taught in the Departments of English at Tufts and Northeastern Universities, and has published widely on eighteenth-century literature and history and on the theory and use of film.

Alexandra Todd is Associate Professor of Sociology at Suffolk University. She received her Ph.D. at the University of California, San Diego and has spoken and written on women's issues in doctor-patient relationships. She is coeditor of *The Social Organization of Doctor-Patient Communication* and of *The Structure of Discourse and Institutional Authority: Law, Medicine, Education.*

David G. Tuerck is Professor and Chairman, Department of Economics at Suffolk University. He received his Ph.D. at the University of Virginia, has directed a project on the economics of advertising at the American Enterprise Institute, and has been a director in the economic consulting practice of Coopers & Lybrand. He has published books and articles on the economics of education and of advertising, on international trade policy, and on supply-side economics.

Robert C. Webb is Professor of Psychology at Suffolk University, where he has served as Chairman of the Department of Psychology. He received his Ph.D. at Tufts University and has taught and lectured in the field of experimental psychology.

Contents

Introduction: Creativity and Cognition

David G. Tuerck

Late in 1983, the College of Liberal Arts and Sciences of Suffolk University decided to conduct a series of panels on the subject of creativity as part of its approaching fiftieth-anniversary celebration. The panels would be organized into two conferences bearing the title, *Creativity and the Implementation of Change: Liberal Learning in the Practical World.* This volume presents the papers and proceedings of these conferences.

The choice of creativity as the subject of these conferences grew out of a conviction on the part of the college that a fresh examination of the creative process and of the role of liberal learning in understanding and enhancing that process represented both a fitting act of celebration and a promising intellectual endeavor. The decision to conduct two conferences was owed partly to the fact that the anniversary celebration would span the entire 1984–1985 academic year and partly to a feeling that the events to be celebrated called for two different panel formats. The first conference would mark the meeting of the first college classes in the fall of 1934, and the second would mark the signing of the college charter on February 21, 1935. The setting for the first would be more intimate and less formal than that for the second, the hope being that by varying formats in this way, the college would achieve a suitable blend of depth and informality.

The words *symposium* and *colloquium,* though close in meaning, seemed to offer a useful distinction. Webster's *New Collegiate Dictionary* defines a symposium as "a social gathering at which there is free interchange of ideas" and a colloquium as "a usually academic meeting at which one or more specialists deliver addresses on a topic or on related topics and then answer questions relating thereto."

The college conducted its first conference as a faculty symposium on Tuesday afternoons, over the period from October 16 to November 13, 1984. It conducted its second conference as a colloquium, featuring addresses before a widely recruited audience by "specialists" from outside the university, on February 20 to 21, 1985. Although the symposium gave more time to discussion than did the colloquium, both conferences included the presentation of prepared papers and comments. This volume contains these papers and comments.

In a *Prospectus* distributed in advance of the conferences, the college offered two hypotheses for consideration by prospective contributors: (1) that *the*, or at least *a*, principal mission of a college of liberal arts and sciences is to enhance the creative skills of its students in a way that furthers their ability to bring about useful change in a practical world and (2) that a college of liberal arts and sciences should turn to cognitive science, and particularly, within that domain, to artificial intelligence, for clues as to how it might go about performing that mission more effectively. The *Prospectus* cited a "curriculum in design" proposed by Herbert A. Simon in *The Sciences of the Artificial* (1981) and *Gödel, Escher, Bach: An Eternal Golden Braid* (1979) by Douglas R. Hofstadter as particularly rich in clues of this kind.

SOME OBSERVATIONS ON COGNITIVE SCIENCE

Cognitive science describes thinking, in the words of speaker Zenon Pylyshyn (this volume), as a "representation governed process." Insofar as computers are capable of exhibiting intelligence, they, like humans and other highly developed creatures, "can only be understood if we assume that aspects of their internal states are representations—that they are physical instantiations or tokens of symbols that stand for something." Cognitive scientists disagree over the sense in which, and over the degree to which, thinking is reducible to computation. Where they agree is on the importance of representations for explaining the behavior of cognizers, human and artificial.

The importance of representations for explaining this behavior follows from a fundamental distinction that separates cognizers from other entities. This is the fact that, whereas one could offer a purely material explanation for the behavior of the latter, one could not offer a purely material explanation for that of the former. Cognizers have, in their brains, physical characteristics that symbolize someone's intentions for them to do certain things (just *whose* intentions—the cognizer's or someone else's—is a sticky issue, with which Drs. Pylyshyn and Goldkind grapple in their remarks in this volume). In order to explain the behavior of such entities, it is necessary, therefore, to know the intentions that their physical characteristics instantiate. It is necessary to know the meaning behind their actions. The idea that computers exhibit, or might conceivably exhibit, intelligence rests on the argument that it would be impossible to explain their behavior without recourse to a representational interpretation of their physical characteristics.

A Computational View of Cognition

One possible implication of this line of reasoning is that computers can exhibit genuine intelligence, at least in principle. If people conduct essentially the same kind of symbol processing when they think as computers do when they compute, then, considering the pace at which computers have grown in power and versatility, the prospects for artificial intelligence are good. Dr. Pylyshyn, Herbert Simon, and other cognitive scientists appear to accept this view. Simon (1982) has put it as follows:

> Like a modern digital computer's, Man's equipment for thinking is basically serial in organization. That is to say, one step in thought follows another, and solving a problem requires the execution of a large number of steps in sequence. The speed of his elementary processes, especially arithmetic processes, is much slower, of course, than those of a computer, but there is much reason to think that the basic repertoire of processes in the two systems is quite similar. Man and computer can both recognize symbols (patterns), store symbols, copy symbols, compare symbols for identity, and output symbols. These processes seem to be the fundamental components of thinking as they are of computation. (p. 430)

Simon predicted, in a 1957 article, that in ten years computers would be winning world chess championships, discovering and proving important mathematical theorems, writing music "accepted by critics as possessing considerable aesthetic value," embodying "most theories in psychology," and, in general, performing many tasks previously performed by men. Simon admits that he and his coauthor (Simon & Newell, 1982) have had to dodge a lot of brickbats as a result of these predictions. Perhaps, as he says, the reason lies not only in their overoptimism but also in worries they caused about technological unemployment and about the diminished uniqueness of man (pp. 266, 386–387).

In *The Sciences of the Artificial* (1981), Simon considers some implications of computer technology for higher education. Dividing sciences between the natural and the artificial, he characterizes the artificial sciences as falling properly within the domain of the professional schools. It is the business of the professional schools to design artifacts and thus to teach and to organize their curricula around the science of designing artifacts. Unhappily, the professional schools have been surrendering in recent years to a misguided desire to turn their curricula away from the artificial and toward the natural sciences. The cookbook nature of much professional school curricula may, at one time, have explained the feelings of insecurity that underlay this desire. But, if justified before, the expanding arsenal of problem-solving methods made available by advances in management science and in computer science make these feelings obsolete and wrongheaded today. The now-available inventory of computer simulation models provides a rich empirical base for the development of a curriculum in design, an outline of which he offers as a guide to the revitalization of professional education.

The conferences' *Prospectus* proposed a marriage of Simon's curriculum in design to the liberal arts and sciences. Although this might appear as role reversal, much of Simon's own logic argues for placing his curriculum there rather than in the professional schools. Simon points out how the emergence of computer science has created a common language and, perforce, an opportunity with which persons from fields as diverse as music and engineering "can begin to perceive the common creative activity in which they are both engaged, can begin to share their experiences of the creative, professional design process." The communication thus made possible across disciplines has given rise to a "new intellectual free trade" in our "thought processes, our processes of judging, deciding, choosing, and creating." "If I have made my case," Simon writes, "then we can conclude that, in large part, the proper study of mankind is the science of design, not only as the professional component of a technical education but as a core discipline for every liberally educated person" (Simon, 1981, pp. 158–159).

Several of the contributors to this volume address themselves directly or indirectly to Simon's argument. Although the bulk of opinion appears to be negative, there is much that sees a bright future for artificial intelligence and, to that degree at least, for curricular changes of the kind that Simon proposes.

A Noncomputational View of Cognition

In *Gödel, Escher, Bach: An Eternal Golden Braid* (1979) and in some follow-up articles, Douglas Hofstadter rejects the computational view of thinking in favor of an alternative view that stresses the role of analogy and imagery. Hofstadter sees a distinction between computation and thinking, the latter being the kind of brain activity that machines must capture in order to claim intelligence.

Computation takes place at a low (which is to say, hardware or neural) level of brain activity. At this level, symbols are "empty" and "passive" in character, governed by some set of formal rules or program. Symbol processing of the kind that occurs in computation does not characterize true thinking (or, therefore, creativity), although it does still characterize, for the most part, what computers, including supposedly intelligent computers, do (Hofstadter, 1979, p. 570; 1983, pp. 274–279, 285).

Thinking, in Hofstadter's model (1979, 1983), takes place at a high level of brain activity, where symbols mix with each other and emerge unpredictably from their computational substrate to group themselves into meaningful, neurological " 'clouds.' " The clouds thus formed are "active symbols" that "flow and act on their own," incorporating "within their own structures the wherewithal to trigger and cause actions" (1979, p. 570; 1983, p. 278).

Cognizers form a new symbol or concept by creating around it what Hofstadter calls an *"implicosphere"* or *"implicit conterfactual sphere."* This is a cloudlike set of variations on the core theme of the concept that, when properly connected, give meaning ("representation") to the concept in the mind of the cognizer. The very existence of a concept depends on the cognizer's ability to connect in a meaningful way the variations that make up the implicosphere of its core theme:

> The gist of my notion is that having creativity is an automatic consequence of having the representation of *concepts* in a mind. It is not something you add on afterward. It is built into the way concepts are.... If you have succeeded in making an accurate model of *concepts,* you have thereby also succeeded in making a model of the creative process, and even of consciousness. (1985b pp. 238, 245–247, 1985a, pp. 528)

The process of creating a concept is one of letting the imagination conjure up (perhaps nondeliberately but always nonaccidentally) counterfactual or subjunctive ideas that at once resemble and reify its core theme. "We select from our fantasy a world which is close, in some internal mental sense, to the real world. We compare what is real with what we perceive as *almost* real. In so doing, what we gain is some intangible kind of perspective on reality" (Hofstadter, 1979, p. 643). An accurate model of the creative process, therefore, is not one in which the cognizer changes the real world but one in which it uses the imagination as needed to produce concepthood:

> When we daydream or imagine situations, when we dream or plan, we are *not* manipulating the concrete physical world, nor are we sensing it. In imagining fictional or hypothetical or even totally impossible situations, we are still making use of, and contributing to, the meaningfulness of our symbolic neural machinery (Hofstadter, 1983, p. 282).

In order to create new concepts, cognizers must be able not only to build up the implicosphere that surrounds a concept but also to spot the regularities in their thinking processes that identify the implicosphere by which those processes are bound. A true cognizer can look down upon itself, spot regularities in the way it thinks about things,