

MICROCOMPUTERS FOR EDUCATORS

JAMES LOCKARD

PETER D. ABRAMS

WESLEY A. MANY

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Microcomputers for Educators

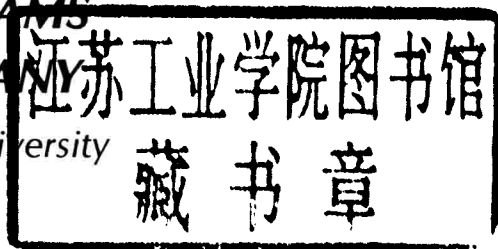
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The first decade of microcomputers in education was the 1980s. Those who experienced this period witnessed and participated in rapid technological development with enormous significance for educators. In ten years, American schools adopted microcomputers to the extent that it is now rare for a school to have none, and teachers who use computers are impressed with their benefits ("The Computer Report Card," 1989). As of 1989, 23 states and the District of Columbia required at least some teachers to have training in microcomputer use to become certified (Bruder, 1989). Considering that the 1980s began with virtually no computers in the classroom, we have clearly come a long way. The question is no longer *whether* to use computers in the schools, but how *best* to use them.

The potential of technology to advance education is much greater than its current application. We have made progress, but the ultimate goal is still far ahead. Although nearly every school in the United States has microcomputers, many have so few as to be able to achieve very little. More than half the states have not yet reached the inevitable conclusion that teacher training must include instruction and experience in the uses of technology in order to aid learners. In fact, teacher training was a major source of concern throughout the eighties; it promises to remain so during the nineties.

The pace of development in computer technology continues to be rapid. It would be easy for educators to feel like hunters shooting at a moving target. Yet it should be obvious that to do nothing is to opt to fall continually further behind. No matter what position one currently takes on the place of technology in the classroom, the course of action must be forward.

Noted educational futurist Christopher Dede (1990) cautioned against four misconceptions concerning emerging technologies of instruction. The "misconception of consolidation" is that the wave of innovation is over; in fact, it is only beginning. The "misconception of literacy" is that technologies are a medium like language, designed to manipulate and communicate symbols; in fact, they are "potential intellectual partners." The "misconception of power" is that students need computers with only limited power; in fact, to benefit from the next generation of software, they need systems *more* powerful than many adult users now have. Finally, the "misconception of timing" is that educators should wait until systems are well (or fully) developed before beginning preparations to use them; in fact, long advance planning is necessary to build new curricula and retrain teachers.

This book addresses many aspects of the challenges of educational technology. It has been prepared to help educators and educators-to-be become knowledgeable of and comfortable with microcomputer technology. The second edition has been thoroughly revised to reflect the developments of the past three years. The original philosophy has not changed from the first edition; hence, the book's organization and general structure remain unchanged as well. This is not to say that the first edition escaped the revisionist's hand. Changes have been extensive: ranging from updated citations, software references, research reports, and activities in all chapters to the total rewrite of several chapters. Many topics have been added or expanded significantly, including: telecommunications, hypermedia, optical discs, interactive video, multi-media, integrated learning systems, intelligent CAI, artificial intelligence, expert systems, publishing software, graphics tools, logic programming, and curriculum integration. More specific classroom applications have also been included. Part 5, "Microcomputers in Education," has been changed thoroughly to emphasize further the need for integration of computers throughout the curriculum and to reflect new views on implementation issues. In sum, the second edition is much more than a cosmetic refurbishing of the first.

We want to thank the many worldwide users of the first edition of this book and trust that this edition will suit their needs still better. We have made every effort to be accurate and current, but this is a fast-changing field. Adopters of this book are encouraged to obtain the accompanying *Instructor's Manual* from Scott, Foresman and Company, which contains some last-minute updates, as well as teaching tips, test items, and transparency masters.

Special thanks go to the following individuals who critically reviewed the first edition, suggested revisions, then critiqued the revised manuscript: Stephen M. Alessi, University of Iowa; Barbara Grabowski, Syracuse University; Michael Simonsen, Iowa State University; and Barrie Jo Price, University of Miami. Their suggestions were most valuable and we have implemented all that we possibly could. New photographs in this edition are the fine work of Barry Stark, Northern Illinois University, Art/Photo Department. At Scott, Foresman and Company we have enjoyed our association with: Chris Jermonson, Education Editor; Anita Portugal, Developmental Editor; and Diane Beausoleil, Project Editor. We gratefully acknowledge their encouragement and guidance, as well as that of Gerri McGowan of Editorial Services of New England who helped oversee the editing and production of this edition.

Throughout this endeavor, our families were constantly with us behind the scenes, helping, encouraging, believing in our efforts. We cannot adequately thank them for their understanding.

J.L.
P.D.A.
W.A.M.

References

- Bruder, I. "Ninth Annual Survey of the States." *Electronic Learning*, October 1989, p. 22–28.
- "The Computer Report Card: How Teachers Grade Computers in the Classroom." *TechTrends*, October 1989, pp. 30–35.
- Dede, C. J. "Educators, Take Hold of the Future." *Electronic Learning*, January 1990, pp. 8–9.

In the few short years since the first microcomputer reached the retail market, a technological revolution has swept across the United States. Computing has become a common term in the American vocabulary and a daily activity for millions of people. This is indicative of what has been called society's movement into a new Information Age. Within this framework, computers also have found their way into classrooms from coast to coast and at all levels in numbers large and growing rapidly.

While the blossoming of computer use in the schools may be viewed as a most proper response to the challenges of the 21st century, there is much reason to pause and consider its true significance. First, it is unique among educational advances in that the driving force is often external to the schools. Parents are demanding that their children learn to use microcomputers as an integral part of their education. Second, compared to any of the previous technologies introduced into the schools, computers require vastly more teacher training to be used effectively. One simply cannot place a microcomputer in the classroom, pat the teacher on the head, and leave expecting miracles to occur. Computer literacy has become a catch word of the 80s, despite its lack of a commonly accepted definition. Clearly teachers need to gain computer knowledge and skills *before* they can help their students toward the same goal. Software availability and quality are problems, to be sure, but improvements in this area will have limited impact unless teachers are educated to use the products. It is the human interface that will make or break this "revolution."

With so many books on the market today aimed at computers in education, is another really needed? Our search for a book to support our approach to educational computing has consistently come up empty-handed. Every volume we have examined fails in one way or another to address our concerns. Some are fervent proponents of the outmoded "literacy is programming" viewpoint; others fail to cover adequately the important tool uses of the computer; some ignore the elements of computer-assisted learning; and few give much attention to the vast research and practical experience literature on computers in education. Each term we have been obliged to rely on our own devices to meet the needs of our students. In this volume, we offer those devices to others with similar needs.

This book is the outgrowth of our experience in preparing teachers to use microcomputers in the classroom. It reflects much serious thought and experimentation as to what the initial step should be in learning to cope with these electronic marvels. In our model of how computers can be used most effectively, the computer as a tool is the cornerstone—those applications which make our

everyday lives easier. The next most important application is the computer as an electronic tutor, an integral component of the learning process. Programming, the computer as learner, occupies third place. We disagree vigorously with the notion that computer literacy is synonymous with programming skills. Instead, we believe that programming is one of the viable elements of a school program, but not the primary one. We have long believed that the ultimate success of the microcomputer in education depends on its becoming an everyday classroom tool, much as chalk and pencils are, rather than being an object of special attention.

Our approach to computers in education is reflected strongly in the book's organization. In Part 1 we lay a foundation by looking at the emergence of computers and by describing microcomputer systems. Parts 2, 3, and 4 focus respectively on the computer as tool (e.g., word processing, databases, and spreadsheets), the computer as tutor (computer-assisted instruction, courseware evaluation, and computer-managed instruction), and the computer as learner (a conceptual approach to programming). In Part 5, we discuss computer literacy, implementing computer education, and issues and implications. We conclude the book with a look at trends which will affect computer education. We have attempted to prepare each section with relative independence from others, so that users can readily adapt the sequence to their own preferences and even omit sections which they choose not to include in their courses. To enhance the usefulness of the material, most chapters include activities and a bibliography.

This book is intended as background material for reading and discussion prior to hands-on laboratory experience, which is the heart of our approach to a beginning course in microcomputers for educators. We do not believe that teachers can be prepared to use computers through a lecture course. Instead, they must become thoroughly familiar with hardware and software which will be the basis of their own teaching. We have purposely not provided detailed recommendations for the hands-on component, since they would necessarily be machine and software dependent. Rather, the chapters and activities suggest the approaches we have found successful. They can be adapted to whatever hardware and software may be available.

Although the contents of this book reflect our own approach to the task of training teachers to make use of computers, our work on the manuscript was influenced by the careful reading and numerous suggestions of reviewers. We wish to express our gratitude to M. Vere DeVault, The University of Wisconsin-Madison; Jeffry Gordon, University of Cincinnati; Theodore M. Kellogg, University of Rhode Island; and David F. Salisbury, The Florida State University. All photographs are the work of Barry Stark and George Tarbay, Northern Illinois University, whose talents are evident despite the short deadlines given to them. In addition, we are indebted to Mylan Jaixen, Senior Editor, College Division, and Barbara Breese at Little, Brown and Co., as well as Julie Hotchkiss who helped oversee the production of the book. Without their encouragement and expert guidance, this project could not have been completed.

Finally, we gratefully acknowledge the continuous support and understanding of our families, from whom countless hours were taken to complete this work.

J.L.

P.D.A.

W.A.M.

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