COMPUTERS AND EDUCATION

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To Douglas Edward Salomon,
a dedicated teacher and friend [CSW],
and to Jennifer [GH]

Preface

Over the past 40 years, computers have had a steadily growing impact on our lives. The invention of miniaturized circuitry and remarkable advances in chip technology have had a dramatic effect on business, industry, and government, not to mention our daily lives. The effects of computing in our schools have followed the model set by society at large, though at a slower pace. The creation of the microcomputer in the early 1970s and the mass production of inexpensive machines beginning in 1977 provided the impetus for the more recent growth of computer use in schools. But having computer equipment available in a school is no guarantee that it will be understood well enough to be used satisfactorily. The products of past educational fads languish in school storerooms across the nation, and teachers are understandably wary of allowing their time to be consumed by projects that eventually are likely to be discarded.

The premise underlying this book, however, is that computers are here to stay, and computer-based technology is taking its place in the array of instructional media in schools. For these reasons, every educator needs to know what computers can do and what they cannot do. College students who plan to enter teaching need to be prepared in this way before they graduate, and practicing teachers need the same information even though they may be well established in their careers. Few, if any, of these people are likely to become computer specialists; yet, if they hope to remain current in their teaching, they need a general level of understanding about computer technology as it applies to their professional roles.

The debates about whether teachers—and their students—should learn to write computer programs will undoubtedly rage on. And advocates for using one language rather than another will continue to air their opinions. Similarly, champions of particular software choices—be they of word processors, filing systems, or instructional software—will also be

heard. Although such discussion and debate mark the dynamism of the field, they can be very confusing to beginners. For this reason, we confine ourselves to the general foundations of educational computing rather than addressing the specifics of particular programs or special points of view. In this way you, the reader, are spared both excessive technical detail as well as the passions of advocacy. Instead, you are treated to a series of discussions about computers in general and educational computing in particular. Our goal is to steer you toward the goal of being able to think through your own rationale for using computers in your professional careers.

As a consequence, we make no attempt to provide information about how to program in a particular high-level language such as BASIC, Logo, or Pascal. Likewise, we do not attempt to provide instruction to make you proficient with a particular word processing program or to run a particular package of instructional courseware. The list of possibilities, in any event, is almost endless and is constantly changing, so any such effort has limited value. Moreover, we believe that the inclusion of practical manuals in a book of this kind would detract from the fundamental information that all teachers need to know about computing. In our opinion, instruction on practice should be handled by special publications or kits that focus exclusively on a given program or language.

In order to achieve our goal of informing educators, we have held the text to a modest length so that it can be used as a primary text for a short course that provides an overview of educational computing. Alternatively, it may be used in conjunction with one or more practice manuals in a comprehensive course that includes work with computers. Each chapter presents an important dimension of educational computing. Chapter 1, for example, consists of an introduction to the history of computing, with particular emphasis on developments during the last half century. Chapter 2 completes the historical overview by reviewing the state of the ongoing electronic revolution. Topics include computing in the workplace, government, and the home, as well as legal and ethical issues. Chapter 3 attempts to clarify the inner workings of computers for people who have had little or no instruction in electronics. The purpose of this chapter is to help readers understand the kind of activity that goes on inside computers. It is all too easy to close one's mind to the fact that a great deal of orderly activity is occurring inside the tiny, enigmatic black computer chips. Moreover, there is considerable temptation to attach mystical—and even threatening—powers to computers, just because they are typically silent and nothing visibly moves.

The counterpart to the actual computer hardware is discussed in Chapter 4 in the examination of the software programs that have been written to drive the hardware. The discussion extends to operating systems, binary code, and computer languages. In addition, the chapter introduces readers to the types of storage that hold large amounts of

information. Although Chapter 5 addresses educational computing specifically for the first time, much of what appears in the preceding chapters is written from the viewpoint of teachers rather than members of the general public. This chapter outlines what has occurred in educational computing since its beginning. It describes what the pioneers in educational computing tried to do, as well as outlining common applications of computers in schools today.

Chapter 6 addresses the familiar subject matter areas of the school curriculum. Instead of writing a book that refers to educational computing only in general terms, we decided that a better service to readers would be to outline how computers may be used in numbers of subject fields. After all, even in elementary schools where teachers are expected to cover almost all curricular areas, they typically divide the school day into time periods for the various subjects. And in secondary schools, teachers typically specialize in one or at the most two areas. Individuals will understandably focus attention on the areas they are to teach. Hopefully, however, they will also read some of the other sections, and in so doing extend their understanding of the contribution that computers can make to the total school curriculum. This chapter also includes a discussion of the computer as the focus of curriculum in the subjects of computer literacy and computer science. The merits of the computer languages that are best suited to educational application are weighed. The chapter concludes with a review of two computer literacy curricula.

Chapter 7 guides readers in the vitally important task of evaluating educational software. In general, teachers will use computing equipment mostly to support the teaching of the subject matter where they feel most competent. And very few are likely ever to write their own programs for general classroom use. Consequently, you need to know how best to become a good critic of published programs. In one sense, the task is not unlike evaluating a book or a film, but the character of computer programs is such that special techniques are needed in order to make effective evaluations and thus avoid spending money wastefully on materials that are either poorly written or inappropriate for a given task.

Finally, Chapter 8 discusses the future of educational computing. No one, of course, knows what the future holds in store, but judging from school trends, not to mention what is known about pending technological advances, there are many possibilities. The purpose of the chapter is to help you anticipate where computing in education is most likely to be moving in the foreseeable future. We will accomplish our goal if, after reading the chapter, you begin to fashion your own ideas about what may happen. This has particular relevance if you decide to become more deeply involved in some aspect of educational computing. But even if expertise in computing is not your goal, you will be preparing yourself to take an active role in the profession rather than passively accepting whatever occurs. This final chapter, in effect, continues the sentiments

expressed at the opening of this Preface: that computing is here to stay and that educators need to keep informed about how to exploit this technology to its fullest in the best interests of student learning.

Acknowledgments

In 1982 the School of Education at Indiana University embarked on the development of an undergraduate teacher endorsement sequence in instructional computing. The idea for this book grew from our search for an appropriate text for the initial course in the sequence—a survey of educational computing—which we co-designed and co-taught. It is thus appropriate that we credit the role played by those early development efforts in shaping our views about educational computing generally and in challenging us to reflect on what knowledge of the field is of most importance to teachers.

Naturally, our students, both preservice and inservice teachers, have also influenced our thinking over the past several years. We owe them a debt of gratitude for helping us to clarify our thinking. We hope we have conveyed some of their wisdom in what appears between the covers of this book.

C.S.W.
G.H.

Contents

CHAPTER 1

The Electronic Revolution

Introduction

Not long ago, one of the authors had the occasion to visit one of those super grocery stores in upstate New York that sells almost anything one might want, except perhaps furs and houses. Patrons of the store have three options for finding what they're looking for: (1) ask someone who works there, (2) walk the width of the store looking at the signs above each of the score of aisles, or (3) go to the nearest computer terminal.

It was really rather easy to use. Let's say you're looking for onions (and you have a cold, so your sense of smell won't help). On the computer screen you see the letters of the alphabet, with the instruction to touch the letter that corresponds to the first letter of what you're seeking. You touch the "O," the screen clears, and you see the beginning of a list of all the store items beginning with the letter "O." Touching another area of the screen makes the list continue, until you see "onions." When you touch the word, the screen clears again and displays a map of the store. The orange box marks where you are; the blue box marks where the onions are. You hear a voice from the computer say, "The onions are in aisle 17B." You're off and running. Meanwhile, you notice the patrons who walk past the terminal rather quickly, intently reading each of the signs above each of the aisles. The past and the future are colliding.

A local library is in the midst of changing its card catalog. Patrons now have two choices for finding the books they want: (1) look through the traditional and familiar card catalog, or (2) go to the nearest computer terminal. Either option provides the information they're accustomed to seeing, but the person who chooses the computer terminal gets more

information. While the card catalog patron begins a futile search through the shelves for the three books she wants, the computer terminal patron is told that one book is checked out and won't be back until Friday. The second book is at the bindery and will be back next week. The third book should be in its place on the shelves. The past and the future collide; the future gains the advantage.

These two very real situations reflect a period of transition in history, where we recognize that we have one foot in the past and the other in the future. As the people who avoided the computer option in these examples show, transitions can produce anxiety accented by frustration. On the other hand, as the computer users learned, transitions are a time of tremendous opportunity, not just as an observer and participant but as an active agent of change. Times of transition carry in them the opportunity for people to help shape the contours of the future, to alter the current trajectories of change to the best of human aims.

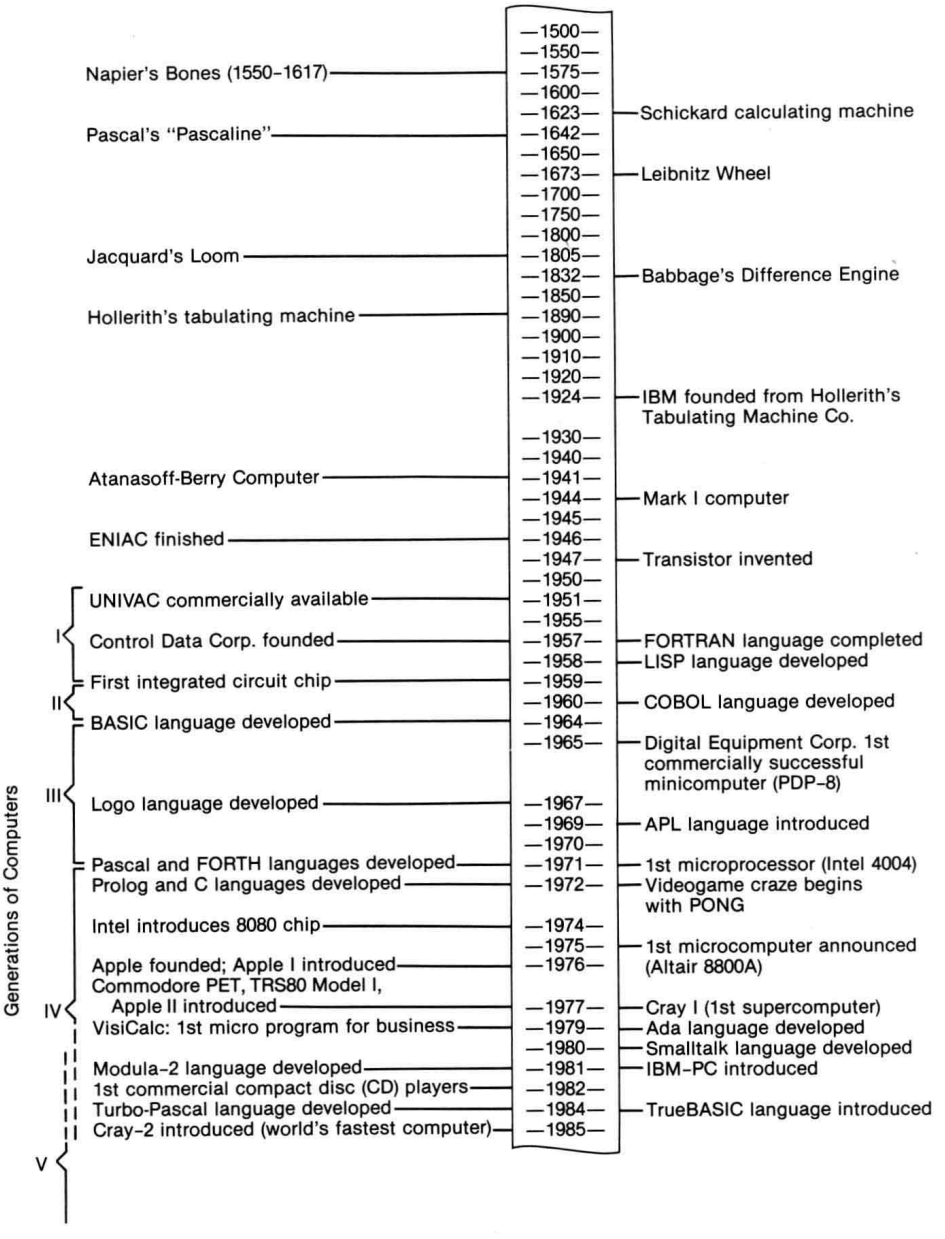
To do this requires not only a vision of the future and alertness to the present but an understanding of the contextually rich past. Knowledge of the forces that have driven technology to its current state inform efforts to mold the future. In this chapter, we focus considerable attention on the past as a means to reflect on the significance of computer technology in our lives. In Chapter 2, we extend the discussion to how we have made computers a part of our lives and where we might take them in the future.

Origins of the Modern Computer

From Abacus to Mark I

If you have ever observed a child struggling to use his or her fingers for counting, you may recall a time when keeping track of quantities was for you no small task. For small quantities there was little trouble, but as amounts increased and (even worse) kept changing, fingers came in handy as devices to help you keep track and to calculate. What the child does is not unlike what early humans did when faced with the same challenge: They used their "digits," five on each hand, to help count and calculate.

Not without resources, though, humans began to employ devices other than anatomical: knots in a robe, pebbles on the ground, marks in the sand. Perhaps five thousand years ago, these devices evolved into the abacus. The word *abacus* has an interesting entymological root. "Abacus" comes from the Phoenician "abak," which referred to a stone spread with sand in which one might make marks. A slab of stone was called an "abax" by the Greeks, with reference to the sand apparently assumed. The Romans married the idea of the stone slab and pebbles. The device they used was called variously as "abaculi" (slab and pebbles) or "calculi" (pebbles). One can identify "abacus" in the first Latin term but not the



Timeline

second. From "calculi" we can derive "calculate," which was precisely what one did with an abacus. In a sense, the abacus was the Roman's calculator.

The pursuit of calculating devices continued to occupy individuals and nations as the field of mathematics evolved and matured. John Napier