Introduction

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COMPUTER-ASSISTED INSTRUCTION IS REALLY nothing more than the electronic application of well-understood principles of learning that gave rise to the popularity, some years ago, of "programmed instruction." But if the instructional use of computers in libraries amounted to little more than self-paced, guided-task, learning, we should not be very interested. In fact, libraries find themselves, as they often do, at a significant intersection of various technologies, services, products, and scholarship that offers unique opportunities. We are in a position to integrate, within the same technology, teaching about scholarship, production of scholarship, delivery of information and services, and effective use of these simultaneously. The computer, and electronic technology generally, has finally begun to realize some of the promise that Memex offered (Bush, 1945). The same technology that delivers information and scholarship can also be used to teach the direct, and indirect, use of that information and associated research and analytical techniques. The "how to" and the "what" can be presented in a seamless environment of tutorial or classroom learning managed and presented by electronic media and computing machines.

This issue of *Library Trends* includes articles that explore both the theoretical and practical aspects of the use of computers to teach, and not merely to deliver, information. Inevitably, any discussion of the use of computers in instruction, and as teachers, will evolve into a discussion about the general nature of the skills to be taught, as well as the skills required to learn from a computerized instructional program. A computer may be used to teach about a great many things, not least importantly about itself.

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One of the things that one may usefully learn from a machine program is the technique of information retrieval and management. And this is what many librarians and faculty members have in mind when they speak about "information literacy." How to define this concept, and how to draw useful connections among the related ideas of "technical literacy" and "information technology literacy" is the subject of contributions here by O'Hanlon, Cox, Kaplowitz, Hansen, and Brandt.[1]

It is important to note that much of the current discussion about "information literacy" is really more about "computer literacy." The ability to handle information in an intelligent and critical way is not different from the kind of thing required of any undergraduate, for example, as a normal part of general education and of meeting the requirements of the major. We might wonder if, in fact, most undergraduates do actually succeed in acquiring these skills and abilities, but that is another matter.

Many colleges and universities have established guidelines for describing this kind of competence and for evaluating undergraduate achievement, but most of these programs simply reflect traditional concern for library and research skills.[2] What some have called "digital literacy" is something else again, although there are overlaps.[3]

Genuine digital competence, in the sense intended, can be thought of as having two distinct aspects: desktop competence and electronic information retrieval competence (largely a matter of World Wide Web skill, but not entirely). These two types of competence are closely related, as Brandt argues, and we need to pay more attention to how the first level of competence contributes to the second (and to the assumptions we make about the prior levels of competence of either kind that our students and users bring to our libraries). If our readers do not possess some minimal set of desktop competencies, they will not be able to profit from instruction by computers, or even in the most basic elements of electronic information retrieval competence as taught by and through computing machines.

One of the most exciting developments in library and information retrieval instruction has been the rapid expansion of quality content—general as well as specialized intellectual resources—available through the Internet. The problem of how to retrieve and evaluate this content, and distinguish it from the vast amount of low- or no-quality information on the Internet, has become the subject of countless conference papers, journal articles, and books by librarians and faculty members alike. The authors of several articles in this issue of *Library Trends* (for instance, O'Hanlon, Cox, Kaplowitz, and Hansen) present the results of practical experiences in teaching these skills and general World Wide Web skills through the medium itself. Using the medium to teach about itself, doing so essentially to the autodidact, exploits two important aspects of one kind of successful learning: the instruction is self-paced and the subject matter

is largely self-taught.[4] Combining instruction of this kind with the use of computers as instructional devices puts this strategy directly into the center of a controversial, and now somewhat neglected, historical tradition.

The idea of using a machine to teach something is not new. The theory and application of programmed instruction (however delivered) is commonly associated with the work of Harvard psychologist B. F. Skinner. But Skinner (1958) was not the first to suggest that a machine could be used to teach a skill, as he was always careful to point out (p. 969) (see also Skinner, 1954, 1961). The most obvious antecedent to Skinner's work was that of Sidney L. Pressey (1926, 1927, 1932) at Ohio State University, who published a series of papers in *School and Society* between 1926 and 1932 on his development of a simple teaching machine to provide self-paced instruction in a variety of basic skills.[5] But Pressey (and Skinner) had been anticipated as long ago as the beginning of the nineteenth century by various "educational appliances" designed to teach spelling, reading, and other basic skills. Whether these devices qualify as genuine teaching machines is a matter for debate (Benjamin, 1988).[6] What these machines, and their electronic offspring, have in common as teaching devices is that they derive their justification from certain fairly well-established principles in the psychology of learning.[7] Briefly summarized, these principles are: that programmed learning recognizes individual differences in learning behavior, that active learning is superior to passive reception, that immediate feedback of results favors learning, and that the acquisition of at least some kinds of knowledge is a stepwise affair (see, for example, Hilgard, 1961). These conclusions, taken together with the frequent observation that students (of all kinds) generally prefer self-teaching when confronted with the kind of instruction that is the subject of this issue of *Library Trends*, would strongly suggest that the use of computers as teaching devices is on firm theoretical and experimental ground.

But to teach what? And, for that matter, to learn what? Historically, the application of teaching-machine technology has been to rote learning and repetitive drill. This is why most of the early successes with programmed instruction were in the teaching of languages and arithmetic. But programmed instruction, whether in the linear mode of Skinner or the branching mode of Crowder, is independent of the particular technology used to deliver it. And the use of computers as teachers need not necessarily involve a strict application of the principles of operant conditioning. It may be true that learning, "in its most general description, is the modification of patterns of behavior, under the influence of agreeable or unpleasant stimulation" (Sayre, 1970, p. 909), but it does not follow that teaching machines, especially computers, cannot be used to provide instruction in higher order conceptual tasks. The application of hypertext technology to instructional and tutorial computer software has taken the possibilities of computer instruction to a new level. And this is precisely where one of

the most interesting recent collaborations of the Internet with teaching machines occurs–the intersection of distance education with independent learning.[8]

Distance education is, of course, quite different from online instruction, but increasingly the two modes have merged in practice. What they have in common is that distance education and online instruction are both intimately connected to the idea of independent learning.[9] Hence, it can be said that independent learning and teaching is what occurs outside the school environment (Moore, 1973, p. 662). And what this means, most importantly, is that a key marker of the independent learning situation is increased learner responsibility. We already know much about the intellectual and psychological characteristics of independent (autonomous) learners: they can organize their time effectively; they are motivated to read and study without direction; they have generally good study habits; they enjoy the process of learning; and they can work cooperatively when they need to. Most of all, perhaps, they prefer to learn on their own. Herbert Thelen (1960) characterizes this personality type as having "captaincy of self" (pp. 14, 51, 75). The goal of education, one might even say, is precisely to turn every student into this kind of learner (Bruner, 1966, p. 53). The marriage of the Internet with computer instruction, in the form of both directed and self-paced tutorial modes, is a match nearly made in heaven. In one way or another, most of the contributors to this issue of *Library Trends* are concerned with this dynamic, but most especially O'Hanlon, Kaplowitz, and Hansen.

But one learns nothing unless one is ready to learn. In the world of information technology and the Internet, this truism comes down to the question of whether students (and other learners) come prepared to understand fairly high-level concepts in the realm of telecommunications, electronic information retrieval, and the digital organization of information in a network environment. And if they do not, as often seems the case, what preconditions must we try to meet to bring novice network users up to this level?

Both Brandt and McFadden explore in some detail the role that mental models, metaphor, and analogy play in constructing an anticipatory framework within which learning about complex information networks can occur most effectively. Drawing extensively upon the theoretical and experimental literature describing what we know about mental models and creative learning, both offer possibilities for new instructional strategies and approaches to teaching by and through the Internet.[10]

Library Trends does not ordinarily reprint papers already published elsewhere, but several recent articles in literature not usually on the regular reading list for most librarians, and in one case from a part of the world about which we often know too little, are directly relevant to the problems and controversies taken up by the original contributors to this issue. Fourie,

for example, describes a series of novel experiments in the use of computer-assisted instruction for distributed learning in library and information science. This program is all the more interesting because it is part of the extensive distance education program offered by the University of South Africa. Many of the same conclusions reached by others in widely dissimilar environments nevertheless emerged from this study, including important indicators of how and when computer-managed instruction is most appropriate as a function of learner readiness and independence.

Pyle and Dziuban make what should be the intuitively obvious point that what can be computerized (or taken online) need not be. Enlarging on the experiences of Fourie, they consider just exactly what kinds of teaching and learning really are best suited for delivery and management by computers. Not surprisingly, they find that, while online and computerized instruction can sometimes just be an instance of seduction of the unwary (perhaps by the unaware), it may also be true that the very appeal of online learning for many of our students can be effectively exploited in drawing students into self-paced and independent learning environments.

Well, once we get them there, what is the "ideal" online course? Clearly, it is not just a transfer of traditional course elements and design to the electronic environment. If a classroom lecture is boring, it will be equally tiresome online. Careful consideration needs to be given to a whole array of new design and content issues when a course is moved from the traditional classroom to, for example, the Internet.

Carr-Chellman and Duchastel survey both the obstacles and the opportunities in making this kind of transition and in the process offer a formal model for an online course that has at least a very good chance of succeeding in a wide variety of learning and teaching environments.

Computers have become ubiquitous in our lives, but more importantly they have also become pervasive. Micromachines and nanotechnology are rapidly transforming what it was once fashionable to call the "mind appliance" into an everyday artifact, scarcely distinguishable from our most common assistive devices. Just how this trend will play out in the storage and delivery of information, and in teaching about these and many other things, remains to be seen. But the potential for increased and enhanced learner initiative and independence, along with vastly greater flexibility in how and where (and when) instruction can be delivered, is clearly enormous. This issue of *Library Trends* can begin a new conversation among librarians about how to participate in the opportunities offered by these rapidly developing instructional and networking technologies.

NOTES

[1] An early attempt to get a handle on the concept of "information literacy" was the general topic of the Winter 1991 issue of *Library Trends*.

[2] The Association of College and Research Libraries approved, in January 2001, a model

statement of objectives for information literacy instruction. It is remarkable how similar these objectives are to traditional standards and practices described somewhat more elegantly in, for example, Barzun and Graff (1957)—some things never change. See ACRL Instruction Section (2001).

[3] It is worth remarking that this is not about (or just about) requiring undergraduates to take one or more courses in computer science.

[4] Undergraduates, in particular, routinely express a preference for learning in this way, especially if what is being taught are computer skills of some kind.

[5] Pressey had demonstrated this machine at the 1924 and 1925 meetings of the American Psychological Association.

[6] Other useful surveys of the history of teaching machines are Fry (1963) and Vargas and Vargas(1992). An excellent early literature review is presented by Morrill (1961).

[7] What they do not have in common is any implied commitment to behaviorism, either as a heuristic or as an ontology of mind.

[8] It is important to note that the "distance" in question does not have to be much—across the campus, for example, is quite far enough to count (Moore, 1973, p. 674).

[9] One way to get at the difference is to consider the distinction between an "online course" and a "distance education course," which might be described as:

Online Course = $_{df}$ A course in which all or most of the following is presented to the student(s) through an electronic medium (e.g., the World Wide Web):

1. the persona of the instructor;
2. the pedagogical content of the course;
3. the management of the course;
4. communication between each student and instructor;
5. communication between or among students; and
6. assessment tools.

It is important to note that a course might satisfy this definition even if the instructor and the class are on the same campus—even in the same building, although that would be odd. The conceptual content of the course, such as would be delivered in a textbook, might or might not be presented to the student(s) through an electronic medium. It might also be the case that any examinations are administered by an actual person in a supervised location.

An offline course is simply one that fails to satisfy this definition. Hence a course, online or offline, might turn out to be a mixed online or mixed offline course, depending on the emphasis of the instructional mode. Thus a classroom-based course might have part of its content and instruction delivered online, with some of the interaction among class, content, and instructor occurring both online and offline. Or a largely online course might have part of its content and instruction delivered offline, with a requirement that some kind of physical encounter among class, content, and instructor be part of the conditions for passing the course.

Distance Education Course = $_{df}$ A course in which the presentation of all or most of the following to the student(s) does not require (for all or most of the course) that the class and the instructor be in the same place at the same time:

1. the persona of the instructor;
2. the pedagogical content of the course;
3. the management of the course;
4. communication between each student and instructor;
5. communication between or among students; and
6. assessment tools.

A distance education course thus understood might also be an online course but need not be. And, contrariwise, an online course as defined might also be a distance education course but need not be.

[10] In fact, one of the differences dividing proponents of linear and branched programming, respectively, in the development of teaching machines was just this question of how much one should try to anticipate the mental geography of users of programmed sequences (McLaughlin, 1964; Hoth, 1961).

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