CHAPTER 1

IDENTIFYING PARADIGMS FOR EDUCATION APPLICABLE TO CAI

This chapter explores possible theoretical foundations for fruitful development in CAI. It begins with a brief literature survey, after which certain omissions in the literature are pointed out. This is followed by a critique of the educational paradigms which fostered use of the computer for drill and practice and a discussion of alternative paradigms in which development of CAI might take place. It is hoped in this chapter to show that there is a need for research to fill in areas where omissions have been noted, for new approaches to the design of CAI materials, and for increased involvement in the production of software by qualified educators.

1.1 Surveys of Research on CAI

Several studies have been done in the past fifteen years measuring the effectiveness of CAI. Our consideration of the results of these studies will be vis-a-vis several surveys which are widely recognized in the field. These are Vinsonhaler and Bass (1972), Jamison, Suppes, and Wells (1974), Edwards, Norton, Taylor, Weiss, and Dusseldorp (1975), and Kulik, Kulik, and Cohen (1980). A fifth literature review, Kearsley and Seidel (1983) has appeared only in its first installment. There follows a discussion of these surveys as they relate to this thesis.

In spite of the fact that "findings of no significant difference dominate the research literature in this area," (Jamison et al., 1974:56), and that conclusive assessment is therefore somewhat tenuous, the surveys mentioned above tend toward the conclusion that CAI is equal to or better than instruction with traditional media (traditional media being in general programmed instruction, lectures, exercises commonly found in textbooks, filmstrips, and the like). There is a much stronger indication that this parity is maintained with striking reductions in time needed for instruction. These surveys also in general note moderately favorable student attitudes toward computers. However, Edwards et al. (1975) found that gains in achievement and in time were offset (in more cases than not) by loss in retention.

1.1.1 Omissions in the Research to Date

There are many omissions in the studies surveyed above. For one thing, the great majority of the studies were done at the elementary or secondary level. Kulik et al. (1980), the only one of these surveys which concentrated on studies done at the college level, were able to find only 59 such studies which met certain research criteria (e.g. utilized controls, used actual classroom settings, etc.). They found that in achievement, "a clear majority of studies favored CBI" (p. 534), and that "there appears to be little doubt

that students can be taught with computers in less time than with conventional methods of college teaching . . . on the average in about two-thirds the time . . ." (pp. 537-8).

Another omission is lack of attention to cognitive and affective variables in almost all studies in CAI done to date. Jamison et al. (1974:53) note that research into cognitive and affective states will "certainly be a major focus of investigations in the next few years." However, Boettcher et al. (1981:13), in examining the possibility "that learning outcomes are influenced not only by the mode of instruction but by the level of the cognitive category addressed in the lessons," find only two other studies specifically addressing this issue with regard to CAI. This is a crucial omission in the research in light of the assertion, to be made later, that CAI is an appropriate vehicle for cognitively based approaches to teaching.

There are also omissions in the research concerning certain experimental settings. Kulik et al. (1980:530) point out that over a third of the studies they surveyed were tutorials (the other categories being management, simulation, and programming) which encompassed entire courses of study and sought to replace a teacher (as opposed to those that supplemented learning in isolated units). No studies whatsoever had been done at the college level using CAI lessons that were stand-alone units (i.e. not part of a

larger course of study) and which were meant to supplement work done in class. Only 8 of the 59 studies surveyed were stand-alone units meant to replace a teacher, and only 3 of these were tutorials. None of these 8 studies dealt with language. The most recent study in the Kulik et al. survey was dated 1978; therefore, up to that time, there had apparently been no research on the effects of stand-alone CALL lessons at the college level at all. It is doubtful whether the gap has since been filled with a substantial body of research.

A final omission in the research in the field of CAI is an examination of variables within CAI lessons themselves. Jamison et al. (1974) cite only two studies, one in PI and the other in CAI, comparing variables within separate lessons. Boettcher et al. (1981) claim their work to be unique because it goes so far as to compare a PI lesson with a CAI lesson whose contents were essentially the same (the independent variable being PI vs. CAI; incidentally, there was no significant difference in results). Kearsley and Seidel (1983) single out individualized instruction and the effects of graphics, speech, animation, and humor in CAI as areas about which we know little. There are of course many more such areas in which little or no research has been done, one of them being choice and control, the subject of the present thesis.

1.1.2 Problems with Qualitative Measurement of CAI

In spite of isolated strong findings favoring the use of CAI as a medium of instruction (Kulick et al., 1980:538), research done to date has been largely inconclusive, and this casts some doubt as to whether gains made with CAI are worth the commitment of resources necessary for its implementation. However, whether conventional research is able to measure the true benefits of CAI is itself doubtful. Molnar (1979:15) notes that at a recent HumRRO conference, it was decided that "conventional approaches to research and development are generally inappropriate if one wants to foster innovation." Hammond (1972:1003) illustrates the dichotomous nature of the problem with conventional research by referring to the cognitively based research of Papert at one extreme and the drill and practice projects of Suppes at the other. Hammond notes that the results of the former are difficult to quantify, while the results of the latter do not seem to measure any better than conscientious drill by a teacher. Hawkins (1979) discusses differences in qualitative and quantitative measurements of CAI and finds, in critiquing an example of each, that neither is particularly revealing.

Smith and Sherwood (1976:351) have the following to say about the difficulty of evaluating PLATO on a quantitative basis:

> It is particularly difficult to measure the value of the direct instruction provided by PLATO since there is an enormous number of variables involved. It is also difficult to make a direct comparison with other teaching methods, partly because little quantitative data exist of the effectiveness of traditional teaching methods and, also, because some components of a PLATO-based course do not exist in traditional courses (one-to-one dialogues and simulations of physical phenomena, among others).

Marty (1981:30) compares the difficulty of evaluating CAI with the difficulty of evaluating the effectiveness of a library; just as it should be obvious that libraries are effective, it is "equally obvious that providing students WHO WANT TO LEARN with a tool which gives them detailed, individual feedback can help them learn more efficiently." However, Marty suggests that it is not possible to measure such gains quantitatively. This is because, in Marty's view, CAI is effective only with students who want to use it.

> Students who voluntarily use the computerized materials do so because they believe that they will get a better grade and/or save time. It would be useful to PROVE that those gains do actually take place, but at the present time it is practically impossible to compare two groups of students who would be perfectly matched and who would be working under identical conditions except for the fact that a group would be in a school where it would have VOLUNTARY access to computerized materials and the other would be in a school without such materials; I believe that this is the only kind of experiment which would be objective since forcing students to use a method of learning which they dislike affects their performance negatively. (p. 40)

Hence, there is a strong case for there not really being an adequate means of evaluating CAI. This is an important point to keep in mind, as it poses a limitation on the present study and shadows the research already conducted in the field. In addition, there is reason to believe that the wrong variables are being evaluated. This has prompted Jamison et al. (1974:59) to conclude their survey with the speculation: "It is at least plausible that many of the conclusions of this survey would be overturned were more imaginative uses of the media explored."

1.2 Current Educational Thinking vs. Drill and Practice Programming

CAI lends itself to highly interactive and aesthetically pleasing instructional materials. This has allowed educators to use computers to embellish traditional mechanical and meaningful drills (Paulston, 1971). It is also suggested that CAI complements recent emphasis on cognitive approaches to teaching (e.g., that of Anderson and Ausubel, 1965). However, attempts have only recently been made to apply new developments in educational theory to implementations of CAI, following an increasing disillusionment with drill and practice, which has until recently been the major focus of CAI.

Drill and practice techniques in CAI run parallel to the pattern practice (Fries, 1945) approach to language

teaching which is in turn an offshoot of behaviorist learning theory, especially that espoused by Skinner (1954), who expanded and improved on Pressey's grading machine of 1924 (Rivers, 1981:111-2; Frenzel, 1980). Then again, CAI can be considered as an extension of programmed instruction, and it was once believed that its sole advantage was that it sped up the process of programmed instruction (Lewis, 1981).

More recently, doubts about drill and practice have surfaced frequently in the literature on CAI, just as doubts have surfaced about the role of pattern practice and mim-mem techniques in language instruction (since Rivers, 1964). Howe and Du Boulay (1979) assert that drill and practice is a misuse of computers, is at odds with current teaching methodologies, and in effect turns the clock back to a previous era in education. Papert (1980b:240) argues that computers are being used now to "reinforce instead of displace the most ritualistic teaching methods." Finally, Scollon and Scollon (1982) suggest that drill and practice is based on an instructional paradigm which is inappropriate as a paradigm for use with computers.

1.3 Computers as Proving Grounds for Current Thinking in Education

It is often suggested that computers are more commensurate with current ideas in language learning than they are with the Skinner-based theories of drill and

practice. Jorstad (1980) discusses several areas of recently updated knowledge of language instruction (she mentions, among others, individual learning styles and affective variables in language learning) that can be utilized in CAI to enable teachers to enhance their output. Lewis (1981:47) notes that emphasis in education has shifted toward promoting "a deeper understanding" (as opposed to regurgitation) of factual knowledge. That "this can best be accomplished by increased student participation in learning" encourages use of CAI. Along the same lines, Otto (1980:61) notes that modern society has undergone "transformations in the area of learning styles that are highly compatible with CAI."

Bork (1981:4) makes the claim that, although there are "wide differences between theoretical approaches to learning, most learning theorists would agree on several persistent ideas. Two such ideas are that learning is best when the student plays an active role in the learning process and that different individuals learn in different ways along a variety of dimensions." Bork cites in particular the Piagetian and "human information processing" schools of learning theory as being central to these concepts, but his ideas concur with Moore and Anderson's (1969) assertions that the learner be allowed not only the agent perspective in learning, but that he be allowed to shift roles according to his changing moods. Bork goes on to discuss how computers

can facilitate this kind of learning (and we will examine Moore and Anderson's assertions momentarily).

Thus it is felt that computers offer an opportunity for educators to put into practice certain recent theories applicable to learning. However, this is true only to the degree that educational paradigms in current use are revised to utilize the medium to take advantage of its unique characteristics. Although drill and practice is appropriate for certain learning tasks, as is pattern practice, drill and practice is probably overused and does not appear to be an optimal application of CAI in many educational situations.

1.4 In Search of Revised Paradigms for Education

Dissatisfaction with drill and practice is actually symptomatic of the larger issue of unsuitability of existing educational paradigms for development of CAI. The educational environment that present day educators were brought up in (and in which they are accustomed to functioning) is not one that is necessarily appropriate for work with computers. According to this line of reasoning, the proliferation of computers will lead to considerable changes in where and how learning is conceived and takes place. Those developing CAI materials must anticipate, and even help to formulate, these changes.

Although there are many calls in the literature for revision of existing paradigms of instructional design, very

few suggestions are found regarding the nature of the proposed paradigms. Hence DeBloois's (1979) comparison of "current instructional design model assumptions" with "probable new instructional design model assumptions" is of interest. DeBloois notes eight differences between the old and new. For example, he suggests that "mosaic/multi-dimensional . . . development of materials and strategies" will replace linear development. Rowe (1983) has similarly novel thoughts on this matter, suggesting, partly in jest, a paradigm he calls CEGOLLE, or computer-enhanced game-optimized language learning experience.

1.5 The Nature of Computing

In order to see what paradigms will best fit educational computing we first have to get at the nature of the beast. This can in turn be divided into the oft-cited advantages and disadvantages of using computers (that is, the visible and concrete parts of the beast) and the more abstract nature of what goes on when people interact with computers (or the heart and soul of the beast.) This latter issue will be dealt with here in conjunction with a discussion of paradigms for education in which educational computing might most productively take place. Let us now set about examining the nature of computing according to these distinctions.

1.5.1 Advantages of CAI

Many writers have sought to characterize the advantages of using CAI. Herriott (1982) lists some of the advantages of CAI as being the ability of computers to (1) teach on a one to one basis with a high success rate, (2) provide imbedded remedial instruction, often unbeknownst to students, (3) provide "enrichment material", and (4) allow for self-pacing. Thé (1982:50) says that some of the obvious advantages of CAI are the ability of the computer to allow immediate feedback, correction without criticism, student control over and interest in learning, and the ability to do all of this with "the patience only the truly mindless can achieve."

Peelle (1982) discusses some advantages and limitations of CAI in training programs. Among the advantages:

(1) Interaction with computers is dynamic and active and engages the learner "cognitively, visually, physically, and soon, auditorially."

(2) Instruction can be self-paced and under the control of the learner, and progress can be measured against well established criteria.

(3) "Learning is low risk" insofar as "mistakes are a matter between the individual and the computer."

(4) A training program can be offered "coherently and consistently, which can be especially helpful if you have a

need for standardized content and quality of instruction." Quality of training is not affected by shortages of or waning enthusiasm in instructors and can be precise, cost-effective, fast, and efficient.

However, the above observations simply note manifestations of what may be deeper considerations in using computers, and it is these deeper considerations that research in educational computing should deal with at this stage of CAI development. Computers are devices whose complexity is capable of challenging the human mind to a greater degree than has any device so far conceived by man. Yet by virtue of being, as Thé said, "mindless", they are also capable of ad nauseum inanity. Their value in education therefore depends on the degree to which the programmer is able to disguise the mindlessness of the computer and to capitalize on the learner's perception that he is interacting with a higher-order intellect. In doing this, the successful CAI programmer should be cognizant of various paradigms for education in which these "higher-order" capabilities might function.

1.5.2 Clarifying Educational Environments

Moore and Anderson (1969) specify four perspectives from which the learner may undergo his own education: agent, patient, reciprocator, and referee. They find that a major fault with most educational models is that they allow the

learner to participate in education from only one of four perspectives, usually from the patient perspective. A patient has no control over events which happen to him. In contrast, the agent is the perpetrator of the event, the reciprocator the one who reacts to another's transactions, and the referee an objective judge of transactions in an event. CAI is inherently a medium in which the learner can alternate between being a patient accepting and assimilating information, an agent causing certain events to happen, and a reciprocator reacting to stimuli from the computer. There may also be situations in which the learner can take a referee perspective.

Perspectives on learning are one aspect of what Moore and Anderson call "clarifying educational environments," which they propose as "fundamentally dynamic" models for education to prepare people for the likelihood of having to learn more than one trade throughout the course of their lifetimes. They submit (p. 60) that learning is "more rapid and deeper" when the learner can employ as many of the four perspectives as possible, and also that "an environment will be more powerful from a learning standpoint if it lets him start off with whatever perspective he brings to it, and then allows him to shift at will." The experimental CAI lesson, allowing as it did choice and control, was designed so that just this sort of shifting of perspective would be possible.